Exponentials and logarithms 14H

1 a When $S = 4 \times 7^x$
$\log S = \log (4 \times 7^x)$
$\log S = \log 4 + \log 7^x$
$\log S = \log 4 + x \log 7$

b $\log S = x \log 7 + \log 4$
Gradient = $\log 7$
Intercept = $\log 4$

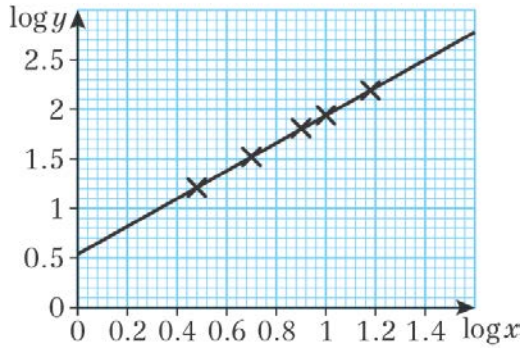
2 a When $A = 6x^4$
$\log A = \log (6x^4)$
$\log A = \log 6 + \log x^4$
$\log A = \log 6 + 4 \log x$

b $\log A = 4 \log x + \log 6$
Gradient = 4
Intercept = $\log 6$

3 a

$\log x$	0.48	0.70	0.90	1	1.18
$\log y$	1.21	1.52	1.81	1.94	2.19

b



c $y = ax^n$
$\log y = \log (ax^n)$
$\log y = \log a + \log x^n$
$\log y = \log a + n \log x$
$\log y = n \log x + \log a$
Gradient = n
Intercept = $\log a$
Calculating the gradient from the table,

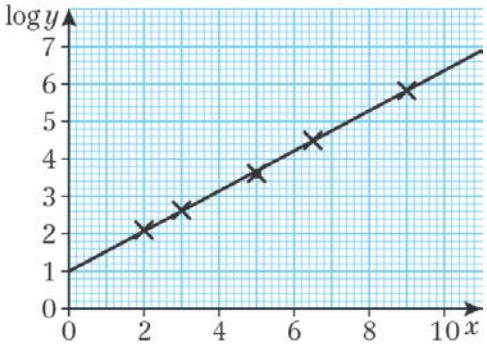
$$n = \frac{2.19 - 1.21}{1.18 - 0.48} = \frac{0.98}{0.7} = 1.4$$

Reading the intercept from the graph,
$\log a = 0.55$
$a = 10^{0.55} = 3.548...$
$a = 3.5$, $n = 1.4$

4 a

x	2	3	5	6.5	9
$\log y$	2.10	2.63	3.61	4.49	5.82

b



c $y = ab^x$
$\log y = \log (ab^x)$
$\log y = \log a + \log b^x$
$\log y = \log a + x \log b$
$\log y = x \log b + \log a$
Gradient = $\log b$
Intercept = $\log a$
Calculating the gradient from the table and the graph,

$$\log b = \frac{5.82 - 1}{9 - 0} = \frac{4.82}{9} = 0.53555...$$

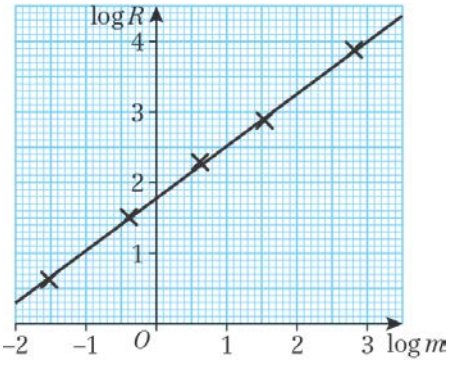
$$b = 10^{0.53555...} = 3.43...$$

Reading the intercept from the graph,
$\log a = 1$
$a = 10^1 = 10$
$a = 10$, $b = 3.4$

5 a

$\log m$	−1.52	−0.39	0.62	1.54	2.81
$\log R$	0.62	1.51	2.29	2.88	3.88

b



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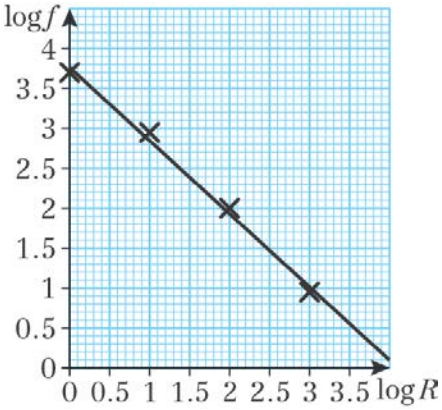
5 c $R = am^b$
$\log R = \log (am^b)$
$\log R = \log a + \log m^b$
$\log R = \log a + b \log m$
Gradient = b
Intercept = $\log a$
Calculating the gradient from the table,
$b = \dfrac{3.88 - 0.62}{2.81 - (-1.52)} = \dfrac{3.26}{4.33} = 0.75288...$
Reading the intercept from the graph,
$\log a = 1.78$
$a = 10^{1.78} = 60.255...$
$a = 60$, $b = 0.75$

d $R = 60m^{0.75}$
When $m = 80$
$R = 60(80)^{0.75} = 1604.97...$
1605 kcal/day

6 a

$\log R$	0	1	2	3
$\log f$	3.69	2.94	1.96	0.95

b



c $f = AR^b$
$\log f = \log (AR^b)$
$\log f = \log A + \log R^b$
$\log f = \log A + b \log R$
$\log y = b \log R + \log A$
Gradient = b
Intercept = $\log A$
Calculating the gradient from the table,
$b = \dfrac{0.95 - 3.69}{3 - 0} = \dfrac{-2.74}{3} = -0.91...$
Reading the intercept from the graph,
$\log A = 3.76$
$A = 10^{3.76} = 5754.39...$
$A = 5800$, $b = -0.9$

