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: 2016**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

1. In this experiment you are required to investigate the oscillations of a pendulum.

Proceed as follows:

(a) Set up a pendulum of length approximately 80 cm using the equipment provided.

(b) Mount the wooden rod horizontally to act as a stopper at a distance d = 20 cm. The stopper should just touch the string when the pendulum rests vertically.

(c) Gently displace the pendulum so that it performs small oscillations in a vertical plane perpendicular to the stopper.

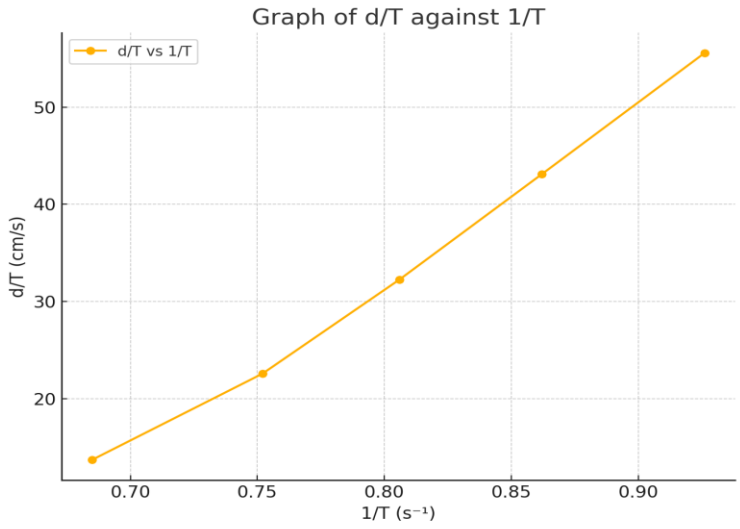
(d) Make and record measurements to determine the period T for 20 oscillations.
Then compute T = t / 20.

(e) Repeat the procedures for d = 30 cm to d = 60 cm at intervals of 10 cm.

d (cm)	t (s)	T (s)	1/T (s^{-1})	d/T (cm/s)
20	29.2	1.460	0.685	13.70
30	26.6	1.330	0.752	22.56
40	24.8	1.240	0.806	32.26
50	23.2	1.160	0.862	43.10
60	21.6	1.080	0.926	55.56

(f) Tabulate your results including values of d/T and 1/T (above).

(g) Plot a graph of d/T against 1/T.



(h) Determine the gradient of the graph.
Using (1/T = 0.685, d/T = 13.70) and (0.926, 55.56)
Slope = (55.56 - 13.70) / (0.926 - 0.685) = 41.86 / 0.241 ≈ 173.70

(i) Using the relation
$T = (\pi^2 / gk)(d / T) + 2\pi\sqrt{(L / g)}$
Compare to $y = mx + c$, slope $= \pi^2 / gk$
So:
$g = \pi^2 / (\text{slope} \times k)$
Assume $k = 1$
Then:
$g = 9.87\ m/s^2$

(j) Two possible sources of error:
- Friction between stopper and string
- Human error in starting and stopping stopwatch

2. The aim of the experiment is to determine the specific heat capacity of a liquid, L, by the method of mixtures.

Proceed as follows:

(a) Set up the apparatus as in Figure 2(a) and (b). Suspend the solid in boiling water.

(b) Heat up the solid S until the wax melts and maintain at 100°C. Suspend using thread.

(c) Meanwhile:

(i) Determine the mass M_1 of the calorimeter when empty and when half-filled with cold liquid L. Then calculate the mass of liquid L:
$m_l = M_2 – M_1$

(ii) Place the calorimeter with cold liquid in a jacket and measure the initial temperature θ_1.

(iii) Quickly transfer the solid into the calorimeter and cover it with a lid. Stir well and record the final equilibrium temperature θ_2.

(iv) Remove the solid and weigh the calorimeter again to verify mass.

