THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

131/3A **PHYSICS 3A**

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 2023**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

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1. You are required to perform an experiment according to the following instructions:

(a) Tie up the given metal ring and suspend it from the retort stand, then tie a pendulum bob at the lower position of the ring as shown in the following Figure:

The setup includes:
- A retort stand with a clamp holding the upper part of the cotton thread.
- Cork pads may be used to prevent slippage.
- A cotton thread tied to a metal ring suspended vertically.
- A bob tied at the bottom of the thread hanging freely below the metal ring.
- The bob swings in a horizontal circular motion when displaced slightly.

This setup simulates a conical pendulum.

(b) Starting with length L = 30 cm, displace the bob slightly sideways and then release it in such a way that it oscillates in a horizontal plane. Determine the time, t for 20 complete oscillations and the periodic time, T.

The time t is recorded using a stopwatch, and T is calculated as T = t / 20.

(c) Repeat the procedures in 1 (a) and (b) for L = 40 cm, 50 cm, 60 cm and 70 cm in each experiment and record the value of t and T.

Using sample values:

L (cm)	t (s)	T (s) = t/20	T^2 (s^2)
30	22.0	1.10	1.21
40	25.4	1.27	1.61
50	28.4	1.42	2.02
60	31.0	1.55	2.40
70	33.0	1.65	2.72

(ii) Plot a graph of L (cm) against T^2 (s^2).
T^2 is on the x-axis, and L (cm) on the y-axis. A straight line is expected indicating $L \propto T^2$.

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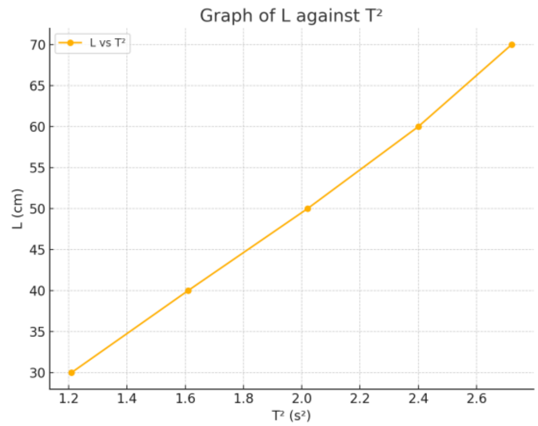

(iii) From the graph, read and record the value of L at $T^2 = 0$.

Extrapolating the straight line back to $T^2 = 0$ gives the intercept on the L-axis. Suppose the intercept is 0.0 cm. This suggests that there is no oscillation when length is zero.

(iv) What is the significance of the value obtained in 1 (iii)?

It confirms the linear relationship between L and T^2, and that oscillations cannot occur when there is no length ($L = 0$).

(v) What is the aim of doing this experiment?

The aim is to verify the relationship between the length of a conical pendulum and its period of oscillation, and to confirm that T^2 is directly proportional to L.

2. You are provided with a beam balance, thermometer, calorimeter with its lid and stirrer and hot liquid labelled B.

(a) Weigh an empty calorimeter with its lid and stirrer and record its mass as M_1.

This mass includes all components except the liquid and is used later to determine the mass of the liquid B.

(b) Fill the calorimeter to about two-thirds full with a liquid B that has been heated to a temperature of about 85°C.

This ensures sufficient volume for accurate heat loss readings.

(c) While stirring, insert the thermometer and start the stopwatch. Read and record the temperature after every 2 minutes interval as liquid cools under forced condition to a temperature of about 55°C.

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These readings are used to determine the rate of heat loss and plot the cooling curve.

(d) After cooling the liquid B to about 55°C, remove the thermometer and weigh the calorimeter with its content and record its mass as M.

This new mass includes the calorimeter plus the liquid B.

(e) Find the mass of liquid B and record it as M_2.

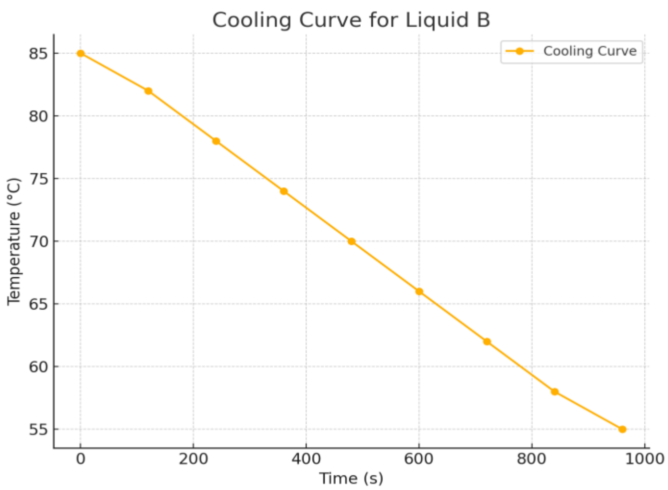
$M_2 = M - M_1$

(i) Tabulate the results of time (seconds) and the temperature (°C).

