VICTORIA JUNIOR COLLEGE
2024 JC2 PRELIMINARY EXAMINATION
Higher 2

Name : ________________________________ CT group : ________________

PHYSICS **9749/04**

Paper 4 Practical

29 August 2024

Candidates answer on the Question Paper.
Additional Materials: As listed in the Confidential Instructions

2 hours 30 minutes

READ THESE INSTRUCTIONS FIRST

Write your name and Civics Group in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE ON ANY BARCODES.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.
The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	
2	
3	
4	
Total	

1 In this experiment, you will determine the resistivity of a metal.

(a) Set up the circuit as shown in Fig. 1.1, using the resistor of resistance R = 68 Ω.

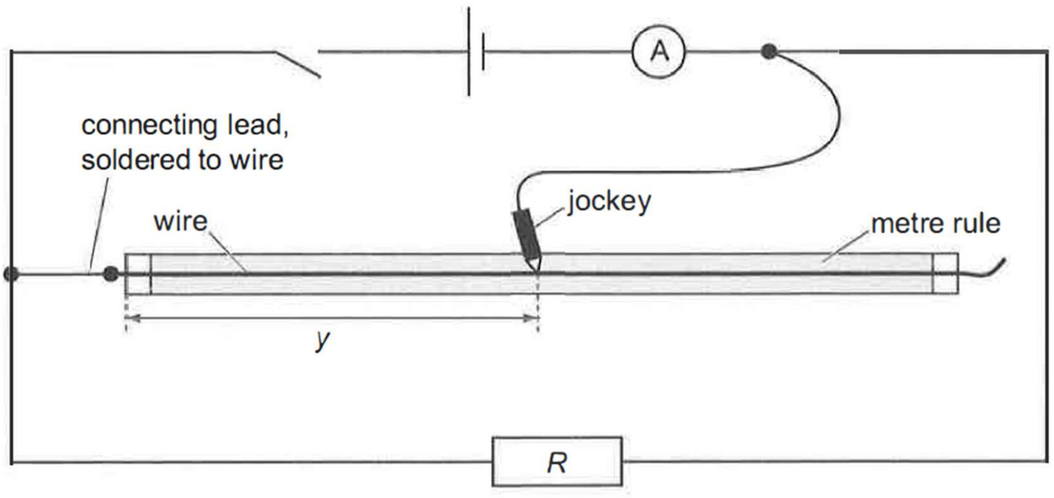

Fig. 1.1

Place the jockey on the wire about half-way along the metre rule. The distance between the end of the wire and the jockey is *y*, as shown in Fig. 1.1.

Close the switch.

Adjust the position of the jockey until the ammeter reading *I* is as close as possible to 121 mA.

Record *R*, *I* and *y*.

R = ……………………………

I = ……………………………..

y = ……………………………..

[1]

Open the switch.

(b) Vary R and adjust y each time so that I is always as close as possible to 121 mA. Present your results clearly.

[3]

(c) It is suggested that R and y are related by the expression:

$$\frac{R}{y} = \frac{QIR}{F} - Q$$

where I is your value from **(a)** and Q and F are constants.

Plot a suitable graph to determine values of Q and F.

Q = ……………………………….

F = ……………………………….

[8]

(d) Theory suggests that:

$$\text{Modulus of } Q = \frac{4\rho}{\pi d^2}$$

where d is the diameter of the wire and ρ is the resistivity of the metal.

Determine a value for ρ.

ρ = ……………………….. Ω m [2]

[Total: 14]

2 In this experiment, you will investigate an oscillating system.

Clamp the short wooden rod to a height of about 0.40 m. Using Blu-Tack, suspend two pendulum bobs A and B on the wooden rod so the they are 15 cm apart (using the notch on the short wooden rod as guide) as shown in Fig. 2.1.

Adjust the length *L* of both pendulums so that they are both equal to 30 cm.

Using the marker pen provided, make a mark at the midpoint of the pendulum A.

