TEMASEK JUNIOR COLLEGE
2024 JC2 PRELIMINARY EXAMINATION
Higher 2

NAME

CG

PHYSICS 9749/04

PAPER 4

28 August 2024

2 hours 30 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name and C.G. in the spaces provided at the top of this page.
Write in dark blue or black pen on both sides of the papers.
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 IN ANY BARCODES.

Shift
Laboratory

Answer **all** questions.

Write your answers in the spaces provided in this booklet.
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 of 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.

For Examiner's Use	
1	/13
2	/ 8
3	/22
4	/12
TOTAL	/55

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1 In this experiment, you will determine the resistivity of two wires with different cross-sectional areas.

(a) Measure and record the diameter d_1 of wire 1.

d_1 = ... [1]

(b) Calculate the cross-sectional area A_1 of wire 1.

A_1 = ... [1]

(c) Repeat **(a)** and **(b)** to obtain the diameter and cross-sectional area for wire 2.

d_2 = ...

A_2 = ...

(d) Connect the circuit shown in Fig. 1.1. The wires should be connected into the circuit using crocodile clips placed close to the ends of the wires. The length of each wire, L between the crocodile clip should be the same at around 35 cm.

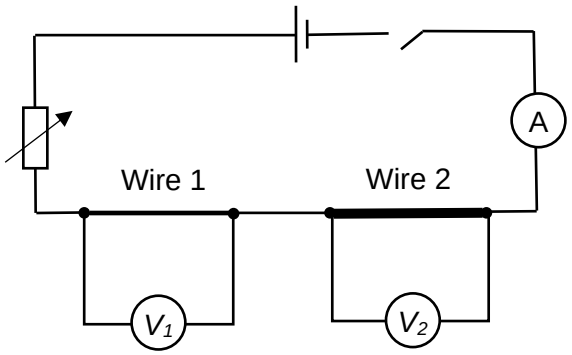


Fig. 1.1

(e) Close the switch. Adjust the rheostat to obtain a minimum current value I in the ammeter. Record the corresponding V_1 and V_2 values in the voltmeters.

I = ……..……..

V_1 = ……..……..

V_2 = ……..……..
[2]

(f) Adjust the rheostat and obtain at least 6 sets of readings for I, V_1 and V_2. For each set of readings, the length of each wire L should be constant at approximately 35 cm.

[3]

