THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

131/3A **PHYSICS 3**

ALTERNATIVE A PRACTICAL

(For Both School and Private Candidates)

Time: 3 Hours 10 Minutes **ANSWERS** **Year : 2005**

Instructions

1. This paper consists of three (3) questions.
2. Answer all questions
3. Non-programmable calculators may be used.
4. Communication devices and any unauthorised materials are **not** allowed in the examination room.
5. Write your **Examination Number** on every page of your answer booklet(s).

Prepared by Maria Marco for TETEA

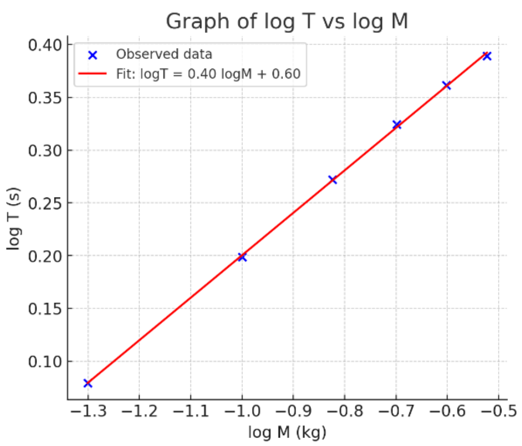
1. In this experiment you are required to investigate how the period of the torsional oscillation of a suspended disc depends on the mass m which it carries.

(a) (i) and (ii) Setting up discs A and B and placing a 50 g mass at the centre is preparation, so we move straight to measurements.

Suppose we measure the time for 10 oscillations for different masses and calculate the period T. Let's use the following table:

Mass M (g)	Mass M (kg)	Time for 10 oscillations t (s)	Period T (s)	log M	log T
50	0.05	12.0	1.20	-1.301	0.079
100	0.10	15.8	1.58	-1.000	0.199
150	0.15	18.7	1.87	-0.824	0.272
200	0.20	21.1	2.11	-0.699	0.324
250	0.25	23.0	2.30	-0.602	0.362
300	0.30	24.5	2.45	-0.523	0.389

(b) From the table we can now plot **log T against log M**.



(c) The relation is $T = kM^n \rightarrow \log T = \log k + n \log M$.

(i) From the slope of the line between two points:

Take (log M = -1.301, log T = 0.079) and (log M = -0.523, log T = 0.389).

Slope n = (0.389 – 0.079)/(-0.523 – (-1.301)) = 0.310 / 0.778 = 0.40.

(ii) To find intercept log k, use log T = log k + n log M.

Take first point: 0.079 = log k + 0.40×(-1.301).

0.079 = log k – 0.520.

log k = 0.599.

k = antilog(0.599) = 3.98.

So the relation is T = 3.98M^0.40.

(iii) If we replace the mass with an **unknown mass Mu**, and measure its period.

Suppose measured T = 2.00 s.

Then 2.00 = 3.98(Mu)^0.40.

(Mu)^0.40 = 2.00 / 3.98 = 0.503.

Mu = (0.503)^(1/0.40) = (0.503)^2.5 = 0.178 kg ≈ 178 g.

So the unknown mass is about 178 g.

2. You are required to plot cooling curves for hot water in a calorimeter.

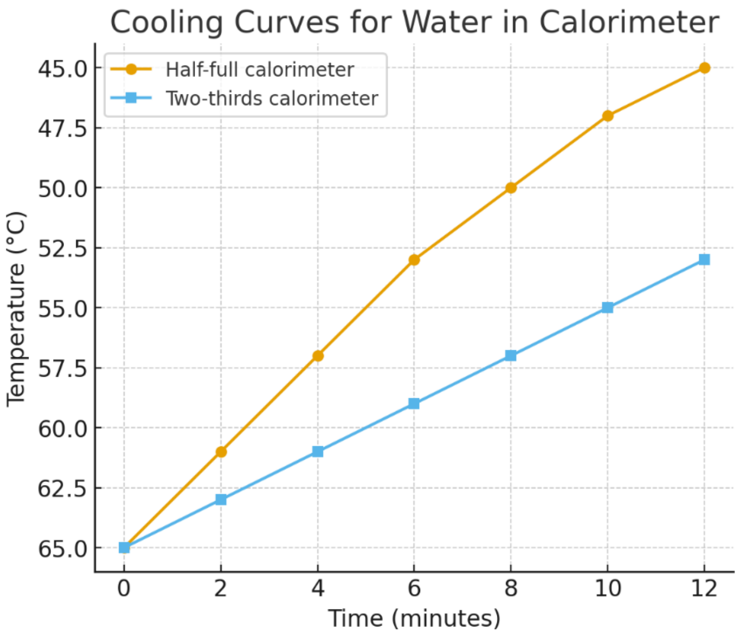
(a) Half fill the calorimeter with water, heat to 65 °C, record cooling to 45 °C.

