PHYSICS PRACTICAL SHEETS

Name ..Omkar kr. chaudhary...... ....NCIT.... CAMPUS Date 2079/10/11

Grade ...B.E civil...... Experiment No. ..1..

Roll No ...11...... Group ...6...

Shift ...Morning...... Sub. Group ....

Object of the Experiment (Block letter) Set ....

DETERMINATION OF THE ACCELERATION DUE TO GRAVITY AND RADIUS OF GYRATION OF THE BAR PENDULUM ABOUT AN AXIS PASSING THROUGH ITS CENTRE OF GRAVITY.

APPARATUS REQUIRED:

a) Bar pendulum b) stop watch c) Meter scale, d) knife edge, e) spirit Level f) graph paper.

THEORY:

A compound pendulum is a rigid body of arbitary shape, capable of being oscillated in a vertical plane about a horizontal axis passing through it. It is also called real of physical pendulum. And bar pendulum is a symmetric compound pendulum usually a rod having equal no. of holes.

Figure (a) shows a compound pendulum free to rotate about a horizontal axis passing through the point of suspension S. In its normal position of rest it's c.g "G" lies vertically velow "S". The distance between point of suspension (S) and centre of gravity (G) is called length of pendulum (L).

Let the pendulum be given small angular displacement 'θ' so that it's cg. takes new position G' as shown in figure (b). Due to the weight mg acting vertically downward at G', it constitutes a restoring torque whose action is to tend to bring the pendulum back into its original position.

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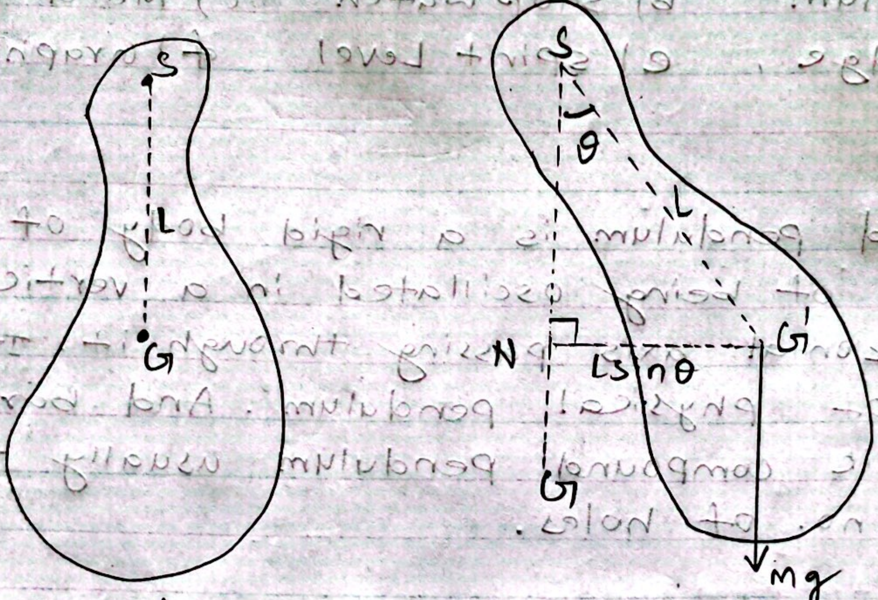

(a) Fig. Compound pendulum (b)

The restoring torque is,

$$\tau = -mg(G'N) = -mgl\sin\theta \quad \text{--- (i)}$$

negative sign indicates that torque is oppositely directed to the displacement 'θ'.

If I is the moment of inertia of the pendulum about the axis of suspension and α be its angular acceleration then,

$$\tau = I\alpha = I\frac{d^2\theta}{dt^2} \quad \text{--- (ii)}$$

from (i) & (ii),

we get, $I\dfrac{d^2\theta}{dt^2} = -mgl\sin\theta$

and, $\sin\theta = \theta - \dfrac{\theta^3}{3!} + \dfrac{\theta^5}{5!} - \cdots$

for θ to be small, $\sin\theta \sim \theta$

so, $I\dfrac{d^2\theta}{dt^2} = -mgl\theta$.

or, $\dfrac{d^2\theta}{dt^2} = \dfrac{-mgl}{I}\theta = 0$

or, $\dfrac{d^2\theta}{dt^2} + w^2\theta = 0 \quad \text{--- (iii)}$

Equation (iii) is the differential equation of S.H.M. Hence the motion of compound pendulum is simple harmonic.

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Equation (iii) is also referred as angular harmonic motion.

Here, $\omega = \sqrt{\frac{mgl}{I}}$, is the angular frequency

or, $\frac{2\pi}{T} = \sqrt{\frac{mgl}{I}}$

or, $T = 2\pi\sqrt{I/mgl}$

If k is the radius of gyration of the pendulum. Then, from the theorem of parallel axis, the total moment of inertia of the pendulum about the axis through point of suspension is,

$$I = I_{CG} + ml^2 = mk^2 + ml^2, \text{ where } I_{CG} = mk^2$$
$$= m(k^2 + l^2)$$

$$\therefore k = 2\pi\sqrt{\frac{m(k^2+l^2)}{mgl}}$$

$$= 2\pi\sqrt{\frac{\frac{k^2}{l} + l}{g}} \quad \text{---(iii)}$$

Thus, time period of compound pendulum is same as that of a simple pendulum of length $L = \frac{k^2}{l} + l$.

This length 'L' is therefore called the length of an equivalent simple pendulum or the reduced length of compound pendulum. Since $k^2 > 0$ i.e. $k^2/l > 0$ the length of equivalent simple pendulum (L) is always greater than length of compound pendulum (l).

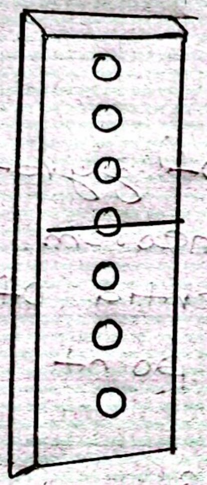


Fig C: Bar pendulum

A bar pendulum is the simplest form of compound pendulum which consists of a uniform metal rod having equally spaced holes drilled along its length on either side of C.G.

The time period of bar pendulum is [shown in figure c]

$$T = 2\pi\sqrt{\frac{L}{g}} \quad --- (iv)$$

where, $L = \left(\frac{k^2 + l^2}{l}\right)$

squaring equation (iv) ~~booth~~ sides,

$$T^2 = (4\pi^2/g)\left(\frac{k^2+l^2}{l}\right)$$

$$lT^2 = \frac{4\pi^2}{g} l^2 + \frac{4\pi^2}{g} k^2 = 0 \quad --- (v)$$

or, $\frac{4\pi^2}{g} l^2 - lT^2 + \frac{4\pi^2}{g} k^2 = 0$

which is the quadratic in l, so it possesses two roots, let they be l_1 and l_2.

$\therefore$ sum of roots, $l_1 + l_2 = -\frac{(-T)^2}{\frac{4\pi^2}{g}} = \frac{gT^2}{4\pi^2}$

or $g = \frac{4\pi^2}{T^2}(l_1 + l_2) = \frac{4\pi^2}{T^2} L \quad ---- (vi)$

and the product of roots, $l_1 \cdot l_2 = \frac{\frac{4\pi^2}{g} k^2}{\frac{4\pi^2}{g}} = k^2$

$\therefore k^2 = l_1 \cdot l_2$

$\therefore k = \pm\sqrt{l_1 \cdot l_2}$ --- (vii)

[since for $ax^2 + bx + c = 0$, sum of roots $= -b/a$ and product of roots $= c/a$]

Here l_1 and l_2 are two values of 'l' for one side of bar pendulum for which the value of time period is same.

[if $l_1 = l$ ~~then~~ then $l_2 = k^2/l$; such that $l_1 + l_2 = k^2/l + l = L$]

PROCEDURE

a) suspend the bar pendulum in the first hole from side A such that pendulum is hanging parallel to wall.

b) set the pendulum into oscillation with small amplitude approximately 5° and note the time taken for 10 complete oscillations.

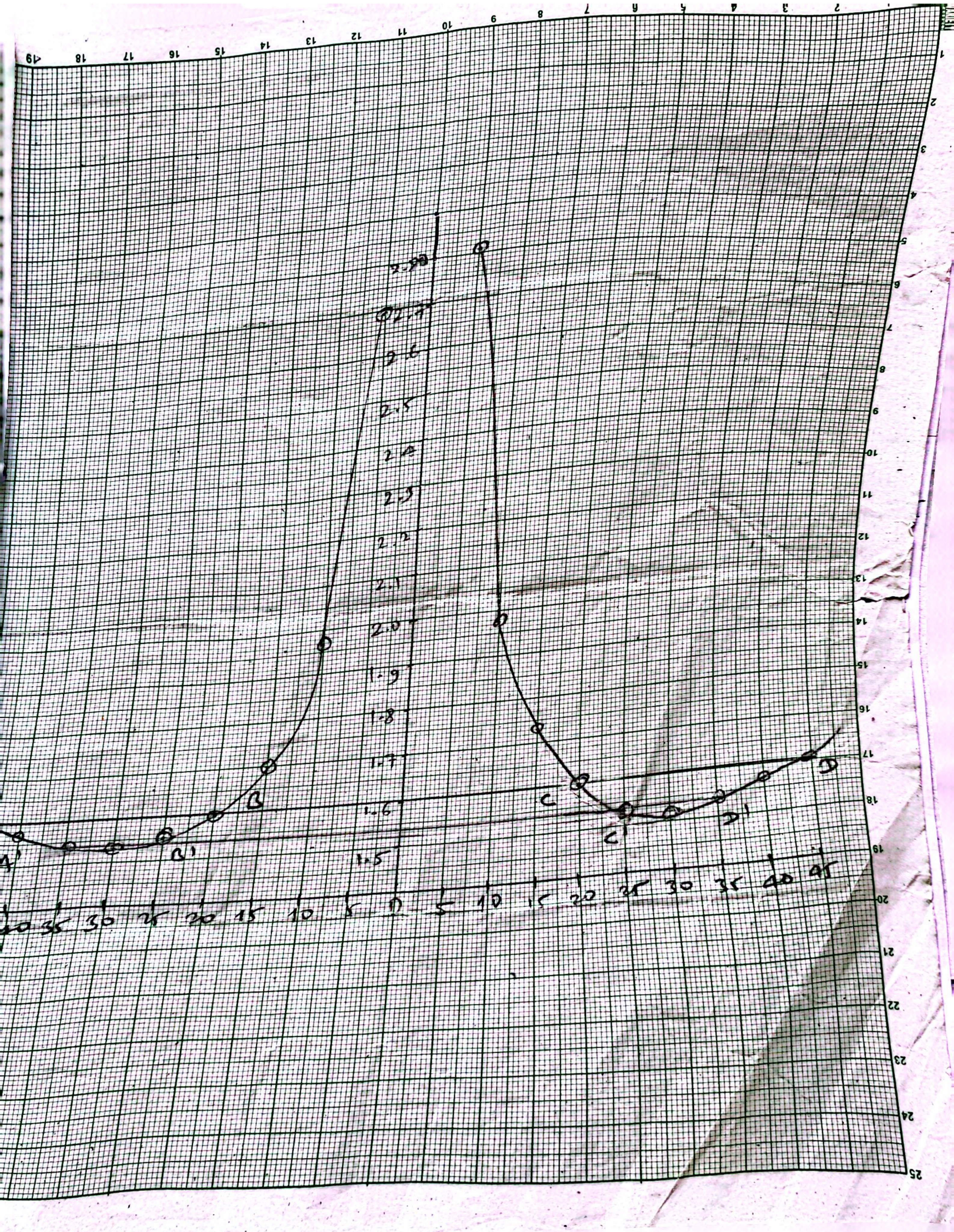
c) Repeat the procedure (b), again and take the mean, let it be (t).

d) Divide it by 10 to get time period (T)

e) Measure the distance (l) of c.g. of the bar from the point of suspension. Repeat the process by hanging the bar through different holes.

f) Suspend the bar on side B and repeat the observation as above.

g) plot of graph between l and T as shown in figure.


2.80
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45
A'
B
B'
C
C'
D
D'

h). Draw horizontal lines ABOCD, A'B'O'C'D' as shown.

i). Again plot a graph between LT^2 and l^2 for both sides A and B as shown in figure.

OBSERVATIONS:-

Table 1: Measurement of length of pendulum (l) and time period (T) for side (A).

S.N.	Distance betw CG and suspension	Time for 10 oscillation 1	2	Mean	Time period T = t/10	T^2	lT^2	l^2
1.	45	16.3	15.97	16.13	1.613	2.601	117.04	2025
2.	40	15.78	15.72	15.73	1.573	2.474	98.96	1600
3.	35	15.50	15.57	15.53	1.553	2.411	84.38	1225
4.	30	15.37	15.40	15.38	1.538	2.365	70.95	900
5.	25	15.43	15.68	15.55	1.555	2.418	60.45	625
6.	20	15.97	15.94	15.95	1.595	2.344	50.88	400
7.	15	17.07	17.03	17.05	1.705	2.907	43.605	225
8.	10	19.81	19.60	19.70	1.970	3.880	38.8	100
9.	5	27.37	27.50	27.43	2.743	7.524	37.62	25

Table 2: Measurement of length of pendulum (l) and time period T for side B.

