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: 2022**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

1. You are provided with a wire W, metre rule, two cork pads, test tube, micrometer screw gauge, slotted mass of 20 g, retort stand with its accessories, marking tape and optical pin.

Proceed as follows:

(a) Measure and record the length, l and diameter, d of a wire W.

The diameter is measured using a micrometer screw gauge by taking multiple readings along the wire and finding the average. The length is measured using a metre rule.

(b) Wind the whole length of the wire W tightly on the test tube making sure the turns are as close as possible but not overlapping.

This forms a uniform coil for spring testing.

(c) Measure the length x of the coil made as shown in Figure 1 and count the number of turns.

This is done by measuring the length covered and counting turns to find turn spacing.

(d) Remove the coil from the test tube; straighten the first and last coil. Clamp one end on the retort stand while bending the other end to make a hook. Count the number of complete turns n remaining and measure the distance h_1 between the ends of the coil as shown in Figure 2.

This is the unstretched length of the hanging coil under no load.

(e) Load a 20 g mass on the other end of the coil and arrange as shown in Figure 3. Measure and record the distance h_2 between the ends of the turns.

This is the stretched length of the spring when under tension from a 20 g load.

(f) Remove the mass, reduce the number of turns by straightening three turns of the coil from the upper end and adjust the point of suspension of the coil. Record the number of turns n remaining and measure the new h_1. Load 20 g mass on the coil again, measure and record h_2.

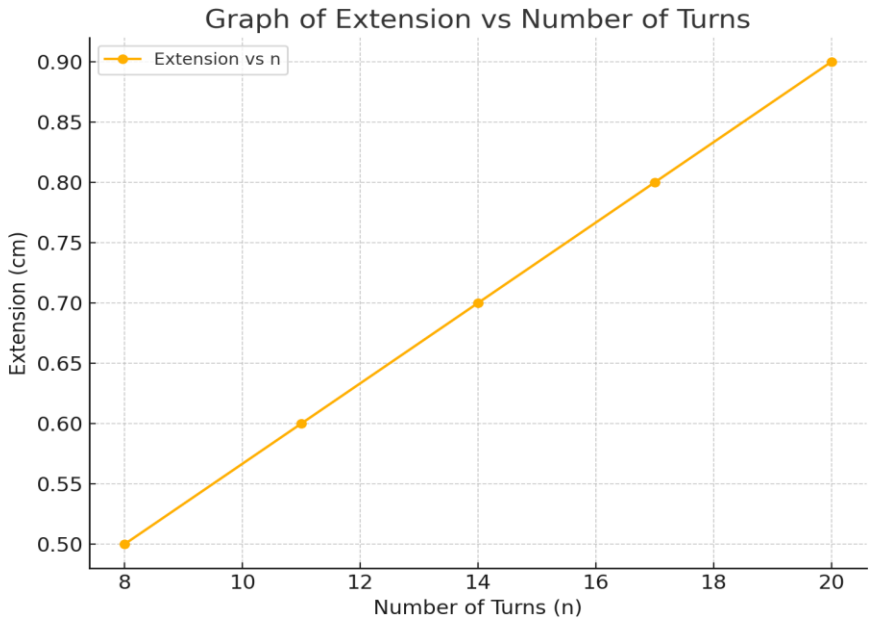
(g) Repeat procedures in 1 (f) to (g) to obtain a total of five readings for h_1 and h_2.

(i) Record the values of n, h_1 and h_2 and find extension e as shown in the table:

Number of turns n	h_1 (cm)	h_2 (cm)	Extension e = h_2 - h_1 (cm)
20	8.2	9.1	0.9
17	6.9	7.7	0.8
14	5.8	6.5	0.7

| 11 | 4.4 | 5.0 | 0.6 |
| 8 | 3.1 | 3.6 | 0.5 |

(ii) Plot a graph of extension e against the number of turns n.
The x-axis represents n and y-axis represents extension e.



(iii) Determine the slope S of the graph.

