H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME			
CLASS		TUTOR'S NAME	
CENTRE NUMBER	S	INDEX NUMBER	

PHYSICS

9749/04

19 August 2024

2 hours 30 minutes

Paper 4 Practical

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your name, class, tutor's name, Centre number and index number 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 a HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

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.

Give details on the practical shift and laboratory, where appropriate, in the boxes provided.

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	**/ 55**

1 In this experiment, you will investigate the resistivity of a constantan wire.

(a) (i) Connect the circuit as shown in Fig. 1.1 with the switch open.

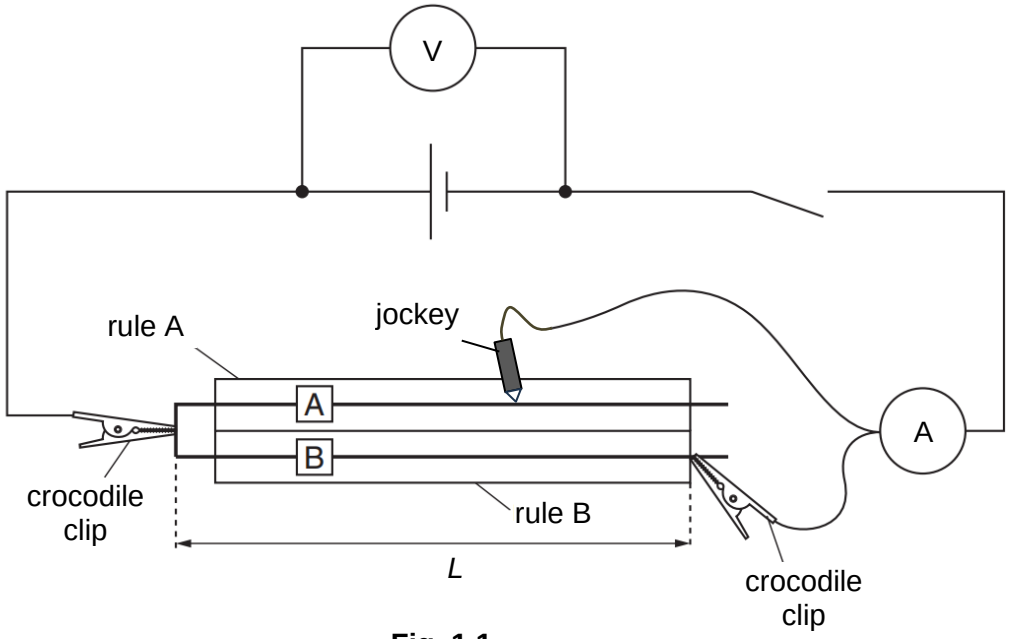


Fig. 1.1

The wire on rule B should be connected by a crocodile clip at each end.

L is the length of wire between the crocodile clips.

(ii) With the switch open, record the voltmeter reading *V*.

V = ...

(b) (i) Measure and record the length *L*.

L = ... [1]

(ii) Estimate the percentage uncertainty in your value of *L*.

percentage uncertainty = ... [1]

(c) (i) Close the switch. Place jockey on the wire on rule A at a distance *x* from the end of the rule, as shown in Fig. 1.2. The value of *x* should be approximately 40 cm.

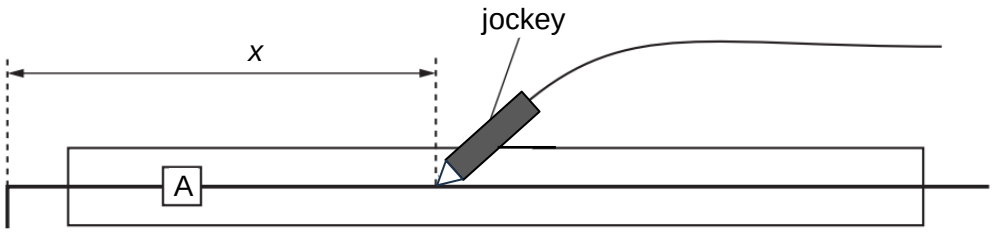


Fig. 1.2

(ii) Measure and record the distance *x* and the ammeter reading I.

x = ...

