NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME	

CLASS		TUTOR'S NAME	
CENTRE NUMBER	S	INDEX NUMBER	

PHYSICS

9749/04

21 August 2023

Paper 4 Practical

2 hours 30 minutes

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	**/ 15**
2	**/ 6**
3	**/ 22**
4	**/ 12**
Total	**/ 55**

1 In this experiment, you will investigate an electrical circuit.

(a) Set up the circuit shown in Fig. 1.1, using a 15 Ω resistor as *P* and a 22 Ω resistor as *Q*.

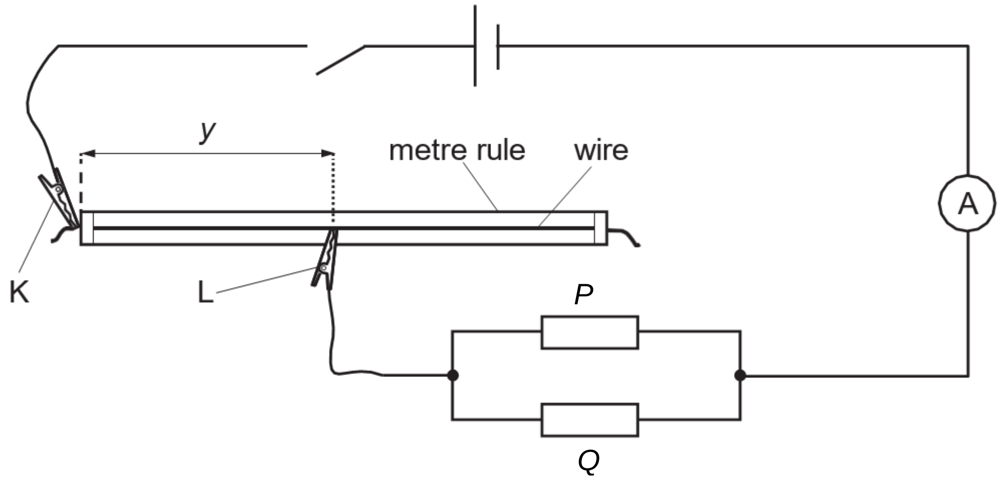

Fig. 1.1

K and L are crocodile clips.

Place L approximately half-way along the wire.

The distance between K and L is *y* as shown in Fig. 1.1.

Record *P*, *Q* and *y*.

P = ...

Q = ...

y = ...

Close the switch.

Record the ammeter reading *I*.

I = ... [1]

Open the switch.

(b) Change one or both of the resistors in *P* and *Q*.

Record the new values of *P* and *Q*.

P = ...

Q = ...

Close the switch.

Change the position of L on the wire so that the ammeter reading is as close as possible to the value for *I* in **(a)**.

Record *y*.

y = ... [1]

Open the switch.

(c) Repeat **(b)** until you have six sets of readings of *P*, *Q* and *y*, using different combinations of the resistors provided as *P* and *Q*.

Present your results clearly.

[5]

(d) It is suggested that the quantities *y*, *P* and *Q* are related by the expression

$$y = -\frac{MPQ}{P+Q} + N$$

where *M* and *N* are constants.

Plot a suitable graph to determine *M* and *N*.

M = ...

N = ...

[6]

(e) Theory suggests that

$$\frac{N}{M} = \frac{E}{I}$$

where *E* is the electromotive force (e.m.f.) of the cell.

Calculate *E*. Give an appropriate unit.

E = ... [1]

(f) *M* is inversely proportional to *r*, the resistance per unit length of the wire taped to the meter rule, while *N* is the ratio of the total resistance in the circuit to *r*.

On the graph on page 5, draw the line that would show the result obtained if the wire taped to the meter rule is changed to one made of the same material, but having a larger diameter. [1]

[Total: 15]

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

(a) Place the wooden strip on the pivot, as shown in Fig. 2.1.

