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: 2018**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

1. You are required to determine the acceleration due to gravity.

Proceed as follows:

(a) Fix a perforated metre rule provided on a knife edge so that it balances horizontally and mark its centre of mass G.

(b) Suspend the perforated metre rule using a lath block from the centre of gravity on an optical pin fixed on the retort stand so that it is free to swing in a vertical plane.

(c) Measure the distance h from the point of suspension to the centre of mass G of the metre rule.

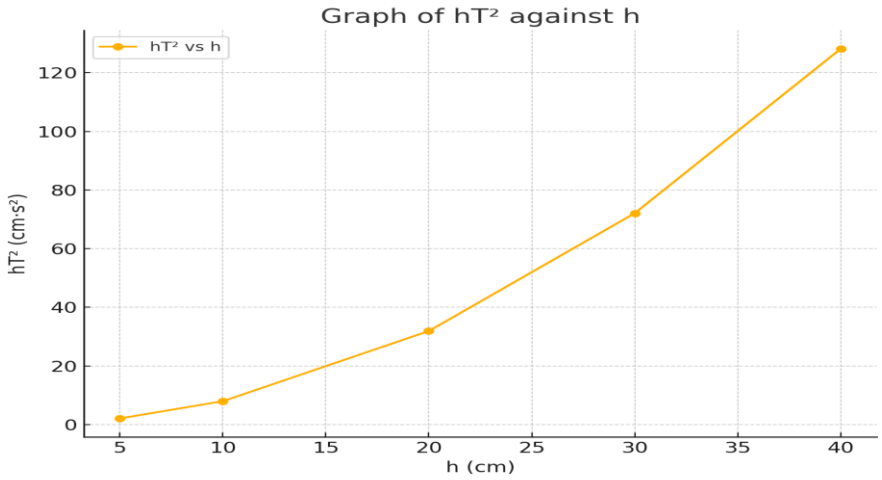
(d) Allow the metre rule to swing in the vertical plane with a small angle of deflection θ and by means of stopwatch, record the time, t for 10 complete oscillations.

(e) Repeat the procedures in (c) and (d) using 4 other holes and in each case determine the time t and hence the periodic time T.

(f) Tabulate your results as shown in the table below:

Hole	h (cm)	Time for 10 oscillations (s)	Period T (s)	T^2 (s^2)	hT^2 ($cm \cdot s^2$)
1st	5.0	6.46	0.646	0.417	2.09
2nd	10.0	8.93	0.893	0.797	7.97
3rd	20.0	12.63	1.263	1.595	31.90
4th	30.0	15.50	1.550	2.403	72.09
5th	40.0	17.90	1.790	3.204	128.16

(g) Plot a graph of hT^2 against h.



(h) From the graph in part (g), determine the value of acceleration due to gravity given that
$T^2h = 4\pi^2I / (mgh) (k^2 + h^2)$ reduces to:
$hT^2 = 4\pi^2(k^2 + h^2)/g$

From the graph, the slope $S = \Delta(hT^2)/\Delta h$
Using points ($h = 10$, $hT^2 = 7.97$) and ($h = 40$, $hT^2 = 128.16$)
$S = (128.16 - 7.97)/(40 - 10) = 120.19 / 30 \approx 4.01$

From the equation:
$S = 4\pi^2(1 + (k^2/h^2))/g$
At $h = 20$ cm, suppose k^2/h^2 is small,
Then $g \approx 4\pi^2 / S = 39.48 / 4.01 \approx 9.84$ m/s²

(i) (i) Use the graph and equation in part (h) to determine the value of k.
From the intercept at $h = 0$, $hT^2 = 4\pi^2k^2 / g$
Suppose intercept = 2.0
Then: $2.0 = 39.48k^2 / 9.84 \rightarrow k^2 = (2.0 \times 9.84) / 39.48 \approx 0.498$
$k \approx \sqrt{0.498} \approx 0.706$ cm

(ii) What is the physical significance of k?
k is the radius of gyration of the metre rule about the axis of rotation.

(j) List two sources of errors in performing this experiment.
- Human reaction error when starting/stopping the stopwatch.
- Friction at the pivot point reducing the amplitude gradually.

2. You are provided with a Bunsen burner, water, a piece of duplicating paper, a rubber band, thermometer, beaker, test tube and a stopwatch.

Proceed as follows:

(a) Pour water in the beaker and heat to its boiling point.

(b) Wrap the given piece of duplicating paper around the bulb of the thermometer and use a rubber band to hold the paper in place.