S.N.	Distance betw C.G and suspension	Time for 10 oscillation			Time period $T = t/10$	T^2	lT^2	l^2
		1	2	Mean (t)				
1.	45	16.06	15.93	15.725	1.599	2.556	115.02	2025
2.	40	15.65	15.66	15.665	1.565	2.449	97.96	1600
3.	35	15.56	15.53	15.543	1.554	2.414	84.89	1225
4.	30	15.31	15.34	15.33	1.532	2.347	70.41	900
5.	25	15.35	15.37	15.36	1.536	2.359	58.97	625
6.	20	15.94	15.94	15.94	1.594	2.540	50.80	400
7.	15	17.22	17.16	17.19	1.719	2.954	44.31	225
8.	10	20.22	20.16	20.19	2.019	4.076	40.76	100
9.	5	28.31	28	28.155	2.815	7.924	39.62	25

CALCULATIONS:

Table 4: Measurement of g from the plot T ~ l.

S.N.	straight line	length of equivalent simple pendulum			Time period (T)	$g = \frac{4\pi^2 l}{T^2}$	$\bar{g}$	$g_i - \bar{g}$	$(g_i - \bar{g})^2$	$\sigma_g = \sqrt{\frac{\Sigma (g_i - \bar{g})^2}{n(n-1)}}$
		1.	2.	Mean (l)						
1.	ABCD	65	65	65	1.60	10.02	10.14	0.22	0.0484	0.3669
2.	A'B'C'D'	65	60	62.5	1.58	10.275		0.47	0.2209	

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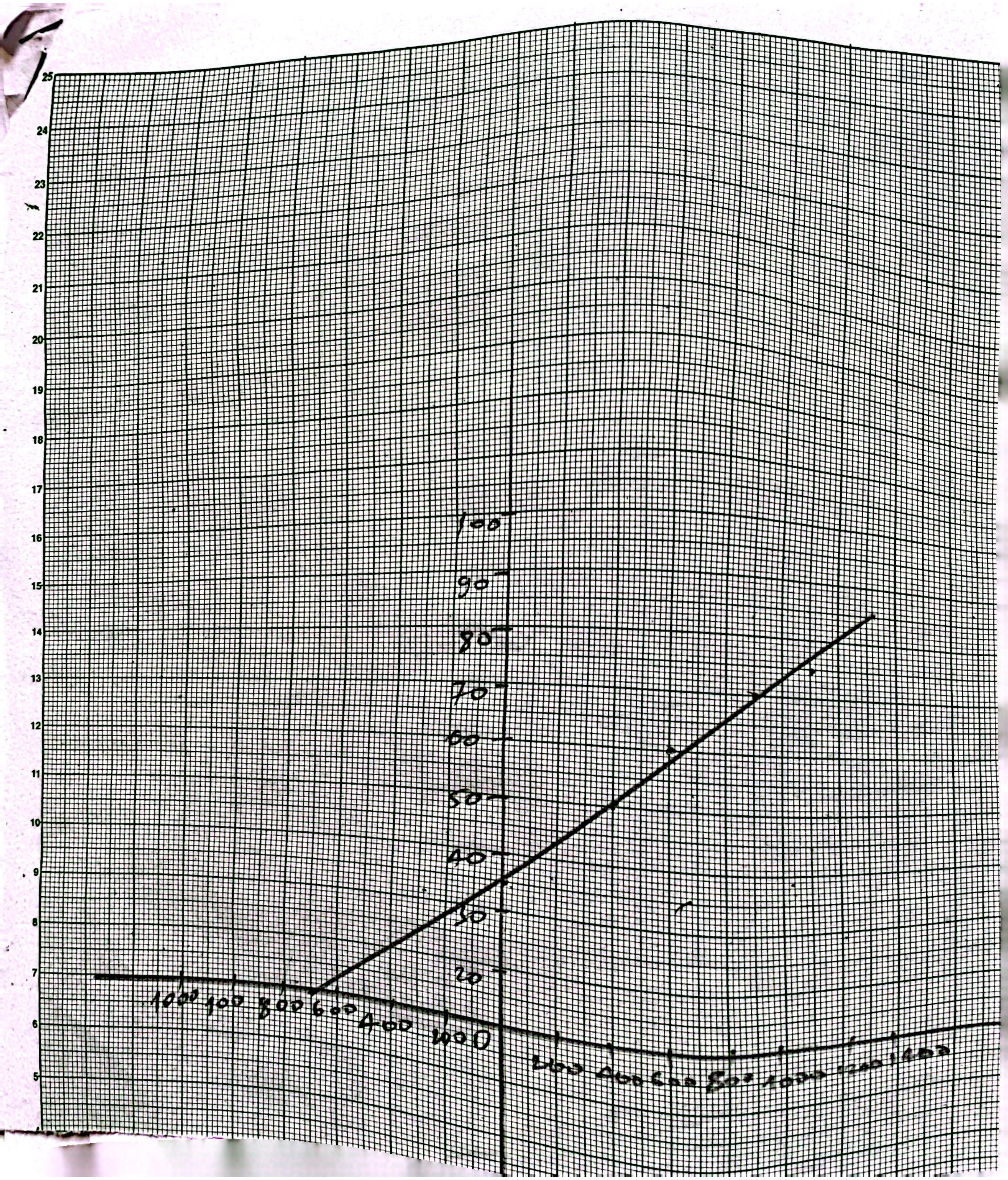

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Table No. 2 : Measurement of K from the plot of T ~ l

S.N.	l_1	l_2	$K = \sqrt{l_1 l_2}$	$\bar{K}$	$K_i - \bar{K}$	$(K_i - \bar{K})^2$	$\sigma_K = \sqrt{\frac{\Sigma (K_i - \bar{K})^2}{n(n-1)}}$
1.	45	20	30		-3.43	11.76	3.43
2.	45	20	30	33.43	-3.43	11.76	
3.	65	25	40.31		-0.88	47.33	

Table No. 3 :- Determination of g and K from the plot of $LT^2 \sim l^2$

S.N.	Side	OA	OD	Slope = $\frac{OA}{OD}$	$g = \frac{4\pi^2}{slope}$	$K = \sqrt{OD}$
1.	A	36	700	0.051	77408	26.45
2.	B	36	725	0.049	8.05.68	26.92

RESULTS :-

1. The value of g,
(i) 10.14 (ii) 7.88 (iii) mean = 9.01 m/s^2

2. Standard value of g in kathmandu valley
$= 9.8 \left(1 - \frac{2h}{R}\right) = 9.79\ m/s$

where, average height of kathmandu valley from sea level (h) = 1350 m, radius of earth (R) = 6400 km

3. percentage error in $g = \left| \frac{9.79 - 9.01}{9.79} \right| \times 100\% = 7.90\%$

~~CONCLUSION~~!

~~Thus, we find the acceleration due to gravity and radius of gyration of bar pe~~

4 - The value of $K = 26.68$

5 - standard value of $K = \frac{\text{Total length of bar}}{\sqrt{12}} = \frac{100}{\sqrt{12}} = 28.87$ cm

6. percentage error in $K = \left|\frac{26.68 - 28.87}{26.68}\right| \times 100\% = 8.20\%$

CONCLUSION!

Thus, we found the acceleration due to gravity and radius of gyration of bar pendulum about an axis passing through its center of gravity and the ~~value~~ of found value of g is $9.01\ m/s^2$

PRECAUTION:

1. Measure the length properly
2. The graph should be free hand drawn.

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PHYSICS PRACTICAL SHEETS

NCIT Campus

Date: 2079/11/16
Class: BE civil
Roll No.: 11
Shift: Morning

Experiment No.: 02
Group: C
Sub.:
Set:

Object of the Experiment (Block Letter)

2079/11/16

DETERMINATION OF THE VALUE OF MODULUS OF RIGIDITY OF THE WIRES AND MOMENT OF INERTIA OF A CIRCULAR DISC USING TORSION PENDULUM.

APPARATUS REQUIRED:

a) Torsion pendulum set, b) Thin wire c) stopwatch
d) screw gauge, e) Meter scale f) spirit level
g) Balance

THEORY:

A disc suspended at its mid-point by a long and thin wire to a rigid support constitutes a torsion pendulum. It is called so because when it is twisted and then released, it executes torsional vibrations about the ~~wire~~ wire as axis.

If the pendulum is turned through an angle 'θ', the wire exerts a restoring torque proportional to angular displacement 'θ',

i.e. $T \propto \theta$

or, $T = -C\theta$ ——— (i)

where 'c' is called torsion constant of the wire which depends upon its property. It is defined as the restoring torque per unit twist in the wire and given by

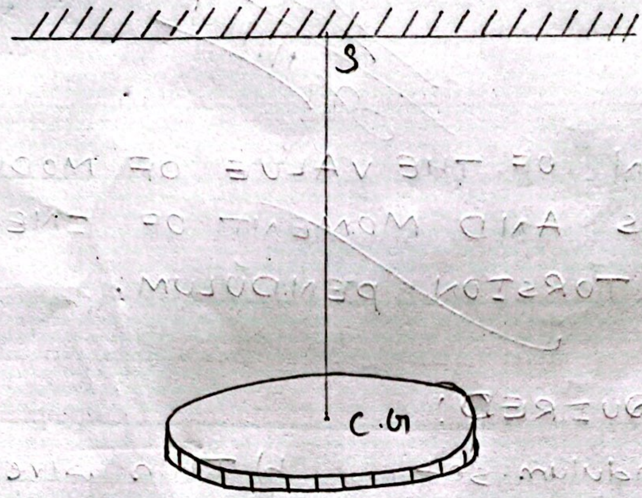


fig: Torsion pendulum

figure-1

$$c = \frac{\pi n r^4}{2l}$$

where, η = modulus of rigidity of wire
r = radius of wire
l = length of wire

The torque is also given by
$$\tau = I\alpha \quad \text{---} \quad (ii)$$

Equations (i) and (ii) give $I\alpha = -c\theta$

or, $\alpha = -\frac{c\theta}{I}$

or $\frac{d^2\theta}{dt^2} + \frac{c\theta}{I} = 0$

or, $\frac{d^2\theta}{dt^2} + \omega^2\theta = 0$

This shows that the motion of torsion pendulum is simple harmonic.

Here, $\omega^2 = \frac{c}{I}$

or, $\omega = \sqrt{\frac{c}{I}}$

or, $\frac{2\pi}{T} = \sqrt{\frac{c}{I}}$

or, $T = 2\pi\sqrt{\frac{I}{c}} \quad \text{---} \quad (iii)$

This is the time period of torsion pendulum.

Let I_1 be the moment of inertia of circular disc, then its time period is given by

$$T_1 = 2\pi \sqrt{\frac{I_1}{c}}$$

or, $T_1^2 = 4\pi^2 \frac{I_1}{c}$ --- (iv)

Now, a circular ring is placed on the circular disc co-axially with the wire, then the period of oscillation for this combination is given by

$$T_2 = 2\pi \sqrt{\frac{I_1 + I_2}{c}}$$

where, I_2 is the moment of inertia of circular ring.

or, $T_2^2 = 4\pi^2 \left(\frac{I_1 + I_2}{c}\right)$ --- (v)

subtracting eqn (iv) from (v).