I = ...

(iii) Remove the jockey from the wire on rule A and open the switch.

(d) Repeat **(c)** for further values of *x* and the corresponding values of I.

[3]

(e) Theory suggests that I and x are related by the expression

$$I = \frac{P}{x} + Q$$

where P and Q are constants.

Plot a suitable graph to determine the values of P and Q.

P = ...

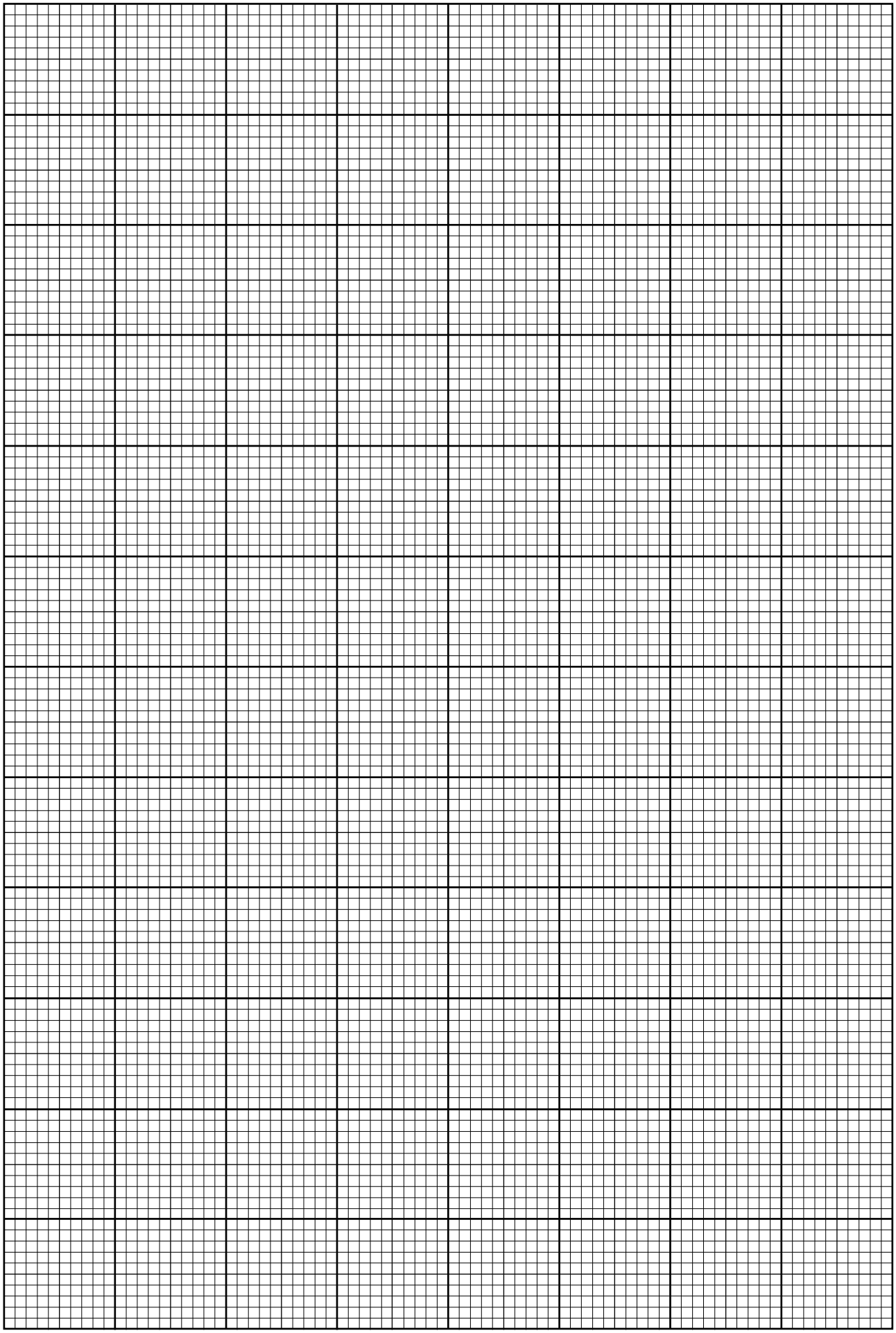
Q = ...
[6]

(f) The experiment is repeated with a battery of larger value of e.m.f.

