Mark scheme for Topic 1

1 The change in temperature is about 32 degrees. Two measurements must be made: for the initial and final temperatures. The uncertainty in each measurement is, conservatively, $0.5\ ^\circ\text{C}$, and so the uncertainty in the change in temperature is $1\ ^\circ\text{C}$. This dictates that the answer is **B**.

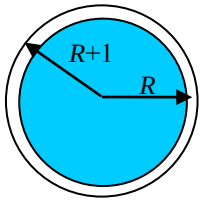
2 The resistance is, without using a calculator, $\frac{898\times10^{-3}}{0.45}\approx\frac{0.90}{0.45}=2.0$, so **A** (answer must have 2 s.f.)

3 The uncertainty in the square of the radius is $2\times3=6\%$, and so the volume uncertainty is $6\%+4\%=10\%$, **B**.

4 Without any work the answer has to be **D**! Or, number of hydrogen atoms is $\frac{10^{30}}{1.67\times10^{-27}}\approx\frac{10^{30}}{2\times10^{-27}}=5\times10^{56}$, so best answer is **D** since there is one electron in every hydrogen atom.

5 The time is $\frac{10^{17}}{3\times10^{6}}\approx3\times10^{10}$ so **B**.

6 The total length required is $2\pi(R+1)=2\pi R+2\pi$, i.e. the additional length is 2π metres or just about 6 m, **A**.



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7 **a** **i** The period is short, so the percentage uncertainty in the measured value of the period is large and so by measuring ten periods the percentage uncertainty is reduced. **[1]**

ii Each measurement is subject to random errors and so, by taking an average, the random errors are reduced. **[1]**

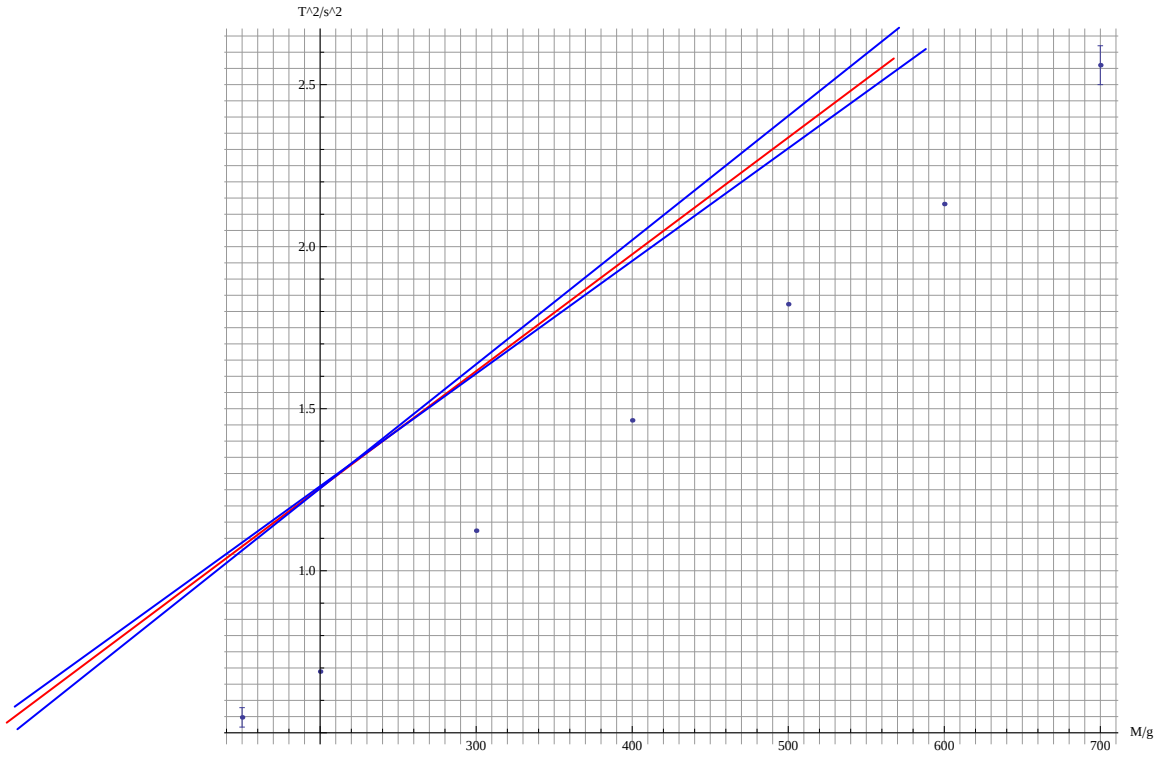
b It is not possible to fit a straight line through the error bars that will also go through the origin. **[1]**

c **i** Since $\frac{\Delta T^2}{T^2} = 2\frac{\Delta T}{T}$;

we have that $\Delta T^2 = 2T\Delta T = 2 \times 1.21 \times 0.02 = 0.0484 \approx 0.05\ \text{s}^2$ (answer to 1 s.f.). **[2]**

Exam tip: you cannot go to the exam without at least being able to do this type of calculation.

ii



iii Measured slope from line of best fit and maximum and minimum slopes are:

$$\frac{2.50-0.95}{690-260}=0.0036\ \text{s}^2\ \text{g}^{-1},\ \frac{2.62-0.52}{700-150}=0.0038\ \text{s}^2\ \text{g}^{-1}\ \text{and}\ \frac{2.50-0.58}{700-150}=0.0035\ \text{s}^2\ \text{g}^{-1}$$

so uncertainty in slope is $\frac{0.0038-0.0035}{2}=1.5\times10^{-4}\ \text{s}^2\ \text{g}^{-1}$.

$$L=\sqrt[3]{\frac{0.12^2}{\text{slope}}}=\sqrt[3]{\frac{0.12^2}{0.0036}}=1.587\ \text{m}$$

$$\frac{\Delta L}{L}=\frac{1}{3}\frac{\Delta\text{slope}}{\text{slope}}\Rightarrow\Delta L=\frac{1}{3}\times1.587\times\frac{1.5\times10^{-4}}{0.0036}=0.0220\approx0.02\ \text{m}.$$

Exam tip: answer to 1 s.f.

So $L=1.59\pm0.02$ m. **[4]**

Exam tip: number of decimal places in L dictated by uncertainty, which is in the second decimal place.

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