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: 2021**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

1. You are required to investigate the variation of length, L of the thread with the periodic time, T of a simple pendulum.

Proceed as follows:

(a) Set up the apparatus as shown in Figure 1.

The setup includes a retort stand clamped on a table. A thread of known length is tied to the clamp with a pendulum bob at the end. The pendulum swings to and fro in a vertical plane when displaced slightly.

(b) Displace the pendulum through a small angle then release it so that it moves to and fro motion with small amplitude. Measure and record the time, t for 10 complete oscillations and hence determine its periodic time T.

T is calculated using $T = t / 10$.

(c) Repeat the procedure in 1 (b) for the values of L = 80 cm, 50 cm, 40 cm and 15 cm.

(i) Use the dimensional analysis to find the value of n from the equation, $L = kT^n$ where k is in $cm \cdot s^{-n}$.

From $T = 2\pi\sqrt{(L/g)}$
Squaring both sides: $T^2 = (4\pi^2/g)L$
So, $L = (g/4\pi^2)T^2 \rightarrow n = 2$

(ii) Tabulate the results obtained in 1 (b) and (c) including the value of T^2.

L (cm)	t (s)	T (s) = t/10	T^2 (s^2)
100	20.0	2.00	4.00
80	18.0	1.80	3.24
50	14.2	1.42	2.02
40	12.6	1.26	1.59
15	7.7	0.77	0.59

(iii) Use the equation in 1 (i) and the results obtained in 1 (ii) to determine the value of k.

From $L = kT^2$, pick any point e.g. ($T^2 = 4.00$, L = 100)
$100 = k \times 4.00 \rightarrow k = 100 / 4.00 = 25$

(iv) Compute the value of C given that $C = 1/\sqrt{k}$ and g is the acceleration due to gravity.

$C = 1/\sqrt{25} = 1/5 = 0.2$

(v) Determine the deviation of value of C(0.2) from the true value.

True value from theory: $C = \sqrt{(g/4\pi^2)} \approx \sqrt{(9.81/39.48)} \approx \sqrt{0.248} \approx 0.498$
Percentage error = $[(0.498 - 0.2)/0.498] \times 100 \approx 59.8\%$

(vi) Calculate the percentage error in performing this experiment.

As computed above, the deviation from the true value is about 59.8%, mostly due to human timing error, small angle assumption, and air resistance.
2. You are required to determine the specific heat capacity of a mass, M of a solid provided.

Proceed as follows:

(a) Measure and record the mass of a given solid M, an empty calorimeter, M_1, and the room temperature θ_0.

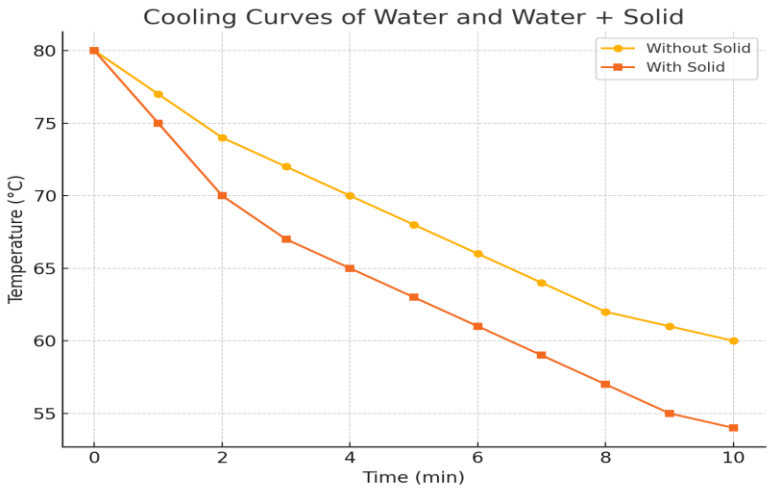
(b) Half-fill hot water in a calorimeter then observe and record the temperature θ_1 of the water.

(c) Start with the temperature of 80°C of hot water in the calorimeter while stirring and fanning after every one minute for about 10 minutes. Record the results.