Sketch a line on your graph grid used in **(e)** to show the expected result.

Label this line W. [1]

[Total: 12]



2 In this experiment, you will investigate the oscillations of a torsional pendulum.

Set up the apparatus as shown in Fig 2.1. Adjust the lengths of the strings such that the red markings on the strings lie just below the disc B, and secure the strings to disc B using the binder clips provided. Place **four** 50g masses on the centre of disc A in a vertical stack.

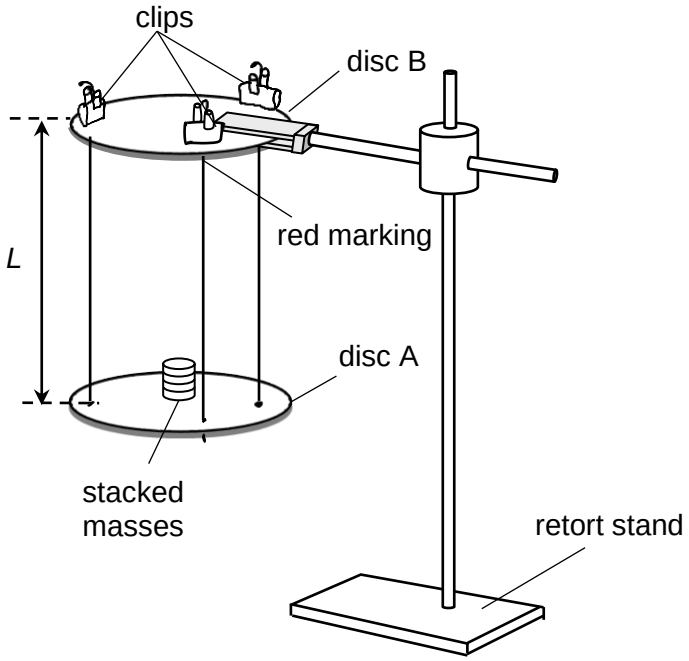


Fig 2.1 (Front view)

(a) Measure and record the distance *L* between the two discs.

L = ... cm [1]

(b) Displace disc A by a small angle about the centre of the disc. Release the disc so that it performs torsional oscillations in the horizontal plane about its centre. (See Fig. 2.2.)

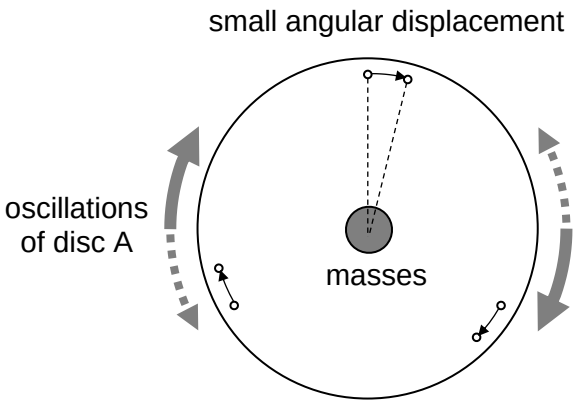


Fig. 2.2 (Top view)

Make measurements to determine the frequency f of the oscillations.

f = ... Hz [3]

(c) Make further measurements to determine the mass M required at the centre of disc A such that the frequency f of the oscillations is 1.50 Hz. Show your working clearly.

M = ... g [3]

(d) Explain why it is not feasible to determine the value of M for f = 5.00 Hz using the method in **(c)**.

.....

.....

.....[1]

[Total: 8]

3 A flywheel is a mechanical device that uses the conservation of angular momentum to store rotational energy.

In this experiment, you will investigate the properties of a flywheel modelled by a slotted mass system.

(a) (i) Measure and record the diameter D_1 of the 100 g slotted mass.

D_1 = ... cm [1]

(ii) Calculate C using

$$C = M_1 D_1^2$$

where M_1 = 0.100 kg.

