

- 1 **a** $\log_{10} 1000 = 3$ **b** $\log_3 81 = 4$ **c** $\log_2 256 = 8$ **d** $\log_7 1 = 0$
 e $\log_3 \frac{1}{27} = -3$ **f** $\log_{32} \frac{1}{2} = -\frac{1}{5}$ **g** $\log_{19} 19 = 1$ **h** $\log_{36} 216 = \frac{3}{2}$
- 2 **a** $5^3 = 125$ **b** $2^4 = 16$ **c** $10^5 = 100\,000$ **d** $23^0 = 1$
 e $9^{\frac{1}{2}} = 3$ **f** $10^{-2} = 0.01$ **g** $2^{-3} = \frac{1}{8}$ **h** $6^1 = 6$
- 3 **a** $= \log_7 7^2$
 $= 2$ **b** $= \log_4 4^3$
 $= 3$ **c** $= \log_2 2^7$
 $= 7$ **d** $= \log_3 3^3$
 $= 3$
 e $= \log_5 5^4$
 $= 4$ **f** $= \log_8 8^1$
 $= 1$ **g** $= \log_7 7^0$
 $= 0$ **h** $= \log_{15} 15^{-1}$
 $= -1$
 i $= \log_3 3^{-2}$
 $= -2$ **j** $= \lg 10^{-3}$
 $= -3$ **k** $= \log_{16} 16^{\frac{1}{4}}$
 $= \frac{1}{4}$ **l** $= \log_4 4^{\frac{3}{2}}$
 $= \frac{3}{2}$
 m $= \log_9 9^{\frac{5}{2}}$
 $= \frac{5}{2}$ **n** $= \log_{100} 100^{-\frac{3}{2}}$
 $= -\frac{3}{2}$ **o** $= \log_{25} 25^{\frac{3}{2}}$
 $= \frac{3}{2}$ **p** $= \log_{27} 27^{-\frac{2}{3}}$
 $= -\frac{2}{3}$
- 4 **a** $5^x = 25$
 $x = 2$ **b** $2^6 = x$
 $x = 64$ **c** $x^3 = 64$
 $x = 4$ **d** $10^{-3} = x$
 $x = \frac{1}{1000}$
 e $x^{\frac{2}{3}} = 16$
 $x = 64$ **f** $5^x = 1$
 $x = 0$ **g** $x^1 = 9$
 $x = 9$ **h** $10^x = 10^{12}$
 $x = 12$
 i $\log_x 7 = \frac{1}{2}$
 $x^{\frac{1}{2}} = 7$
 $x = 49$ **j** $4^{1.5} = x$
 $x = 8$ **k** $x^{-\frac{1}{3}} = 0.1$
 $x = 1000$ **l** $\log_8 x = -\frac{1}{3}$
 $8^{-\frac{1}{3}} = x$
 $x = \frac{1}{2}$
- 5 **a** $= \log_a (4 \times 7)$
 $= \log_a 28$ **b** $= \log_a (10 \div 5)$
 $= \log_a 2$ **c** $= \log_a 6^2$
 $= \log_a 36$
 d $= \log_a (9 \div \frac{1}{3})$
 $= \log_a 27$ **e** $= \log_a 25^{\frac{1}{2}} + \log_a 3^2$
 $= \log_a 5 + \log_a 9$
 $= \log_a (5 \times 9)$
 $= \log_a 45$ **f** $= \log_a 48 - \log_a 2^3 - \log_a 9^{\frac{1}{2}}$
 $= \log_a 48 - \log_a 8 - \log_a 3$
 $= \log_a [48 \div (8 \times 3)]$
 $= \log_a 2$
- 6 **a** $= 5 \log_q x$ **b** $= \frac{15}{2} \log_q x$ **c** $= \log_q x^{-1}$
 $= -\log_q x$ **d** $= \log_q x^{\frac{1}{3}}$
 $= \frac{1}{3} \log_q x$
 e $= 4 \log_q x^{-\frac{1}{2}}$
 $= -2 \log_q x$ **f** $= 2 \log_q x + 5 \log_q x$
 $= 7 \log_q x$ **g** $= \log_q x^{-2} + \log_q x^{-3}$
 $= -2 \log_q x - 3 \log_q x$
 $= -5 \log_q x$ **h** $= 6 \log_q x - 2 \log_q x$
 $= 4 \log_q x$

