TEMASEK JUNIOR COLLEGE
2023 JC2 PRELIMINARY EXAMINATION
Higher 2

NAME

CG

PHYSICS 9749/04

PAPER 4

30 August 2023

2 hours 30 minutes

Candidates answer on the Question Paper.

Shift
Laboratory

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.

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	/12
2	/ 9
3	/22
4	/12
TOTAL	/55

1 In this experiment, you will investigate the motion of a small container in water.

(a) You have been provided with two glass marbles and a small container with a separate lid.

The dimensions of the glass marbles and the small container are shown in Fig. 1.1.

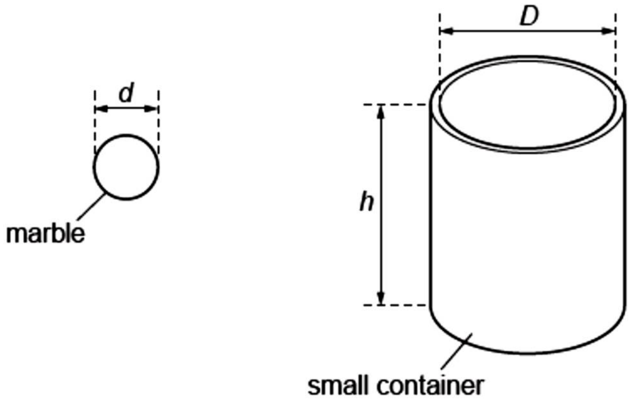

Fig 1.1

(i) Measure and record the diameter d of the marble.

d = ... [1]

(ii) Measure and record the height h and the inner diameter D of the small container.

h = ...

D = ... [1]

(b) (i) Place the small container in the tray. Fill the small container with water.
You may use the beaker to transfer water.

(ii) Place **one** glass marble in the small container. Wait until the water has stopped overflowing. Place the lid on the small container.

(iii) The fraction x of glass in the small container is given by

$$x = \frac{2nd^3}{3D^2h}$$

where n is the number of marbles in the small container.

Calculate x.

x = ... [1]

(iv) Justify the number of significant figures that you have given for your value of *x*.

....

....

.... [1]

(c) **(i)** Place the small container containing water and the marble in the cylinder as shown in Fig. 1.2.

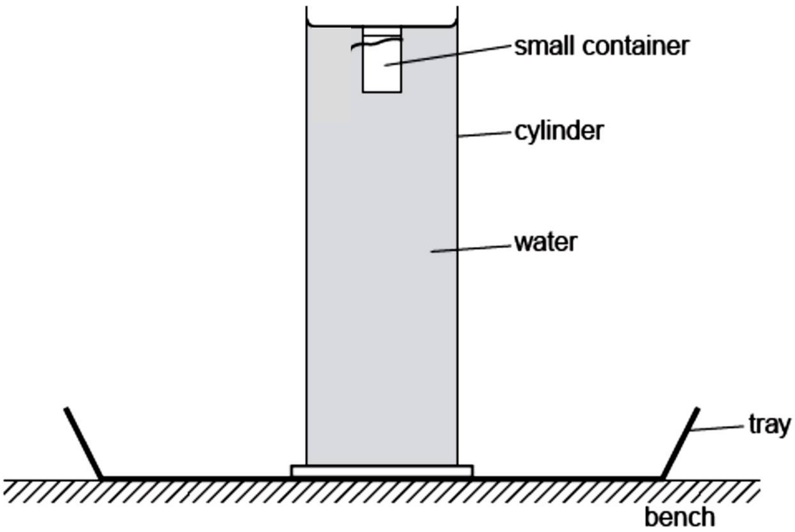

Fig. 1.2

(ii) Release the small container and measure the time t taken for it to fall to the bottom of the cylinder.

t = ... [1]

(iii) Estimate the percentage uncertainty in your value of t.

percentage uncertainty = ... [1]

(d) Repeat **(b), (c)(i) and (c)(ii)** using **two** marbles.

x = ... [1]

t = ... [1]

(e) It is suggested that the relationship between t and x is

$$t^2 = \frac{k}{x} \qquad \text{where } k \text{ is a constant.}$$

(i) Using your data, calculate two values of k.

first value of k = ...

second value of k = ... [1]

(ii) State whether the results of your experiment support the suggested relationship. Justify your conclusion by referring to your value in **(c)(iii)**.