(g) Theory suggests that V_1, V_2 and I are related by the expression

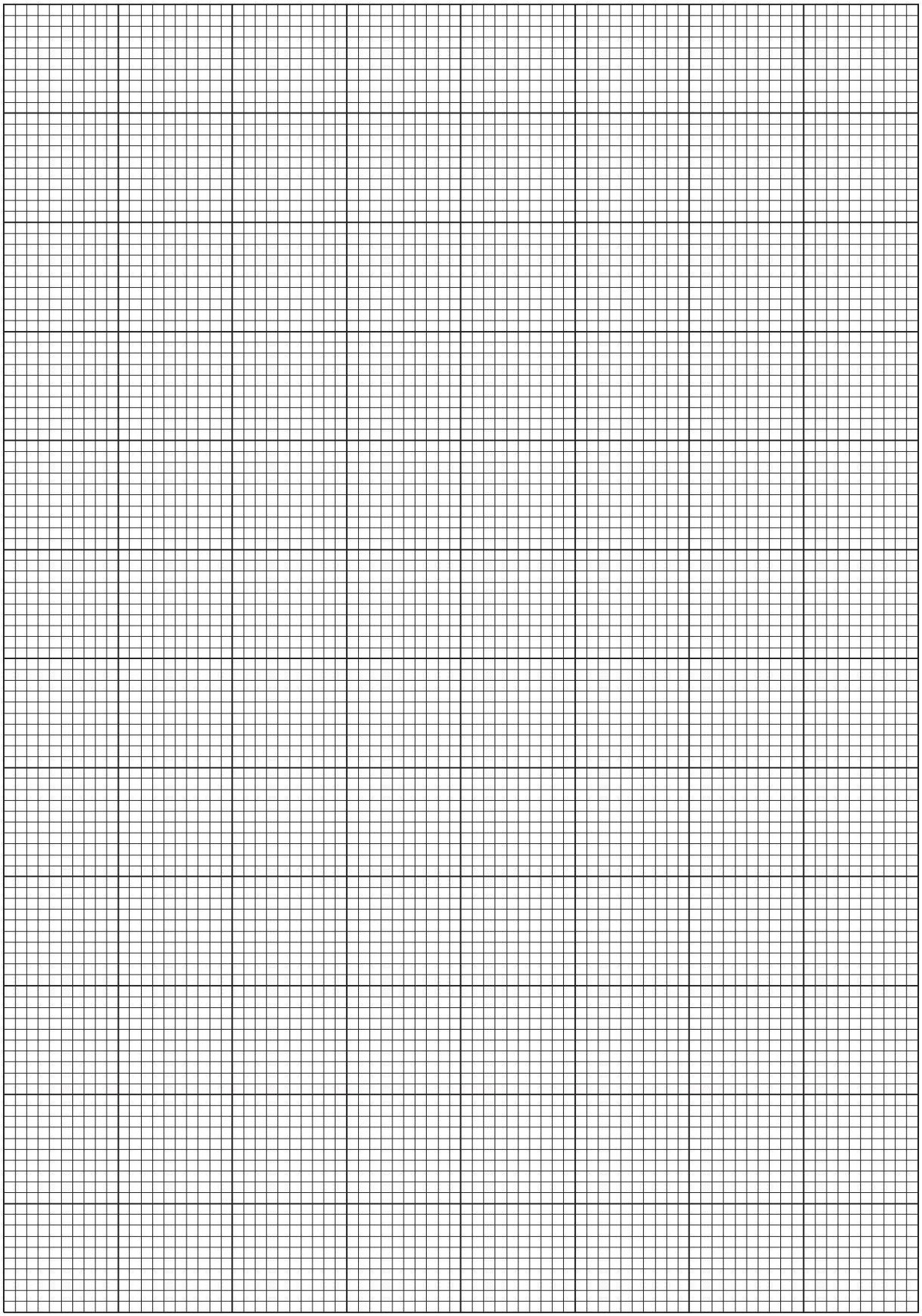
$$V_1 + V_2 = \rho L \left(\frac{1}{A_1} + \frac{1}{A_2} \right) I$$

where ρ is the resistivity of the wires.

Plot a suitable graph to determine the value of ρ.

□□□□□□ρ□ = ……..……

[5]



(h) Using the given apparatus, suggest a way to obtain the ratio of cross-sectional areas of the wires without measuring the diameters of the wires.

.....

.....

..... [1]

[Total: 13]

2. In this experiment you are provided with a ball attached to a thread and a solid vertical surface. You will investigate how the rebound distance of the ball is related to the release distance when it swings against the solid surface.

(a) Assemble the apparatus as shown in Fig. 2.1, with the thread clamped between the two wooden pieces so that *L* is about 50 cm, and with the wooden block positioned so that it is just touching the stationary ball.

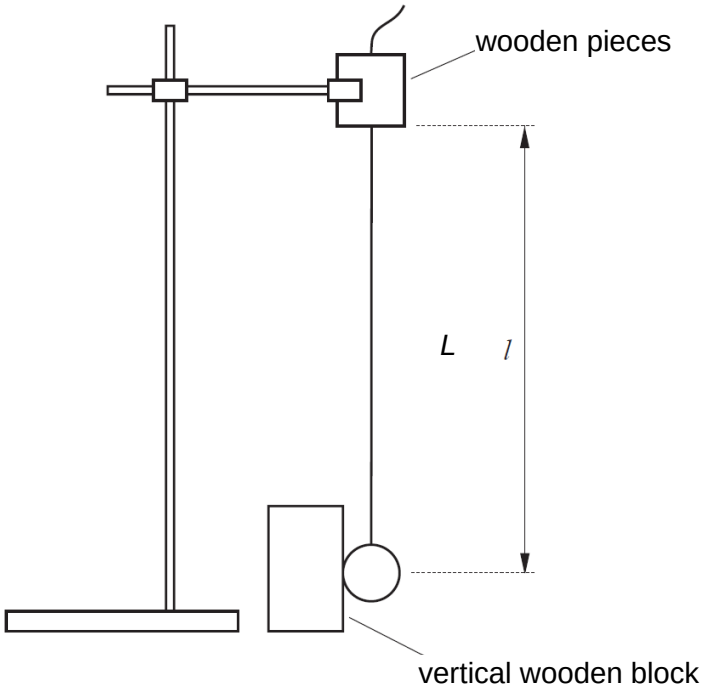


Fig 2.1

Measure *L*.