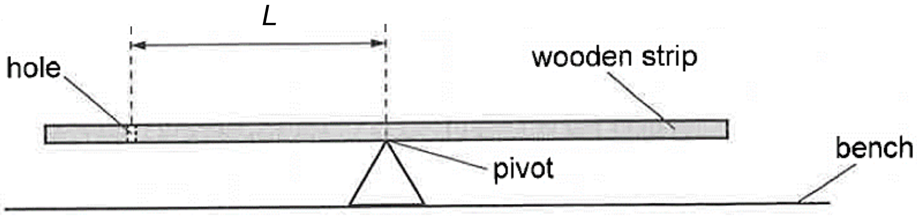

Fig. 2.1

Adjust the position of the wooden strip on the pivot until it balances. The distance between the centre of the hole in the wooden strip and the pivot is *L*.

Without marking the wooden strip, measure and record *L*.

L = ... [1]

(b) Set up the apparatus as shown in Fig. 2.2.

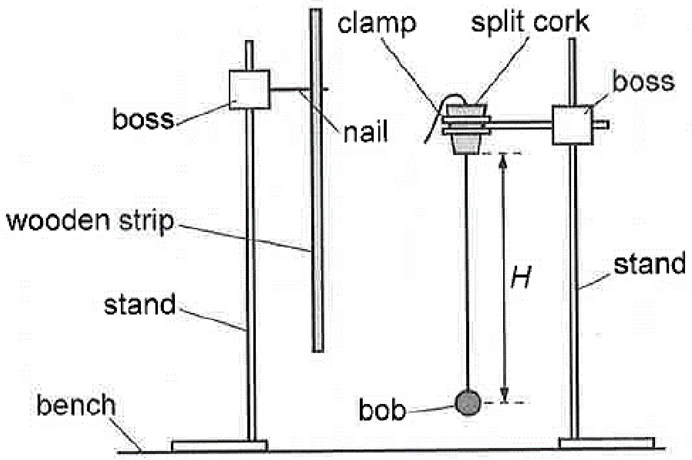

Fig. 2.2

The distance between the bottom of the split cork and the centre of the bob is *H*.
Adjust the string in the split cork until *H* is approximately 40 cm.

Displace the bob and the bottom of the wooden strip towards you through a short distance. Release the bob and the strip at the same time. The oscillations of the bob and the strip will be out of phase.

Adjust *H* so that the oscillations of the bob and the strip remain in phase for several cycles after release.

Measure and record *H*.

H = ... [1]

(c) The quantities L and H are related by the equation

$$b = \sqrt{L(H - L)}$$

where b is a constant.

(i) Calculate b.

b = ... m [2]

(ii) If you were to repeat this experiment using a similar wooden strip with several holes at different positions along its length, describe the graph that you would plot to determine *b.*

....

....

....

....

....

....

....[2]

[Total: 6]

3 A simplified mechanism of a fuel gauge in a car is shown in Fig. 3.1. A rod attached to a float rotates about a pivot as the float moves up or down. This causes the reading on the fuel gauge to change.