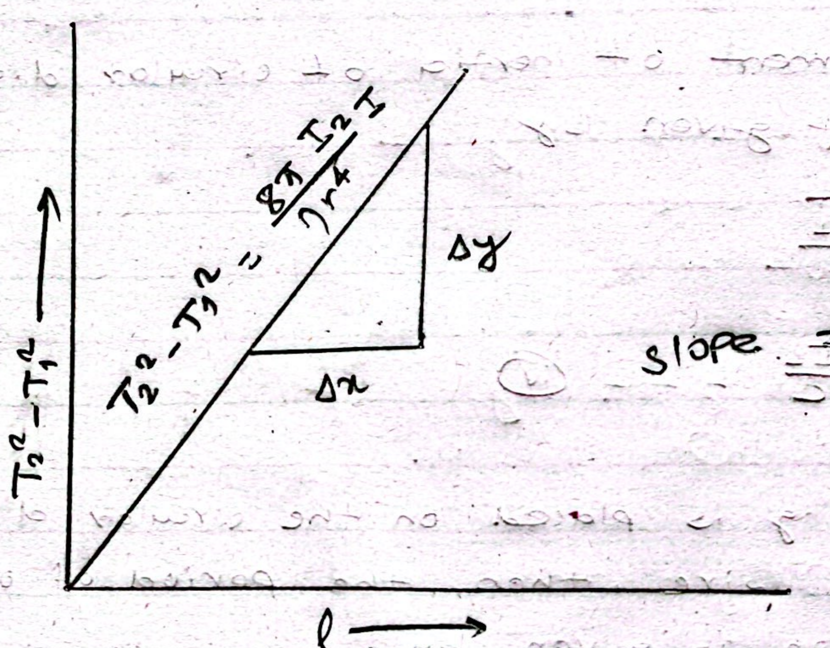
$T_2^2 - T_1^2 = \frac{4\pi^2 I_2}{c}$ --- (vi)

$$T_2^2 - T_1^2 = \frac{4\pi^2 I_2}{\pi \eta r^4} \times 2l$$

$\therefore \eta = \frac{8\pi I_2 l}{(T_2^2 - T_1^2) r^4}$ --- (vii)

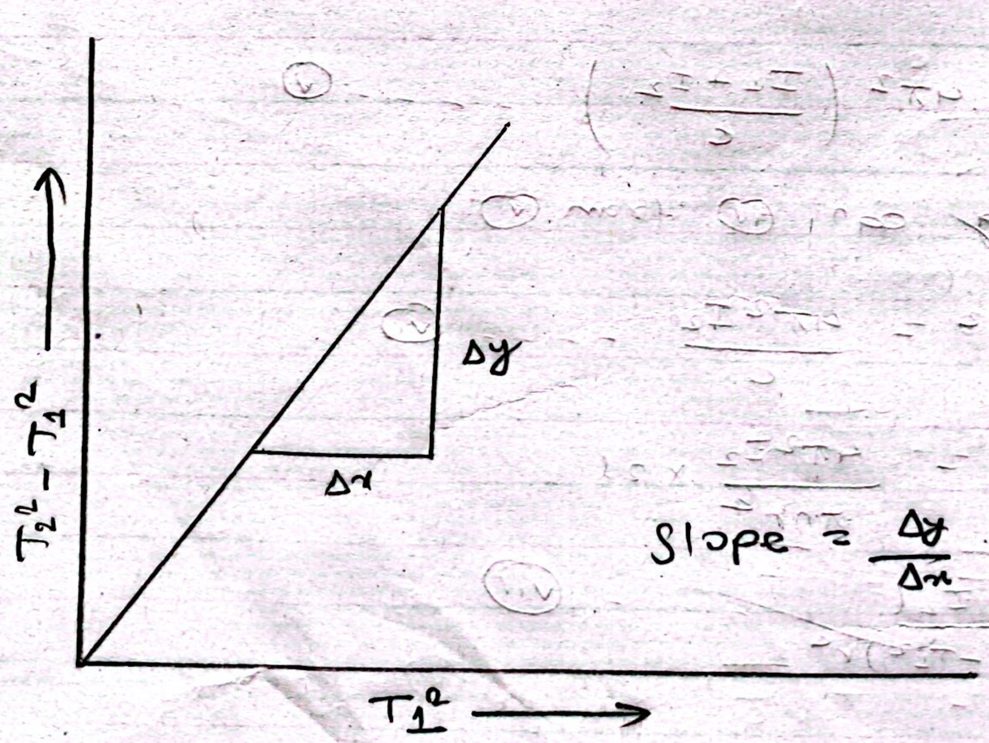
Again, dividing eqn (iv) by (vi)

$$\frac{T_1^2}{T_2^2 - T_1^2} = \frac{I_1}{I_2}$$



$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{8\pi I_2}{\eta r^4}$$

Fig: Graph between $T_2^2 - T_1^2$ and l



$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{I_2}{I_1}$$

Fig: Graph between $T_2^2 - T_1^2$ and T_1^2

$$I_1 = \left(\frac{T_1^2}{T_2^2 - T_1^2} \right) I_2 \quad \text{---- (viii)}$$

PROCEDURES:

1.) Suspend the circular disc with a ring from a rigid support.

2). Take the circular ring out of the circular disc and place it over the rigid support.

3.) Twist slightly the disc in horizontal plane, Then, note the time taken for 10 oscillation and calculate the time period T_1 for circular disc.

4) Now place the circular ring on the circular disc in such a way that the axis of the wire passes through centre of gravity of the ring.

5) Again, note the time period T_2 for disc and ring for the same length as in case of circular disc.

6.) Repeat the process for different lengths of wire.

7.) plot a graph between $(T_2^2 - T_1^2) \sim l$ and $(T_2^2 - T_1^2) \sim T_1^2$ and find η and I_1.

OBSERVATIONS:

1.) Mass of circular ring (m) = 820 g

2). Mass of circular disc (m') = 850 g

3.) Radius of suspension wire (r) = 0.0425 cm

4.) Radius of circular disc (R) = 6.085 cm

5.) Internal radius of circular ring (R_1) = 9.4 + 0.01 × 2 = 4.71 cm

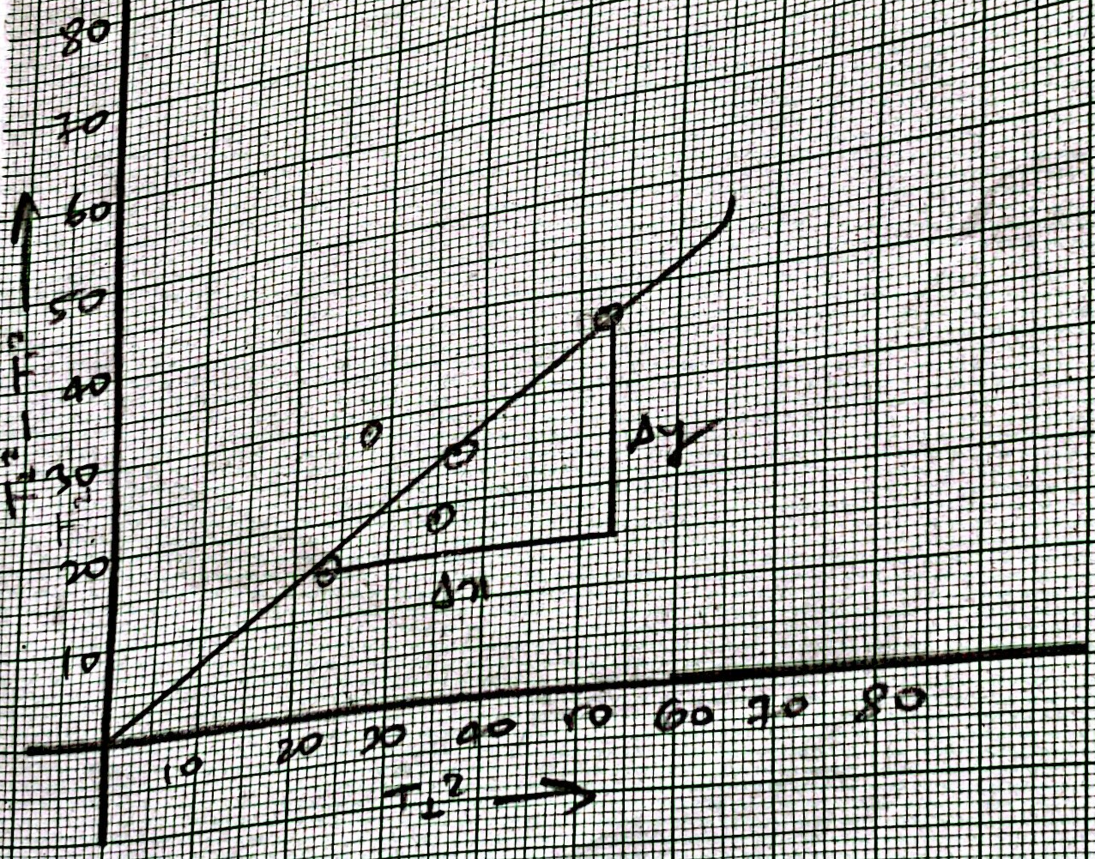
6.) External radius of circular ring (R_2) = 12.1 + 0.01 × 7 = 6.0885 cm

7.) Moment of inertia of circular ring $I_2 = \frac{M(R_1^2 + R_2^2)}{2} = 9473.816$ g cm²

$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{I_2}{I_1}$$

$$\frac{22.17}{29.25} = \frac{I_2}{I_1}$$

$$I_1 = 11901.73 \ g\,cm^2$$



$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{8\pi I l}{\eta r^4}$$

$$\frac{20}{15} = \frac{8\pi I l}{\eta r^4}$$

$$\eta = 6.69 \times 10^{10}$$

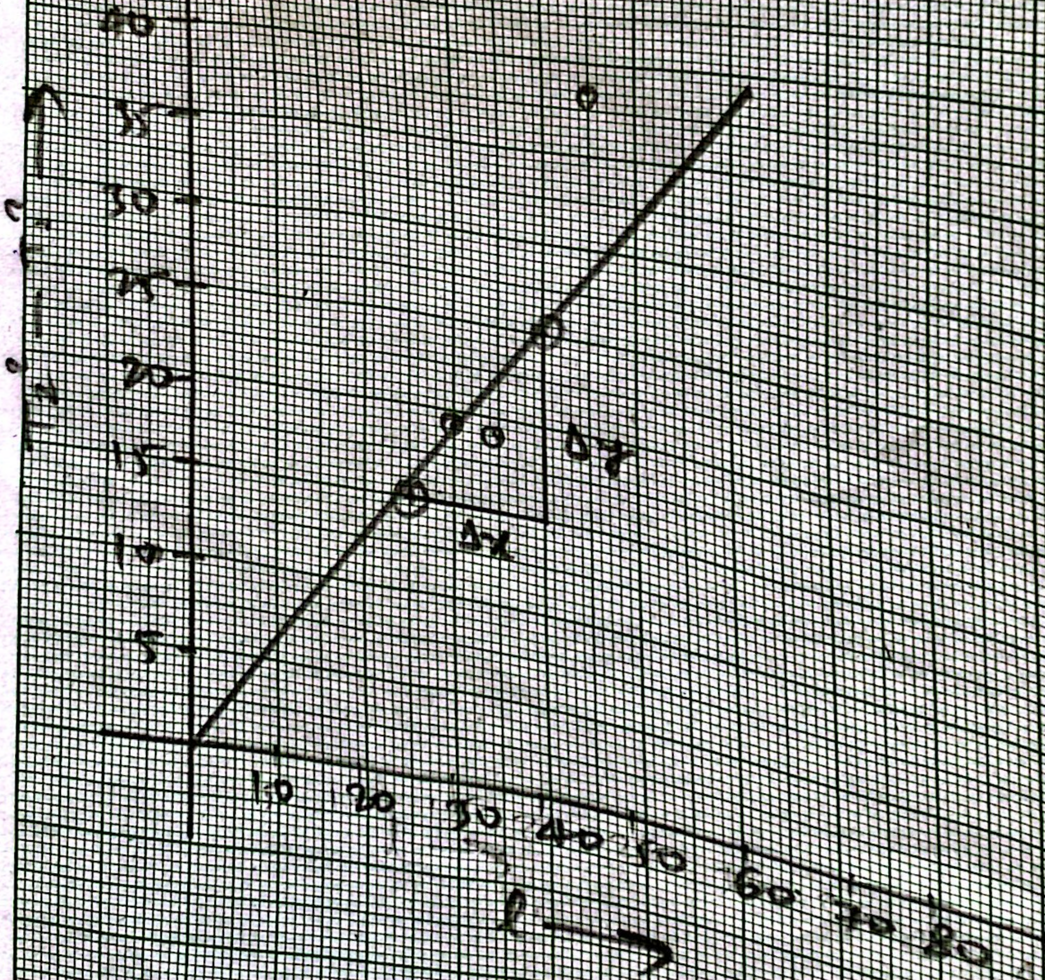


Table no. 1. Determination of time period

S.N.	length cm	Determination of T_1 (Disc) Time for 10 oscillation 1	2	Mean	Time period (T_1)	Determination of T_2 (Disc+ring) Time for 10 oscillation 1	2	Mean	Time period (T_2)
1.	45	71	71	71	7.1	94	93	93.5	9.35
2.	40	60	60	60	6.0	78	78	78	7.8
3.	35	58	60	59	5.9	73	73	73	7.3
4.	30	51	51	51	5.1	67	67	67	6.7
5.	25	46	46	46	4.6	60	60	60	6.0

Table no. 2 : Measurement of modulus of rigidity of wire (η) and moment of inertia of disc (I_2)

S.N.	l (cm)	T_1^2 s^2	T_2^2 s^2	$T_2^2 - T_1^2$ s^2	η dyne/cm²	$\bar{\eta}$ dyne/cm²	I_1 g cm²	$\bar{I_1}$ g cm²
1.	45	50.41	87.42	37.01	8.87×10^{10}		12903.94	
2.	40	36	60.84	24.84	1.17×10^{11}		13730.16	
3.	35	34.81	53.29	18.48	1.38×10^{11}	$= 1.16 \times 10^{11}$	17845.42	14207.96
4.	30	26.01	44.89	18.88	1.15×10^{11}		13051.58	
5.	25	21.16	36	14.84	1.22×10^{11}		13508.48	

RESULTS:

1.) The value of modulus of rigidity of wire $(\eta) = 8.16 \times 10^{11}$ dyne/cm^2

2.) standard value of $\eta = 8.4 \times 10^{11}$ dyne/cm^2

3.) percentage error = $\left| \frac{8.16\times10^{11} - 8.4\times10^{11}}{8.4\times10^{11}} \right| \times 100\ \% = 7.05\%$

4.) The value of moment of inertia of circular disc $(I_1) = 14207.7$ gcm^2

5.) standard value of $I_1 = \frac{MR^2}{2} = 15736.57$ gcm^2

6.) ~~pere~~percentage error in $I_1 = \left| \frac{14207.7 - 15736.57}{15736.57} \right| \times 100\% = 9.71\%$.

