1. Figure shows a spring whose upper end is firmly clamped to a rigid stand, and a light pointer attached to its lower end. You are to determine the spring constant (k) of the spring. A set of standard weights and a metre ruler are provided.

   (a) Draw the metre ruler on the figure at its correct position in order to measure the extension (e) of the spring.

   (b) The extension (e) versus load (M) graph for such a spring is shown below.
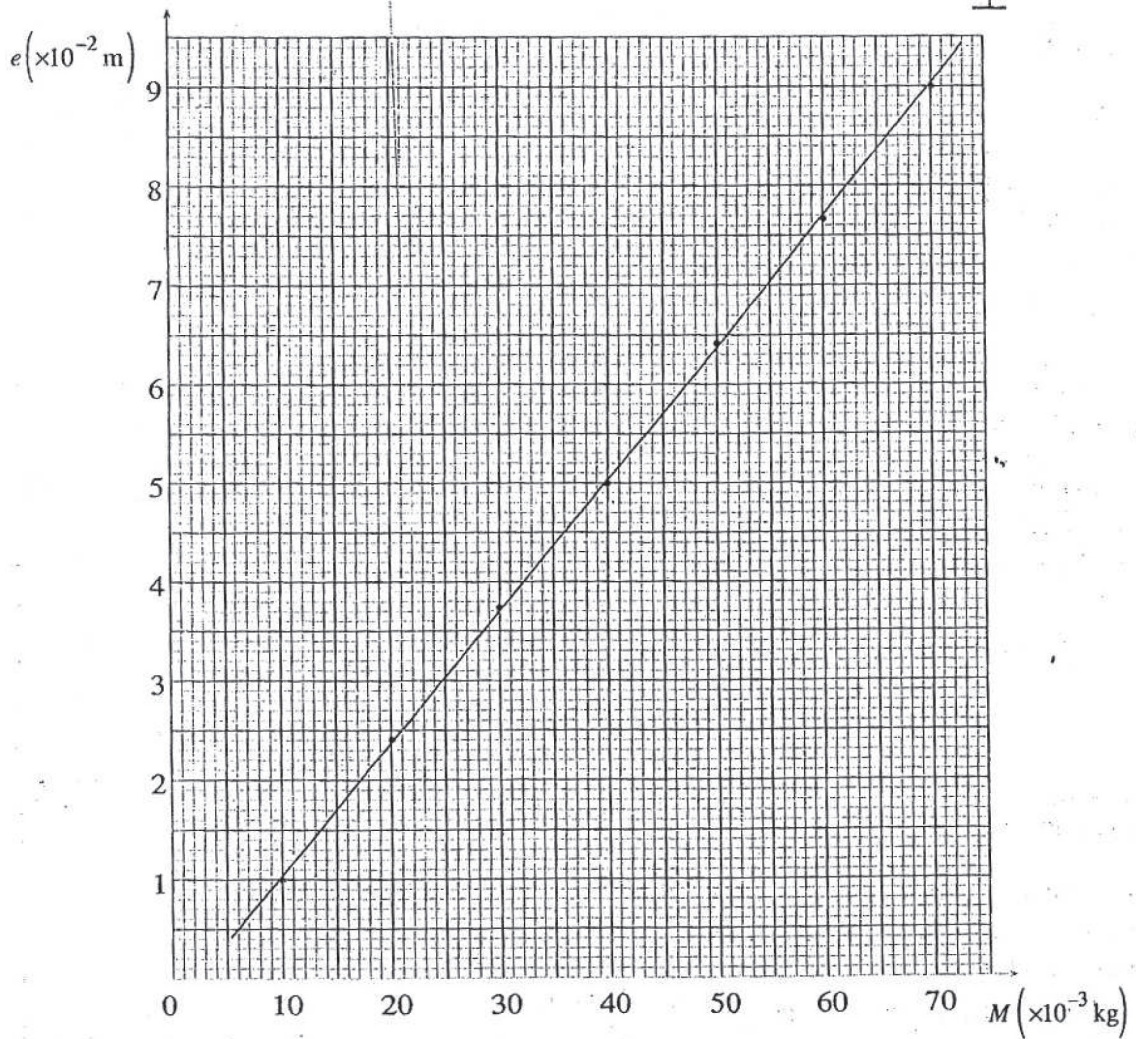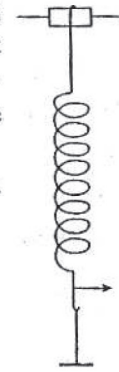
   (i) Determine the spring constant k of the spring in $kg\,m^{-1}$.

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   (ii) Clearly indicate on the graph the two points which you have used to determine k.

(c) The spring with a load M attached is set in vertical oscillations by giving a small displacement. The period (T) of the oscillations is given by

$$T = 2\pi\sqrt{\dfrac{M + \dfrac{m}{3}}{kg}}$$ where m is the mass of the spring.

(i) Rearrange the above expression in the **most suitable** manner to draw a graph in order to determine the acceleration due to gravity (g) and mass (m) of the spring.

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(ii) What additional instrument do you need to take measurements in this experiment?

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(iii) What quantities would you extract from the graph to determine g and m?

To determine g : ....

To determine m : ....

(d) If the percentage error of M values is 1%, how many oscillations would you need to take in order to match the percentage error of T also to 1%? (Fractional error of T is $\dfrac{2\Delta T}{T}$, and error in time measurement is 0.1 s. Take $T = 2$ s).

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(e) A student used a brand new spring whose turns are **pressed against each other** to draw the graph mentioned in (b) above. On the figure given below, sketch the shape of the graph that you would expect in this situation.