Physics

Standard level

Paper 1B

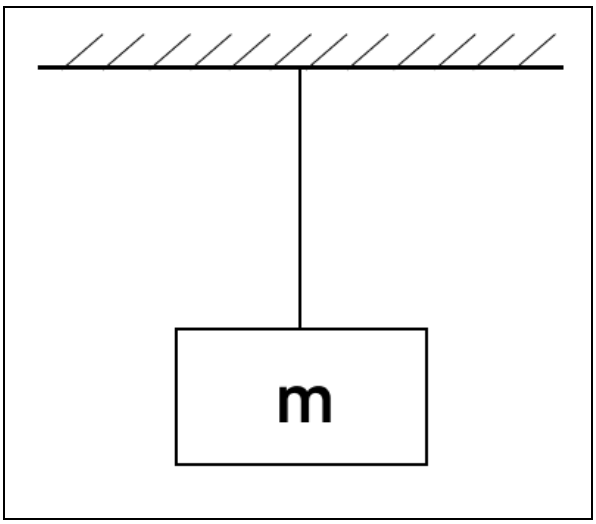
1 hour 30 minutes [Paper 1A and 1B]

Instructions to candidates

- Do not open the examination paper until instructed to do so.
- Answer all questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A calculator is required for this paper.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for paper 1B is **[20 marks]**.

The maximum mark for paper 1A and paper 1B is **[45 marks]**.

1. A student is investigating the factors affecting the change in length ΔL of a light copper wire due to a force. She performs an experiment to determine the effect of cross-sectional area of the wire on ΔL by hanging a constant mass m on differently sized wires.



The student hypothesizes that the change in length is given by the following formula: $\frac{\Delta L}{L} = \frac{F}{EA}$ where L is the original length of the wire, A is the cross-sectional area, F is the force applied to the wire, and E is a constant.

(a) State the units of E. [1]

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(b) Explain why the mass m attached to the wire must be constant. [2]

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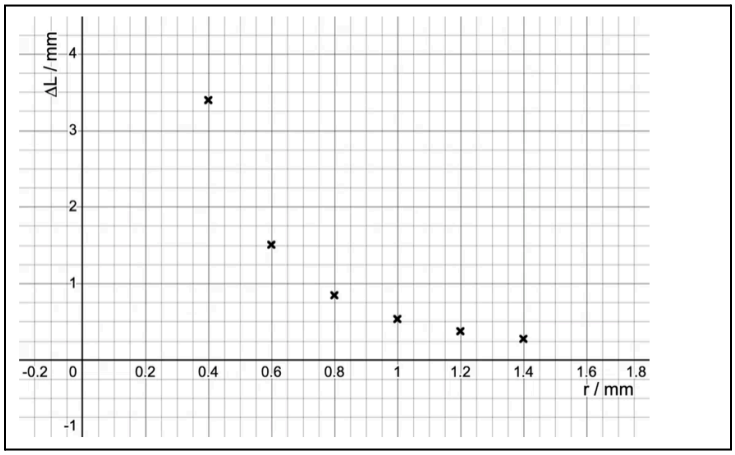
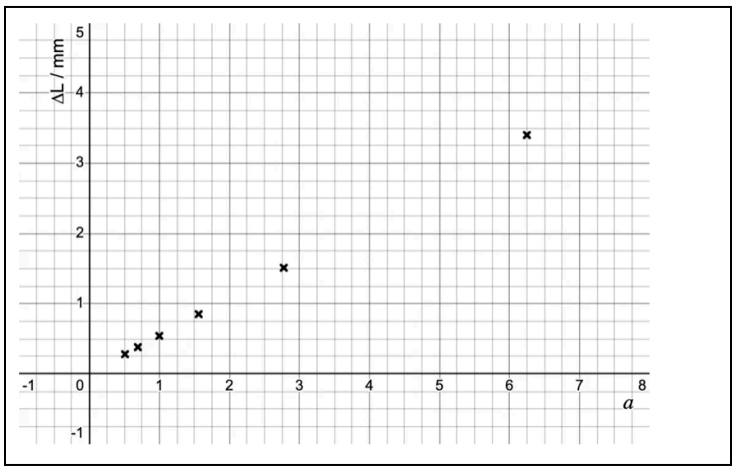
The student measures the change in length of each wire and plots it against the radius r. The results are shown below.



