**P510/3**
**Physics**
**Paper 3**
**July/August 2024**
**3¼ hours**

# NATIONAL EDUCATION RESEARCH & EXAMINATION BUREAU

## UACE NEREB NATIONAL MOCKS 2024

## PHYSICS

### PAPER 3

**3 HOURS 15 MINUTES**

**INSTRUCTIONS TO CANDIDATES**

- Answer question 1 and one other question.
- Any additional question answered will not be marked.
- Candidates are not allowed to use the apparatus or write for the first fifteen minutes.
- Graph papers are provided.
- Mathematical tables and silent non-programmable calculators may be used.
- Candidates are expected to record on their scripts all the observations as these observations are made and plan the presentation of the records so that it is not necessary to make a fair copy of them.
- The working of the answers is to be handed in.
- Details on the question paper should not be repeated in the answer, nor is the theory of the experiment required unless specifically asked for. Candidates should however record any special precaution they have taken and any particular feature of their method of going about the experiment.
- Marks are given mainly for clear record of the observations actually made, for their suitability and accuracy and for the use made of them.

1. In this experiment you will determine the moment of inertia, I of the metre rule by two methods.

**METHOD 1**

(a) Measure and record the mass, **M** of the metre rule labeled **A**.
(b) Clamp a half metre rule with its scale facing you.
(c) Tie two pieces of threads at points **X** and **Y** on the metre rule such that the distance $e$ = 0.100m and the threads are at equal distances from the 50cm mark.
(d) Suspend the metre rule labeled A from the half metre rule using the two threads, as shown in figure 1. Make sure that the scale of the metre rule faces upwards and the threads are parallel.
(e) Adjust the length, d to 0.600m