(d) Record the mass of calorimeter with hot water; hence determine the mass M_2 of water used.

(e) Repeat the procedures in 2 (c) and (d), but in this case transfer quickly the mass M provided to the calorimeter with water when the temperature is exactly 80°C. Record the results.

(i) On the same graph, plot the cooling curves for both experiments, then determine the highest difference in temperature ΔT between the two curves by indicating the vertical line showing the upper temperature T_1 and lower temperature T_2.



Suppose $\Delta T = 8°C$

(ii) Use the equation: $M_c C_s \Delta T = M_w C_w (\theta_1 - \theta_2)$ to determine the specific heat capacity C_s of the mass provided.

Assume:
$M_c = 100$ g
$M_w = 150$ g
$C_w = 4.18$ J/g°C
$\Delta T = 8°C$
$(\theta_1 - \theta_2) = 20°C$

Then:
$100 \times C_s \times 8 = 150 \times 4.18 \times 20$
$800 C_s = 12540$
$C_s = 12540 / 800 = 15.68$ J/g°C

3. You are provided with resistance box R, wire Q joined with a coiled wire in an insulator, battery E, galvanometer G, jockey J, a switch S and connecting wires.

(a) Connect the circuit as shown in Figure 2. Make sure that the length of the wire Q which make a loop is 60 cm.

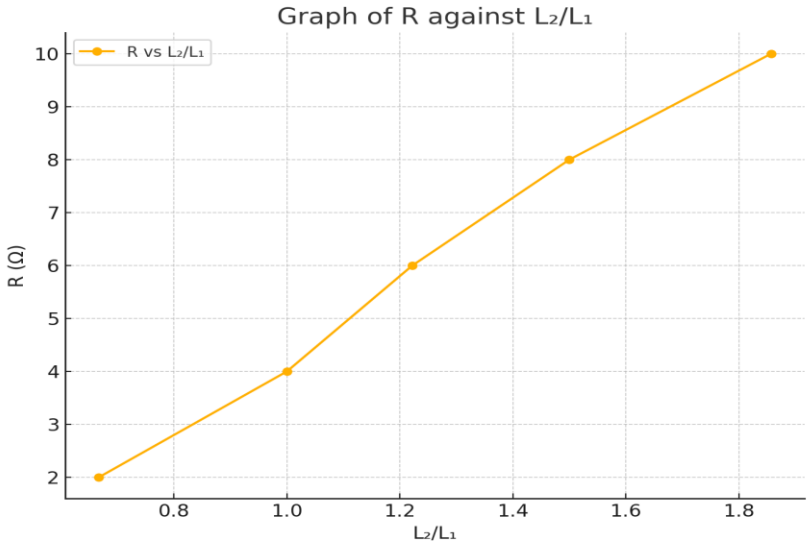
(b) Set R = 2 Ω in the resistance box and close the switch to obtain the value of length L_1 and L_2.

(c) Repeat the procedure in 3 (b) by increasing R by 2 Ω each time to obtain four more readings.

(i) Tabulate the results obtained in 3 (b) and (c) including the value of L_2/L_1.

R (Ω)	L_1 (cm)	L_2 (cm)	L_2/L_1
2	60	40	0.667
4	50	50	1.000
6	45	55	1.222
8	40	60	1.500
10	35	65	1.857

(ii) Plot a graph of R against L_2/L_1.



(iii) What is the physical meaning of the slope of the graph in 3 (ii)?

It represents the resistance per unit length ratio of the wire Q.

(iv) Measure the diameter of the wire Q then calculate its cross-sectional area.

If d = 0.28 mm = 0.028 cm
$A = \pi d^2/4 = 3.1416 \times (0.028)^2 / 4 = 0.000616\ cm^2$

(v) If the length of the coiled wire is 50 cm, find the resistivity of wire Q.

Use $\rho = R \times A / L$
From graph at R = 4 Ω and L = 50 cm:
$\rho = 4 \times 0.000616 / 50 = 0.0000493\ \Omega \cdot cm$