Sample data:

Time (s)	Temperature (°C)
0	85
120	82
240	78
360	74
480	70
600	66
720	62
840	58
960	55

(ii) Plot a cooling curve for liquid B.
Time (s) on the x-axis, temperature (°C) on the y-axis. A smooth curve declining with time is expected.



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(iii) Draw the tangent at the temperature of 70°C and obtain the rate of cooling of the liquid B.

From the tangent at 70°C, determine Δθ/Δt. Suppose the line drops 8°C over 300 s:
Rate = Δθ/Δt = 8 / 300 = 0.0267 °C/s

(iv) Use the equation:
$(M_1C_1 + 400)\ d\theta/dt = 10.096$ J/s
Suppose $M_1 = 60$ g and $C_1 = 0.39$ J/g°C

(60 × 0.39 + 400) × 0.0267 = 10.096
(23.4 + 400) × 0.0267 = 10.096
423.4 × 0.0267 = 10.096
C_B ≈ 4.18 J/g°C

The specific heat capacity of liquid B is approximately 4.18 J/g°C.

3. You are provided with a battery E, a key K, ammeter A, voltmeter V, resistance box S, unknown resistor R and pieces of connecting wires.

(a) Connect the given components in series except the voltmeter which should be connected in parallel with the unknown resistor.

The voltmeter measures potential difference across R while the ammeter measures total current in the circuit.

(b) Set the resistance of 10 Ω in a resistance box. Close the key and record the readings of the ammeter and voltmeter.

(c) Repeat the procedures in 3 (b) each time by setting the resistance to 15 Ω, 20 Ω, 25 Ω and 30 Ω.

(i) Draw a circuit diagram for the connection.

- Battery E connected in series with resistor box and unknown resistor R.
- Ammeter connected in series to measure current.
- Voltmeter connected across R in parallel.

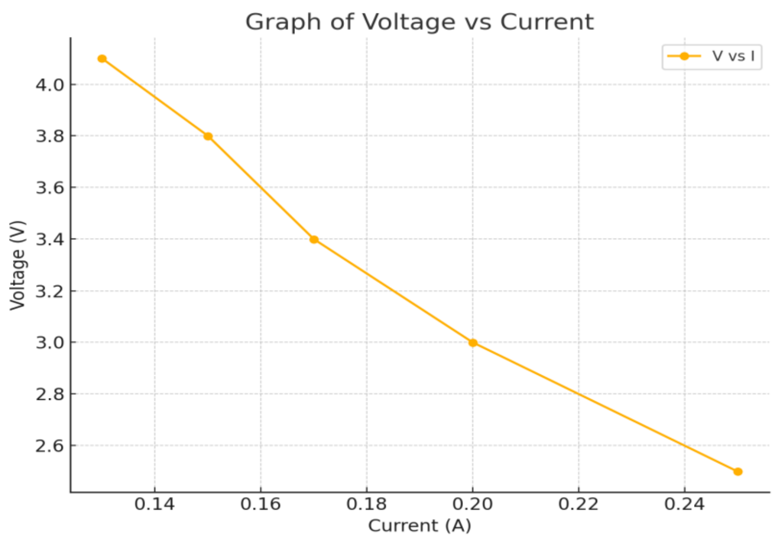
(ii) Tabulate the results obtained in 3 (b) and (c).

Sample data:

R (Ω)	V (V)	I (A)
10	2.5	0.25

15	3.0	0.20
20	3.4	0.17
25	3.8	0.15
30	4.1	0.13

(iii) Plot a graph of voltage (V) against current (I).
V on y-axis, I on x-axis. A straight line is expected if Ohm's law holds.



(iv) Compute the value of unknown resistance.

Using the graph, determine the slope = ΔV/ΔI.
Using $(V_1, I_1) = (2.5, 0.25)$, $(V_2, I_2) = (4.1, 0.13)$:
Slope = (4.1 - 2.5) / (0.13 - 0.25) = 1.6 / -0.12 = -13.3 Ω
Taking magnitude, R = 13.3 Ω

The unknown resistance is approximately 13.3 Ω.

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