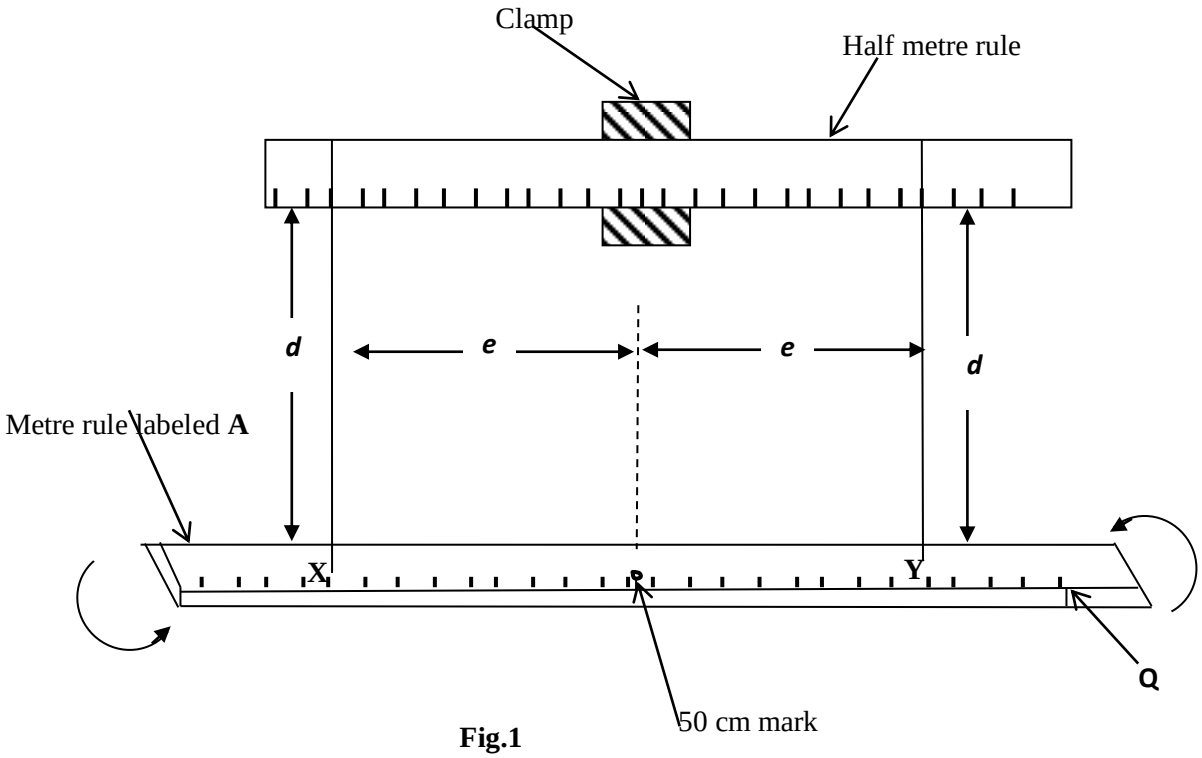


**Fig.1**

(f) Turn the metre rule through a small angle about a vertical axis through the centre and release it to oscillate.
(g) Measure and record the time to for 20 oscillations.
(h) Determine the period $T_o$
(i) Calculate the value of $I_o$ from the expressions.

(j) $I_o = \frac{mge^2T_o^2}{4\pi^2 d}$

**METHOD II**

(a) Set up the apparatus as shown in figure 2.
(b) Place two masses, m, each of mass 0.050kg such that the distance, $y_o$ = 0.100m from the 50cm mark.

