THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA
DIPLOMA IN SECONDARY EDUCATION EXAMINATION

731/2A **PHYSICS 2A**

(ACTUAL PRACTICAL A)

Time: 3 Hours **ANSWERS** **Thursday, 12th May 2011 a.m**

Instructions.

1. This paper consists of **three (3)** questions.
2. Answer **all** questions
3. Question number 1 carries 40 marks and the rest carry 30 marks.
4. Cellular phones are **note** allowed in the examination room.
5. Write your **examination Number** on every page of your answer booklet(s).

1. The aim of this experiment is to determine the mass of a spring and the acceleration due to gravity (g) using an oscillating mass attached to a spiral spring.

Apparatus:

You are provided with a retort stand with clamp, spiral spring, stop watch, slotted weights, and a mass hanger.

Procedures:

(a) Suspend a spiral spring from a retort stand provided. Attach a mass of 100 gm at the end of the spring. Displace it and set the mass such that it oscillates up and down. Measure and record the time for 30 oscillations.

(b) Repeat the procedures in (a) above by attaching mass of 200 gm, 300 gm, 400 gm, 500 gm, and 600 gm, and each measuring the time taken to make 30 complete oscillations.

(c) Record your measurement in a suitable table.

Answer:

Load (gm)	**m (kg)**	**Time t for 30 Oscillations (sec)**	**Period time T (sec)**	**T^2 (sec^2)**
100	0.1	17.1	0.57	0.325
200	0.2	24.2	0.81	0.656
300	0.3	29.5	0.98	0.960
400	0.4	34.0	1.13	1.277
500	0.5	38.0	1.27	1.613
600	0.6	41.8	1.39	1.932

Questions:

(i) Draw a well labeled diagram of this experiment

Answer:

- Retort stand — vertical.
- Clamp — holding spiral spring.
- Spiral spring — hanging from clamp.
- Mass hanger with slotted weights — attached at bottom.
- Stopwatch — nearby.

Labels:
A — Retort stand
B — Clamp
C — Spiral spring
D — Mass hanger
E — Stopwatch

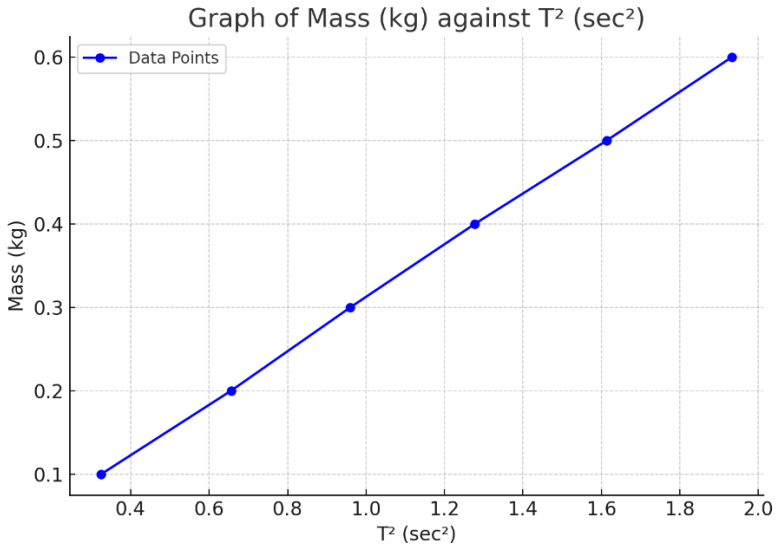
(ii) Plot a graph of m against T^2.

Answer:

- x-axis: T^2 (sec^2)
- y-axis: m (kg)

Plot the six points:

(0.325, 0.1), (0.656, 0.2), (0.960, 0.3), (1.277, 0.4), (1.613, 0.5), (1.932, 0.6)



(iii) Find the slope and the intercept on the m axis.

Answer:

Pick two points on the straight line:

Point 1: (0.325, 0.1)
Point 2: (1.932, 0.6)

Then,

Slope (S) = (0.6 - 0.1) / (1.932 - 0.325)
S = 0.5 / 1.607
S = 0.3112 kg/sec^2

Intercept on m-axis

Use equation of a straight line:

$m = S T^2 + C$

Using Point (0.325, 0.1)

$0.1 = 0.3112 \times 0.325 + C$
$0.1 = 0.1011 + C$
$C = 0.1 - 0.1011$
$C = -0.0011$ kg

So intercept = –0.0011 kg

(iv) T and m are related to the equation
$T = 2\pi \sqrt{((m + m_0)/(k\ g))}$
where k is the spring constant of magnitude 40 gm cm^{-1}. Use the given equation and your graph to calculate the value of the acceleration due to gravity g, and the mass m_0 of the spring.