C = ... [1]

(iii) Justify the number of significant figures that you have given for your value of C.

.....

.....[1]

(iv) A plastic straw has been inserted into the slot of the slotted mass, as shown in Fig. 3.1.

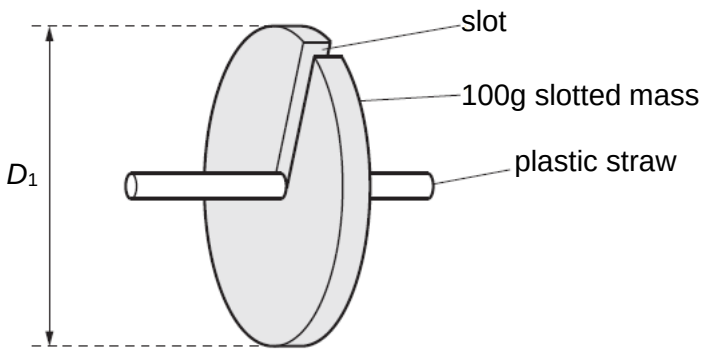


Fig. 3.1

(v) Set up the apparatus as shown in Fig. 3.2.

Loop one end of the string around one end of the straw and **pass the rest of the string through the slot of the slotted mass** and down to the floor, as shown in Fig. 3.2.

Hook the mass hanger onto the other end of the string loop and then adjust the height of the flywheel until the mass hanger is just touching the floor and the rod is horiztonal.

