1 **a** **i** $= 4^0 = 1$ **ii** $= 4^{0.5} = 2$ **iii** $= 4^1 = 4$ **iv** $= 4^{1.5} = 8$

b 16 f(x) doubles with each increase of 5 in the value of x

c $= 2 \times 5.278 = 10.556$

2 **a** N doubles with each increase of 18 in t $\therefore N = 2 \times 30 = 60$

b $480 = 8 \times 60 = 2^3 \times 60$ $\therefore t = 36 + (3 \times 18) = 90$

3 **a** the value of P is divided by 3 with each increase of 4 in t

$2 = \frac{1}{9} \times 18 = (\frac{1}{3})^2 \times 18$ $\therefore t = 20 + (2 \times 4) = 28$

b $16 = 4 \times 4$ $\therefore P = 54 \times 3^4 = 4374$

4 **a** $t = 10$, $N = 50e^{-2} = 6.77$ (3sf)

b $3 = 50e^{-0.2t}$

$t = -5 \ln \frac{3}{50} = 14.1$ (3sf)

5 **a** $160 = 240e^{180k}$

$k = \frac{1}{180} \ln \frac{2}{3} = -0.00225$ (3sf)

b $m = 240e^{-0.002253t}$

$120 = 240e^{-0.002253t}$

$t = \frac{-1}{0.002253} \ln \frac{1}{2} = 308$ years (3sf)

6 **a** $t = 0$, $m = m_0$

$\therefore t = 410$, $m = \frac{1}{2} m_0$

$\therefore \frac{1}{2} m_0 = m_0 e^{410k}$

$410k = \ln \frac{1}{2}$

$k = \ln \frac{1}{2} \div 410 = -0.00169$ (3sf)

b $m = m_0 e^{-0.001691t}$

$388 = m_0 e^{(-0.001691 \times 150)}$

$m_0 = 388 \div e^{-0.2536} = 500$ (3sf)

7 **a** when t increases by 10, N is reduced to $\frac{225}{300} = \frac{3}{4}$ of previous value

$\therefore$ when $t = 0$, $N_0 = \frac{4}{3} \times 300 = 400$

b $t = 10$, $N = 300$ $\therefore 300 = 400e^{10k}$

$k = \frac{1}{10} \ln \frac{3}{4} = -0.0288$ (3sf)

c $N = 400e^{-0.02877t}$

$150 = 400e^{-0.02877t}$

$t = \frac{-1}{0.02877} \ln \frac{3}{8} = 34.1$ (3sf)