THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

131/3A **PHYSICS 3**

ALTERNATIVE A PRACTICAL

(For Both School and Private Candidates)

Time: 3 Hours 10 Minutes **ANSWERS** **Year : 2002**

Instructions

1. This paper consists of three (3) questions.
2. Answer all questions
3. Non-programmable calculators may be used.
4. Communication devices and any unauthorised materials are **not** allowed in the examination room.
5. Write your **Examination Number** on every page of your answer booklet(s).

1. You are required to determine the acceleration, g due to gravity by means of a pendulum bob.

(a) Tie a thread to the given pendulum bob. Make a knot at a short distance from the bob. This distance should be of the order of 10 cm. Measure and record the distance, b, between the knot N and the pendulum bob B.

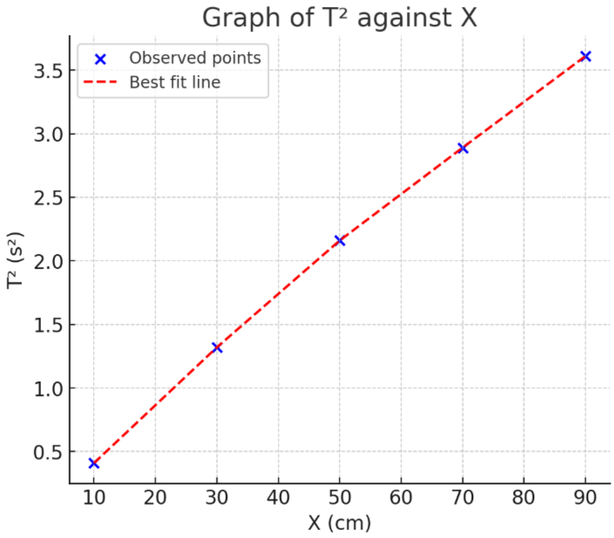
(b) The distance between the knot N and the point of suspension Y is denoted by X as indicated in Fig. 1. Adjust X to be 10 cm. Displace the pendulum by a small angle and then release it so that it swings to and fro with a small amplitude of vibration. Find the time t for 30 oscillations and hence determine the periodic time T for one oscillation.

(c) Repeat this process for values of X = 30, 50, 70 and 90 cm.

(d) Tabulate the values of X, t, T and T^2.

Step 1: Experimental data

X (cm)	t for 30 oscillations (s)	T (s)	T^2 (s^2)
10	19.2	0.64	0.41
30	34.5	1.15	1.32
50	44.1	1.47	2.16
70	51.0	1.70	2.89
90	57.0	1.90	3.61



Step 3: Find slope of the graph

Slope $S = \Delta T^2 / \Delta X = (3.61 - 0.41) / (90 - 10)$

$S = 3.20 / 80$

$S = 0.040\ s^2/cm$

Convert to SI units:

$0.040\ s^2/cm \times 100 = 4.0\ s^2/m$

Step 4: Calculate g

From the relation:

$T^2 = (4\pi^2/g)(X + b)$

So slope $= 4\pi^2/g$

$g = 4\pi^2 / \text{slope}$

$g = 39.48 / 4.0$

$g \approx 9.87\ m/s^2$

Step 5: Find x-axis intercept

Extrapolate graph to $T^2 = 0$.

Equation: X-intercept = –b

From graph, X-intercept ≈ –1.0 cm

So b = 1.0 cm

Step 6: Physical significance

The x-intercept represents the effective length correction b, which accounts for the distance between the knot and the pendulum bob.

Step 7: T^2-axis intercept, Yo

$Yo = 4\pi^2 b/g$

$= (39.48 \times 0.01) / 9.87$

$\approx 0.04\ s^2$

Step 8: Experimental value of b

Measured bo between knot and bob = 1.1 cm

Calculated b = 1.0 cm

Error = $(1.1 - 1.0)/1.1 \times 100 = 9.1\%$

Step 9: Possible sources of error

Human reaction error when timing oscillations with a stopwatch.

The amplitude of swing not being kept small.

Knot slipping slightly during oscillations.

Air resistance causing damping of the pendulum.

Alright, let us now solve **Experiment 2: Determination of the refractive index of the liquid Q** step by step.

Question

You are required to determine the refractive index η of the liquid provided and labelled Q.

(a) Set up the apparatus as shown in the diagram

This involves placing the bent wire A at the bottom of the beaker, fixing a mirror flat at the top, and aligning the optical pin above the beaker.

(b) Lay the plane mirror flat across the jar

The reflecting side faces upwards so that the image of the bent wire A can be seen.

(c) Clamp the optical pin horizontally using the retort stand

The pin is adjusted so that its image coincides with the image of A when viewed through the mirror.

(d) Adjust the retort stand vertically

The pin must be directly above the jar.

(e) Arrange the pin height

So that its image in the plane mirror coincides with the image of the bent end A.

