Index Number		Name	

Anglo-Chinese School (Independent)
A Methodist Institution (Founded 1886)

PRELIMINARY EXAMINATION 2024
YEAR 4 EXPRESS

PHYSICS **6091 / 03**

Tuesday **30 July 2024** **1 hour 50 minutes**

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an 2B pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.
All of your answers should be written in this Question Paper: scrap paper must **not** be used.
Graph paper is provided in this Question Paper. Additional sheets of graph paper should be used only if it is necessary to do so.

You will be allowed to work with the apparatus for a maximum of 55 minutes for each section.
You are expected to record all your observations as soon as they are made.
An account of the method of carrying out the experiments is not required.

The use of an approved scientific calculator is expected, where appropriate.

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	
2	
3	
Total	

Section A

1 *In this experiment, you will deduce the path taken by a light ray undergoing total internal reflection in a glass block.*

You are provided with:

- A4 Plain Paper
- Cork mat
- Five optical pins
- Rectangular glass block
- Protractor
- 30.0 cm ruler
- Set square

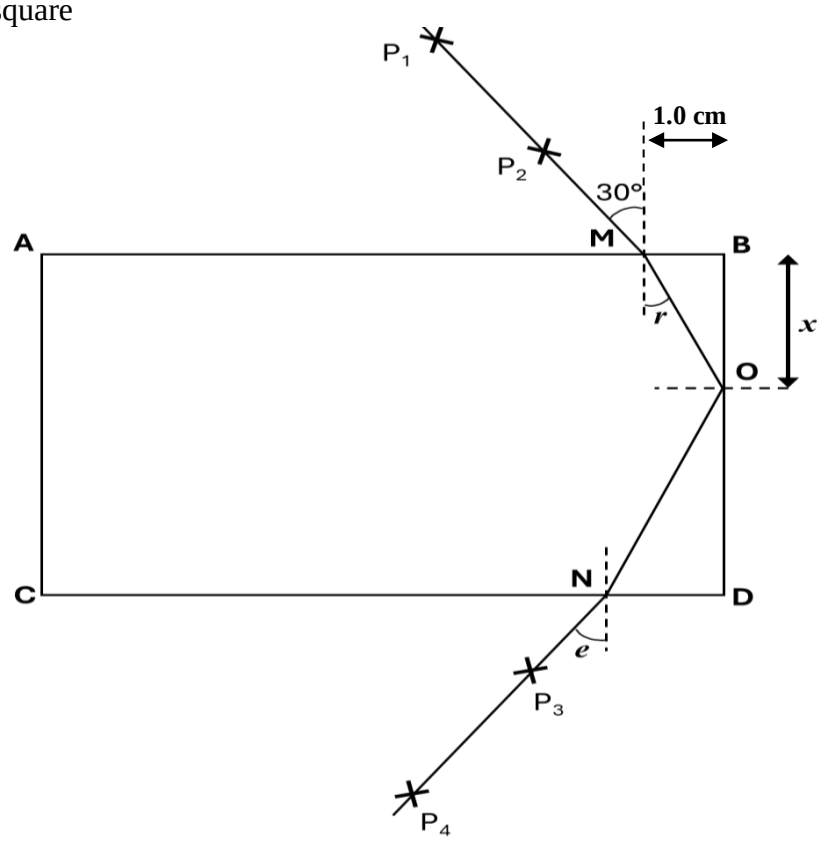

Fig. 1.1 (not to scale)

(a) Place the largest surface of the block in the middle of the sheet of plain paper. Draw around the block to mark its position.

Remove the glass block and label the corners **ABCD** as shown in **Fig. 1.1**.
Draw a normal at point **M**, 1.0 cm from the corner point **B** of the block, as shown in **Fig. 1.1**. Use the protractor to construct an incident ray at an angle of incidence ***i*** of 30°.

Replace the block and place the plain paper on the cork mat.
Place the two object pins $\mathbf{P_1}$ and $\mathbf{P_2}$ along the incident ray.
Position your eyes to look through the side **CD** of the glass block. You should observe 2 reflected images of $\mathbf{P_1}$ and $\mathbf{P_2}$ appear at side **BD** when looking through the side **CD**.

Place two further pins **P_3** and **P_4** in line with the reflected images of **P_1** and **P_2** so that, when viewed through the block, the four pins appear to be one behind the other.

Remove the block and draw a line joining **P_4** and **P_3** to the edge of the block and mark the point of intersection as point **N**. This line is the emergent ray.