7.) The value of η from graph = 6.69×10^{10} dyne/cm^2

8.) The value of I_1 from graph = 11901.73 gcm^2

CONCLUSION:

It shows that the modulus of rigidity of wire is 8.16×10^{11} dyne/cm^2 and moment of inertia of circular disc is

PRECAUTIONS:

1.) The disc rotate equally on both side of the reference mark.

2.) There should be no kinks in the wit.

3). The disc should rotate about axis of wire are not about horizontal axis through rigid.

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PHYSICS PRACTICAL SHEETS

Date: 2079/11/27 .... NCIT CAMPUS
Class: BE civil
Roll No.: 11
Shift:
Experiment No.: 03
Group: C
Sub.:
Set:

Object of the Experiment (Block Letter)

DETERMINATION OF THE WAVELENGTH OF SODIUM LIGHT BY USING NEWTON'S RING METHOD.

APPARATUS REQUIRED:

a) A travelling microscope consisting an optically plane glass plate inclined at an angle 45° and plano convex lens on another glass plate.

b.) Na-light,

c) spherometer

d) Torch light

THEORY:

When a plano convex lens of large focal length is placed on a plane glass plate, a thin film of air is enclosed between the lower surface of the lens and upper surface of the plate. The thickness of the film is in ascending order to a certain value around the point of contact of lens and glass plate. When a parallel beam of monochromatic light is made to incident on such combination, interference fringes are observed in the form of series of concentric rings with their centre at the point of contact. Such rings due to interference are first observed by Newton and hence called Newton's ring.

Newton's rings are formed due to both reflected and transmitted rays. In case of interference in thin film

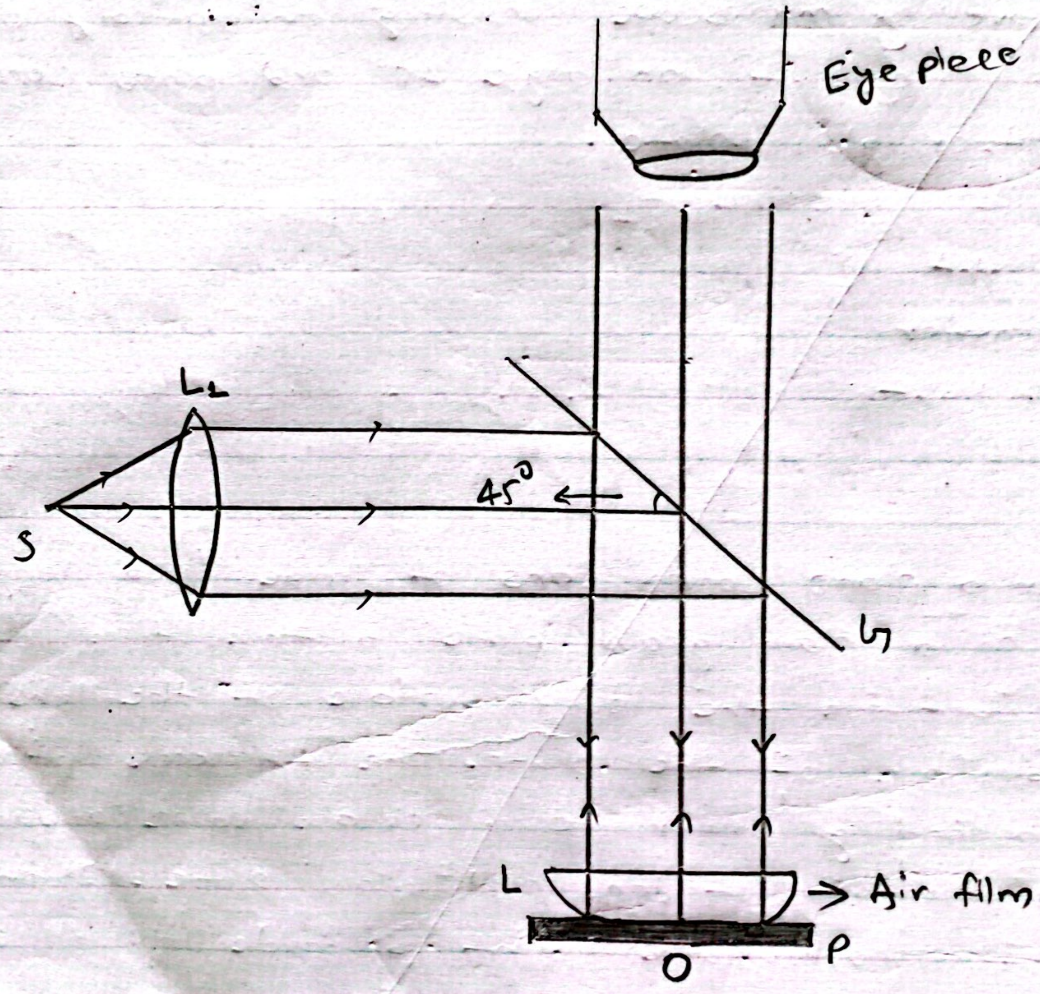

fig (a): Experimental arrangement for Newton's ring.

due to reflected light, the conditions for maximum and minimum intensity are,

$$\therefore 2\mu t \cos r = (2n-1)\frac{\lambda}{2} \quad \text{——— (i)}$$

and,

$$2\mu t \cos r = n\lambda \quad \text{——— (ii)}$$

where, μ = refractive index of the film
t = thickness of the film
r = angle of refraction and
n = order

Consider a plano-convex lens and glass plate arrangement as shown in figure (d). Let PQ the position of n^{th} ring at which thickness of the film PQ = t, Therefore, PS = r_n is the radius of n^{th} ring. R be the radius of curvature of plano convex lens.

from figure,

$$OP^2 = PS^2 + OS^2$$

or, $R^2 = r_n^2 + (R-t)^2$

or, $R^2 = r_n^2 + R^2 - 2Rt + t^2$

or, $r_n^2 = 2Rt - t^2$

Neglecting t^2 being small quantity

$$r_n^2 = 2Rt$$

$$\therefore t = \frac{r_n^2}{2R} \quad \text{——— (iii)}$$

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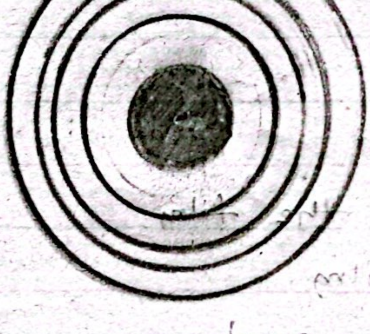


Fig(b): Newton's rings due to reflected rays.

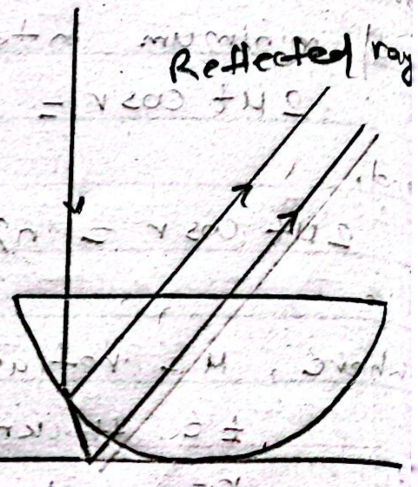


Fig 'c'

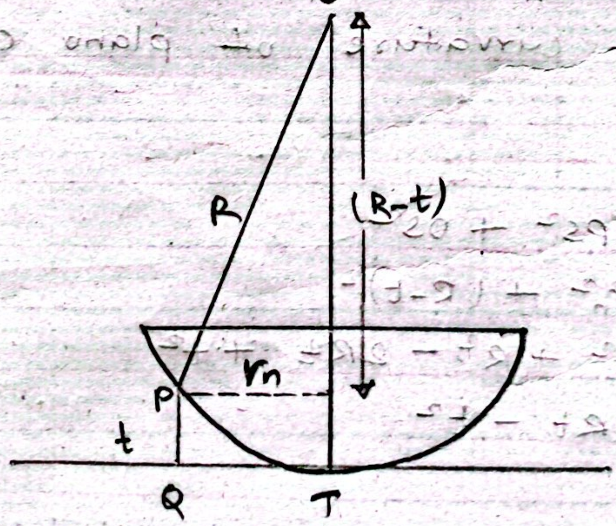


Fig 'd'.

for normal incidence $(r=0)$ and for air as medium $(\mu=1)$. so, equation (ii) can be written as

$$2t = n\lambda$$

$$\therefore 2 \cdot \frac{r_n^2}{2R} = n\lambda$$

or, $r_n^2 = n\lambda R$

Hence, r_n represents the radius of n^{th} dark ring in case of Newton's ring due to reflected light.

If D_n is diameter of n^{th} dark ring.

$$D_n^2 = (2r_n)^2 = 4r_n^2 = 4n\lambda R$$

$$D^2_n = 4n\lambda R$$

similarly, if $D_m = 4m\lambda R$ —— (iv)

$$D^2_m = 4m\lambda R \quad \text{—— (v)}$$

subtracting eq^n (iv) from (v)

$$D^2_n - D^2_m = 4(n-m)\lambda R$$

$$\therefore \lambda = \frac{D_n^2 - D_m^2}{4(n-m)R} \quad \text{—— (vi)}$$

PROCEDURE:

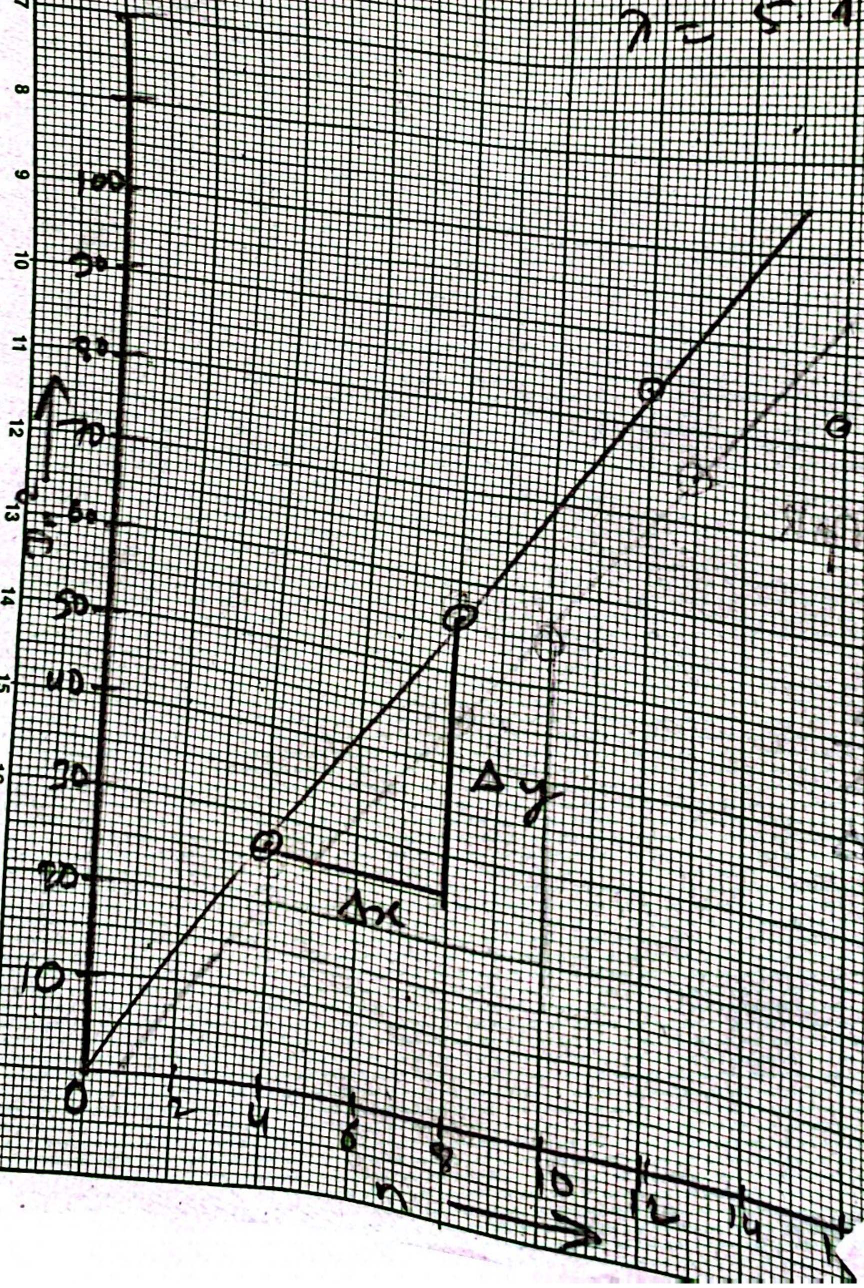
1. clean the glass plates and lenses with a cotton cloth.
2. place a plano convex lens above the base glass plate with its curved surface in contact with plane

X-axis - 10 small division =
Y-axis - 10 small division =

$$\text{slope} = \frac{\Delta y}{\Delta x} = 4\lambda R$$

$$16 = 4\lambda R$$

$$\lambda = 5.12 \times 10^{-4}\ mm$$



$e = \frac{\Delta y}{\Delta x} = A$

D_n^2 and

surface of the glass plate

3. Look through the travelling microscope and focus the rings sharply. place the cross wire in the centre of the rings.

4. slide the microscope towards left and note the corresponding readings (m.s. and v.s.) by placing the cross wire tangentially at 4th, 8th and 16th dark rings gradually.