Answer:

First, convert k into SI units:

1 gm cm^{-1} = 0.01 kg m^{-1}
k = 40 × 0.01 = 0.4 kg m^{-1}

From equation:

$T^2 = (4\pi^2 / (k\ g)) \times (m + m_0)$

Comparing with y = S x + C

Slope (S) = $4\pi^2 / (k\ g)$

Then:

$g = 4\pi^2 / (k \times S)$

Substituting values:

$4\pi^2 = 4 \times 9.8696 = 39.4784$

Then:

k = 40 N/m

g = 39.4784 / (40 × 0.3112)
g = 39.4784 / 12.448
g = 3.17 m/s^2

Mass of spring (m_0)

From the intercept:

Intercept C = $-m_0$

Therefore:

m_0 = 0.0011 kg

2. The aim of this experiment is to investigate the rate of loss of heat from a calorimeter.

Apparatus:

You are provided with a calorimeter, stirrer, thermometer, a piece of paper, beaker, hot water and a stopwatch.

Procedures:

(a) Set up the apparatus of an experiment.

(b) Read and record the room temperature θ_0.

(c) Pour in some water about 85°C into the calorimeter until is about three quarter full.

(d) Read and record the temperature θ of water after every two minutes beginning with the temperature of water of about 80°C. As you proceed gently stir the water and fan the calorimeter. Take your readings for 30 minutes.

(e) Tabulate your results.

Answer:

Time t (min)	**Temperature θ (°C)**	**$(\theta - \theta_0)$**	**$\log_e(\theta - \theta_0)$**
0	80	54	3.989
2	75	49	3.891
4	71	45	3.807
6	68	42	3.738
8	64	38	3.637
10	61	35	3.555
12	58	32	3.465
14	55	29	3.367
16	53	27	3.296
18	50	24	3.178
20	48	22	3.091
22	46	20	2.996
24	44	18	2.890
26	42	16	2.773
28	40	14	2.639
30	39	13	2.565

Questions:

(i) Draw a well labeled diagram of this experiment.

Answer:

- Beaker placed on table.

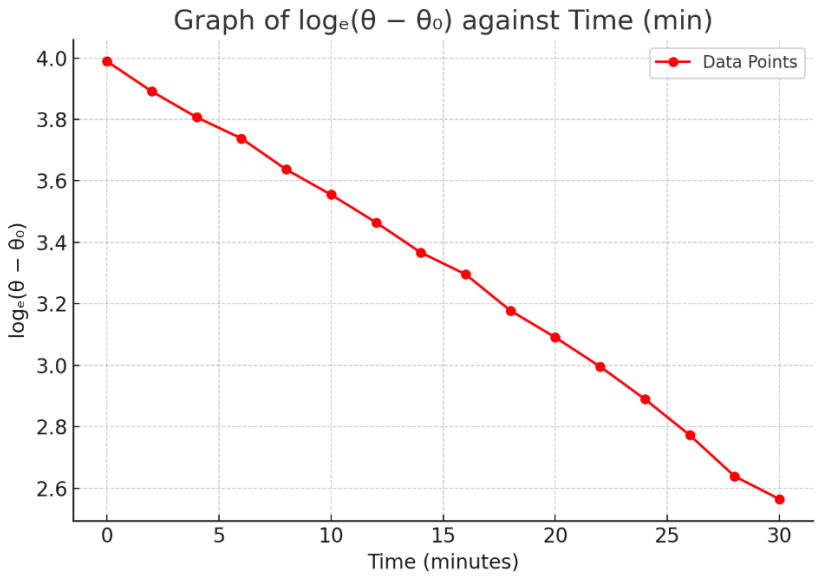
- Calorimeter inside beaker.
- Water inside calorimeter.
- Thermometer inside.
- Stirrer inside.
- Stopwatch nearby.

Labels:
A — Beaker
B — Calorimeter
C — Water
D — Thermometer
E — Stirrer
F — Stopwatch

(ii) Plot a graph of $\log_e(\theta - \theta_0)$ against time t.

Answer:
x-axis: time (min)
y-axis: $\log_e(\theta - \theta_0)$

Plot the points from the table above.



(iii) The experiment obeys the relation, $\log_e(\theta - \theta_0) = -A\,t + B$. Determine the value of A and the constant B.

Answer:

Pick two points:

(0, 3.989) and (30, 2.565)

Then,

A = (3.989 – 2.565) / (30 – 0)
A = 1.424 / 30
A = 0.0475 per minute

Constant B is the y-intercept at t = 0:
B = 3.989

(iv) What is the physical meaning of k?

Answer:
k is the cooling constant. It represents the rate at which the calorimeter loses heat per unit temperature difference to the surroundings.

(v) Mention two sources of error in the experiment.

Answer:

1. Loss of heat to the surroundings through the walls of the calorimeter and beaker.
2. Inaccuracy in temperature reading due to lag in thermometer response or improper stirring.

3. The aim of this experiment is to determine the electromotive force (e.m.f) and the internal resistance of a given dry cell.