....

....

....

.... [1]

(f) **(i)** State **one** significant sources of error in this experiment.

....

....

.... [1]

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

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.... [1]

[Total : 12 marks]

2 In this experiment, you will investigate how the voltage across components in a circuit varies as the resistance of the circuit is changed.

(a) **(i)** Set up the circuit as shown in Fig. 2.1.

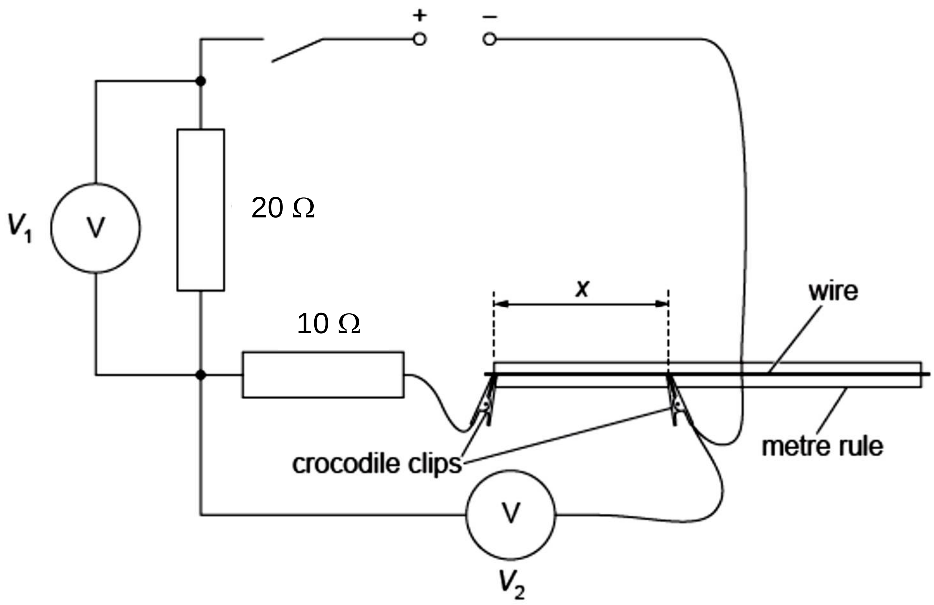


Fig 2.1

Attach the crocodile clips to the wire so that the distance *x* is approximately 20 cm.

(ii) Measure and record *x*.

x = ... [1]

(b) **(i)** Close the switch.

(ii) Record the voltmeter readings V_1 and V_2.

V_1 = ...

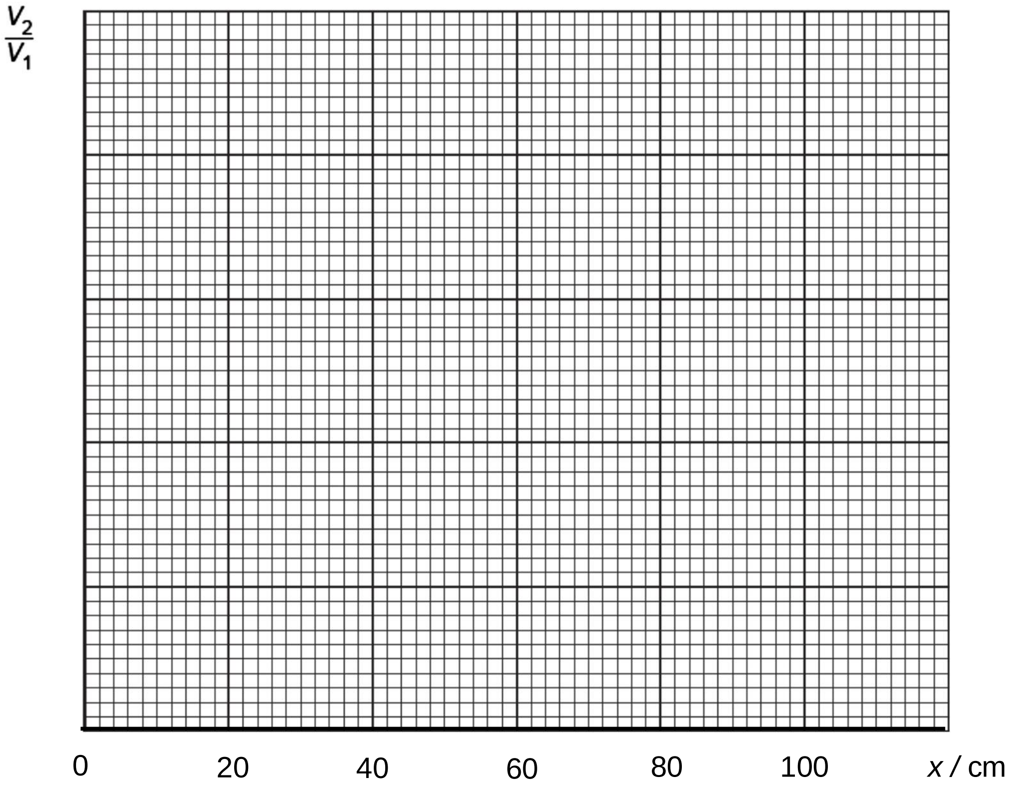
V_2 = ... [1]