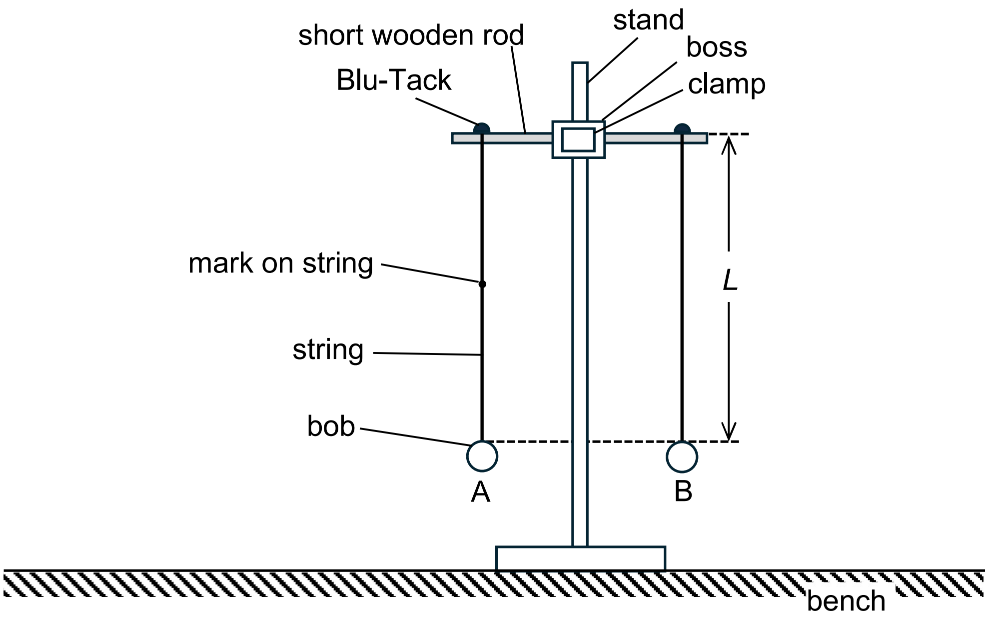

Fig. 2.1

(a) Clamp the long wooden rod on another stand and set up as shown in Fig. 2.2.

The long wooden rod should pass between the stand and the strings.

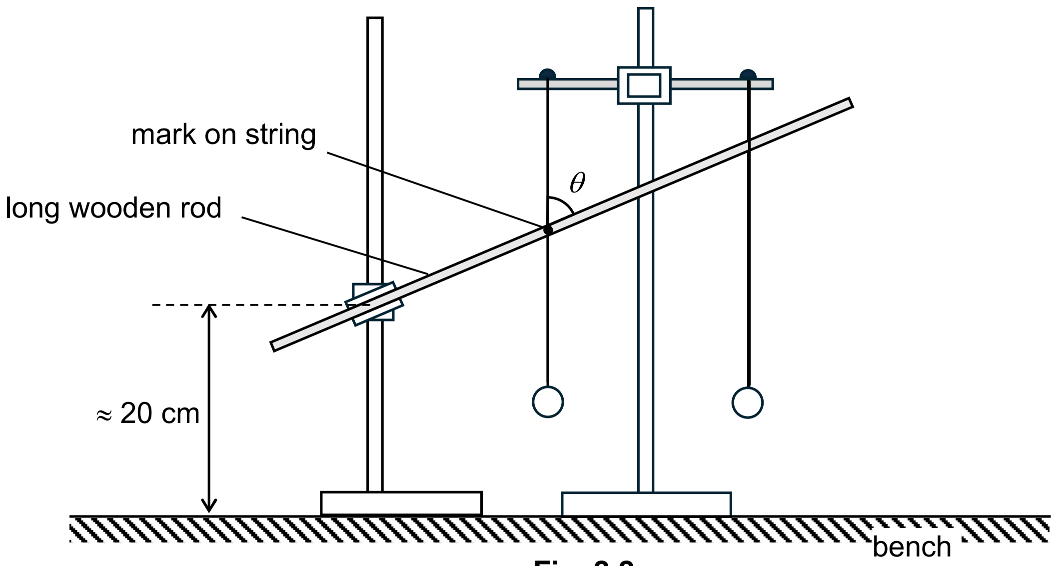

Fig. 2.2

(i) The angle between the long wooden rod and the string supporting A is θ.

Adjust the position of the long wooden rod so that θ is approximately 60° and the rod is **behind** the mark on the string supporting A. The rod should be just touching both strings, with the string hanging vertically.

Measure and record θ.

θ = ...° [1]

(ii) Pull A and B a short distance away from the long wooden rod. Keep the same separation between A and B.