L = ...

(b) **(i)** Pull back the ball and measure the distance *a* shown in Fig. 2.2. Do not exceed *a* = 25 cm.

a = ... [1]

(ii) Release the ball and make measurements to determine the rebound distance *b* shown in Fig. 2.2.

b = ... [2]

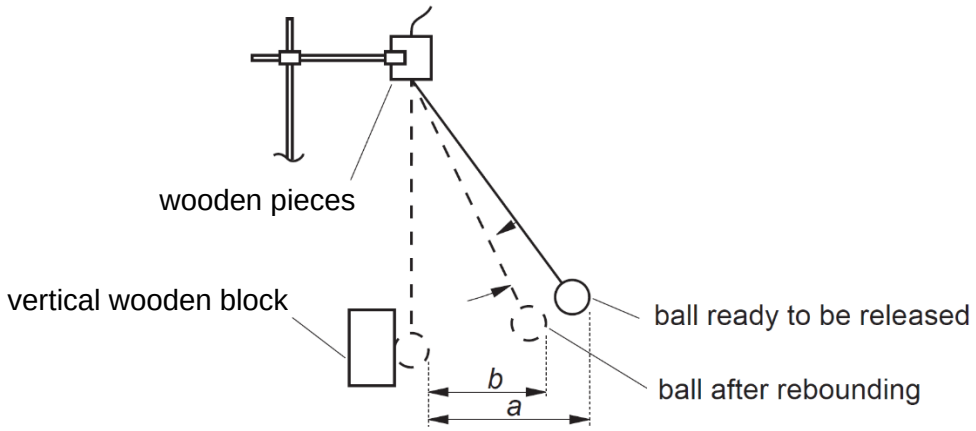


Fig. 2.2

(c) **(i)** Explain how you ensured that the rebound distance *b* was measured as accurately as possible.

.....

.....

.....

.....

..... [1]

(ii) Estimate the percentage uncertainty in *b*.

percentage uncertainty in *b* = ... [1]

(d) For values of *a* less than 25 cm, theory predicts that

$$k = \frac{L - \sqrt{L^2 - b^2}}{L - \sqrt{L^2 - a^2}}$$

where *k* is a constant. Calculate a value for *k*.

k = ... [1]

(e) If you were to repeat the experiment in (b), describe the graph that you would plot to determine the value of *k*.

.....

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..... [2]

[Total: 8 marks]

3 In this experiment, you will investigate the behaviour of an oscillating system.

You have been provided with a set of acrylic discs and three long strings.

(a) (i) Fig. 3.1 shows disc B of diameter *D*. On the disc are three small holes at equal distance *r* from the centre of the disc.

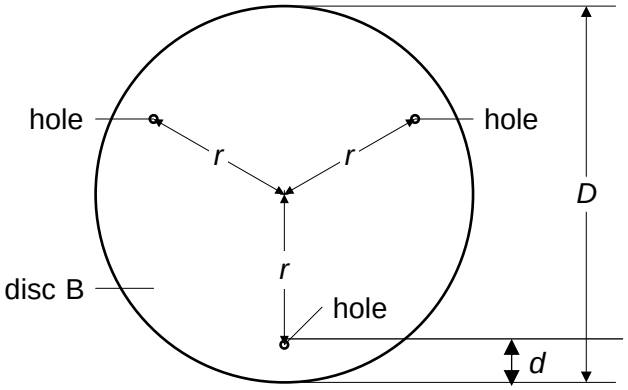


Fig. 3.1

Measure the diameter *D* of disc B using a pair of vernier callipers.