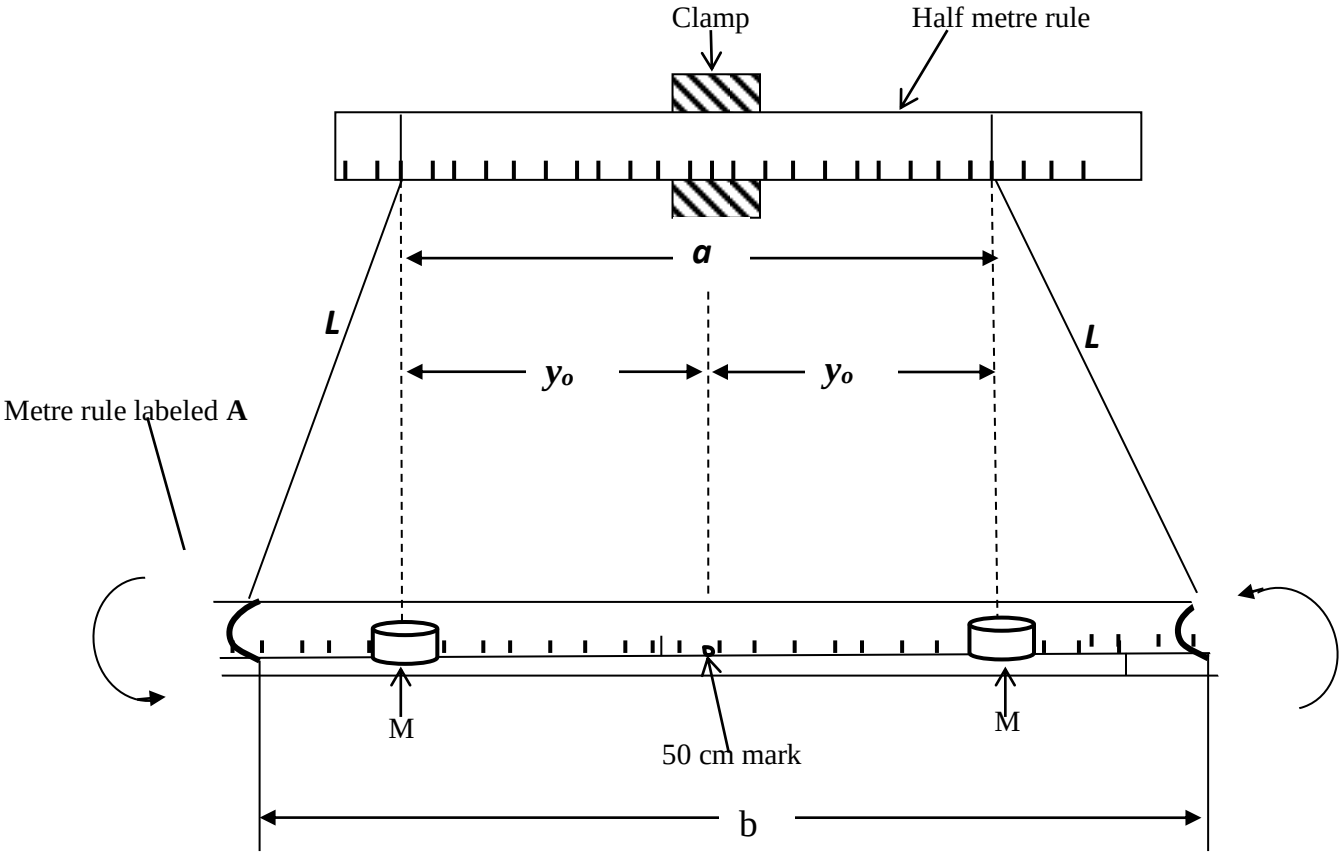


**Fig.2**

(c) Adjust the distance, a, to 0.200m and the lengths ***L*** of the threads to 0.6 00m.
(d) Adjust the separation, b, of the threads to 0.900m. Ensure that the threads are at equal distances from the 50cm mark.
(e) Turn the metre rule through a small angle about a vertical axis through the centre and release it to oscillate.
(f) Measure and record the time, **t** for 20 oscillations.
(g) Determine the period, **T**.
(h) Repeat procedures from (d) to (g) for values of b = 0.800, 0.700, 0.600, 0.500 and 0.400m.
(i) Tabulate your results including values of $T^2$ and $\frac{1}{b}$.
(j) Plot a graph of $T^2$ against $\frac{1}{b}$

(k) Find the slope, **s**, of your graph.

(l) Calculate the value of $I_2$ from the expression

$I_2 = \frac{Mgs}{16\pi^2 d}$ where $\pi = 3.14, g = 9.81ms^{-2}$,

d = 0.600m.

(m) Calculate the value of $I$ from the expression: $I = \frac{I_1 + I_2}{2}$

2. In this experiment you will determine the refractive index, n, of the material of the glass block by two methods.

**METHOD 1**

(a) Fix a plain sheet of paper on the soft board using drawing pins.

(b) Place the glass block in the middle of a plain sheet of the paper with the broadest face upwards and trace its outline PQRS.

(c) Remove the glass block.

(d) Construct a normal LN at N where PN = 5.0cm.

(e) Draw a line EN such that the angle $\alpha = 30^o$ as shown in fig. 3.

