Section 3: Modelling curves

Solutions to Exercise level 1

1. (i) $s = at^c$

Taking logarithms of both sides: $\log s = \log(at^c)$

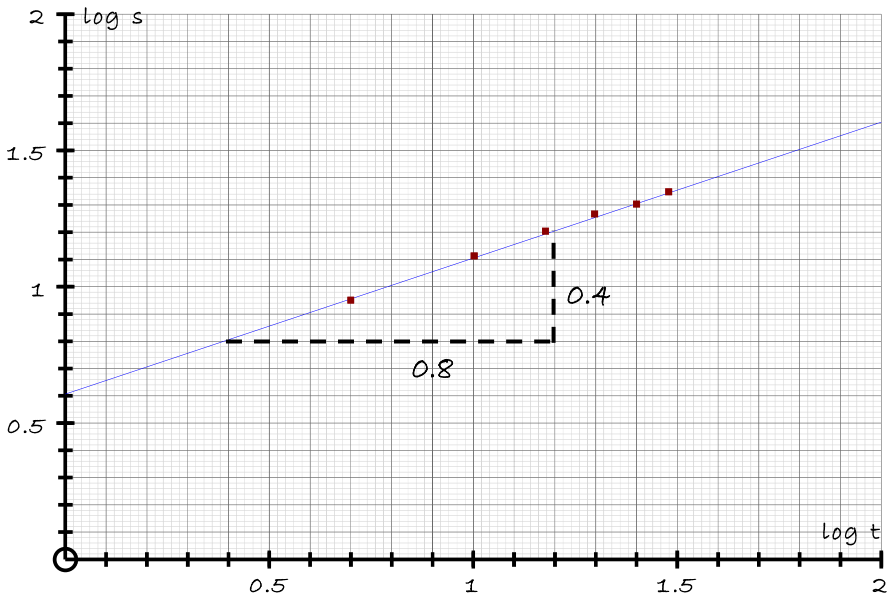
$= \log a + \log t^c$

$= \log a + c\log t$

(ii) Since log a and c are constants, the equation $\log s = \log a + c\log t$ is the equation of a straight line, in which the variables are log t and log s, and which has gradient c and intercept log a. So if the model is appropriate, plotting log s against log t will give an approximate straight line.

(iii)

s	9	13	16	18	20	22
t	5	10	15	20	25	30
log s	0.95	1.11	1.20	1.26	1.30	1.34
log t	0.70	1	1.18	1.30	1.40	1.48



Equation of graph is $\log s = \log a + c\log t$

Gradient $= \dfrac{0.4}{0.8} = 0.5$, so $c = 0.5$

Intercept = 0.6, so $\log a = 0.6 \quad \Rightarrow a = 10^{0.6} \approx 4$.

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2\. (i) $b = mn^a$

$\ln b = \ln(mn^a)$

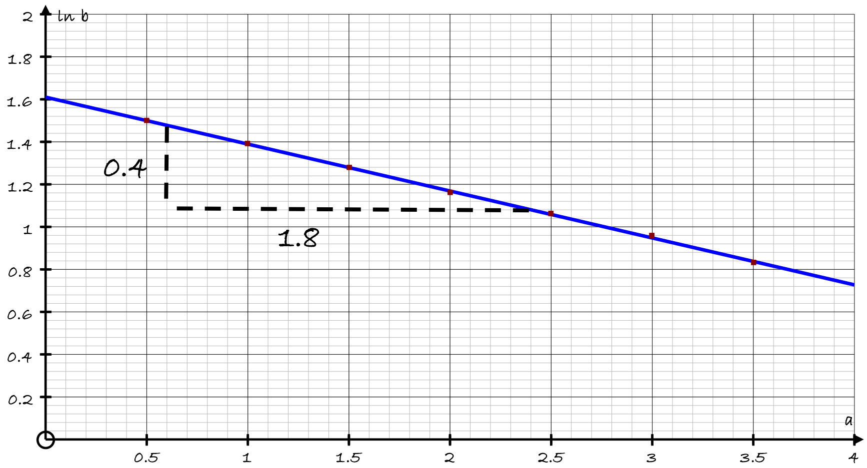
$= \ln m + \ln n^a$

$= \ln m + a \ln n$

(ii) The equation $\ln b = \ln m + a \ln n$ is the equation of a straight line, in which the variables are ln b and a, and which has gradient ln n and intercept ln m. So if the model is appropriate, then plotting ln b against a will give an approximate straight line graph.

(iii)

a	0.5	1.0	1.5	2.0	2.5	3.0	3.5
b	4.5	4.0	3.6	3.2	2.9	2.6	2.3
ln b	1.50	1.39	1.28	1.16	1.06	0.96	0.83



Equation of graph is $\ln b = \ln m + a \ln n$

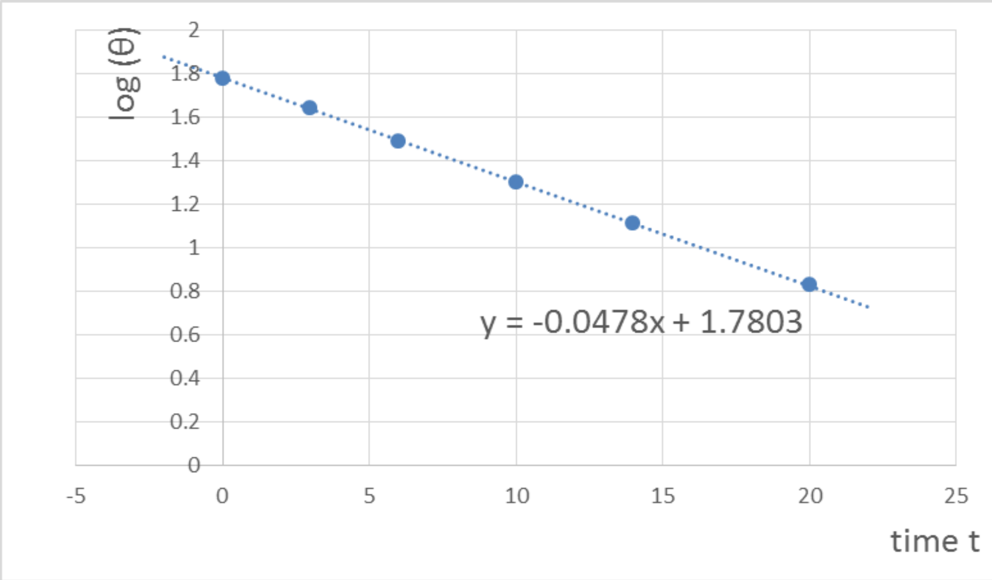
Gradient $= -\dfrac{0.4}{1.8} = -0.22$, so $\ln n = -0.22 \quad \Rightarrow n = e^{-0.22} \approx 0.8$

Intercept $= 1.6$, so $\ln m = 1.6 \quad \Rightarrow m = e^{1.6} \approx 5$

3\. (i)

t minutes	0	3	6	10	14	20
θ °C	60	44.1	30.9	19.9	12.9	6.7
log(θ)	1.778151	1.644439	1.489958	1.298853	1.11059	0.826075

so the graph of log θ against t is:



(ii) The equation of the graph is $\log\theta = -t\log a + \log k$

Gradient $\approx -0.0478 = -\log a \Rightarrow a \approx 1.116$

Intercept $\approx 1.7803 = \log k \Rightarrow k \approx 60.3$

so the law is $\theta \approx 60.3 \times 1.116^{-t}$