5. Again slide the microscope toward right and note the corresponding readings by placing the cross wire tangentially at 4th, 8th and 16th dark rings gradually.

6. find the diameters of corresponding rings.

7. plot a graph between D_n^2 and n as figure below.

OBSERVATIONS:

1. Radius of curvature of plano-convex lens (R) = 1520 mm

2. Vernier constant of microscope = 0.01 mm

Table No. 1. Determination of the diameter of rings

order of rings	Microscope reading (Left)(x)			Microscope reading (right)(y)			Diameter	D_n^2
	M.S	V.S	M.S.+(VS×V.C)	M.S	V.S.	M.S.+(V.S.×V.C)	$D_n = x-y$	
4	44	79	44.79	39	86	39.85	4.94	24.406
8	45	64	45.64	38	01	38.10	7.67	58.216
12	46	35	46.35	38	77	38.77	8.00	84
16	46	86	46.86	37	77	37.77	9.09	82.62

Table No. 2. Measurement of wavelength (λ)

S.N.	n-m	$D_n^2 - D_m^2$	λ	$\bar{\lambda}$	$\lambda_i - \bar{\lambda}$	$(\lambda_i - \bar{\lambda})^2$	$\sigma_{\bar{\lambda}}$
1.	8 - 4	31.81	1.39×10^{-4}		-4.03×10^{-4}	16.24×10^{-8}	
2.	12 - 4	5.784	2.37×10^{-4}		-3.05×10^{-4}	9.30×10^{-8}	
3.	12 - 8	39.59	8.1×10^{-4}	5.42×10^{-4}	2.68×10^{-4}	7.18×10^{-8}	0.012
4.	16 - 4	18.62	7.65×10^{-4}		2.23×10^{-4}	4.9×10^{-8}	
5.	16 - 8	24.404	8.017×10^{-4}		0.4×10^{-4}	0.16×10^{-8}	
6.	16 - 12	58.214	8×10^{-4}		2.58×10^{-4}	6.65×10^{-8}	

RESULTS:

1. The value of wavelength of given light (λ) = 5.42×10^{-4} mm
2. standard value (λ) = 5893 A° = 5.893×10^{-4} mm
3. percentage error in λ = $\left| \frac{5.42 \times 10^{-4} - 5.893 \times 10^{-4}}{5.893 \times 10^{-4}} \right| \times 100\%$. 28.030%
4. λ from graph = 5.42×10^{-4} mm

CONCLUSION:

Thus, the wavelength of Na-light can be calculated by using Newton's ring method.

PRECAUTION:

1. Be careful while measuring the m.s and v.s. scale
2. Do not move the scale without taking reading.

PHYSICS PRACTICAL SHEETS

Name Omkar kr. chaudhary
Grade B.E. Civil 1st sem
Roll No 11
Shift Morning
Object of the Experiment (Block letter)

NCIT CAMPUS

Date 2079/10/06
Experiment No. 4
Group 6
Sub. Group
Set

DETERMINATION OF THE WAVELENGTH OF LASER LIGHT USING DIFFRACTION GRATING.

APPARATUS REQUIRED:

a) Laser Light b) Diffraction grating,
c) Graph as screen (graph paper),
d) Optical bench, e) Measuring scale.

THEORY:

Laser stands for the 'Light Amplification for the stimulated Emission of Radiation'. It is a highly coherent, undirectional, monochromatic light. It finds its use in wide areas such as in medical surgery, industries, etc. (Note: 2018 Nobel prize in physics has been awarded to laser field).

Diffraction is the characteristic of the wave. It is the bending of wave (here EM wave i.e. Laser) around the corners of an obstacle.

A transparent glass plate consisting of a Large number of ruled lines is called diffraction grating. Each line acts as an obstacle while the spacing between the lines allows LASER to pass through the grating. If the width of the transparency and opacity be 'a' and 'b' respectively, the distance (a+b) is called grating element.

and $(a+b) = \frac{1}{N}$

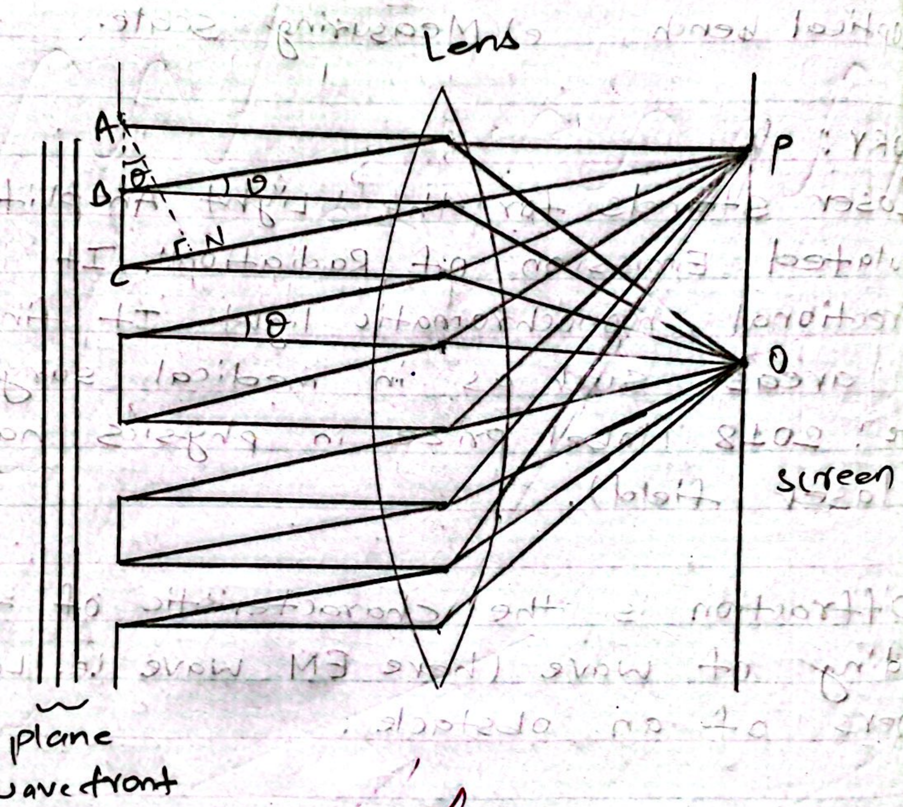
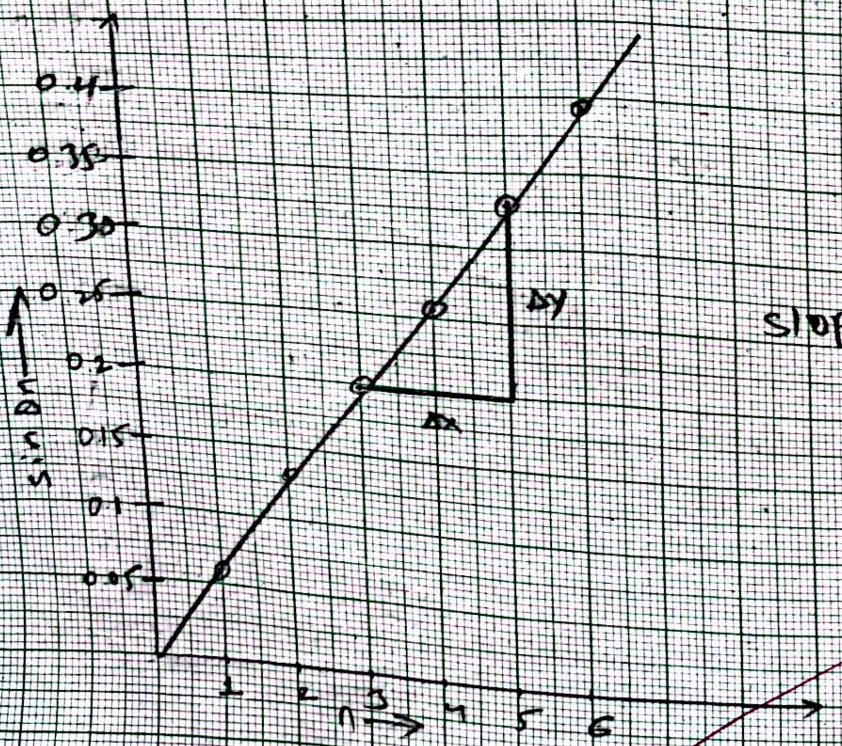


fig:1(a). Diffraction through grating

$$\text{scale} = \frac{0.356 - 0.068}{6} = 0.05$$



$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{0.13}{2} = 0.065$$

fig: plot of $\sin\theta_n \sim n$ for grating

The point 'p' will be maximum intensity if the path difference is equal to integral multiple of 'λ'. i.e. when

$$(a+b)\sin\theta = n\lambda \quad \text{—— (1)}$$

where, $n = 1, 2, 3, ----$

Eqn (1) is the required diffraction grating equation. and the condition of minima is,

$$(a+b)\sin\theta = (2n+1)\lambda/2 \quad , n = 0, 1, 2, 3, ——$$

Note! The asterik (*) below is assigned for the extra theoretical feedback for the students & can be omitted.

* Fraunh offer diffraction through single slit :-

consider a slit of width 'a'. As the plane wave front is incident on the slit AB, each point on it act as source of secondary disturbance. The secondary waves travelling in the direction of incident wave front come to focus at point 'o' on screen and a central bright fringe is observed. consider secondary waves travelling in the direction inclined at angle θ with horizontal come to focus at point 'p' on the screen. The point 'p' will be of maxima or minima depends upon path difference between secondary waves that originate from corresponding points of the wavefront. From figure, this path difference = BN = $a\sin\theta$.

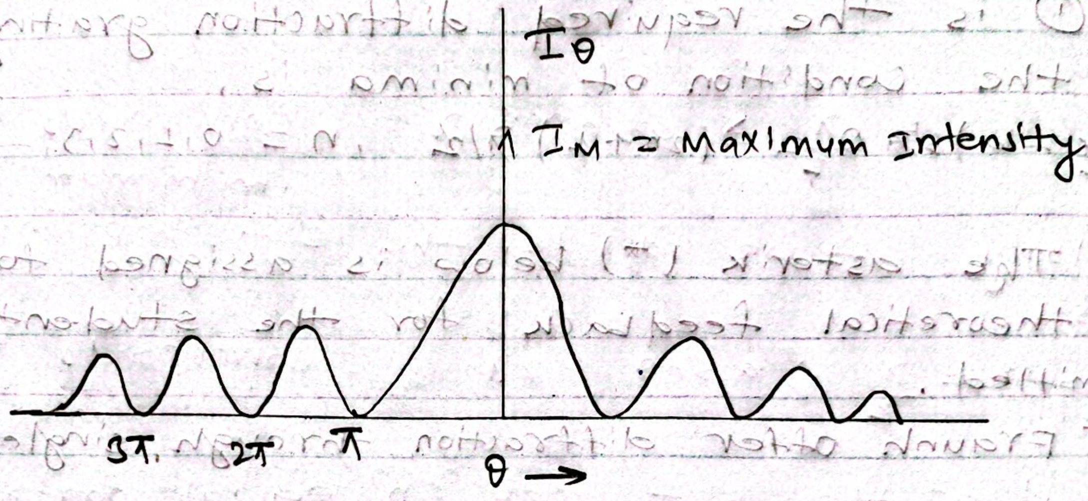


fig 1(d). Intensity distribution for diffraction through sing

If we divide slit into two equal parts. The path difference between the waves originating from extreme of each part is $\lambda/2$ as the ray from bottom of each part travels half wavelength more than rom the top part. This has been proved by Fresnel giving the concept of Fresnel's zones.

$$\frac{a}{2}\sin\theta = \frac{\lambda}{2} \Rightarrow a\sin\theta = \lambda$$ --- corresponds to first minimum

Similarly, if we divide the slit into four equal parts,

$$\frac{a}{4}\sin\theta = \frac{\lambda}{2} \Rightarrow a\sin\theta = 2\lambda$$ --- corresponds to second minimum

Dividing the slit into $2n$ equal parts,

$$\Rightarrow \frac{a}{2n}\sin\theta = \frac{\lambda}{2} \Rightarrow a\sin\theta = n\lambda \quad \text{---(ii) minimum}$$

Eq^n (ii) is the condition of minima for diffraction through single slit.