Release A and B at the same time.

B first oscillates in phase with A, then out of phase, and then back in phase again. This takes n oscillations of B.

Determine n.

n = ... [2]

(b) It is suggested that:

$$n = k \tan\theta$$

where k is a constant.

Calculate k.

k = ... [2]

(c) Determine n and k for two more values of θ.

Tabulate your results.

[2]

(d) Explain why you would not select a value of $\theta = 90^\circ$ in **(c)**.

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.... [1]

[Total: 8]

3 A cantilever beam is a beam that is supported at one end only.

In this experiment, you will investigate how the following properties affect the behaviour of a cantilever beam:

- the length of the beam
- the load on the beam
- the cross-section of the beam
- the stiffness of material from which the beam is made.

(a) Set up the half-metre rule on the benchtop as shown in Fig. 3.1.

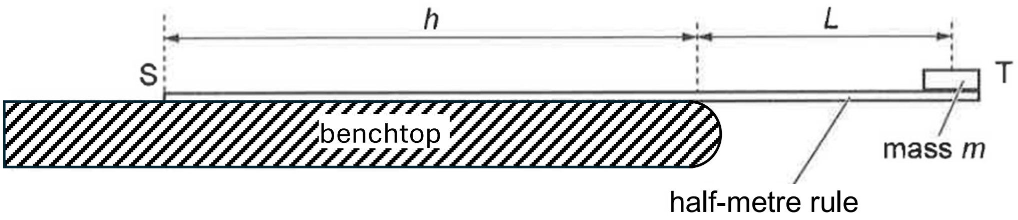


Fig. 3.1

The ends of the rule are S and T.

Use Blu-Tack to firmly attach a mass m, where m = 50 g, at T.

The distance between S and the edge of the surface is h.

The distance between the centre of mass m and the edge of the surface is L.

(i) Adjust the position of the rule so that S just lifts off the surface.

Measure and record h and L.

h = ……………………………..

L = ……………………………..

[1]

(ii) Calculate $\frac{h}{L}$.

$\frac{h}{L}$ = ……………………………

[1]

(iii) Estimate the percentage uncertainty in your value of $\frac{h}{L}$.

percentage uncertainty in $\frac{h}{L}$ = ... [2]

(b) Vary *m* and repeat **(a)(i)** and **(a)(ii)**.

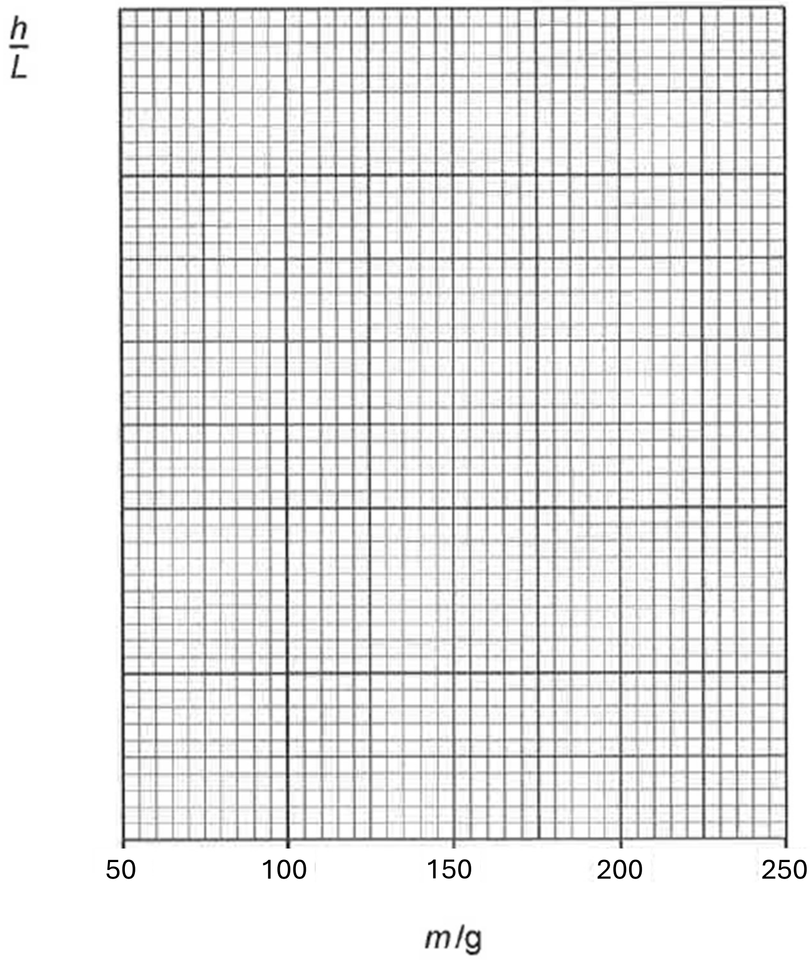
[2]