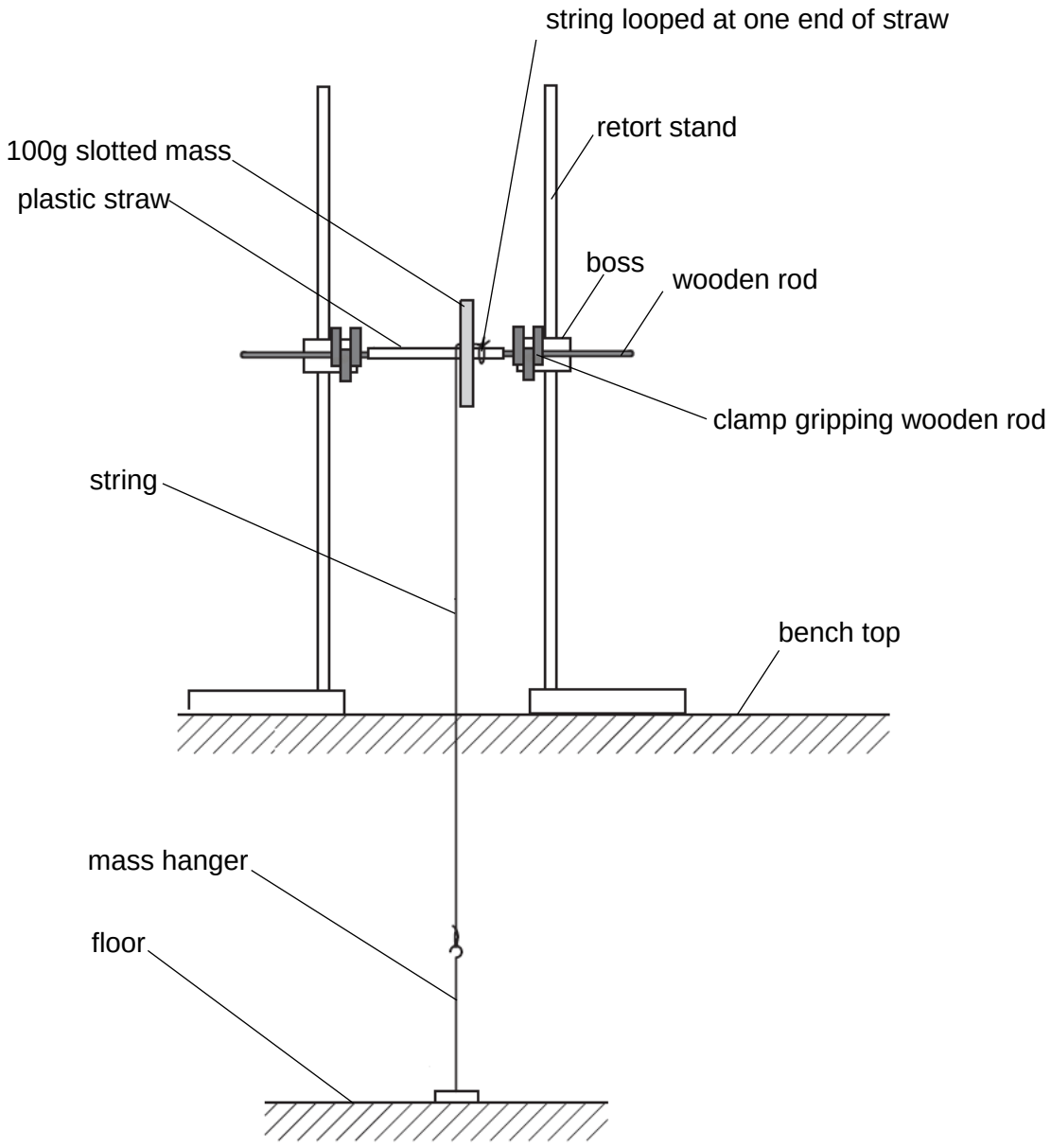


Fig. 3.2

(vi) Rotate the slotted mass 20 times so that the string is wound around the straw, as shown in Fig. 3.3.

