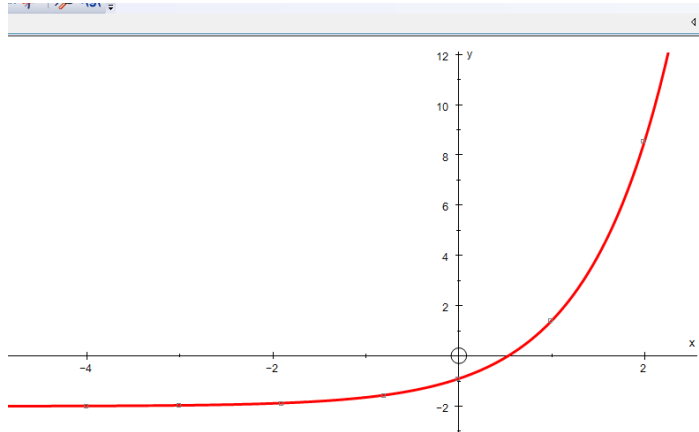


Section 3: Modelling curves

Solutions to Exercise level 3

1. (i)

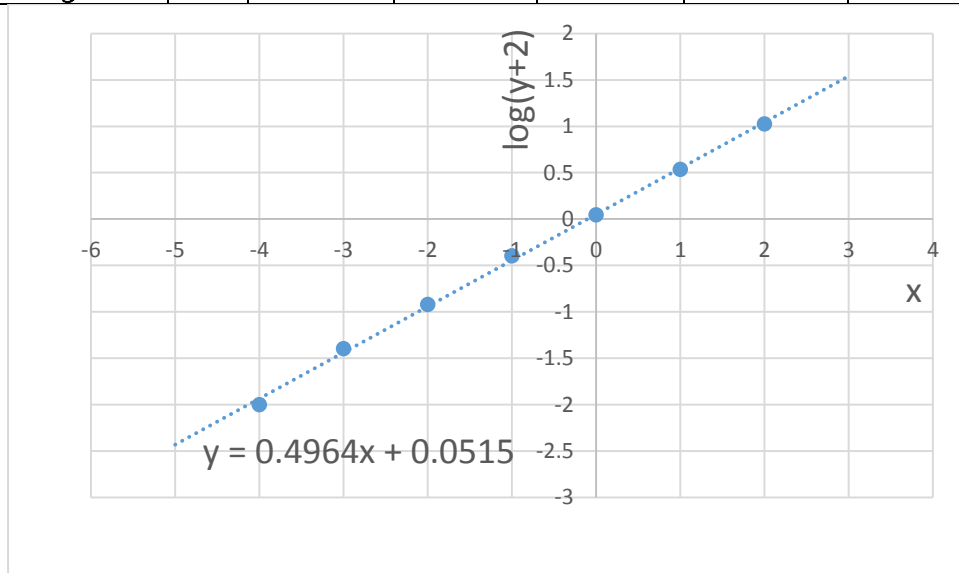


The graph suggests $C = -2$, so the rule is of the form $y = -2 + ak^x$

(ii) use $(y + 2) = ak^x$
 $\Rightarrow \log(y + 2) = x \log k + \log a$
 so plot $\log(y + 2)$ against x

(iii)

x	-4	-3	-2	-1	0	1	2
$\log(y+2)$	-2	-1.39794	-0.92082	-0.39794	0.045323	0.532754	1.024075



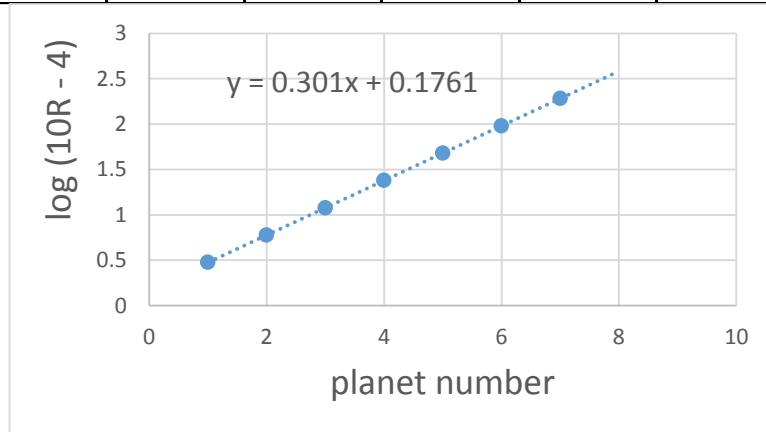
(iv) Gradient $\approx 0.4964 = \log k \Rightarrow k \approx 3.136$
 Intercept $\approx 0.0515 = \log a \Rightarrow a \approx 1.129$
 so law is $y + 2 \approx 1.129 \times 3.136^x$
 $\Rightarrow y \approx 1.129 \times 3.136^x - 2$

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2. (i) $R = \frac{1}{10}(ab^n + 4) \Rightarrow 10R - 4 = ab^n$
 $\Rightarrow \log(10R - 4) = n \log b + \log a$
 so plot $\log(10R - 4)$ against n .

(ii)

n	1	2	3	4	5	6	7
$\log(10R - 4)$	0.477121	0.778151	1.079181	1.380211	1.681241	1.982271	2.283301



gradient $\approx 0.301 = \log b \Rightarrow b \approx 2.00$
 Intercept $\approx 0.1761 = \log a \Rightarrow a \approx 1.500$
 so Bode's law is $R = \frac{1}{10}(1.5 \times 2^n + 4)$

(ii) $n = 0 \Rightarrow R_0 \approx 0.55$
 $n = 8 \Rightarrow R_0 \approx 38.8$
 $n = 9 \Rightarrow R_0 \approx 77.22$
 so the complete table is

Planet	n	Bode's Law (AU)	True (AU)
Mercury	0	0.4	0.39
Venus	1	0.7	0.72
Earth	2	1	1
Mars	4	1.6	1.52
Ceres	8	2.8	2.77
Jupiter	16	5.2	5.2
Saturn	32	10	9.54
Uranus	64	19.6	19.2
Neptune	128	38.8	30.06
Pluto	256	77.22	39.44

Bode's Law does not seem useful as it seems to fit only the 'planets' known at the time of its invention.

[In fact, there is no known scientific justification for Bode's Law, though some possible theories have been advanced. It seems likely that it is just a numerical coincidence, based on just the 'old' 7 planets.]