The condition of maxima is

$$a\sin\theta = (2n+1)\frac{\lambda}{2}, \quad n = 0, 1, 2, 3, ---$$

Where, N = no. of lines per unit length of grating.

Let a plane wave front of light of wavelength 'λ' be incident normally on the grating surface. Then all the secondary waves travelling in the same direction as that of incident light will come to focus at point 'O' on the screen as shown in figure. since the path difference between corresponding waves arriving at 'O' is zero, so all the secondary wave reinforce on one another to give central bright maximum at 'O'.

consider, secondary waves travelling in a direction inclined at an angle θ with the direction of incident light, which comes to focus at point 'P' on the screen. The intensity at 'P' will depend on the path difference between the secondary waves originating from corresponding points A and C of two neighboring slits.

From figure,

$$\sin\theta = \frac{CN}{AC}$$

or, $CN = AC\sin\theta = (a+b)\sin\theta$

$\therefore$ path difference, $CN = (a+b)\sin\theta$

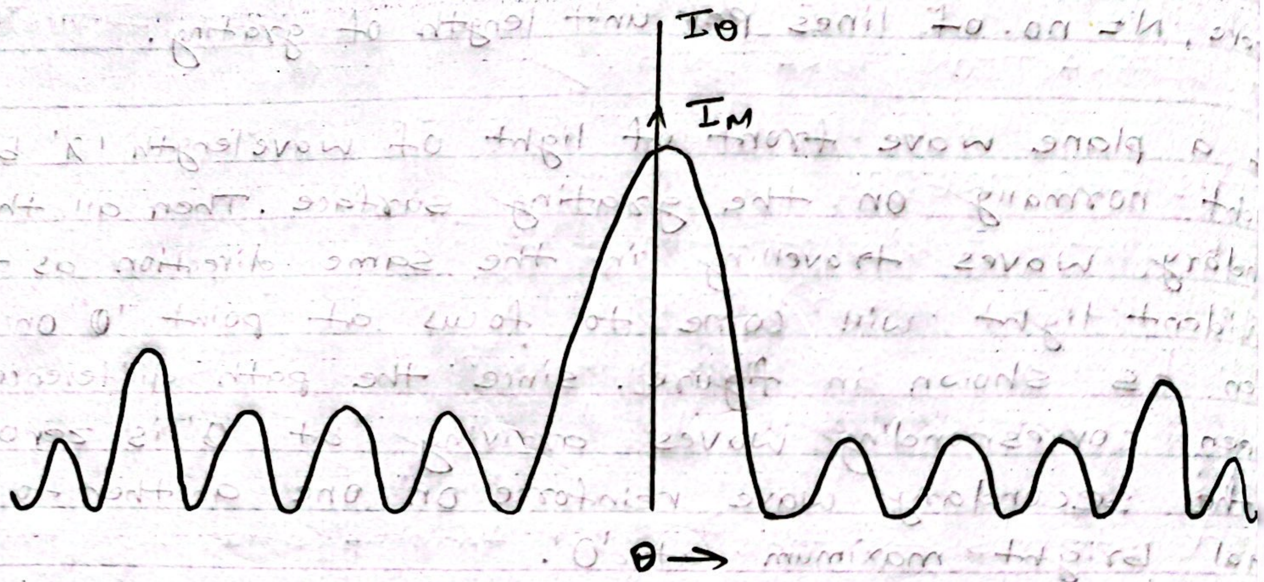


fig. (b). Intensity distribution for diffraction through

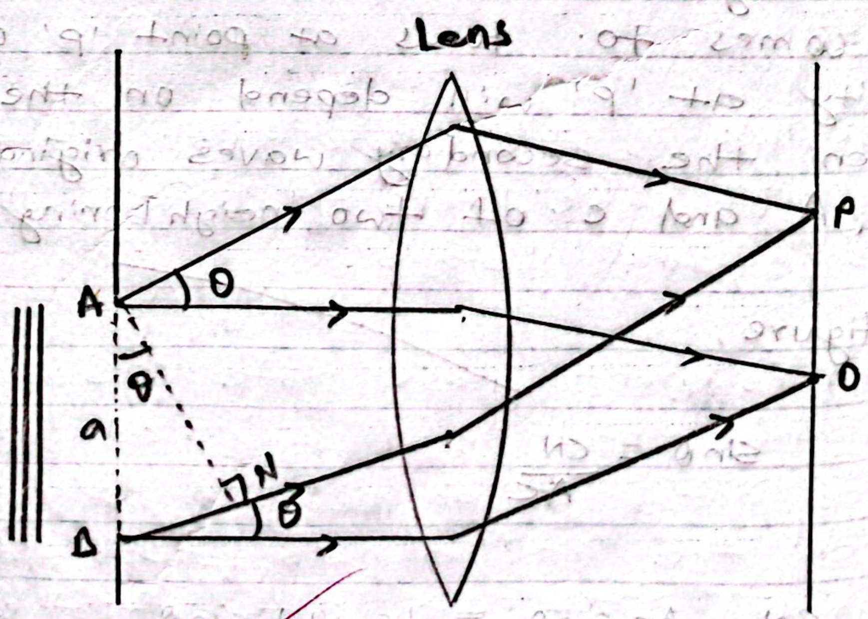


fig (c). Diffraction through single slit

Table No. 1. Determination of wavelength of given light (λ)

(Sl)	Separation between grating and screen (D)	Distance between bright spot about centre (y)	Distance $x = \frac{y}{2}$	$\tan\theta = \frac{x}{D}$	$\sin\theta$	$\lambda = \frac{(a+b)\sin\theta}{n}$	$\bar{\lambda}$	$(\lambda_i - \bar{\lambda})^2$	$\sigma_{\bar{\lambda}}$
1.	49	6.8	3.4	0.069	0.068	6.90×10^{-5}	6.77×10^{-5}	1.69×10^{-12}	2.98×10^{-10} cm
2.	49	13.4	6.7	0.136	0.134	6.80×10^{-5}		9×10^{-14}	
3.	49	20.1	10.05	0.205	0.200	6.77×10^{-5}		0	
4.	49	27.1	13.55	0.276	0.265	6.73×10^{-5}		1.6×10^{-13}	
5.	49	34.5	17.25	0.352	0.331	6.72×10^{-5}		2.5×10^{-13}	
6.	49	42.4	21.2	0.432	0.396	6.70×10^{-5}		4.9×10^{-13}	

CALCULATION:

$(a+b)$ is grating element $= \frac{1}{N} = \frac{2.54}{2500} = 1.016 \times 10^{-3}$ cm

Average wavelength $(\bar{\lambda}) = \frac{\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6}{6}$

$\therefore \bar{\lambda} = 6.77 \times 10^{-5}$ cm

RESULT:

The wavelength of given light $(\bar{\lambda}) = 6.77 \times 10^{-5}$ cm

standard value of $(\lambda) = 6.80 \times 10^{-5}$ cm

λ from graph $= m(a+b) = 0.065 \times 1.016 \times 10^{-3} = 6.604 \times 10^{-5}$ cm

$$\text{percentage error} = \left| \frac{\bar{\lambda} - \lambda_s}{\lambda_s} \right| \times 100\%$$

$$= \left| \frac{6.77 \times 10^{-5} - 6.80 \times 10^{-5}}{6.80 \times 10^{-5}} \right| \times 100\%$$

$$= 0.44\ \%$$

CONCLUSION:

After performing the experiment the laser wavelength was found to be 6.77×10^{-5} cm.

PRECAUTION:

1. Be careful with the equipment
2. Mark points carefully on the graph while doing experiment.

10/13

PHYSICS PRACTICAL SHEETS

NCIT Campus

Date 2079/11/30

Class : BE civil

Roll No.: 11

Shift:

Experiment No.: 5

Group : C

Sub.:

Set :

Object of the Experiment (Block Letter)

DETERMINATION OF THE CAPACITANCE OF A GIVEN CAPACITOR BY CHARGING AND DISCHARGING THROUGH RESISTOR.

APPARATUS REQUIRED:

a) capacitor
b) microammeter (0-100 MA)
c) stop watch
d) connecting wires
e) variable high resistance box
f) Battery

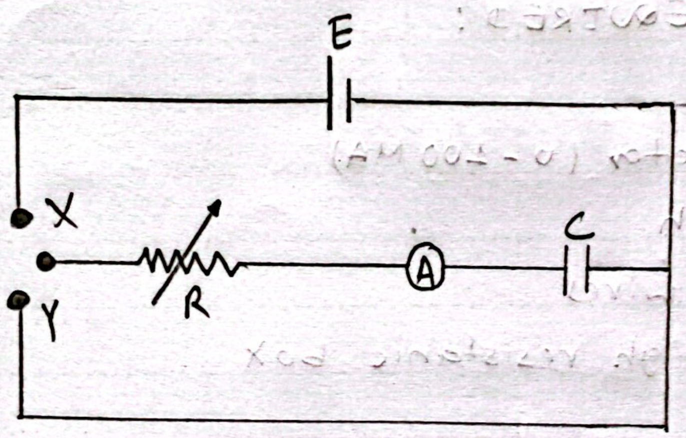
THEORY:

charge is the intrinsic property. Modern technology revolves around the use of charge and current.

capacitor is a device used to store charge or electric potential energy. capacitance is its ability to store charge.

For charging:

Let a capacitor having capacitance 'C' is connected in series with a resistor of resistance 'R', ammeter (A), a battery with emf E and a two key as shown in figure, when the key X is on the capacitor, it is in charging mode. The positive and negative charges



fig(a): charging and discharging of capacitor appear on the plates and oppose the flow of electrons. As the charges accumulate, the potential difference between the plates of capacitor increases and the charging current falls asymptotically to zero.

Applying Kirchhoff's loop rule,

$$E = V_C + V_R = \frac{q}{C} + IR$$

$$= \frac{q}{C} + \frac{dq}{dt} R$$

$$\Rightarrow \frac{dq}{dt} R = E - \frac{q}{C} = \frac{EC - q}{C}$$

$$\Rightarrow \frac{dq}{dt} = \frac{1}{RC} (EC - q)$$

$$\Rightarrow \frac{dq}{(EC - q)} = \frac{1}{RC} \cdot dt$$

for a capacitor, $q = CV$ and maximum charge, $q_0 = CE$

$$\therefore \frac{dq}{q_0 - q} = \frac{dt}{RC}$$

Integrating, we get

$$-\ln(q_0 - q) = \frac{t}{RC} + A \quad \text{—— (i)}$$

where A is the integrating constant

To find A:-

At $t = 0, q = 0$

so, eq^n (i) becomes

$$-\ln(q_0) = A \quad \text{---} (ii)$$

using equation (i) & (ii)

$$\Rightarrow \quad -\ln(q_0 - q) = \frac{t}{RC} + \ln q_0$$

$$\Rightarrow \quad -[\ln(q_0 - q) - \ln q_0] = \frac{t}{RC}$$

$$\Rightarrow \quad \ln\left(\frac{q_0 - q}{q}\right) = -\frac{t}{RC}$$

$$\Rightarrow \quad q_0 - q = q_0 e^{-\frac{t}{RC}}$$

$$\therefore \quad q = q_0\left(1 - e^{-\frac{t}{RC}}\right) \quad \text{---} (iii)$$

where $q_0 = EC$ is the maximum charge stored in the capacitor. Differentiating eq^n (iii) with respect to time,

$$\frac{dq}{dt} = -q_0\left(-\frac{1}{RC}\right) e^{-\frac{t}{RC}}$$

$$\therefore \quad I = \frac{q_0}{RC} e^{-\frac{t}{RC}} = \frac{EC}{RC} e^{-\frac{t}{RC}} = \frac{E}{R} e^{-\frac{t}{RC}} = I_0 e^{-\frac{t}{RC}}$$

$$\therefore \quad I = I_0 e^{-\frac{t}{RC}} \quad \text{---} (iv)$$

where, $I_0 = \frac{E}{R}$ is the maximum current

Again from (iv),

$$\frac{I_0}{I} = e^{\frac{t}{RC}}$$

2.) close the switch X, charging starts and ammeter gives the maximum reading. This is I_0 for time $t = 0$, The current then starts decreasing.