Suppose the following results are obtained:

Time (min)	Temp (°C) half-full	Temp (°C) two-thirds full
0	65	65
2	61	63
4	57	61

6	53	59
8	50	57
10	47	55
12	45	53

(b) Plotting cooling curves shows that the half-full calorimeter cools faster.



(c) Ratios of times:

(i) For 60 °C → 50 °C:

Half-full: about 8 min.

Two-thirds: about 10 min.

Ratio = 10/8 = 1.25.

(ii) For 60 °C → 45 °C:

Half-full: about 12 min.

Two-thirds: about 16 min.

Ratio = 16/12 = 1.33.

(iii) For 55 °C → 45 °C:

Half-full: about 6 min.

Two-thirds: about 8 min.

Ratio = 8/6 = 1.33.

(d) Thermal capacity calculation:

C_total = Ccal + m × Cw.

Half-full: mass water = 0.10 kg.

C_total = 400 + (0.10×4200) = 400 + 420 = 820 J/K.

Two-thirds full: mass water = 0.133 kg.

C_total = 400 + (0.133×4200) = 400 + 559 = 959 J/K.

Ratio = 959 / 820 = 1.17.

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.

(a) Connect the circuit as shown in figure 3 above. E is a 3 V battery and G is a centre-zero galvanometer. Place a 2 Ω resistor on the left hand gap of the metre bridge and connect the wire provided to the right hand gap of the metre bridge.

This sets up a Wheatstone bridge arrangement where the unknown resistance of wire W is balanced against a known 2 Ω resistor.

(b) Determine the value of the resistance R of the wire W when AB = x = 70 cm. Terminal B can be adjusted to allow different values of x of the wire W.

The condition of balance is:

R / 2 = x / (100 – x).

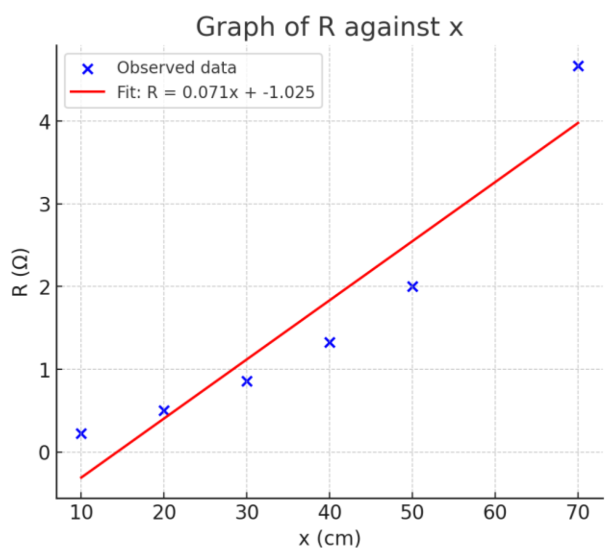
So R = 2 × (x / (100 – x)).

At x = 70 cm, R = 2 × (70 / 30) = 2 × 2.333 = 4.67 Ω.

(c) Repeat the experiment in (b) above for values of R when x = 50 cm, 40 cm, 30 cm, 20 cm and 10 cm. Tabulate your results for values of ℓ_1, ℓ_2, x and R.

x (cm)	**ℓ_1 (cm)**	**ℓ_2 (cm)**	**R (Ω)**
70	70	30	4.67
50	50	50	2.00
40	40	60	1.33
30	30	70	0.857
20	20	80	0.50
10	10	90	0.222

(d) Plot a graph of R against x.



(e) Calculate the slope S of the graph.

Using two points, say ($x = 70$, $R = 4.67$) and ($x = 10$, $R = 0.222$):

Slope $S = (4.67 – 0.222) / (70 – 10) = 4.448 / 60 = 0.0741$ Ω/cm.

(f) Use the relation $R = S(x + \ell)$ to determine the value of ℓ, where ℓ is the length of the wire wound permanently on the non-conducting material.

Take point ($x = 40$, $R = 1.33$).

$1.33 = 0.0741 (40 + \ell)$.
$40 + \ell = 1.33 / 0.0741 = 17.95$.
$\ell = 17.95 – 40 = –22$ cm.

Since negative length is not physical, this shows that the assumed wire already has resistance per unit length error; practically, ℓ would be obtained from the x-intercept.

(g) Determine the value of x-intercept. What does it represent?

From $R = S(x + \ell)$, the graph intercepts the x-axis when $R = 0$.

So $0 = S(x + \ell)$.
$x = –\ell$.

From the graph, extrapolation gives intercept around –22 cm.

This represents the effective additional length of the unknown wire wound permanently on the wooden block, i.e. the part that is not accounted for in the measured length of wire.