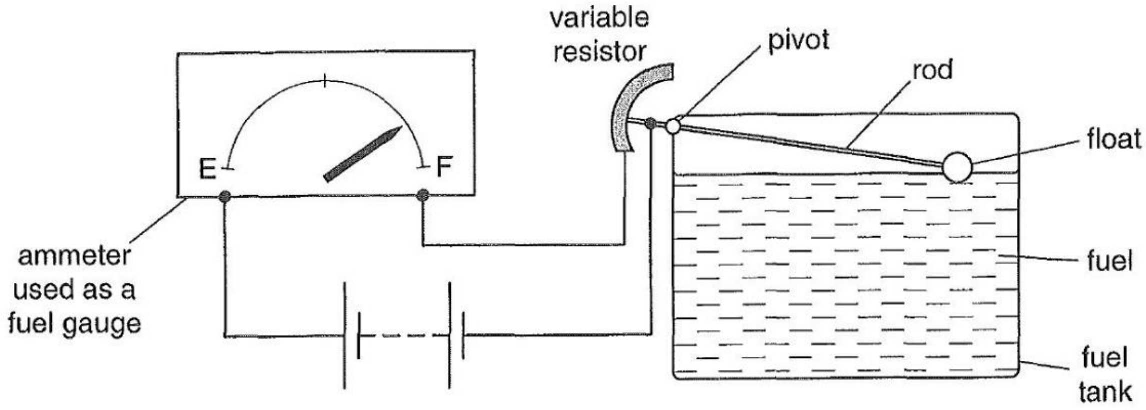

Fig. 3.1

In this experiment, you will investigate a model of this mechanism.

You have been provided with a metre rule which models as the rod, and a tube which models as the float.

(a) (i) The distance between the centre of the hole in the metre rule and the 50 cm mark on the metre rule is *L*, as shown in Fig. 3.2.

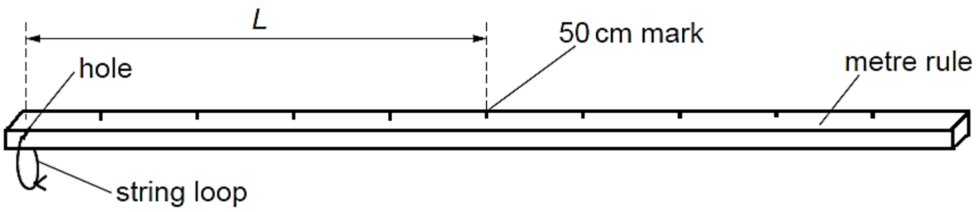

Fig. 3.2

Determine *L* in metres.

L = ... m

The outer diameter of the tube is *d*, as shown in Fig. 3.3.

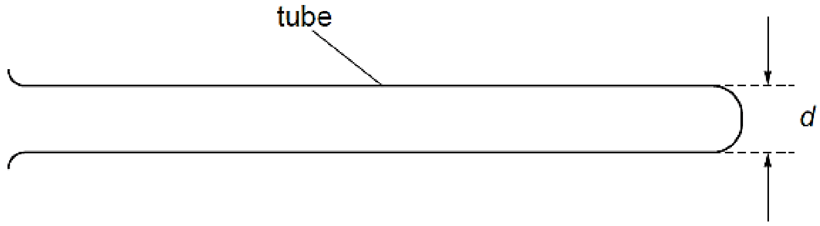

Fig. 3.3

Measure and record *d* in metres.

d = ... m [1]

(ii) Calculate the cross-sectional area A of the tube where

$$A = \frac{\pi d^2}{4}.$$

A = ... m^2 [1]

(b) (i) Add sand to the tube as shown in Fig. 3.4.

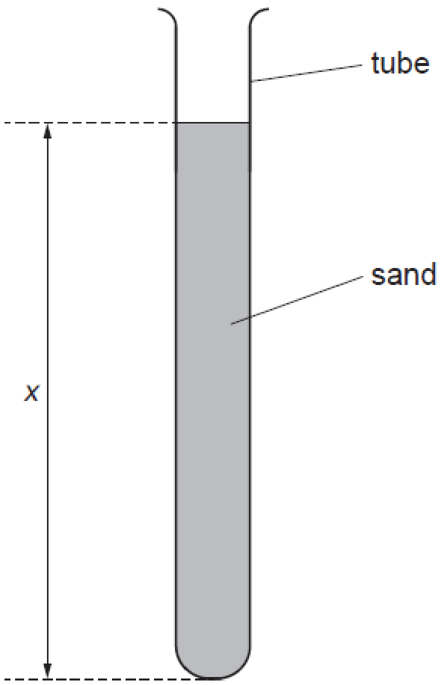

Fig. 3.4

The height of sand in the tube is x. Adjust the amount of sand in the tube until x is approximately 12 cm.

Measure and record x in metres.

x = ... m

(ii) Push the stopper securely into the tube.

(iii) Set up the apparatus as shown in Fig. 3.5. Fill the beaker with water and place it inside the tray.