3.) The maximum current I_0 is noted and then the current I for fixed interval of time (say 5 or 10 sec) is noted.

4). changing the polarity of ammeter disconnect X and connect Y, note the data as in steps (2) & (3).

5.) Find half life $T_{1/2}$ from the plot of I and t.

6). plot a graph between $\ln\left(\frac{I_0}{I}\right)$ and t for all cases and find the capacitance of capacitor from slopes of the plot.

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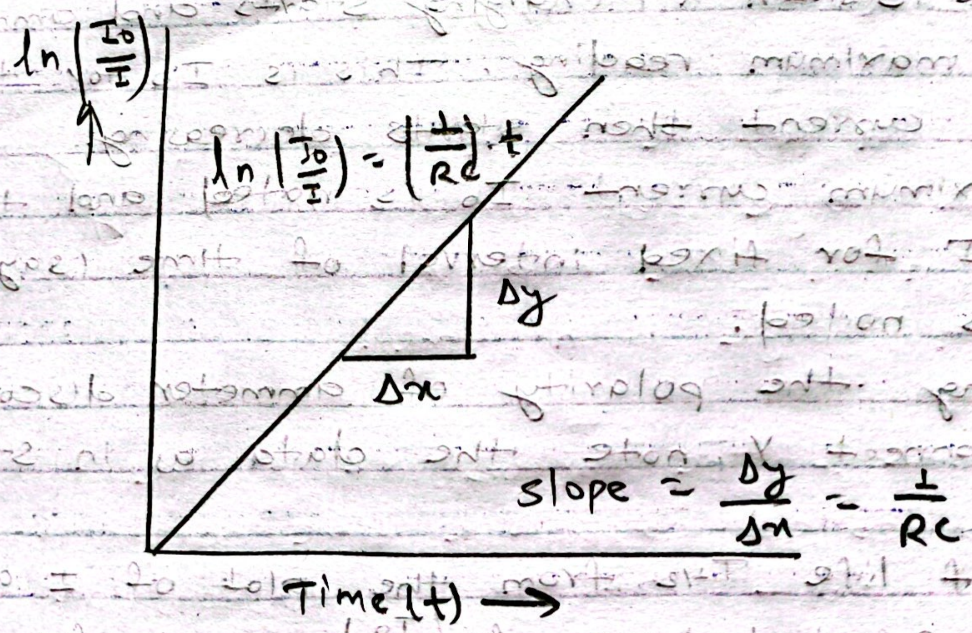

fig (b). plot between $\left(\frac{I_0}{I}\right)$ and 't'

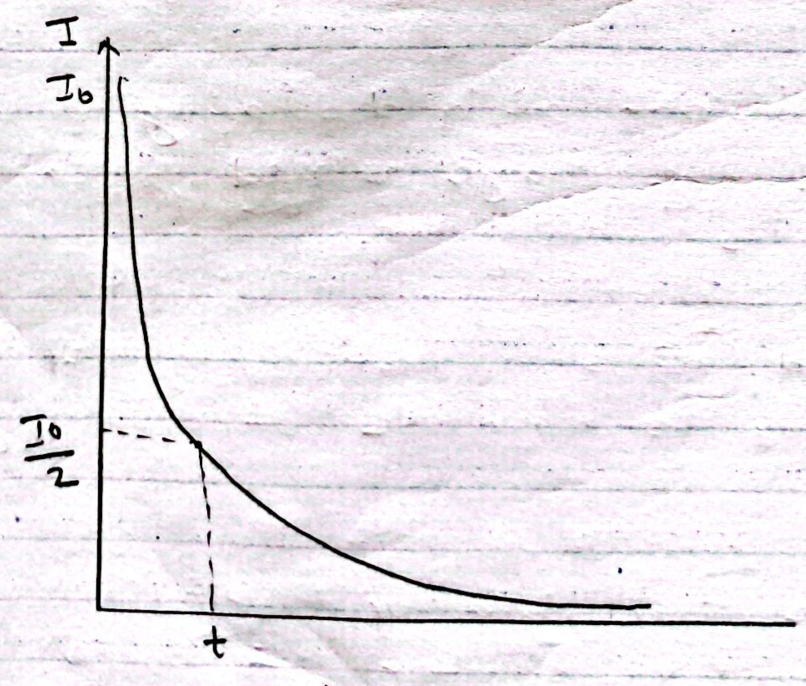

fig. (c) plot of $I \sim t$ showing exponential nature.

OBSERVATIONS:-

Least count of clock = 0.01 second

S.N.	Time (t) sec.	Current (I)		Resistance
		Charging	Discharging	(R) ohm
1.	0	231	84	
2.	5	140	57	$2\times10^{4}\ \Omega$
3.	10	103	42	
4.	15	80	32	
5.	20	59	24	
6.	25	45	18	
7.	30	35	13	
8.	35	26	10	
9.	40	20	8	
10.	45	15	7	
11.	50	11	5	
12.	55	9	4	
13.	60	7	3	
14.	65	6	2	
15.	70	4	2	

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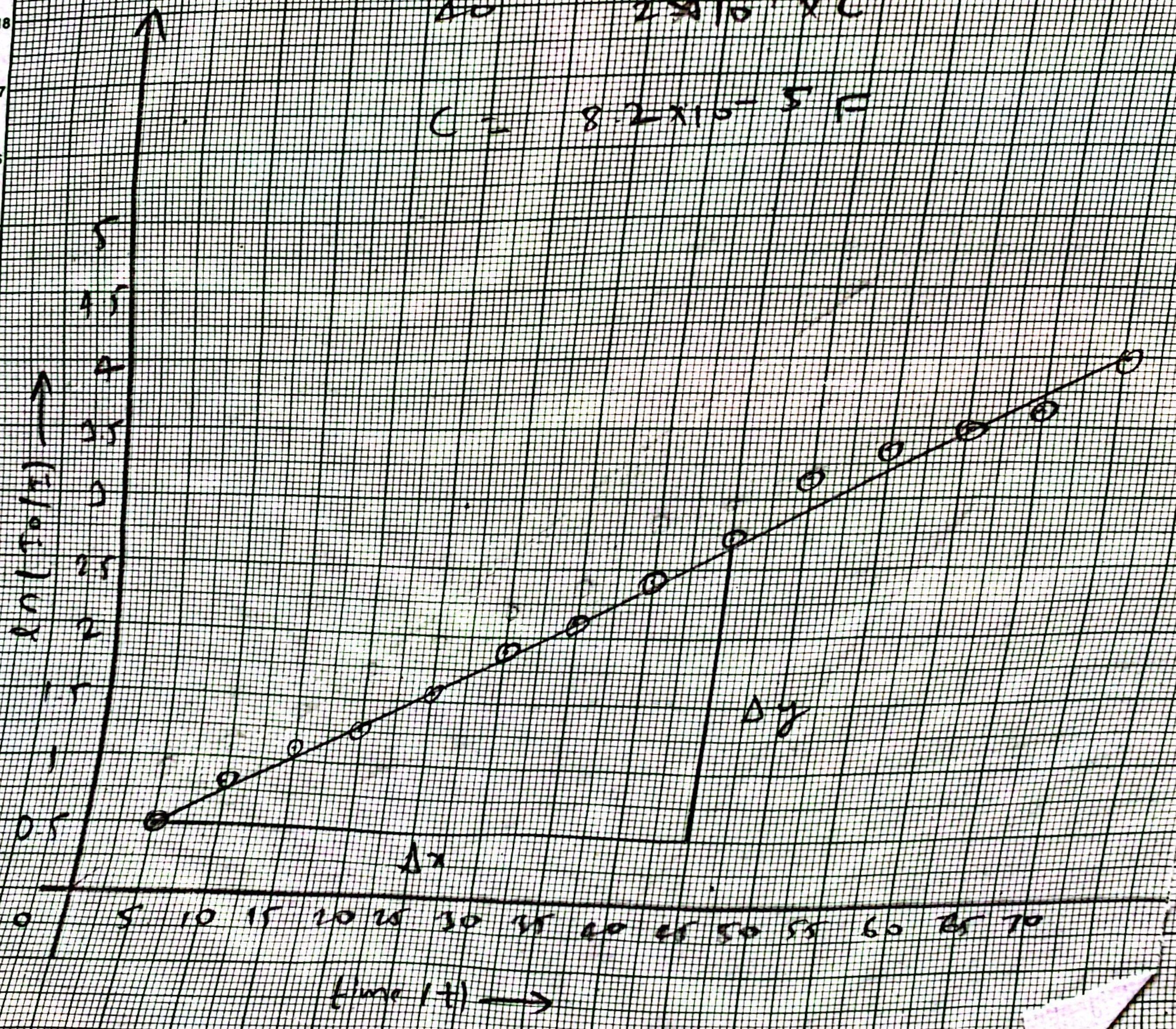
Charging

$$C = \frac{t}{R \ln(I_0/I)}$$

$$\frac{\ln(I_0/I)}{t} = \frac{1}{RC}$$

$$\frac{2.5}{40} = \frac{1}{2 \times 10^4 \times C}$$

$$C = 8.2 \times 10^{-5}\ F$$



Discharging

Along x-axis :- 10 small sq. boxes = 5 sec

Along y-axis :- 10 small sq. boxes = 0.5 division

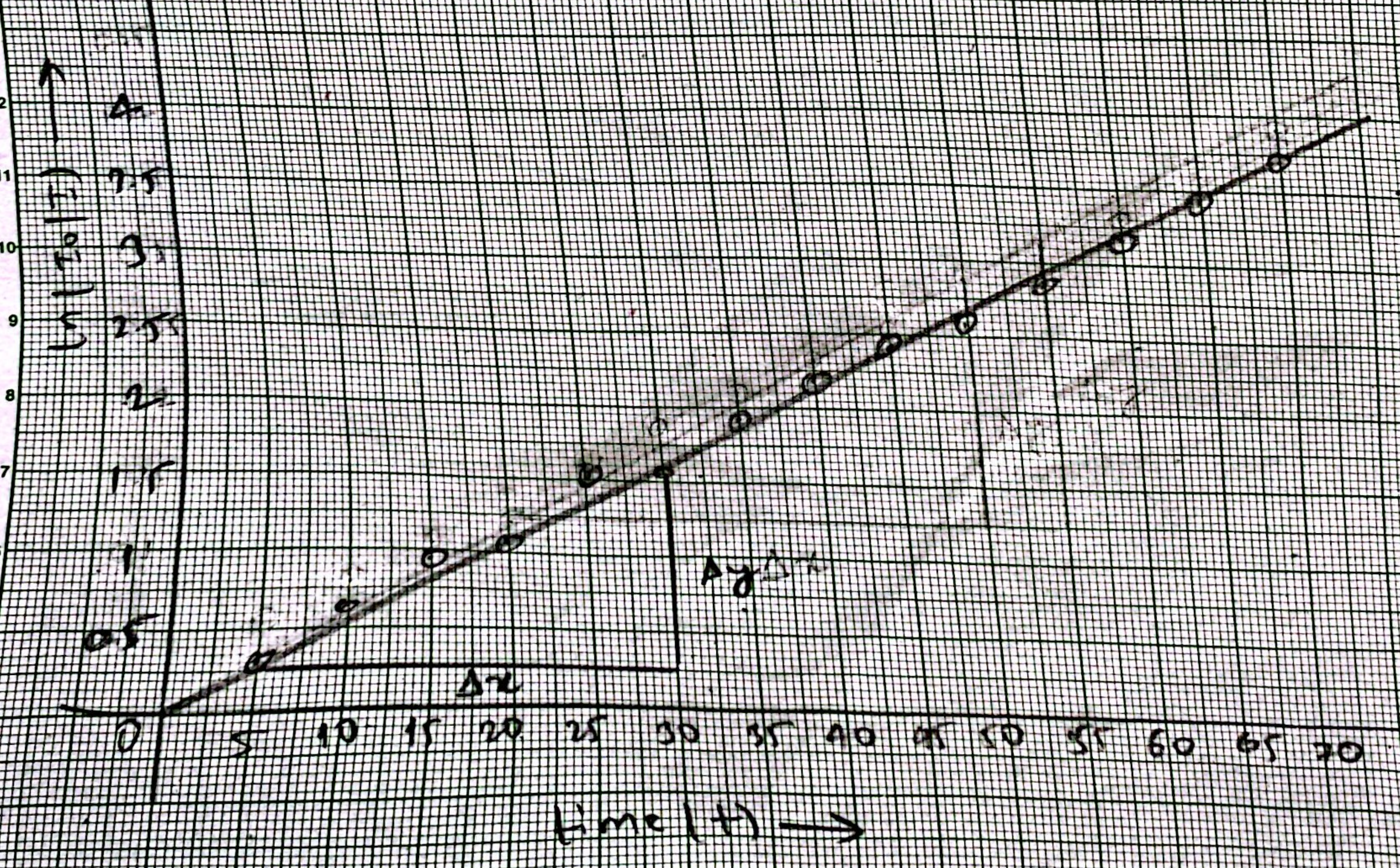
$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{1}{RC}$$