Measure and record the distances **BD** and **ND** from your trace using the ruler.

BD = ...

ND = ... [1]

(b) **(i)** Calculate the value of x, using the equation $x = \frac{BD}{ND+1.0} \times 1.0\ cm$, where **BD** and **ND** are expressed <u>in centimetres</u>.

x = ... [1]

(ii) At a distance of x below corner **B** of the block, mark out the point **O** on side **BD**, as shown in **Fig. 1.1**.

Draw straight lines from **M** to **O**, and **O** to **N** to represent the path taken by the incident ray after entering the block.

Measure the angle of refraction r inside the block.

r = ... [1]

(c) State 2 precautions you took to improve the accuracy of the experiment.

1 ……

……

2 ……

……
[2]

(d) Comment on the relationship between the angle of incidence, i, and the angle of emergence, e, based on your experiment.

……
[1]

(e) Submit your trace together with this answer sheet at the end. [4]

[Total: 10]

2 *In this experiment, you will investigate the current in a circuit where a fixed resistor and a variable resistor are arranged in parallel.*

You are provided with:

- a 3.0 V battery holder with batteries
- a switch
- an ammeter
- a voltmeter
- a length of resistance wire mounted on a metre rule
- six connecting leads
- a resistor labelled **R**
- a jockey

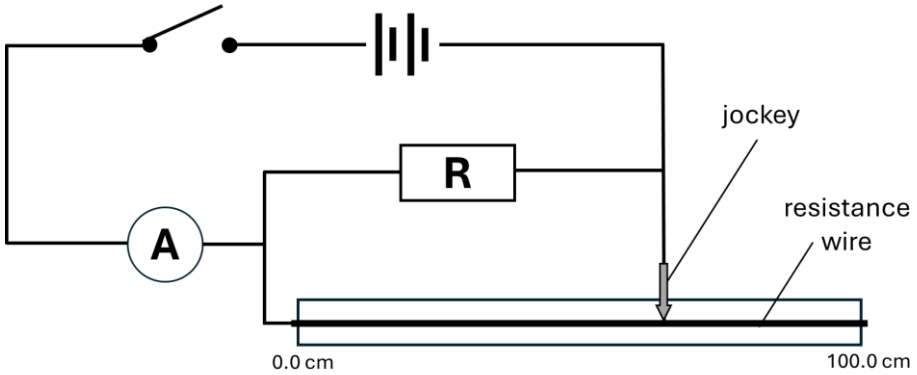

Fig. 2.1

Set up the apparatus as shown in **Fig. 2.1**.

The jockey can be connected at different points along the length of the resistance wire. Connect the jockey to the wire at the 50.0 cm mark of the ruler.

Close the switch.

(a) With the jockey still connected in this position,

(i) Record the length, ***L***, from the 0.0 cm mark of the metre rule to the position of the jockey on the wire, <u>in metres</u>.

L = ... m [1]

(ii) Record the reading of current on the ammeter, ***I***.

I = ... [1]

(b) Open the switch. Disconnect the jockey from the resistance wire.

Connect the voltmeter across the two ends of the battery.
Record the reading of electromotive force (e.m.f.) on the voltmeter, ***V***.

V = ... [1]

(c) Calculate the value of 1/***L***.

1/***L*** = ... [1]

(d) Quantities ***I*** and ***L*** are related by the equation

$$I = \frac{V}{L \times R_w} + \frac{V}{R_1}$$

where
I is the current in the circuit,
V is the e.m.f. of the battery,
L is the position of the jockey on the resistance wire (<u>in metres</u>)
$\boldsymbol{R_w}$ is the resistance of the full 1.000 m length of resistance wire,
$\boldsymbol{R_1}$ is the resistance of resistor **R**.

Using the same apparatus provided as the above experiment, plan an experiment to determine the values of $\boldsymbol{R_w}$ and $\boldsymbol{R_1}$.

Your plan should include:

- a description of how you would perform the experiment,
- one precaution taken to ensure the accuracy of your experiment,
- a statement of the graph that you would plot to test the relationship,
- a sketch of the graph that you would expect to obtain,
- an explanation of how you would obtain a value of the constant $\boldsymbol{R_w}$ and $\boldsymbol{R_1}$ from your graph if the suggested relationship is correct.