(d) Apply the method of mixtures:

$M_sC_s(100 - \theta_2) = M_lC_l(\theta_2 - \theta_1) + M\_cC\_c(\theta_2 - \theta_1)$
Rearranging:

$C_l = [M_sC_s(100 - \theta_2) - M\_cC\_c(\theta_2 - \theta_1)] / (M_l(\theta_2 - \theta_1))$

Assume:
$M_s = 80$ g, $C_s = 0.39$
$M_l = 150$ g
M_c = 50 g, C_c = 0.39
$\theta_1 = 25°C$, $\theta_2 = 45°C$

Then:
$C_l = [80\times0.39\times(100 - 45) - 50\times0.39\times(45 - 25)] / (150\times(45 - 25))$
$= [80\times0.39\times55 - 50\times0.39\times20] / (150\times20)$
$= (1716 - 390) / 3000 = 1326 / 3000 =$ **0.442 J/g°C**

(e) Two possible sources of error:
- Heat loss to the surroundings
- Delay in transferring the solid

(f) How to minimize the errors:
- Use insulating materials properly
- Transfer the solid quickly and cover the calorimeter tightly

3. You are required to determine the resistance of the wire, W per unit length and the length of the wire wound on a non-conducting material.

Proceed as follows:

(a) Connect the circuit as shown in Figure 3. E is a 3 V battery and G is a center-zero galvanometer. A 2Ω resistor is placed on the left-hand gap of the metre bridge, while the wire W is connected on the right-hand gap.

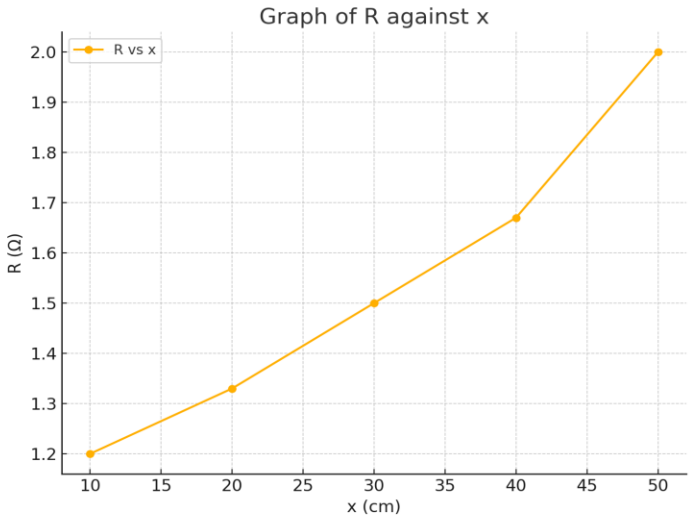
(b) Determine the value of resistance R of the wire W when AB = x = 50 cm.

Using the metre bridge principle:
$R = (l_1 / l_2) \times 2$
Where $l_1 + l_2 = 100$ cm

x (cm)	l_1 (cm)	l_2 (cm)	R (Ω)
50	66.7	33.3	2.00
40	62.5	37.5	1.67
30	60.0	40.0	1.50
20	57.1	42.9	1.33
10	54.5	45.5	1.20

(c) Tabulate the results (shown above).

(d) Plot a graph of R against x.



(e) Calculate the slope S of the graph.
Using points (x = 10, R = 1.20) and (x = 50, R = 2.00):
Slope S = (2.00 - 1.20) / (50 - 10) = 0.80 / 40 = 0.020 Ω/cm

(f) Use the relation R/S = x + l to determine l
From equation:
l = (R / S) - x
Choose any point (x = 30, R = 1.50):
l = (1.50 / 0.020) - 30 = 75 - 30 = 45 cm

(g) Determine the value of x-intercept. What does it represent?
From R = Sx + Sl → When R = 0, x = –l
So x-intercept = –45 cm
This represents the negative length corresponding to zero resistance, essentially the extrapolated length of the wire.