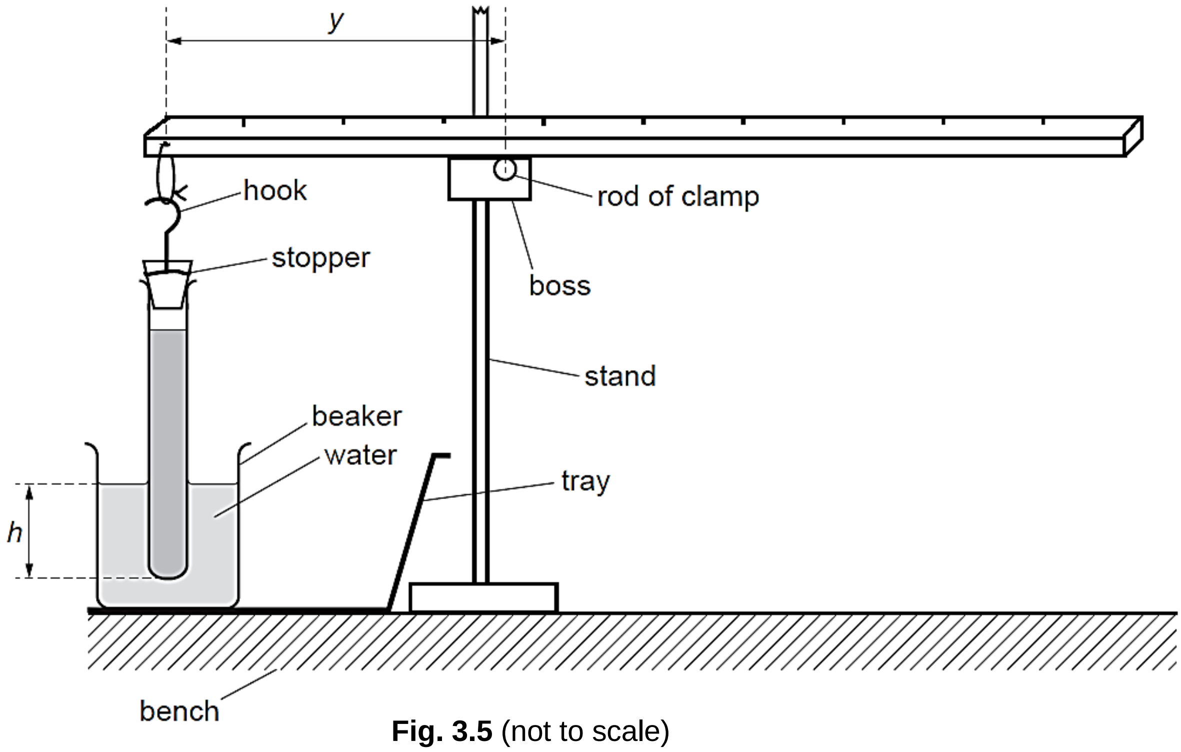

Fig. 3.5 (not to scale)

Using the hook, suspend the tube from the string loop and place the tube in the water.

The distance between the bottom of the tube and the surface of the water in the beaker is *h*.

Adjust the apparatus so that the rule is pivoted on the rod of clamp, with the rule approximately parallel to the bench and the value of *h* approximately 5 cm.

The distance between the rod of clamp and the hole in the rule is *y*.

Measure and record *h* and *y*. Give your values in metres.

h = ... m

y = ... m
[2]

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

percentage uncertainty = ... % [1]

(v) The mass *M* of the metre rule and string is indicated on the metre rule.

Write down the value of *M*.

M = ... kg

Calculate *C* using

$$C = \frac{1}{L} - \frac{Ah\rho}{ML}$$

where $\rho = 1.0 \times 10^3$ kg m^{-3}.

C = ... m^{-1} [1]

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

....

....

....[1]

(c) **(i)** Remove some of the sand from the tube so that *x* is approximately 8 cm.