The graph is then linearized by plotting ΔL against a:



(c) Find a, giving an appropriate unit. [2]

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The mass attached to the wires measures 20 kg, and the wire is 1.00 m long.

(d) By drawing the line of best fit, or otherwise, find E. [5]

2. A sonometer is a hollow wooden box that is attached to a wire stretched across the top, as shown in the following diagram.

A student investigates the dependence of the fundamental frequency f (1st harmonic) on the tension T in the string. The student strums the string and measures the frequency of vibration.

(a) Suggest a possible safety concern during this experiment. [1]

The student predicts that:

$$f = A\sqrt{T}$$

where f is the frequency and A is a fixed constant.

(b) Find the units of A. [1]

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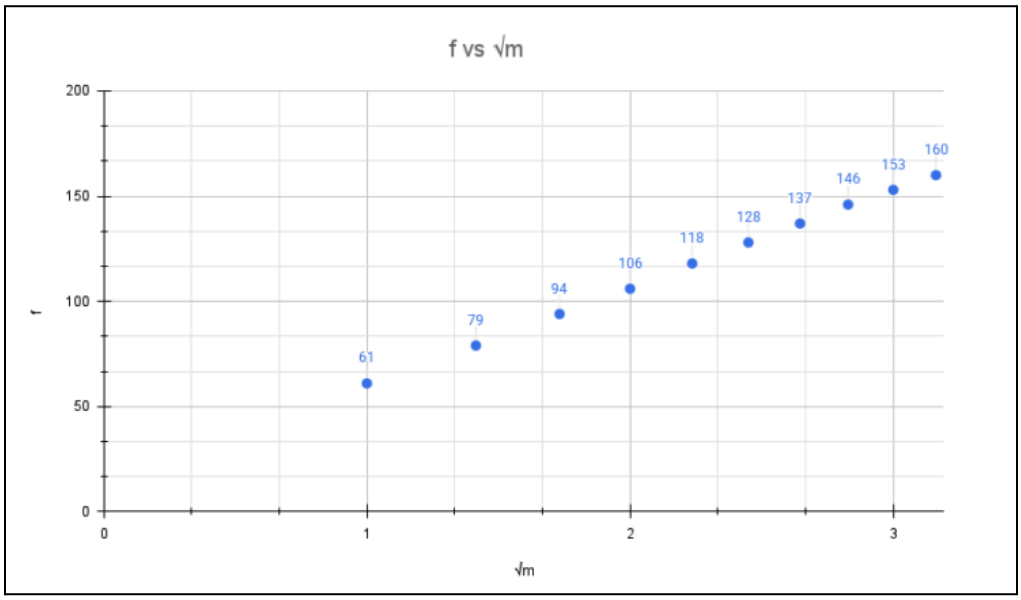
The tension in the string is increased by adding masses to the end, so $T = mg$, where m is the mass added and g is the gravitational field strength.

The student plots a graph of f versus m and obtains the following graph:



(c) Find the gradient of this graph and state its units. [2]

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(d) Explain one assumption in the experiment and how this leads to the graph not passing through the origin as predicted. [2]

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The student estimates the uncertainty in each mass measurement as ±0.05 kg and the uncertainty in each frequency measurement as ±2 Hz.

(e) Outline how these uncertainties would affect the accuracy and reliability of the gradient obtained from the graph. [2]

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(f) The frequency of vibration is related to the energy stored in the vibrating string. Outline how increasing the tension affects the total energy stored in the string and explain why. [2]

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