$$7 \quad \begin{array}{llll} \mathbf{a} & = \lg(5 \times 4) & \mathbf{b} & = \lg(12 \div 6) & \mathbf{c} & = \lg 2^3 & \mathbf{d} & = \lg 3^4 - \lg 9 \\ & = \lg 20 & & = \lg 2 & & = \lg 8 & & = \lg 81 - \lg 9 \\ & & & & & & & = \lg(81 \div 9) \\ & & & & & & & = \lg 9 \end{array}$$

$$\begin{array}{llll} \mathbf{e} & = \lg 16^{\frac{1}{2}} - \lg 32^{\frac{1}{5}} & \mathbf{f} & = \lg 10 + \lg 11 & \mathbf{g} & = \lg \frac{1}{50} + \lg 10^2 & \mathbf{h} & = \lg 10^3 - \lg 40 \\ & = \lg 4 - \lg 2 & & = \lg(10 \times 11) & & = \lg \frac{1}{50} + \lg 100 & & = \lg 1000 - \lg 40 \\ & = \lg(4 \div 2) & & = \lg 110 & & = \lg(\frac{1}{50} \times 100) & & = \lg(1000 \div 40) \\ & = \lg 2 & & & & = \lg 2 & & = \lg 25 \end{array}$$

$$8 \quad \begin{array}{lll} \mathbf{a} & = \log_3(54 \div 2) & \mathbf{b} & = \log_5(20 \times 1.25) & \mathbf{c} & = \log_2 2^4 + \log_3 3^3 \\ & = \log_3 27 & & = \log_5 25 & & = 4 + 3 \\ & = \log_3 3^3 & & = \log_5 5^2 & & = 7 \\ & = 3 & & = 2 & & \end{array}$$

$$\begin{array}{lll} \mathbf{d} & = \log_6(24 \times 9) & \mathbf{e} & = \log_3(12 \div 4) & \mathbf{f} & = \log_4(18 \div 9) \\ & = \log_6 216 & & = \log_3 3 & & = \log_4 2 \\ & = \log_6 6^3 & & = 1 & & = \log_4 4^{\frac{1}{2}} \\ & = 3 & & & & = \frac{1}{2} \end{array}$$

$$\begin{array}{lll} \mathbf{g} & = \log_9(4 \times 0.25) & \mathbf{h} & = \lg 2^2 + \lg 25 & \mathbf{i} & = \log_3 8^{\frac{1}{3}} - \log_3 18 \\ & = \log_9 1 & & = \lg 4 + \lg 25 & & = \log_3 2 - \log_3 18 \\ & = 0 & & = \lg(4 \times 25) & & = \log_3(2 \div 18) \\ & & & = \lg 100 & & = \log_3 \frac{1}{9} \\ & & & = \lg 10^2 & & = \log_3 3^{-2} \\ & & & = 2 & & = -2 \end{array}$$

$$\begin{array}{lll} \mathbf{j} & = \log_4 64^{\frac{1}{3}} + (2 \times \log_5 5^2) & \mathbf{k} & = \frac{1}{2} \log_5 \frac{25}{16} + \log_5 10^2 & \mathbf{l} & = \log_3 5 - \log_3 6^2 - \log_3 \frac{15}{4} \\ & = \log_4 4 + (2 \times 2) & & = \log_5 \left(\frac{25}{16}\right)^{\frac{1}{2}} + \log_5 100 & & = \log_3 [5 \div (36 \times \frac{15}{4})] \\ & = 1 + 4 & & = \log_5 \frac{5}{4} + \log_5 100 & & = \log_3 \frac{1}{27} \\ & = 5 & & = \log_5 \left(\frac{5}{4} \times 100\right) & & = \log_3 3^{-3} \\ & & & = \log_5 125 & & = -3 \\ & & & = \log_5 5^3 & & \\ & & & = 3 & & \end{array}$$