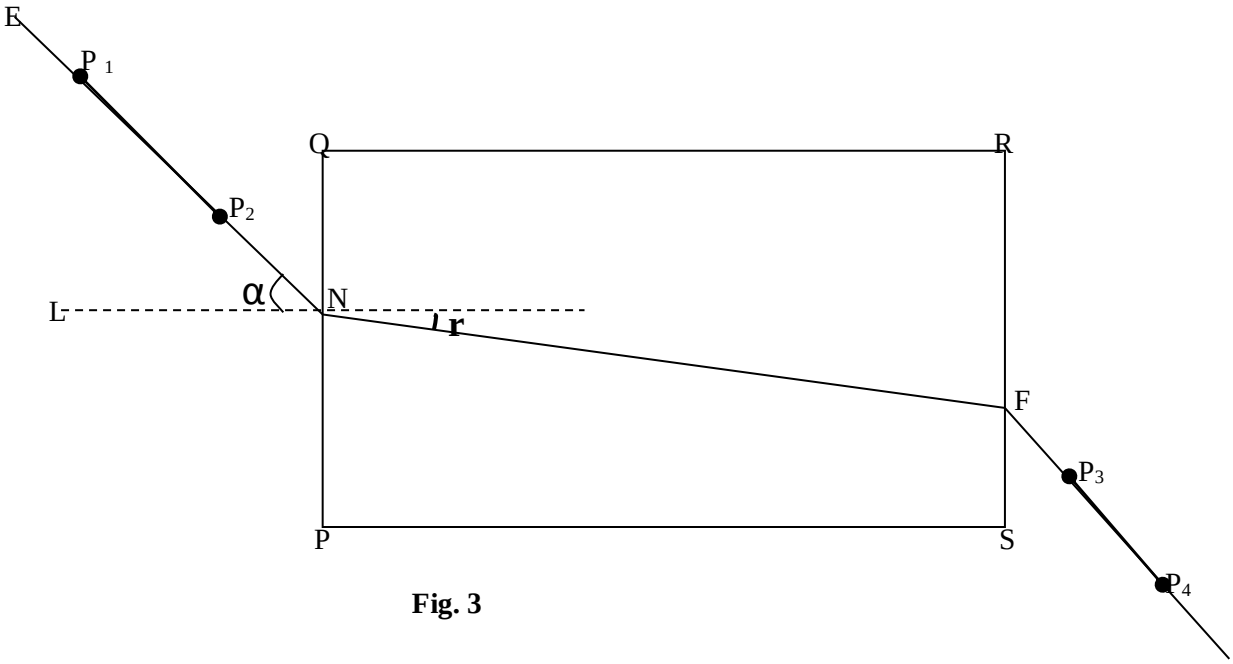


**Fig. 3**

(f) Fix two optical pins $P_1$ *and* $P_2$ vertically on the line **EN**.

(g) Place the glass block on its outline.

(h) While looking through the glass block from side RS, fix pins $P_3$ *and* $P_4$ vertically such that they appear to be in line with the images of $P_1$ *and* $P_2$

(i) Remove the glass block and the pins.

(j) Draw a line through $P_3$ *and* $P_4$ to meet RS at F.

(k) Join **F** to **N**.

(l) Measure and record angle, r.

(m) Calculate the value of $n_1$ from the expression.

$$n_1 = \frac{sin\alpha}{sinr}$$

**METHOD II**

(a) Measure and record the width, w, of the glass block.
(b) Calculate the value of $w^2$.
(c) Fix a fresh plain white sheet of paper on the soft board using drawing pins.
(d) Place the glass block in the middle of the plain white sheet of paper with the broadest face up wards and trace its outline ABCD.
(e) Remove the glass block.
(f) Construct a normal NQ at Q where AQ = $\frac{1}{4}$ $(AB)$
(g) Draw a line OQ such that the angle ***i*** = 20° as shown in figure 4.

