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: 2020**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

1. You are required to determine the acceleration due to gravity, g, using a simple pendulum.

Proceed as follows:

(a) Attach a piece of thread of 100 cm long to the pendulum bob and set up the apparatus as shown in Figure 1. Note that d is the distance from the bob to the reference line.

The pendulum is suspended from the retort stand, and the total length L is taken as the vertical distance from the suspension point to the center of the bob. By increasing d by 10 cm intervals, the effective length of the pendulum is reduced accordingly.

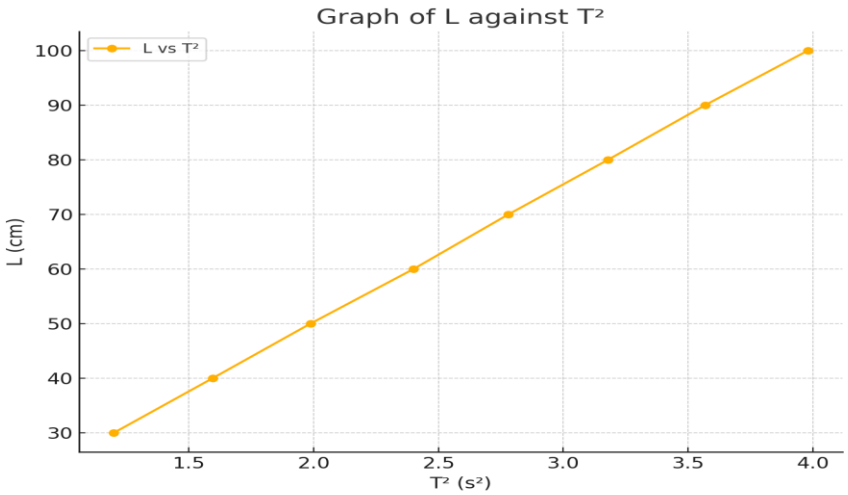
(b) Set the pendulum bob to oscillate through a small angle and determine the time, t, for 20 complete oscillations. Then calculate the periodic time T as $T = t / 20$.

(c) Repeat the procedure in 1 (b) while reducing the length of the thread by increasing d from 0 cm to 10, 20, 30, 40, 50, 60, and 70 cm. This gives corresponding pendulum lengths of 100, 90, 80, 70, 60, 50, 40, and 30 cm.

(i) Tabulate your results including the values of the length of the thread and T^2.

L (cm)	t (s)	T (s) = t/20	T^2 (s^2)
100	39.90	1.995	3.980
90	37.78	1.889	3.568
80	35.65	1.783	3.179
70	33.34	1.667	2.780
60	30.97	1.549	2.400
50	28.17	1.409	1.987
40	25.25	1.263	1.595
30	21.90	1.095	1.199

(ii) Plot a graph of L against T^2.
L (in cm) is plotted on the y-axis and T^2 (in s^2) on the x-axis. The graph is expected to be a straight line passing through the origin, indicating that $L \propto T^2$.



(iii) Compute the acceleration due to gravity g from the equation:

From the simple pendulum theory:
$L = (g / 4\pi^2) \times T^2$
So from the graph, slope $S = L / T^2$
Then: $g = 4\pi^2 \times S$

Using the points ($T^2 = 1.199$, $L = 30$) and ($T^2 = 3.980$, $L = 100$):

$S = (100 - 30) / (3.980 - 1.199) = 70 / 2.781 \approx 25.17$
$g = 4\pi^2 \times 25.17 = 39.48 \times 25.17 \approx 993.3$ cm/s² = 9.93 m/s²

(iv) What does the y-intercept represent?

The y-intercept on the graph of L against T^2 represents any systematic correction to the length — such as the vertical distance from the clamp to the center of the bob that may not have been included in the measured thread length. If the graph passes through the origin, it confirms that this correction is negligible.

2. You are provided with a beaker, liquid L, a thermometer, a stirrer and a wooden slab.

Proceed as follows:

(a) Weigh the empty beaker provided and record its value.

(b) Set up the apparatus as shown in Figure 2.

The thermometer and stirrer are immersed in the beaker containing liquid L, which is placed on a wooden slab to minimize heat transfer to the table.

(c) Pour 150 ml of liquid L which is heated to about 90°C in a beaker. While stirring gently, record the temperature of liquid L after every two minutes until it falls to 50°C.

This data helps in plotting a cooling curve.

(d) Weigh the beaker with its contents and determine the mass of liquid L.

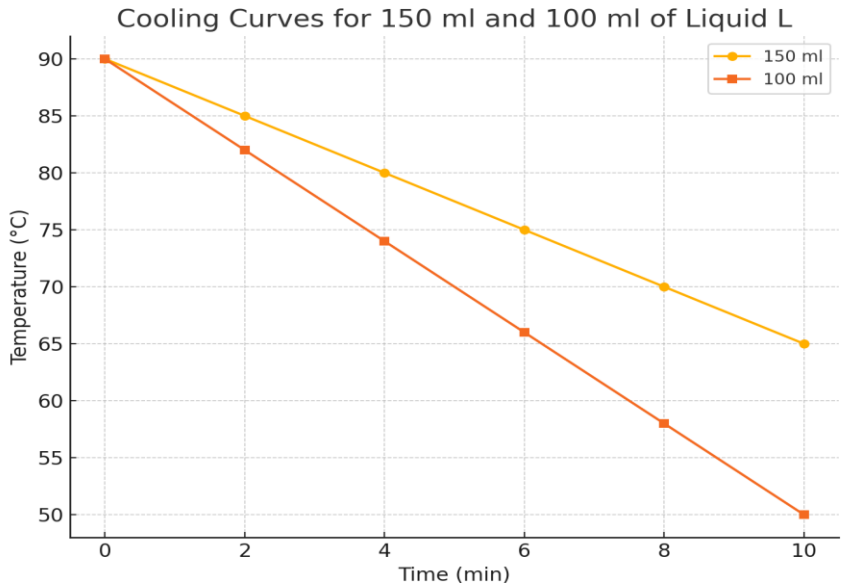
Subtract the mass of empty beaker to find the actual liquid mass.