D = ... [1]

(ii) Measure the distance between the hole and the edge of the disc, *d* .

d = ... [1]

(iii) Using your answers to **a(i)** and **a(ii)**, determine the distance r.

r = ... [1]

(iv) Estimate the percentage uncertainty in your value of *r*.

percentage uncertainty in *r* = ... [2]

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

Clamp the top disc between two wooden blocks.

Thread the strings through the holes on both discs and secure the strings to the discs with adhesive tape only.

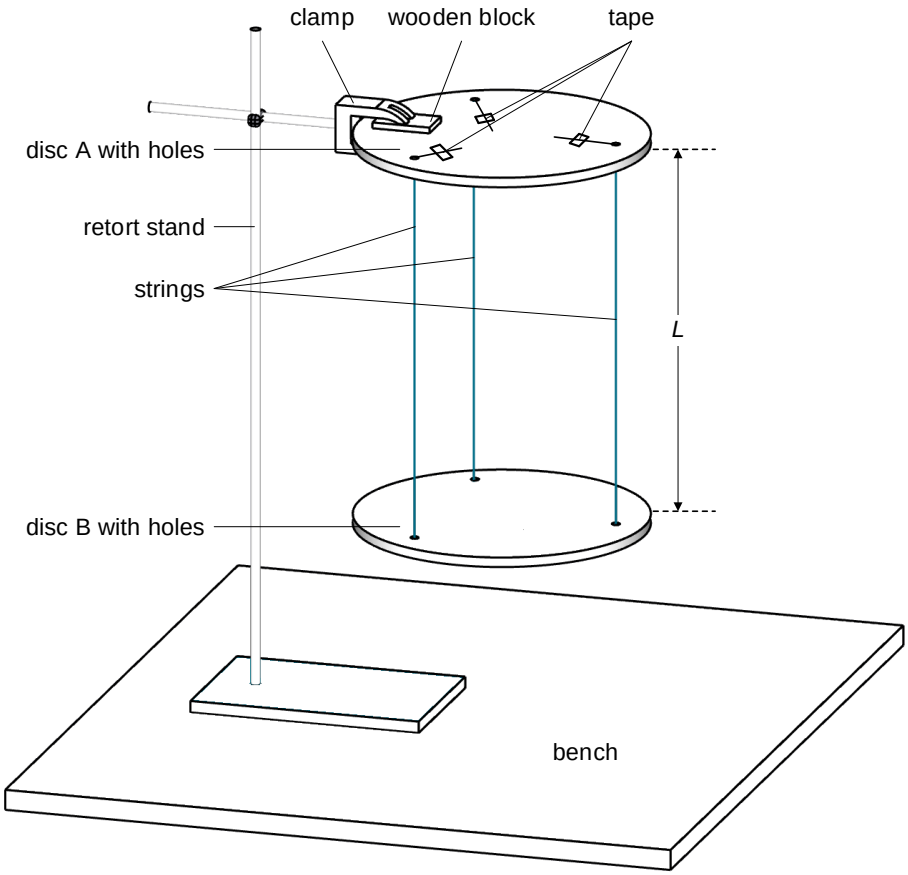


Fig. 3.2

The distance between the bottom face of disc A and the top face of disc B is *L*.

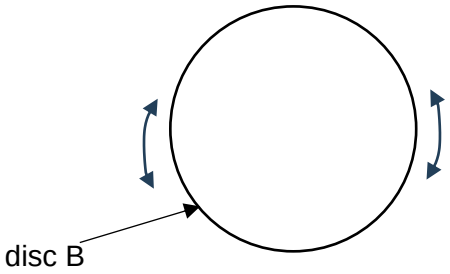
Adjust the lengths of the strings until *L* is approximately 30 cm.

Both discs should be horizontal.

Measure and record *L*.

L = ...

(i) For the first mode of oscillation, rotate disc B so that it oscillates about a vertical axis through its centre as shown in Fig. 3.3.



Top view

Fig. 3.3

Determine the period T_R of these oscillations.

T_R = ... [1]

(ii) For the second mode of oscillation, Displace disc B to the left and release such that it oscillates in a vertical plane.