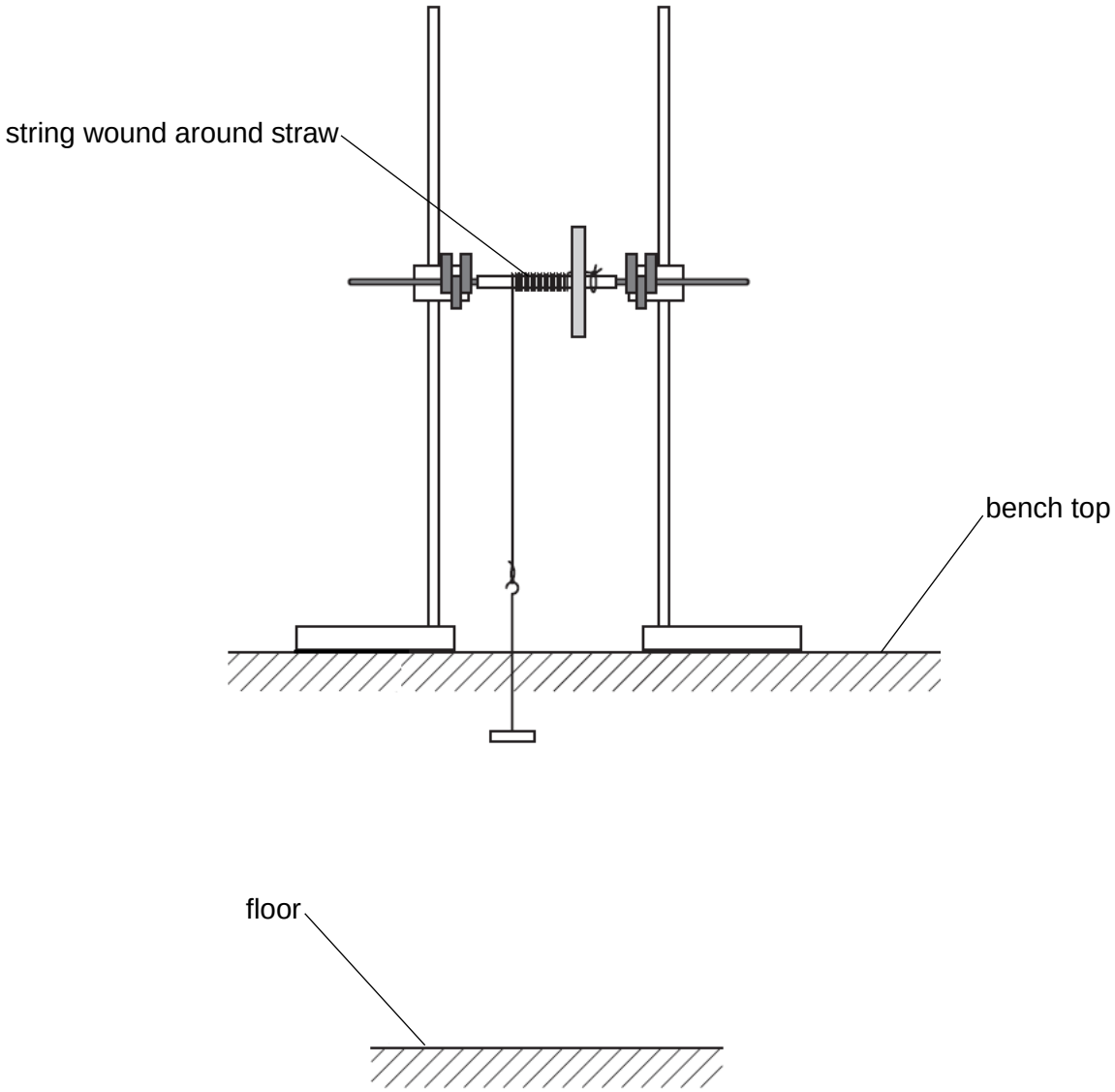


Fig. 3.3

Release the slotted mass and take measurements to determine the time t for the mass hanger to just touch the floor.

t = ... [2]

(b) (i) Using **all** the modelling clay, mould the modelling clay to form a ring of uniform thickness around the outside of the slotted mass, as shown in Fig. 3.4. Ensure that the modelling clay is securely attached to the slotted mass so that it does not fall off when rotating.

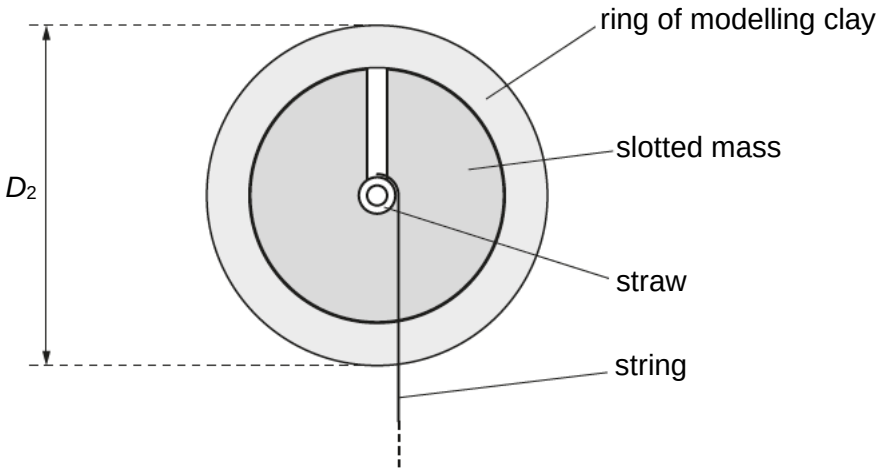


Fig. 3.4

Measure and record the outer diameter D_2 of the ring of modelling clay and slotted mass, as shown in Fig. 3.4.

D_2 = ... cm [1]

(ii) Estimate the percentage uncertainty in your value of D_2.

percentage uncertainty = ... % [1]

(iii) Calculate C using

$$C = (M_1 + M_2)D_1^{\,2} + M_2D_2^{\,2}$$

where the mass of the modelling clay, M_2 = 0.100 kg.

C = ... [1]

(iv) Rotate the slotted mass 20 times so that the string is wound around the straw, as shown in Fig. 3.3.

Release the slotted mass and take measurements to determine the time t for the mass hanger to just touch the floor.

t = ... [2]

(c) (i) It is suggested that the relationship between t and C is

$$t^2 = kC$$

where k is a constant.

Using your data, calculate two values of k.

first value of k = ...

second value of k = ...

[1]

(ii) State whether or not the results of your experiment support the suggested relationship. Justify your conclusion by referring to your value in **(b)(ii)**.

.....

.....

.....[1]

(d) (i) Suggest **one** significant source of error in this experiment.