(c) It is suggested that h, L and m are related by the expression:

$$\frac{h}{L} = \frac{2m}{X} + 1$$

where X is the mass of the half-metre rule.

(i) Plot your results on the grid and draw the line of best fit.



[1]

(ii) Use your graph to determine a value for X.

X = ... g [1]

(d) Use a balance to determine the mass X of your half-metre rule.

X = ... g

Show whether your value in (a)(iii) explains the difference between your two values of X.

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[1]

(e) You will now use a metal hacksaw blade as a cantilever beam.

When one end of the blade is fixed and the other end is loaded, the loaded end will move downwards, as shown in Fig. 3.2.

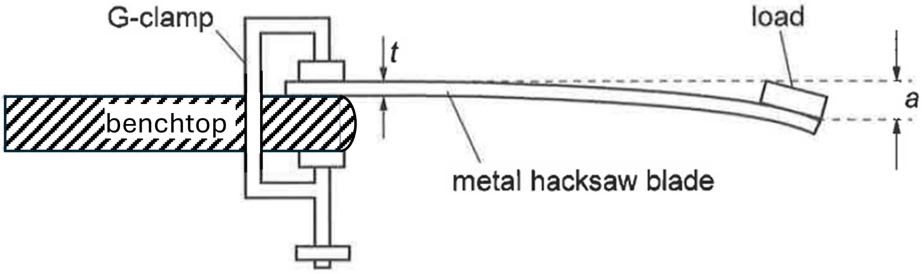

Fig. 3.2

The distance moved down is a, given by:

$$a = \frac{4MgL^3}{Yut^3}$$

where:

- M is the mass of the load
- L is the distance between the centre of the load and the edge of the surface
- u is the width of the blade
- t is the thickness of the blade
- Y is the stiffness of the of the metal
- g = 9.81 N kg^{-1}

(i) Wearing safety goggles, set up the apparatus as shown in Fig. 3.2.

Use Blu-Tack to firmly attach a 50 g mass to the metal hacksaw blade.

Take measurements to determine a value for Y.

Y = ……………………………..…. GPa [4]

(ii) Suggest one significant source of uncertainty in this measurement.

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(iii) The value of Y for wood is 12 GPa.

Explain why it is **not** possible to perform this experiment using a wooden beam with the same dimensions as the metal hacksaw blade.

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…………………………………………………………………………………………… [1]

(f) A diving board at a swimming pool has length L. A person of mass M jumps up and down on the end of the diving board.

The frequency of oscillation of the end of the diving board is f, given by:

$$f^2 = \frac{Z}{ML^3}$$

where Z is a constant.

The metal hacksaw blade can be used as a model diving board.

Plan an investigation to find Z for the blade.

Your answer should include a diagram, your experimental procedure and a precaution to improve the safety of the experiment.

Wearing safety goggles, use your apparatus to determine two values of Z for different values of M and L. Tabulate your results.

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[7]

[Total: 22]

4 Two of the sources of naturally-occurring background radiation are from buildings and from soil.

The amount of background radiation detected depends on the distance *b* from a building and the distance *s* from the soil.

The background count rate *C* is given by the equation:

$$C = K\ b^{p} s^{q}$$

where *K*, *p* and *q* are constants.

Design an experiment to determine the values of *p* and *q.*

Assume that the investigation takes place outdoors close to a building and that you have a Geiger-Muller (GM) tube which counts individual particles.

Draw a diagram to show the arrangement of your apparatus. You should pay particular attention to:

(a) the equipment you would use
(b) the procedure to be followed
(c) the control of variables
(d) any precautions that should be taken to improve the accuracy of the experiment.

Diagram

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[11]

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