Determine the period T_S of these oscillations.

T_S = ... [1]

(c) Increase L to approximately 50 cm. Repeat **(b)(i)** and **(b)(ii)**.

L = ...

T_R = ...

T_S = ... [2]

(d) It is suggested that

$$T_R = k\frac{\sqrt{L}}{r}$$

where k is a constant.

(i) Use your values from **(a)(iii)**, **(b)** and **(c)** to determine two values of k.

first value of k = ...

second value of k = ... [2]

(ii) Justify the number of significant figures given in your values of k.

.....

.....

..... [1]

(iii) State whether the results of your experiment support the suggested relationship.

Justify your conclusion by referring to your answer in **(a)(iv)**

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[1]

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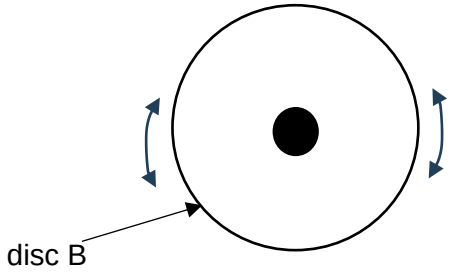
(e) Different numbers of 50 g masses were now placed at the centre of the disc B, and the disc was rotated so that it oscillates about a vertical axis through the centre as shown in Fig. 3.4.



