

1	(i) 2.5, 2.50, 2.500, 2.499..	B2	M1 for $\log_{10} 316$ or $\ln 316/\ln 10$	5
	(ii) 6 www	B3	B2 for $6 \log_a a$ or $\log_a(a^6)$ Or B1 for $2\log_a(a)$ or $-\log_a a^{-4}$ SC1 Using $a=10 \Rightarrow 6$ SC2 Using numerical a, not $10 \Rightarrow 6$	

2	i	Excess temperature At $t=0$ oe	B1	nb AG If $z=68, 53\dots$ P1, L1, M1, M1, M1 available	2
	ii	$\log z = \log z_0 + \log(10^{-kt})$ $= \log z_0 - kt \log 10$	B1 B1		2
	iii	$Z = \begin{matrix} & 46 & 31 & 20 & 14 & 9 \end{matrix}$ $\log z : 1.66 \quad 1.49 \quad 1.30 \quad 1.15 \quad 0.95$ correctly plotted line of best fit $k = 0.017$ to 0.019 or 0.02 $z_0 = 66$ to 73 temp of drink = 25 to 27	T1 P1 L1 G2 B2 C2	fit their values, within 2mm Ruled, using their points M1 for attempting +/- gradient M1 for $(\log) z_0 = 1.82$ to 1.86 M1 3 to 5 or their 69×10^{-70} x their k	9 [13]

3	ai	13	1	M1 for attempt at AP formula fit their a , d or for $3 + 5 + \dots + 21$	1
	aii	120	2		2
	bi	$\frac{125}{1296}$	2	M1 for $\frac{1}{6} \times \left(\frac{5}{6}\right)^3$	2
	ii	$a = 1/6, r = 5/6$ s.o.i. $S_\infty = \frac{\frac{1}{6}}{1 - \frac{5}{6}}$ o.	1+1 1	If not specified, must be in right order	3
	iii	$\left(\frac{5}{6}\right)^{n-1} < 0.006$ $(n-1) \log_{10} \left(\frac{5}{6}\right) < \log_{10} 0.006$ $n-1 > \frac{\log_{10} 0.006}{\log_{10} \left(\frac{5}{6}\right)}$ $n_{\min} = 30$ Or $\log(1/6) + \log(5/6)^{n-1} < \log 0.001$ $(n-1) \log(5/6) < \log(0.001/(1/6))$	M1 M1 DM1 B1 M1 M1	condone omission of base, but not brackets NB change of sign must come at correct place	4