Diagram:

Figure 1

(As per your paper: a simple series circuit with a dry cell E, key K, voltmeter V in parallel to the cell, and a rheostat R)

Procedures:

(a) Set up the electric circuit as shown in figure 1, where K= key; E= dry cell, V = voltmeter and R = rheostat.

(b) Starting with a resistor R=20Ω and the key closed, record R and reading V of the voltmeter.

(c) Repeat the procedure in (b) above for values of R equal to 10Ω, 5Ω, 4Ω, 3Ω, 2Ω and 1Ω.

Questions:

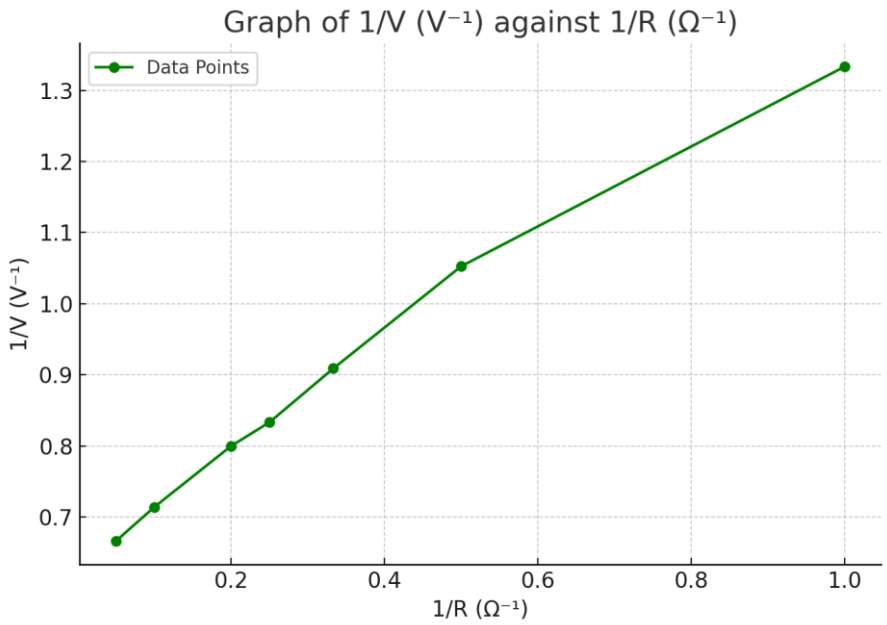
(i) Plot a graph of 1/R against 1/V.

Answer:

First, prepare data:

R (Ω)	V (V)	1/R (Ω^{-1})	1/V (V^{-1})
20	1.50	0.0500	0.6667
10	1.40	0.1000	0.7143
5	1.25	0.2000	0.8000
4	1.20	0.2500	0.8333
3	1.10	0.3333	0.9091
2	0.95	0.5000	1.0526
1	0.750	1.0000	1.3333

Now plot the graph of 1/R (Ω^{-1}) on the x-axis and 1/V (V^{-1}) on the y-axis.



(ii) From the graph, determine the slope and intercepts.

Answer:

Pick two clear points from the plotted line:

Point 1: (0.0500, 0.6667)
Point 2: (1.0000, 1.3333)

Calculate slope (m):

$m = (y_2 - y_1) / (x_2 - x_1)$
$m = (1.3333 - 0.6667) / (1.0000 - 0.0500)$
$m = 0.6666 / 0.9500$
$m = 0.7027$

Intercept (c):

Use equation of a straight line:
$y = m\,x + c$

Substituting Point 1 ($x = 0.0500$, $y = 0.6667$)

$0.6667 = 0.7027 \times 0.0500 + c$
$0.6667 = 0.0351 + c$
$c = 0.6667 - 0.0351$
$c = 0.6316$

(iii) Write down the relation that connects 1/R and 1/V.

Answer:

From the theory:
$V = E - I\,r$

Using Ohm's law:
$I = V / R$

Substituting gives:
$V = E - (V/R) \times r$

Rearranged to:
$1/V = (r/E) \times (1/R) + (1/E)$

This is the relation connecting 1/R and 1/V — a straight line equation.

(iv) Use the result in (iii) above to find the e.m.f and the internal resistance of the dry cell.

Answer:

From the relation:
$1/V = (r/E) \times (1/R) + (1/E)$

Comparing with $y = m\,x + c$:

Slope (m) = $r/E = 0.7027$
Intercept (c) = $1/E = 0.6316$

Now calculate E:

$E = 1 / c$
$E = 1 / 0.6316$
$E = 1.583$ V

Now calculate r:

$r = m \times E$
$r = 0.7027 \times 1.583$
$r = 1.113\ \Omega$

(v) State the source of error and precaution taken in this experiment.

Answer:

Source of error:

- Internal resistance of the voltmeter affecting readings.
- Contact resistance at the connection points.

Precautions:

- Use a high-resistance voltmeter.
- Ensure tight, clean, and secure connections.
- Take readings quickly to minimize temperature changes in the cell.