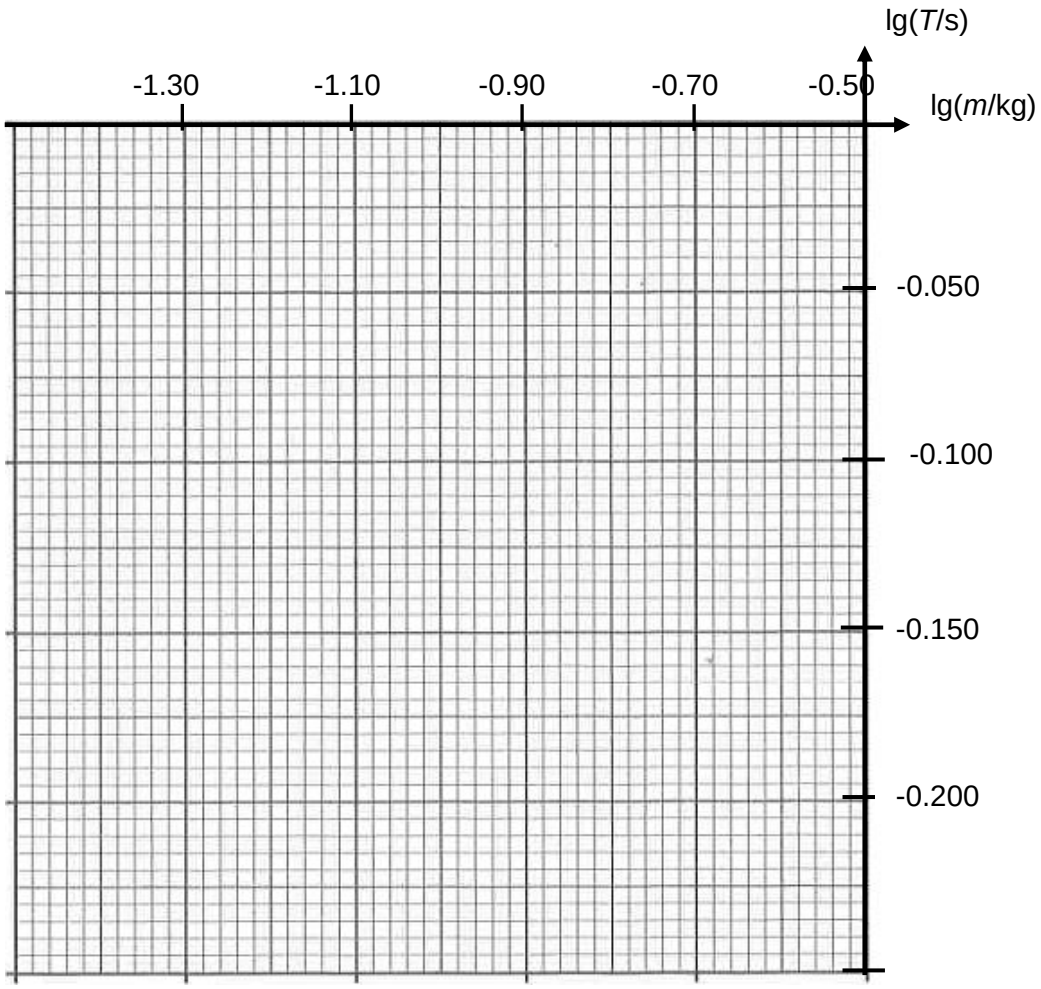
Top view

Fig. 3.4

The following results for mass *m*, time for *N* oscillations *t*, period *T*, lg (*T*/s) and lg (*m*/kg) were recorded.

m /kg	*N*	Time for *N* oscillations			*T* /s	lg (*T*/s)	lg (*m*/kg)
		t_1 /s	t_2 /s	<*t*> /s			
0.050	15	15.0	15.0	15.0	1.00	0.000	-1.30
0.100	20	16.5	16.4	16.5	0.823	-0.085	-1.000
0.150	20	14.6	14.6	14.6	0.730	-0.137	-0.824
0.200	20	13.3	13.3	13.3	0.665	-0.177	-0.699
0.250	20	12.4	12.4	12.4	0.620	-0.200	-0.602

(i) Plot lg (*T*/s) against lg (*m*/kg) on the grid and draw the straight line of best fit. [1]



(ii) Theory suggests that T and m are related by the equation

$T = k\, m^{\,n}$ where n and k are constants.

Use your graph to determine the value of n.

n = ... [3]

(f) The behaviour of the oscillating system in **(b)(i)** also depends on *r*, the distance of the strings from the centre of the disc according to the expression in **(d)**.

Explain how you would investigate this relationship.

Your account should include:

- your experimental procedure
- how the holes in both discs are accurately located
- control of variables
- how you would use your results to show that *T* is inversely proportional to *r*.

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[5]

[Total: 22 marks]

4. Acoustical engineers use foam material to manage reflection of sound as part of acoustic engineering of a venue. Different foam materials can be characterized by its density, ρ .

A student is investigating how the intensity of reflected sound from a foam attached to a wall, as shown in Fig. 4.1 varies with density of the foam, ρ, and the frequency of the incident sound, *f.*

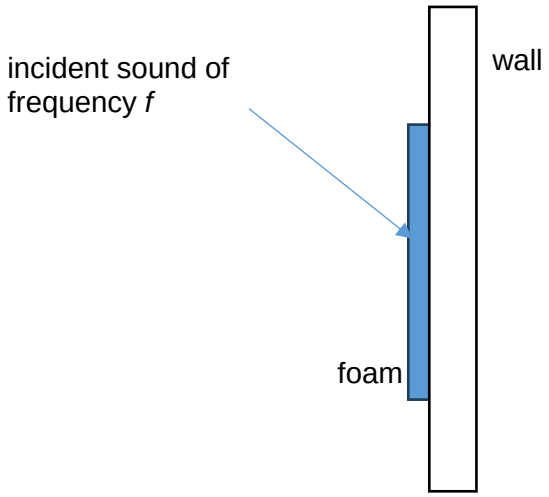

Fig. 4.1

It is suggested that the intensity of the reflected sound I, is related to frequency of sound *f* and density of foam ρ by the relationship

$$I = \mathrm{P}\, f^{m} \rho^{n}$$

where P, *m* and *n* are constants.
You are provided with a variety of foams of different densities. You may also use any other equipment usually found in the physics laboratory.

Design an experiment to determine the values of P, *m* and *n*.

Draw a diagram to show the arrangement of your apparatus. Pay particular attention to:

(a) the equipment you would use,

(b) the procedure to be followed,

(c) how you would measure the frequency and determine intensity of the reflected sound,

(d) the control of variables,

(e) any precautions that would be taken to improve the accuracy and safety of the experiment.

Diagram

[Total : 12 marks]