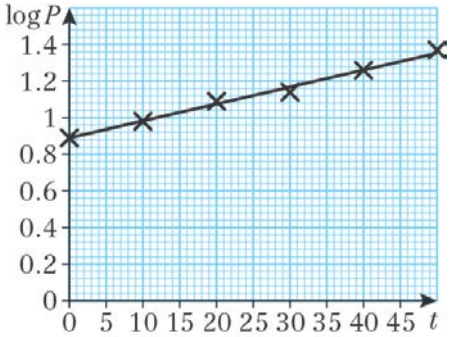
6 d $f = 5800R^{-0.9}$ per 100 000 words
When $R = 57$
$f = 152.45...$
For 455 125 words, $4.55125 \times f = 693.85...$
694 times

7 a

t	0	10	20	30	40	50
$\log P$	0.88	0.98	1.08	1.13	1.26	1.37

b When $P = ab^t$
$\log P = \log (ab^t)$
$\log P = \log a + \log b^t$
$\log P = \log a + t \log b$

c



d Gradient = $\log b$
Intercept = $\log a$
Calculating the gradient from the table,
$\log b = \dfrac{1.37 - 0.88}{50 - 0} = \dfrac{0.49}{50} = 0.0098$
$b = 10^{0.0098} = 1.0228...$
Reading the intercept from the graph,
$\log a = 0.88$
$a = 10^{0.88} = 7.5857...$
$a = 7.59$, $b = 1.03$

e The rate of growth is often proportional to the size of the population

8 a $N = ab^t$
$\log N = \log (ab^t)$
$\log N = \log a + \log b^t$
$\log N = \log a + t \log b$
Gradient = $\dfrac{2.55 - 1.6}{10 - 0} = \dfrac{0.95}{10} = 0.095$
Intercept = 1.6
$\log N = 0.095t + 1.6$

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8 b $\log a = 1.6$
$a = 10^{1.6} = 39.8...$
$\log b = 0.095$
$b = 10^{0.095} = 1.2445...$
$a = 40$, $b = 1.2$

c a is the initial number of sick people

d $N = ab^t$
$N = 40(1.2)^{30} = 9495.052 = 9500$ (2 s.f.)
After 30 days people may start to recover, or the disease may stop spreading as quickly.

9 a $A = pw^q$
$\log A = m \log w + c$
Intercept $= -0.1049$
Gradient $= 2$
$\log A = 2 \log w - 0.1049$

b $A = pw^q$
$\log A = \log (pw^q)$
$\log A = \log p + \log w^q$
$\log A = \log p + q \log w$
Equating coefficients
$q = 2$
$\log p = -0.1049$
$p = 10^{-0.1049}$
$p = 0.785416...$

c The shapes are circles.
Multiply p by 4
$4p = 3.1416... \approx \pi$
So p is approximately $\frac{1}{4}$ of π

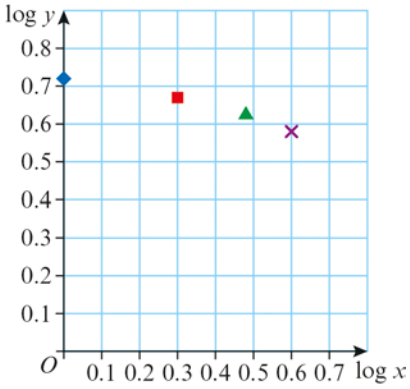
So $A = \frac{\pi}{4} w^2$

The width is the diameter of the circle

so $A = \frac{\pi}{4}(2r)^2 = \pi r^2$

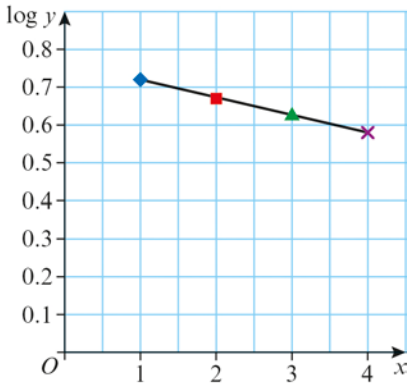
Challenge

$\log x$	0	0.30	0.48	0.60
$\log y$	0.72	0.67	0.63	0.58



The relationship between $\log x$ and $\log y$ is not linear so the relationship is perhaps $y = ax^n$

x	1	2	3	4
$\log y$	0.72	0.67	0.63	0.58



The second graph, $\log y$ against x, is a linear relationship so the relationship is of the form $y = ab^x$.
$\log y = \log (ab^x)$
$\log y = \log a + \log b^x$
$\log y = \log a + x \log b$
Intercept $= 0.75$
$\log a = 0.75$
$a = 10^{0.75} = 5.8$

$$\text{Gradient} = \frac{0.58 - 0.72}{4 - 1} = -\frac{0.14}{3} = -0.04666...$$

$\log b = -0.04666...$
$b = 10^{-0.04666...}$
$= 0.90$

So the formula is $y = 5.8 \times 0.9^x$

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