[6]

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[Total: 10]

Section B

3 *In this experiment, you will investigate how the length of a wool string affects the time taken for a suspended rotating tube to come to a momentary rest.*

You are provided with:

- a pair of wooden blocks
- a retort stand, boss and clamp
- a hollow tube with groove in the middle and a mark at one end
- a wool string
- a metre rule
- a stopwatch

In this experiment, a tube is suspended from a length of wool. The tube will be rotated. You will investigate how the time taken for the rotating tube to momentarily come to rest depends on the length of the wool holding the tube.

Attach the wool to the middle of the tube making use of the groove on the tube to position the wool correctly. Clamp the other end of the wool securely using the two wooden blocks. The length ***l*** should be 50 cm, as shown in **Fig. 3.1**.

Assemble the apparatus as shown in **Fig. 3.1**.

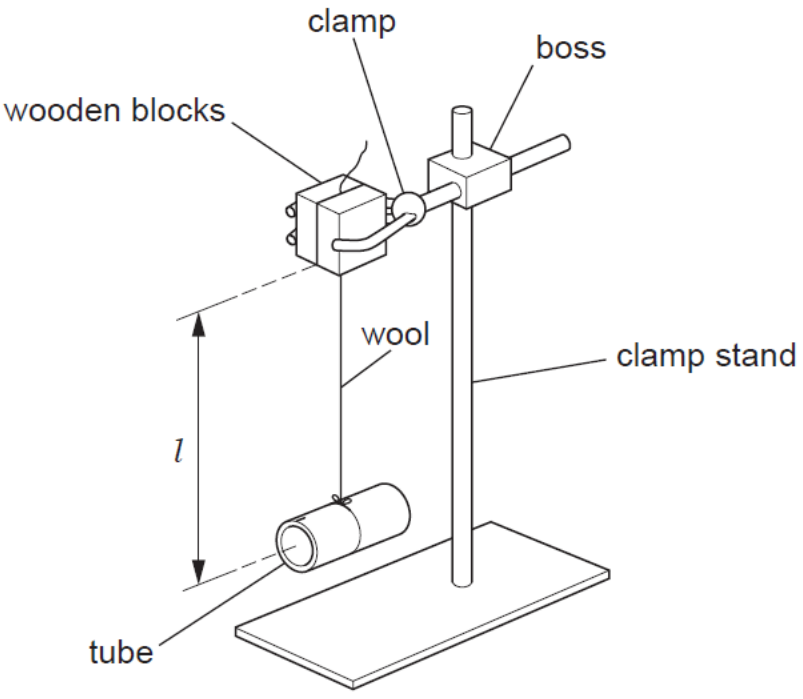

Fig. 3.1

The distance from the bottom of the wooden blocks to the centre of the hollow tube is ***l***. Loosen the clamp and adjust the wool string until ***l*** is equal to 50 cm. Tighten the clamp.

(a) **(i)** Record the length of the wool string from the bottom of the wooden blocks to the centre of the hollow tube.

l = ...
[1]

(a) **(ii)** Explain one difficulty in obtaining an accurate value for ***l***.

.....

.....

.....
[1]

Keeping the wool taut and the tube horizontal, turn the tube through ten complete turns in order to twist the wool, as shown in **Fig. 3.2**.

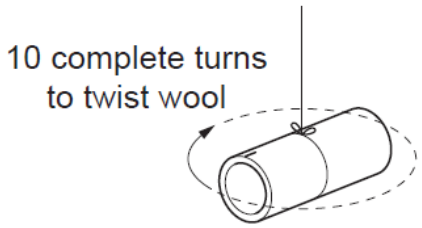

Fig. 3.2

The mark at one end of the tube is to help you count complete turns.

When you release the tube, the wool will untwist and then twist again, before coming to rest momentarily. It will then untwist in the other direction.

(b) Release the tube, and record the time ***t*** taken for the tube to come to rest momentarily for the first time. Determine an accurate value for the time ***t***.

t = ...
[3]

(c) Change ***l*** and repeat the experiment until you have five sets of values for ***l*** and ***t***. The length ***l*** of the string from **Fig. 3.1** should be in the range 10 cm to 50 cm.

Include the values of $\sqrt{\boldsymbol{l}}$ in your table of results.

Record all of your measurements and calculated values in your table. [5]

(d) Using the grid provided,

(i) plot a graph of ***t*** against $\sqrt{\boldsymbol{l}}$. Draw the line of best fit. [5]

(ii) determine the gradient and y-intercept of this line.

gradient = ... [2]

y-intercept = ... [2]

(e) Describe **one** improvement to the experiment that reduce experimental error.

……

……

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[1]

[Total: 20]