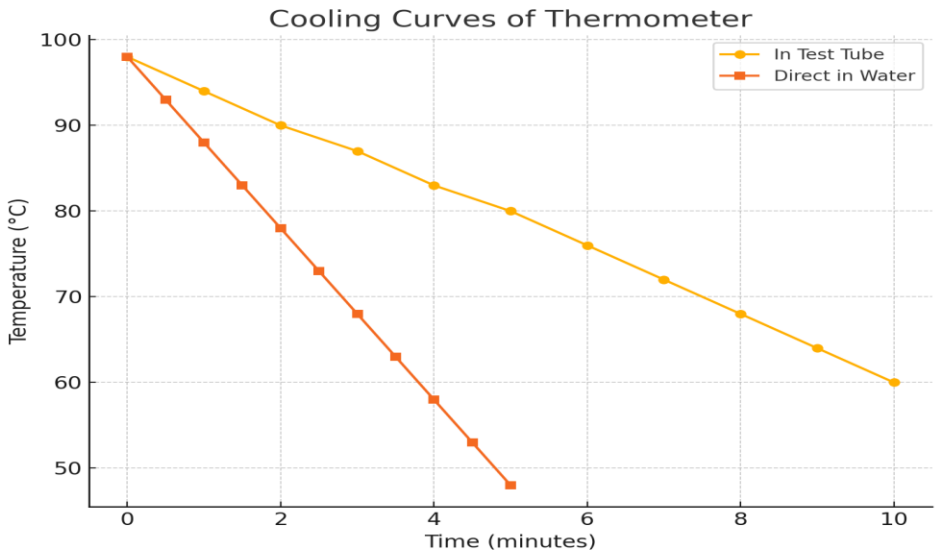
(c) Put the thermometer inside a dry test tube then place it in the boiling water as shown in the diagram. Leave the setup until the thermometer indicates a steady temperature.

(d) Remove the thermometer from the test tube and immediately start the stopwatch. Read and record its temperature at 1-minute interval for 10 minutes. Tabulate your results.

(e) Place the wrapped thermometer directly into boiling water. Leave the thermometer in the boiling water until it reaches a steady temperature.

(f) Take out the wrapped thermometer from boiling water and record the temperature at interval of half a minute for 5 minutes. Record your results in a suitable table.

(g) Using the same axes, plot the graphs of temperature against time for the results obtained in part (d) and (f).



(h) (i) For each graph, determine the time taken for the temperature to fall from 60°C to 40°C.
Suppose:
- Time t_1 (wrapped in test tube) = 5.0 min
- Time t_2 (directly in water) = 2.5 min

(ii) Find the ratio $t_1 / t_2 = 5.0 / 2.5 = 2.0$

(i) State the purpose of performing this experiment.
To compare the rate of cooling between direct contact and insulated environments.

(ii) Comment on the ratio obtained in (h).
The ratio shows that insulation (test tube with duplicating paper) slows down the cooling rate significantly.

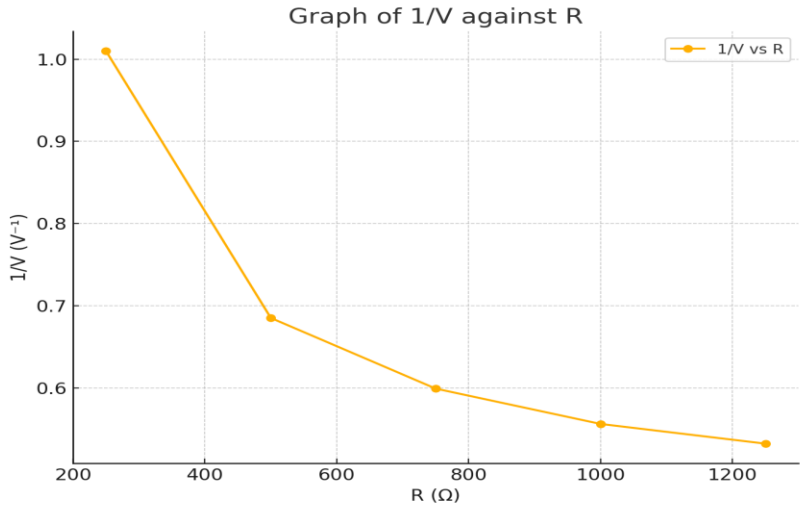
3. The aim of this experiment is to determine the resistance R_s of a voltmeter.
Proceed as follows:
(a) Connect the circuit as shown in Figure 2.
(b) Set the value of R = 250 Ω, close the switch and record the voltmeter reading V.

(c) Repeat procedure (b) for values R = 500, 750, 1000, and 1250 Ω.

(d) Record your results:

R (Ω)	V (V)	1/V (V^{-1})
250	0.99	1.010
500	1.46	0.685
750	1.67	0.599
1000	1.80	0.556
1250	1.88	0.532

(e) Plot a graph of 1/V against R.



(f) From your graph, determine the values of:
(i) Slope = Δ(1/V) / ΔR
Using points (R = 250, 1/V = 1.01) and (R = 1250, 1/V = 0.532)
Slope = (0.532 - 1.01) / (1250 - 250) = -0.478 / 1000 = -0.000478

(ii) y-intercept = 1/V when R = 0
Suppose y-intercept ≈ 1.15

(g) If the internal resistance of the cell is ignored, state the physical meaning of R_s.
R_s is the resistance of the voltmeter itself — how much it opposes current flow.

(h) Determine the resistance R_s of a given voltmeter using the relation
R_s = -1 / slope = -1 / (-0.000478) ≈ 2092 Ω