Measure and record *x*.

x = ... m

(ii) Adjust the apparatus shown in Fig. 3.4 so that the rule is approximately parallel to the bench and *h* has the same value as in **(b)(iii)**.

Measure and record *y*.

y = ... m
[2]

(d) **(i)** It is suggested that the relationship between *y*, *x* and *C* is

$$\frac{1}{y} = (kx + C)$$

where *k* is a constant.

Use your values from **(b)** and **(c)** to determine 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)(iv)**.

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....[1]

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

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....[1]

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

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....[1]

(f) **(i)** Using the tube of sand where x is approximately 8 cm, vary h to determine the effect on y.

Present your results and conclusion clearly.

....

....[3]

(ii) During actual testing, the beaker is to be filled with fuel (petrol).

Suggest, with a reason, whether your values of y in **(f)(i)** increase, remain the same or decrease for the same values of x and h used.

....

....

....[1]

(g) To model the emptying of the fuel tank, water is gradually removed from the beaker.

The apparatus in Fig. 3.5 requires the metre rule to be supported on the pivot and the position of the pivot must **not change**. The metre rule should rotate accordingly to achieve equilibrium.

(i) Predict, without taking further readings, whether the metre rule in Fig. 3.5 will rotate clockwise or anticlockwise about the pivot.

....[1]

(ii) The angle of rotation θ of the metre rule from its horizontal position about the pivot depends on the water level H in the beaker.

Describe how you would investigate the effect of H on θ.

You may suggest the use of any additional apparatus commonly found in a school physics laboratory.

You account should include:

- your experimental procedure and how can θ be measured directly
- control of variables
- how you would use your results to investigate the relationship of H on θ
- why it would be difficult to obtain enough results to reach a valid conclusion.

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....[4]

[Total: 22]

4 When a stream of water falls from a tap onto a plate, the water spreads out in a relatively thin layer until it reaches a particular distance from the stream where the water suddenly increases in depth. The phenomenon where this depth change occurs is called a hydraulic jump and separates two distinct regions A and B, as shown in Fig. 4.1.

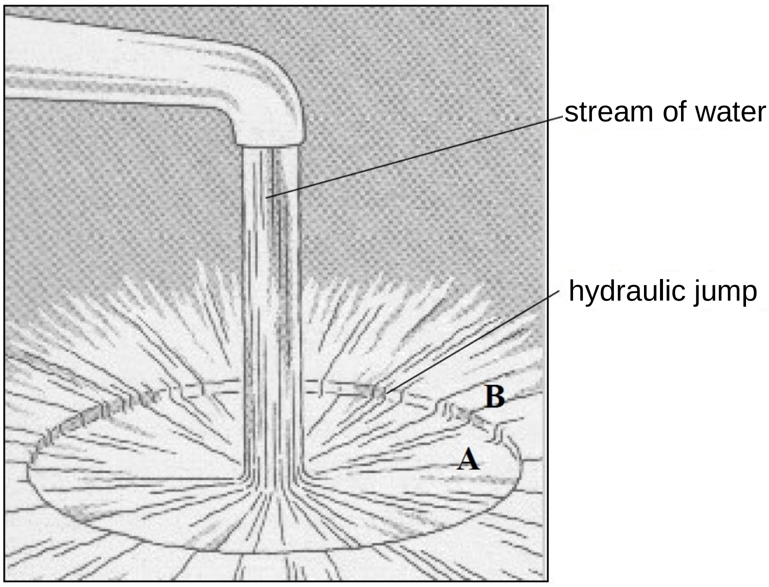

Fig. 4.1

The diameter *D* of region A will depend on the volume flow rate (volume per unit time) *V* and the height *h* of the stream of water.

The diameter of region A is given by

$$D = kV^p h^q$$

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

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

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

- the equipment you would use
- the procedure to be followed
- how the diameter of region A may be measured non-invasively
- the control of variables
- any precautions that should be taken to improve the accuracy of the experiment

Diagram

[12]

End of Paper