Using two points:
(8, 0.5) and (20, 0.9)
S = (0.9 - 0.5) / (20 - 8) = 0.4 / 12 = 0.0333

(iv) Compute the value of constant G from the equation:
$1 = Gx / (n\ d^2) \times e$
Rewriting:
$e = (Gx / d^2) \times (1/n)$

From the slope S of e against n:
$G = (S \times d^2) / x$

Suppose d = 0.30 mm = 0.030 cm, x = 4.5 cm
$G = (0.0333 \times 0.030^2) / 4.5$
$G = (0.0333 \times 0.0009) / 4.5 = 0.00003 / 4.5 \approx 6.7 \times 10^{-6}$ cm/g

2. Form Five Physics students were debating on whether hot objects made with the same material but having different masses have the same rate of cooling or not. Conclude that debate by performing the following procedure:

(a) Measure the mass M_1 of empty calorimeter provided.

(b) Heat 200 g of water to 90°C in one beaker and 400 g in another, then cover the calorimeter with a lid.

(c) Insert the thermometer and record temperature drop every 5°C drop to 55°C.

(d) Remove the thermometer and weigh to get M and find $M_2 = M - M_1$.

Repeat procedure (2) (c) to (d) with the calorimeter half filled with water.

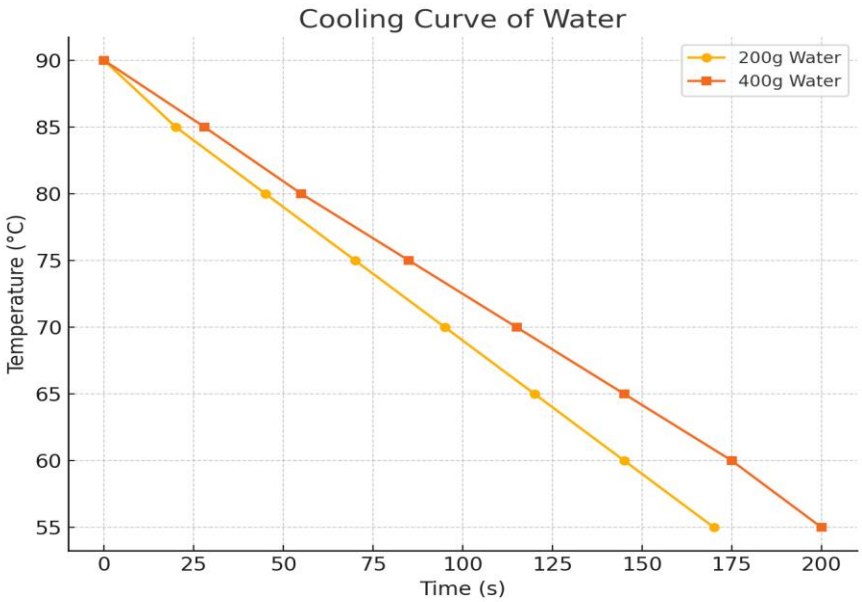
(i) Tabulate the results obtained in 2 (c) and (d).

Temperature (°C)	Time for 200 g (s)	Time for 400 g (s)
90	0	0
85	20	28
80	45	55
75	70	85
70	95	115
65	120	145
60	145	175
55	170	200

(ii) Find the mass of water M_2 and M_2' as obtained from procedures 2 (a) and (e).

$M_2 = 200$ g, $M_2' = 400$ g

(iii) Plot the graph of time in 2 (c) against temperature in 2 (c).
A curve is plotted with time on the x-axis and temperature on the y-axis. It declines slower for larger mass.



(iv) Determine the slope of the graph plotted in 2 (iii).

Choose segment at 70°C:
200 g: (95 - 70)/(90 - 70) = 25/20 = 1.25 s/°C
400 g: (115 - 85)/(90 - 70) = 30/20 = 1.5 s/°C

Larger mass cools slower.

(v) Determine the ratio of the masses, m_1 and m_2.

$m_1/m_2 = 200 / 400 = 0.5$

(vi) Use the slopes and the ratio of masses obtained to conclude the debate.