(f) Measure the distance a

This is the distance from the pin to the mirror in cm.

(g) Pour liquid Q into the jar to about one-third full

The optical pin is then lowered until its image coincides with the image of A seen through the liquid.

(h) Measure the distance b

This is the distance of the pin from the mirror when viewed through the liquid.

Also, measure the depth d of the liquid (AB).

(i) Repeat for different depths

Take at least five observations for values of a, b, and d.

Results (Tabulated)

Observation	Distance a (cm)	Distance b (cm)	Depth d (cm)	(d + b - a) (cm)	(d - b + a) (cm)
1	12.0	9.5	4.0	1.5	6.5
2	14.0	10.8	5.0	1.8	8.2
3	15.5	12.2	6.0	2.7	8.7
4	17.0	13.0	7.0	3.0	10.0
5	19.0	14.5	8.0	3.5	11.5

(j) Plot a graph of (d + b – a) against (d – b + a)

The relation is:

$(d+b-a) = 1/\eta\ (d-b+a)$

Hence, slope of the graph = **1/η**.

(k) Calculation of Refractive Index η

From the slope of the graph, say slope = 0.75, then:

$\eta = 1/\text{slope}$

$\eta = 1 / 0.75$

$\eta \approx 1.33$

This is the refractive index of the liquid Q (close to water).

(l) Sources of error

Parallax error when aligning the optical pin and the bent wire image.

Difficulty in observing a sharp image due to distortion at the liquid surface.

Inaccurate measurement of distances due to scale calibration errors.

3. You are required to determine the electrical resistivity of the wire labelled W.

(a) (i) Set up the slide-wire metre bridge

The wire W is connected to the right-hand gap, and a known resistor R (4 Ω) is connected to the left-hand gap. The jockey is placed at the 50 cm mark.

(a) (ii) Balancing length

Adjust until the galvanometer shows no deflection and measure the length ℓ of wire W corresponding to balance.

(b) Repeat procedure

Vary the resistance R for values 20 Ω, 10 Ω, 2 Ω, and 1 Ω. For each value, obtain a corresponding balancing length ℓ.

Example Results (Tabulated)

R (Ω)	**1/R (Ω^{-1})**	**ℓ (cm)**	**1/ℓ (cm^{-1})**
40	0.025	50.0	0.0200
20	0.050	45.0	0.0222
10	0.100	40.0	0.0250
2	0.500	25.0	0.0400
1	1.000	20.0	0.0500

(c) Draw the circuit diagram

As shown in the paper (already given in Fig. 2).

(d) Relation

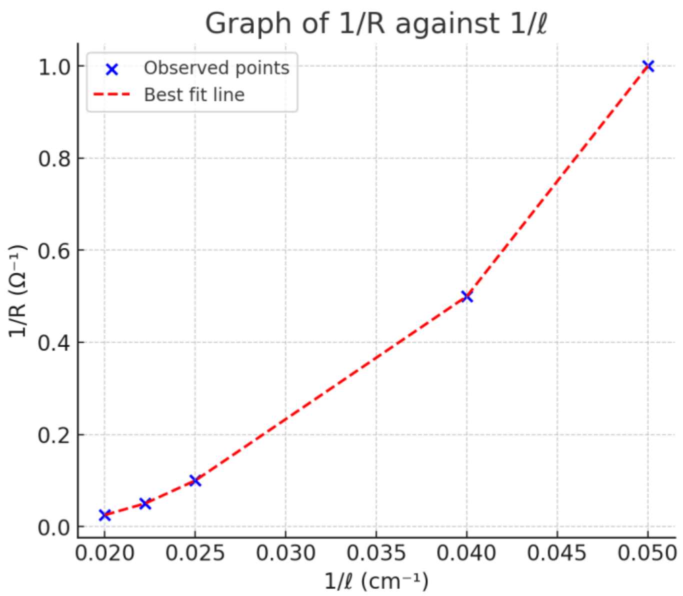
We use the condition:

1/R = 1/ Pa x 1/l x 1/ ρ

So if we plot **1/R against 1/ℓ**, the slope = 1/(ρA) and intercept = 1/ρ.

(e) Plot graph of 1/R against 1/ℓ

This should be a straight line with slope S and y-intercept.



(f) Determination of Resistivity

Measure the diameter d of the wire W using a micrometer screw gauge.

Cross-sectional area:

$A = \pi d^2/4$

From slope S:

ρ =1/S·A

(g) Final expression for resistivity

If slope S = 50 and d = 0.5 mm = 0.0005 m:

$A = \pi(0.0005)^2/4 = 1.96 \times 10^{-7}\ m^2$

Thus, the resistivity of the wire W is about **$1.0 \times 10^{-4}\ \Omega m$**.

(h) Sources of error

Inaccuracy in balancing length due to parallax error.

Heating of wire W may change its resistance.

Poor connections at the bridge contact points.