(e) Repeat the procedures in 2 (c) and (d) for 100 ml of liquid L.

(i) Tabulate the results of your experiment.

Time (min)	Temp (150 ml) °C	Temp (100 ml) °C
0	90	90
2	85	82
4	80	74
6	75	66
8	70	58
10	65	50

(ii) Plot cooling curves for both experiments on the same axes.
Time on x-axis, temperature on y-axis. The 150 ml cools slower.



(iii) Use the graph plotted in 2 (ii) to record the value of time taken for both volumes to fall from 80°C to 60°C at t_1 and t_2 respectively, hence compute the value of t_1/t_2.

From graph:
150 ml: $t_1 \approx 5$ min
100 ml: $t_2 \approx 3$ min
$t_1 / t_2 = 5 / 3 \approx 1.67$

(iv) Determine the ratio of mass of 150 ml to mass of 100 ml.

Assuming same density, ratio = 150 / 100 = 1.5

(v) Compare the values obtained in 2 (iii) and (iv) and give the comments.

The ratio of cooling time is greater than the ratio of masses. This indicates larger masses retain heat longer due to higher heat capacity.

(vi) What is the aim of performing this experiment?

To investigate how volume (and hence mass) of a liquid affects the rate of cooling.

3. You are provided with a dry cell E, ammeter A, resistance box B, switch K and several pieces of connecting wires.

Proceed as follows:

(a) Connect a dry cell E, switch K, an ammeter A and the resistance box B in series.

(b) Using the resistance box, set the resistance R equal to 1 Ω, close the switch K and record the current I (A) passing through the circuit.

(c) Repeat the procedures in 3 (b) for the values of R equal to 2 Ω, 4 Ω, 5 Ω and 6 Ω.

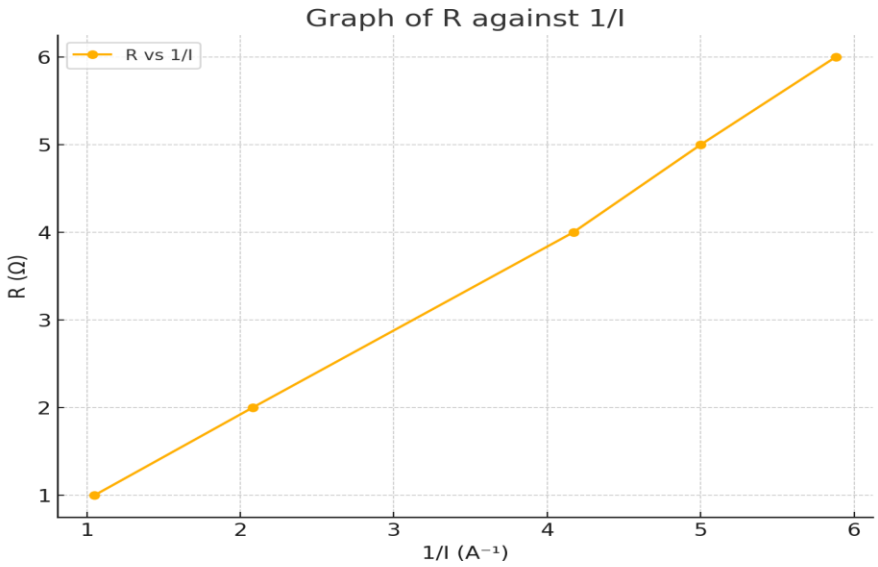
(i) Record the results in a tabular form including the values of 1/I (A^{-1}).

R (Ω)	I (A)	1/I (A^{-1})
1	0.95	1.05
2	0.48	2.08
4	0.24	4.17
5	0.20	5.00
6	0.17	5.88

(ii) Draw a well labelled diagram of your circuit you connected.

Circuit includes battery E, switch K, ammeter A and resistance box B all connected in series.

(iii) Plot a graph of R against 1/I.
R on y-axis, 1/I on x-axis. The graph should be linear.



(iv) Use the graph to compute the value of E.m.f of the cell.

From Ohm's law: $V = IR \rightarrow R = E/I \rightarrow R = E \times (1/I)$
So the slope of the graph = E

Using points (1.05, 1), (5.88, 6):
Slope = (6 - 1) / (5.88 - 1.05) = 5 / 4.83 ≈ 1.035
E = 1.035 V

(v) What is the physical meaning of R-intercept?

It represents the internal resistance of the cell.

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

To determine the electromotive force (E.m.f) and internal resistance of a dry cell.