Heavier masses cool slower. Thus, rate of cooling is inversely proportional to mass for same material and environment.

3. Laboratory equipment dealer wants to know from you the specifications of the wire which was not indicated. You are required to perform an experiment as this:

(a) Measure and record the diameter of the wire.

(b) Connect a 2 Ω resistor in the right pan and the wire in the left pan; adjust jockey to balance galvanometer.

(c) Record the balanced length L on the bridge wire.

(d) Repeat for lengths x = 25 cm, 40 cm, 50 cm.

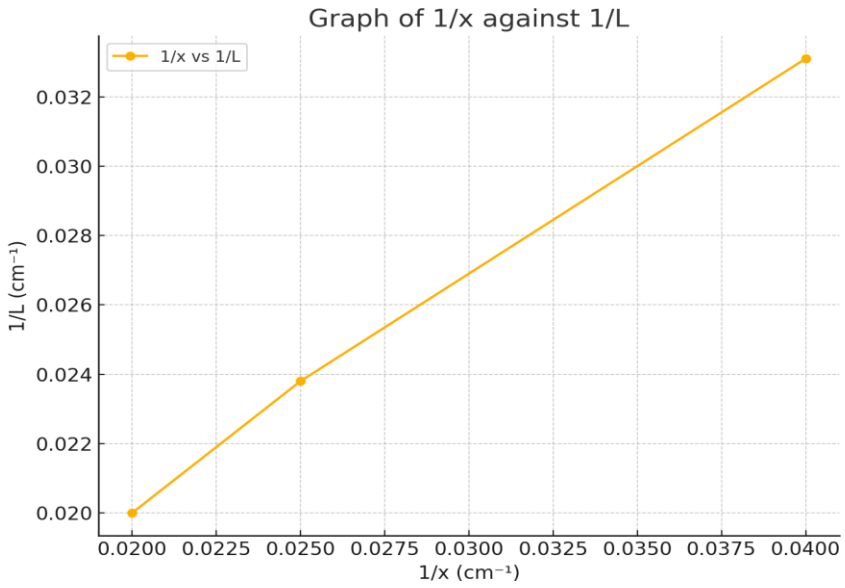
(i) Draw a clearly labelled circuit diagram of this experiment.

Metre bridge connected with:
- Standard resistor in one gap, unknown wire in the other.
- Galvanometer across jockey and midpoint.
- Battery and switch in series.

(ii) Tabulate your results including lengths of wire x (cm), 1/x (cm^{-1}), L (cm) and 1/L (cm^{-1}).

x (cm)	1/x (cm^{-1})	L (cm)	1/L (cm^{-1})
25	0.0400	30.2	0.0331
40	0.0250	42.1	0.0238
50	0.0200	50.0	0.0200

(iii) Plot a graph of 1/x against 1/L.
Both are on respective axes and graph expected to be linear.



(iv) Determine the slope and intercept of the graph in 3 (iii).

Using points: (0.0200, 0.0200) and (0.0400, 0.0331):
Slope = (0.0331 - 0.0200) / (0.0400 - 0.0200) = 0.0131 / 0.0200 = 0.655
Intercept = 0.0068

(v) Determine the average value of unknown resistivity of the wire from the results in 3 (iii).

Using slope m and formula:
$m = \rho / (\pi r^2)$, where $r = d/2$

$\rho = m \times \pi \times r^2$
Assume $d = 0.30$ mm $= 0.030$ cm $= r = 0.015$ cm
$\rho = 0.655 \times \pi \times (0.015)^2 = 0.655 \times 3.1416 \times 0.000225$
$\rho \approx 0.000464\ \Omega$cm

(vi) If a student wants to buy a piece of this wire, what will be the length of the wire required to make a resistance equivalent to 10 Ω?

$R = \rho L / A$
$L = R A / \rho$, $A = \pi r^2 = 0.000225$ cm^2
$L = 10 \times 0.000225 / 0.000464 \approx 4.84$ cm