(iii) Open the switch.

(c) Change x and repeat **(a)(ii)** and **(b)** until you have **five** sets of readings of x, V_1 and V_2 till x = 90 cm.
Include values of $\frac{V_2}{V_1}$ in your table.

[2]

(d) **(i)** Plot a graph of $\frac{V_2}{V_1}$ against x.



[2]

(ii) State the relationship between $\frac{V_2}{V_1}$ and x based on your graph.

.... [1]

(iii) On the same axes of your graph in **(d) (i)**, draw another line to represent the experimental results if the experiment is repeated using a **thinner** wire of the **same** material. Label this line Z.

[2]

[Total : 9 marks]

3 In this experiment, you will investigate a metre rule rocking on a beaker.

(a) Assemble the apparatus as shown in Fig. 3.1 with the beaker placed horizontally. The centres of each of the two masses should be at the same distance r from the centre of the metre rule, where r is approximately 30 cm.

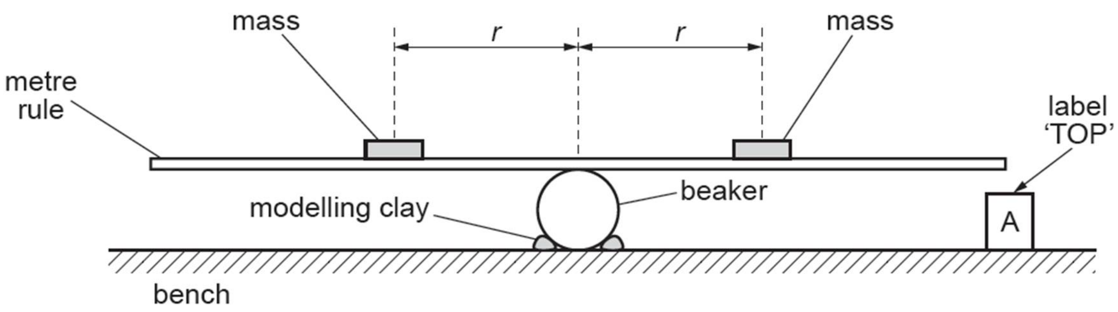


Fig. 3.1

(b) **(i)** Measure and record the distance r.

r = ... [1]

(ii) Explain how you measured r accurately.

....

....

.... [2]

(iii) Adjust the position of the metre rule on the beaker so that the metre rule is balanced and approximately parallel to the bench.

(c) **(i)** Hold down the end of the metre rule on A, as shown in Fig. 3.2.

(ii) Release the metre rule and measure and record the time T for it to move up and then down again to its lowest position, as shown in Fig. 3.2.

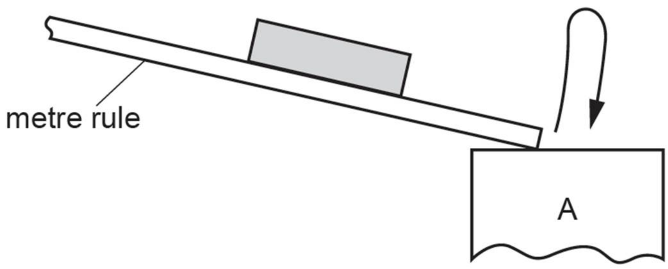


Fig. 3.2

T = ... s [1]

(d) Reposition the two masses at a different distance r from the centre of the metre rule and repeat **(b)(i), (iii)** and **(c)** to obtain further sets of values for r and T.