.....

.....

.....[1]

(ii) Suggest an improvement that could be made to the experiment to reduce the error identified in **(d)(i)**. You may suggest the use of other apparatus or a different procedure.

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.....

.....[1]

(e) Detach the ring of modelling clay. Using **all** of the clay, re-mould the clay **around** the straw, such that the outer diameter D_3 is approximately that of the 100 g slotted mass. The clay must be in contact with the slotted mass, as shown in Fig. 3.5. **Do not shove the modelling clay into the straw as it can become clogged.**

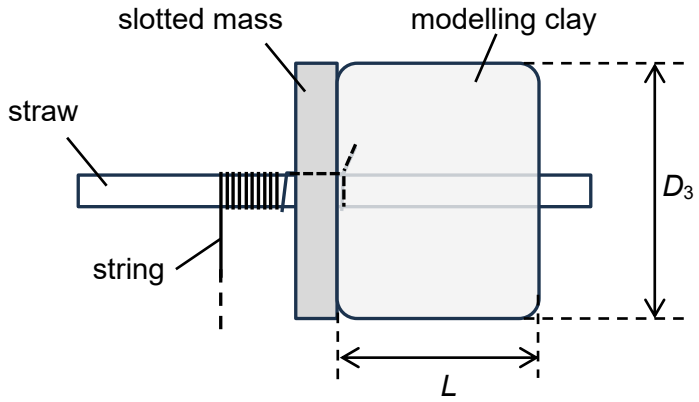

Fig. 3.5

(i) Measure and record the length L and the outer diameter D_3 of the modelling clay.

L = ... cm

D_3 = ... cm

[1]

(ii) Rotate the slotted mass 20 times so that the string is wound around the straw, as shown in Fig. 3.3. Release the slotted mass and take measurements to determine the time t for the mass hanger to just touch the floor.

t = ... [1]

(iii) Estimate the percentage uncertainty in your time t.

percentage uncertainty = ... % [1]

(iv) You have been provided with another 100 g slotted mass.

Use the masses provided and your results in **(e)(ii)** and **(e)(iii)** to determine for a flywheel assembly of diameter D_1, the effect of the density of the masses and the distance between masses, on the time taken t for the mass hanger to just touch the floor.

Your account should be presented clearly which includes:

- your experimental procedure
- control of variables
- results
- conclusion.

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.....

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.....

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.....[6]

[Total: 23]

4 An electric guitar uses a pickup to detect the changes in the magnetic field due to a vibrating metal wire and output the signal detected to an amplifier which produces sound. The position of the pickup with respect to the string is shown in Fig 4.1. Fig 4.2 shows the side view of the pickup which is made up of a wire wound around a permanent magnet.

Fig. 4.1 (top view of pickup)

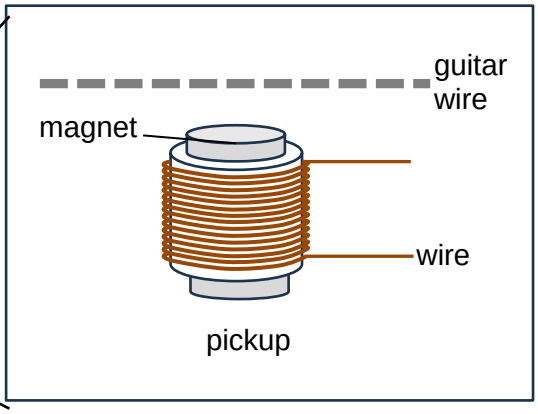

Fig. 4.2 (side view of pickup)

The maximum induced e.m.f. ε across the coil depends on the mass per unit length μ and the initial displacement x of the metal guitar wire to make it vibrate.

The e.m.f. ε is given by:

$$\varepsilon = K\mu^p x^q$$

where K, p and q are constants.

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

You are provided with a pickup and metal guitar wires of different thicknesses.

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

- the equipment you would use
- the procedure to be followed
- the control of variables
- how the maximum induced e.m.f. would be measured
- any precautions that would be taken to improve the accuracy of the experiment.

Diagram

[12]

[Total: 12]

End of Paper