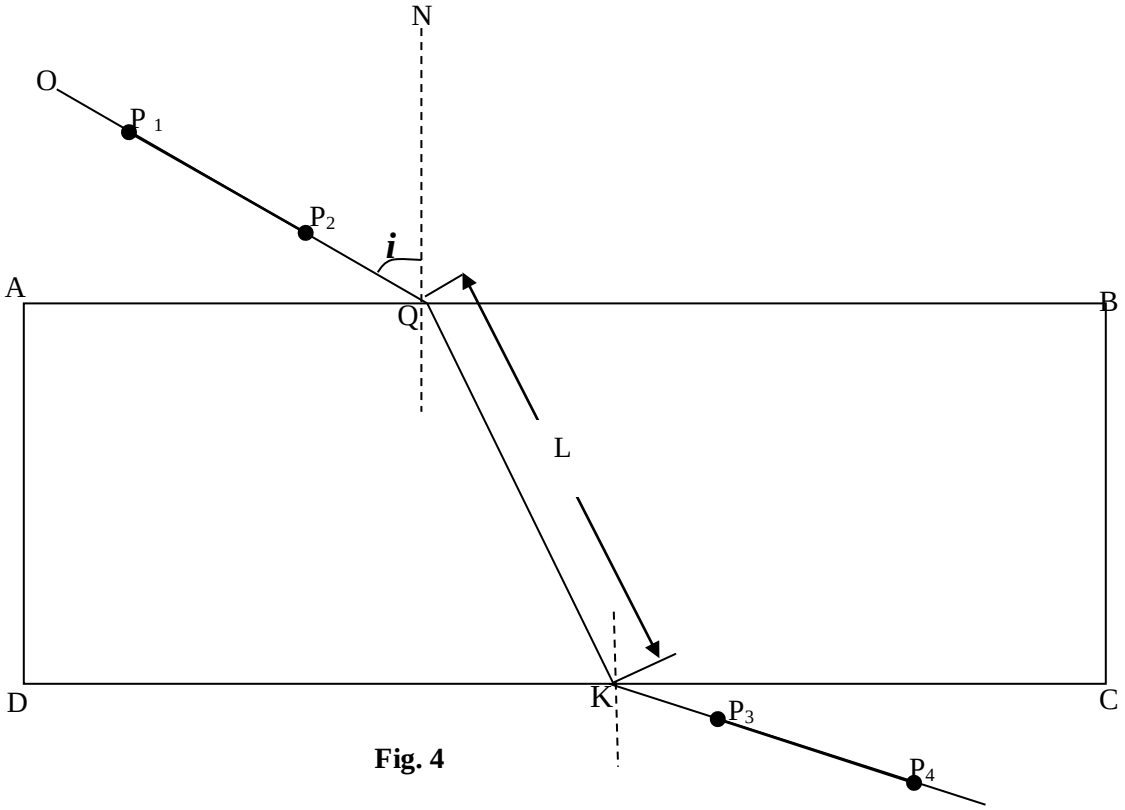


**Fig. 4**

(h) Fix two optical pins $P_1$ $and$ $P_2$ vertically on line OQ.
(i) Place the glass block on its outline.

(j) While looking through the glass block side CD, fix pins $P_3$ and $P_4$ vertically such that they appear to be in line with the images of $P_1$ and $P_2$.

(k) Remove the glass block and the pins.

(l) Draw a line through $P_3$ $and$ $P_4$ to meet CD at **K**.

(m) Join **K** to **Q**.

(n) Measure and record the length**, *L*** of KQ.

(o) Repeat procedures from (g) to (n) for values of $L$ = 30°, 40°, 50°, 60° and 70°

(p) Tabulate your results including values of $\frac{1}{L^2}$ $and$ $sin^2 i$.

(q) Plot a graph of $sin^2 i$ $against$ $\frac{1}{L^2}$.

(r) Find the slope, $\beta$ of your graph.

(s) Calculate the value of $n_2$ from the expression:

$$n_2 = \sqrt{\frac{-\beta}{w^2}}$$

(t) Calculate the value of n from the expression

$$n = \frac{n_1 + n_2}{2}$$

**KEEP YOUR TRACINGS FOR HANDING IN.**

3. In this experiment, you will check the calibration of an ammeter using a slide wire potentiometer.

(a) Connect the voltmeter provided across the terminals of the cell marked E.
(b) Read and record the voltmeter reading $E_o$
(c) Connect the circuit shown in figure 5.