Present your results in a table.

[6]

(e) Theory suggests that T and r are related by the equation

$$T^3 = ar^2 + b$$

where a and b are constants.

Plot a suitable graph to determine the values of a and b. Give appropriate units to your values.

a = ...

b = ... [7]

(f) Comment on any anomalous data or result that you may have obtained. Explain your answer.

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.... [1]

(g) A metre rule can also be made to rock about its centre of mass in a similar mode of oscillation via the force from a coiled spring. A student hypothesized that the period T thus obtained would be described by the equation

$$T^2 = cx + d$$

where c, d are constants and x is the extension of the spring.

You are provided with several coiled springs, each of which have different spring constant.

Design an experiment to investigate whether the equation suggested by the student is valid.

Your account should include:

- Your experimental procedure
- How you would use your results to verify the equation
- Why you might have difficulty in using springs with very small spring constant.

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.... [4]

[Total: 22 marks]

4 A student investigates the power dissipated by a lamp connected to a model wind turbine as shown in Fig. 4.1.

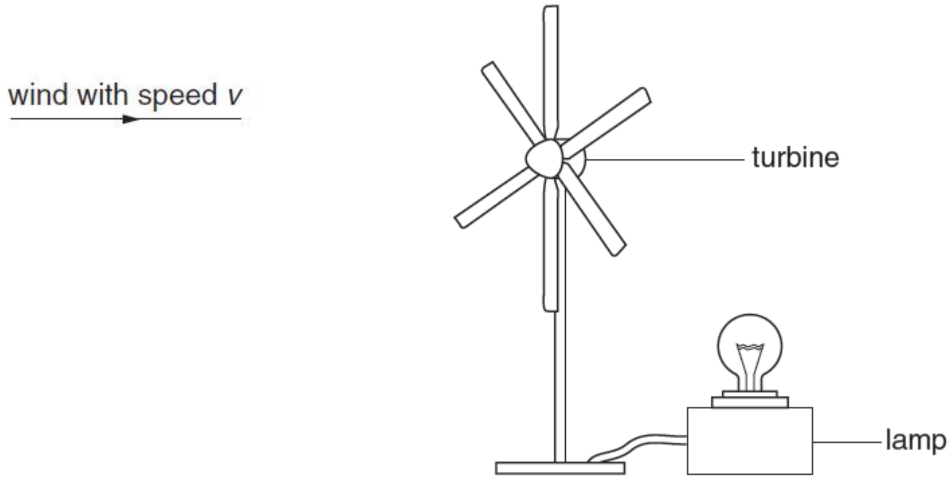

Fig. 4.1

The power P dissipated in the lamp depends on the speed v of the wind and the angle θ between the axis of the turbine and the direction of the wind, as shown by the top view in Fig. 4.2.

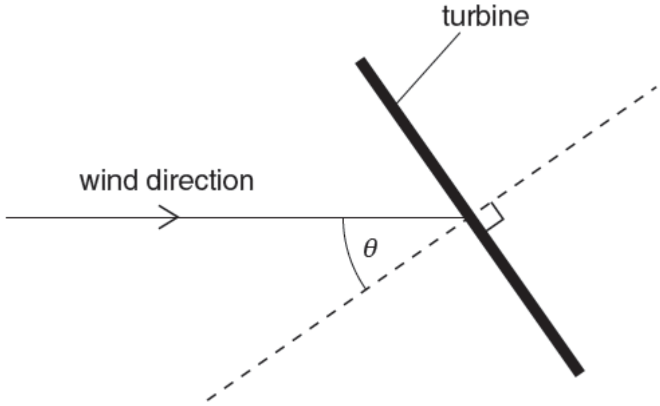

Fig. 4.2

It is suggested that

$$P = k (\cos \theta)^m v^n$$

where k, m and n are constants.

Design a laboratory experiment to determine the values of n and m. Assume that you are given a model wind turbine. You should draw a diagram, showing the arrangement of your equipment.

You should pay particular attention to:

(a) the equipment you would use

(b) the procedure to be followed,

(c) the measurements to be taken,

(d) the control of variables,

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

Diagram

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[Total : 12 marks]