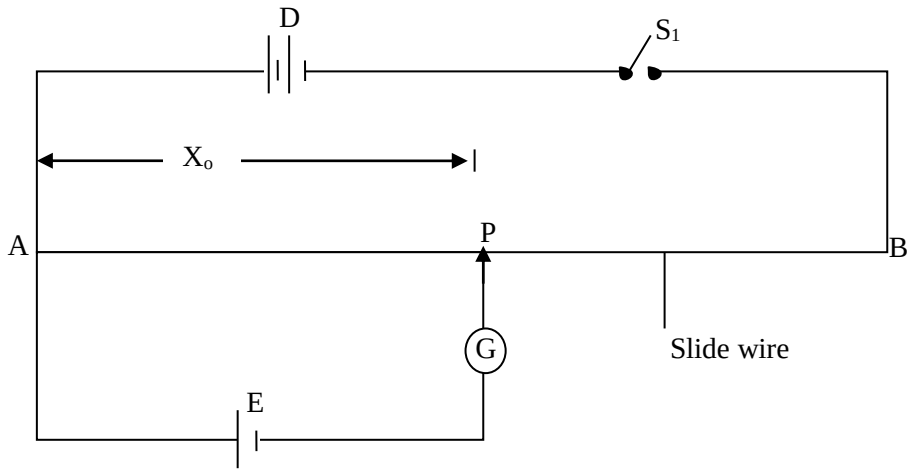


**Fig. 5**

(d) Close the switch, $S_1$.
(e) Move the sliding contact, **P**, along the slide wire, AB to locate a point on it for which **G** shows no deflection.
(f) Measure and record the balance length, $l_o$.
(g) Open switch, $S_1$.
(h) Calculate the value of K from the expression.

$$K = \frac{E_O}{R_S X_O}$$

Where Rs = 1Ω

(i) Connect the circuit shown in figure 6.

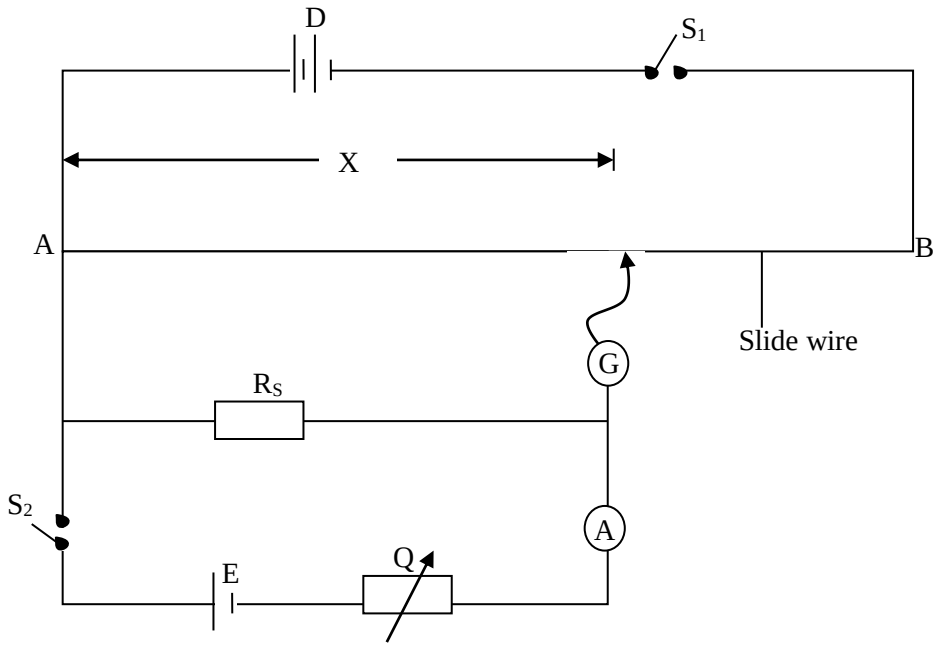


**Fig. 6**

(i) Close switch, $S_2$.

(k) Adjust the rheostat, **Q** until the ammeter A reads $I_r = 0.15A$

(l) Close switch $S_1$

(m) Move the sliding contact, **P**, along the slide wire to locate a point on it for which **G** shows no deflection.

(n) Measure and record the balance length **X**.

(o) Open switch, $S_1$

(p) Repeat procedures (K) to (O) for ammeter readings
$I_r$ = 0.20, 0.25, 0.30, 0.35, 0.40, 0.45 and 0.5A

(q) Tabulate your results including values of $I_a$= Kx.

(r) Plot a graph of $I_a$against $I_r$

(s) Find the slope, **S** of the graph.

(t) Comment on the value of the slope

**END**