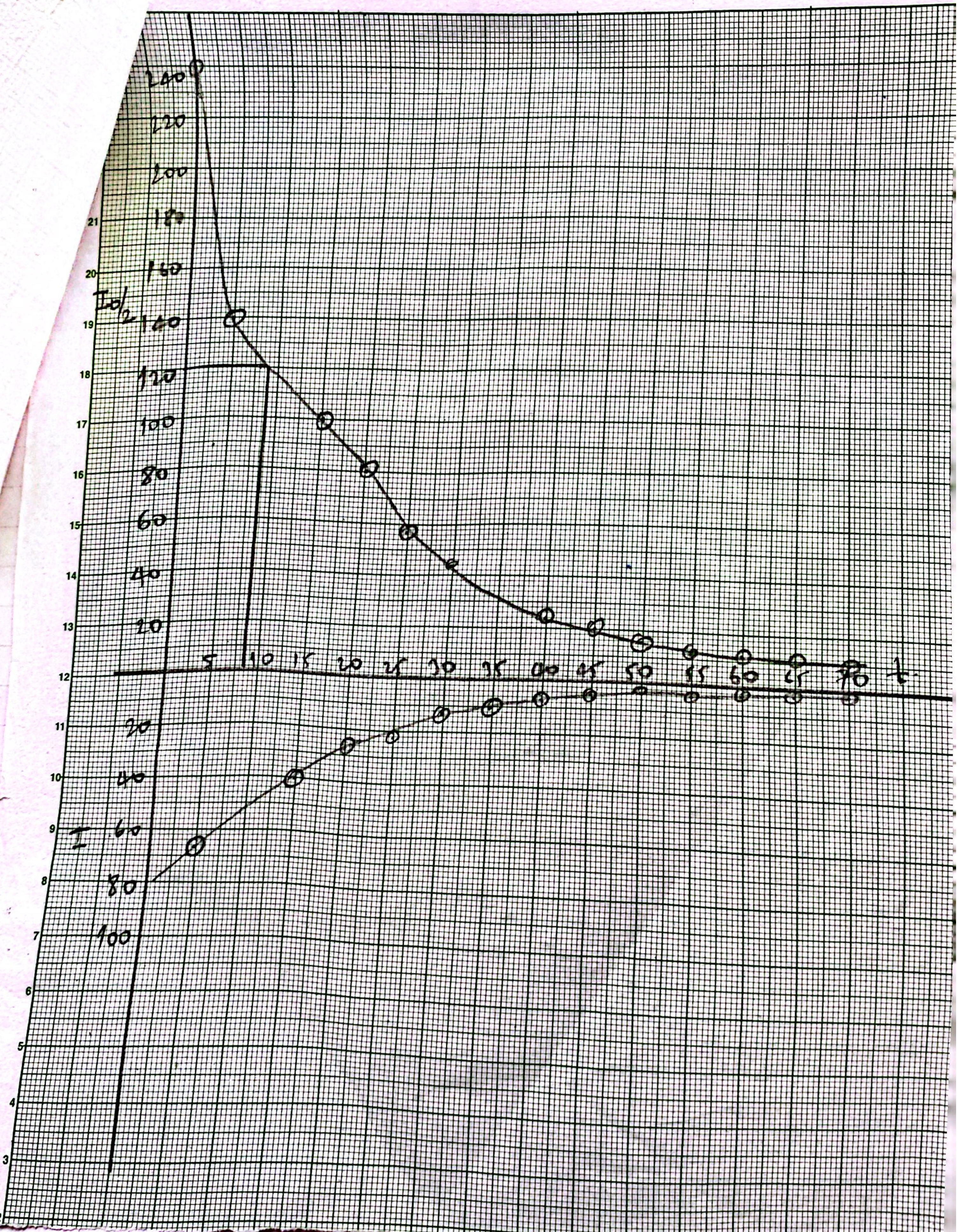
$$C = \frac{t}{R\left(\ln(I_0/I)\right)}$$

or, $$\frac{\ln(I_0/I)}{t} = \frac{1}{RC}$$

or, $$\frac{1.5}{25} = \frac{1}{2.4\times10^{4}\times C}$$

$$C = \frac{25}{2\times10^{4}\times1.5} = 8.50\times10^{-5}\ F$$





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for charging

S.N.	I_0/I	$\ln I_0/I$	C	$\bar{C}$	$C_i - \bar{C}$	$(C_i - \bar{C})^2$	σ_c
1.	1.65	0.5	5×10^{-4}		-2.77×10^{-4}	7.45×10^{-8}	
2,	2.24	0.68	6.25×10^{-4}		-1.48×10^{-4}	2.19×10^{-8}	
3,	2.89	1.06	7.07×10^{-4}		-6.6×10^{-5}	4.35×10^{-9}	
4,	3.92	1.37	7.29×10^{-4}		-4.4×10^{-5}	1.93×10^{-9}	
5.	5.17	1.64	7.62×10^{-4}		-1.1×10^{-5}	1.21×10^{-9}	
6,	6.6	1.89	7.94×10^{-4}		2.1×10^{-5}	4.41×10^{-9}	
7.	8.88	2.18	8.02×10^{-4}	7.73×10^{-4}	2.9×10^{-5}	8.41×10^{-9}	2.903×10^{-7}
8,	11.55	2.45	8.16×10^{-4}		4.3×10^{-5}	1.849×10^{-9}	
9,	15.4	2.73	8.24×10^{-4}		5.1×10^{-5}	2.601×10^{-9}	
10,	21.00	3.04	8.22×10^{-4}		4.9×10^{-5}	2.401×10^{-9}	
11,	25.67	3.24	8.48×10^{-4}		7.5×10^{-5}	5.62×10^{-9}	
12,	37	3.5	8.97×10^{-4}		1.24×10^{-4}	1.53×10^{-8}	
13,	38.5	3.65	8.90×10^{-4}		1.17×10^{-4}	1.368×10^{-8}	
14	57.5	4.06	8.62×10^{-4}		8.9×10^{-5}	7.921×10^{-9}	

or, $\ln\left(\frac{I_0}{I}\right) = \frac{t}{RC}$

$\therefore \ln\left(\frac{I_0}{I}\right) = \frac{t}{RC}$ ---- (v), which is the required equation for determination of C in this experiment.

Equation (iii) and (iv) are called the charging equation in terms of charge and current respectively.

Equation (v) shows that 'C' can be determined from the slope of straight line obtained from the plot between $\ln\left(\frac{I_0}{I}\right)$ and 't' as shown in figure.

The half-life of the circuit, $T_{1/2}$ is the time for the current to decrease to half of its initial value

ie. when $t = T_{1/2}$, $I = \frac{I_0}{2}$

from eqn (v)

$\ln(2) = \frac{T_{1/2}}{RC}$

or, $C = \frac{T_{1/2}}{R\ln 2}$

or, $C = \frac{T_{1/2}}{0.693R}$ ---- (vi)

Time constant (or relaxation time):-

The term RC in equation (iii) and (iv) is called time constant, where $t = RC$, from eq^n (iii),

$$q = q_0(1 - e^{-1})$$

$$= q_0(1 - 0.37) = 0.63\, q_0$$

or $q = 0.63\, q_0 = 63\%$ of q_0

Hence, the time constant of charging circuit is defined as the time in which the capacitor charges by about 63% of its maximum charge.

For discharging of capacitor:-

When the capacitor is fully charged and switch Y is on, discharging occurs in the capacitor through resistor.

Using kirchhoff's voltage or second law,

$$0 = V_C + V_R = \frac{q}{C} + IR \quad \text{[since e.m.f (E) = 0]}$$

or $0 = \frac{q}{C} + \frac{dq}{dt} \cdot R$

or $R\frac{dq}{dt} = -\frac{q}{C}$

or $\frac{dq}{dt} = -\frac{q}{RC}$

or $\frac{dq}{q} = -\frac{1}{RC}\, dt$

Integrating,

$$\int_{q_0}^{q} \frac{dq}{q} = -\frac{1}{RC}\int_0^t dt$$

or, $[\ln q]_{q_0}^{q} = -\frac{t}{RC}$

or $\ln q - \ln q_0 = -\frac{t}{RC}$

or $\ln \frac{q}{q_0} = -\frac{t}{RC}$

or $\frac{q}{q_0} = e^{-\frac{t}{RC}}$

$\therefore q = q_0 e^{-\frac{t}{RC}}$ —— (V)

Differentiating with respect to time,

$$\frac{dq}{dt} = -\frac{q_0}{RC} \cdot e^{-\frac{t}{RC}} = -\frac{EC}{RC} \cdot e^{-\frac{t}{RC}}$$

$$= -\frac{E}{R} \cdot e^{-\frac{t}{RC}} \quad [\because q_0 = EC]$$

$\therefore I = -I_0 e^{-\frac{t}{RC}}$ —— (VI)

The negative sign is due to the opposite direction of the flow of charge (or current) during discharging as compared to that during charging.

where, $I_0 = \frac{E}{R}$ is the maximum current

$\therefore I = I_0 e^{-\frac{t}{RC}}$ ——— (vii) . (in magnitude)

Equation (v) and (vi) are called the discharging equations in terms of charge and current respectively. Here negative sign in the exponential term indicates decrease in charge with time.

Time constant :- The factors RC in the discharging equation is called capacitive time constant of discharging circuit. It has dimensions of time.

When $t = RC$, equation (vi) becomes

$$q = q_0 e^{-1} = \frac{q_0}{e} = 0.37\, q_0$$

$$\therefore q = 0.37\, q_0 = 37\,\%\ \text{of}\ q_0$$

Hence time constant of a discharging circuit is the time at which the charge stored in capacitor fall to 37 %. of its initial time.

Equation (iv) and (viii) show that magnitude of charging current is equal to magnitude of discharging current.

PROCEDURE:-

1) Connect the given capacitor (C MF), resistor (R KΩ) two way key (X, Y), ammeter (0 – 200 MA) and battery as shown in figure.

For Discharging

S.N.	I_0/I	$\ln I_0/I$	C	$\bar{C}$	$C_i - \bar{C}$	$(C_i - \bar{C})^2$	σ_c
1.	1.47	0.39	6.4×10^{-4}		-1.89×10^{-4}	3.57×10^{-8}	
2.	2.[illegible]	0.69	7.24×10^{-4}		-1.06×10^{-4}	1.12×10^{-8}	
3.	2.[illegible]3	0.93	7.73×10^{-4}		-5.7×10^{-5}	3.24×10^{-9}	
4.	3.5	1.25	$.8 \times 10^{-4}$		-3×10^{-3}	$.9 \times 10^{-9}$	
5.	4.67	1.54	8.12×10^{-4}		-1.8×10^{-5}	3.24×10^{-10}	
6.	6.46	1.87	8.02×10^{-4}		-9×10^{-6}	$.8.1 \times 10^{-11}$	
7.	8.4	2.13	8.21×10^{-4}		-2.79×10^{-5}	7.784×10^{-10}	
8.	10.5	2.35	8.52×10^{-4}		7.7×10^{-5}	5.929×10^{-9}	
9.	12	2.48	9.07×10^{-4}		5.6×10^{-5}	3.136×10^{-9}	
10.	16.8	2.82	8.86×10^{-4}	7.73×10^{-4}	7.4×10^{-5}	5.476×10^{-9}	2.156×10^{-5}
11.	21	3.04	9×10^{-4}		7×10^{-5}	5.429×10^{-9}	
12.	28	3.33	9.6×10^{-4}		3.8×10^{-5}	1.44×10^{-9}	
13.	42	3.74	8.64×10^{-4}		2.2×10^{-5}	9.84×10^{-9}	
14.	42	3.74	9.35×10^{-4}		1.05×10^{-5}	1.1×10^{-8}	

RESULTS:

The value of capacitance $= 8.015 \times 10^{-4}$ F

standard value of capacitance $= 4.74 \times 10^{-4}$ F

percentage error $= \left| \frac{8.015 \times 10^{-4} - 4.74 \times 10^{-4}}{4.74 \times 10^{-4}} \right| \times 100\%$

$= 69.09\%$

The value of 'c' from graph (charging) $= 8.61 \times 10^{-5}$ F

The value of 'c' from graph (discharging) $= 8.9 \times 10^{-5}$ F

The value of capacitance from half life (c) $= \frac{T_{1/2}}{0.693\,R}$

$= 9.01 \times 10^{-4}$ F

CONCLUSION:

Thus we determine the capacitance of a capacitor by charging and discharging method.

PRECAUTION:-

1. Change the polarity of ammeter properly
2. Don't loose connect wires.

PHYSICS PRACTICAL SHEETS

.... Campus

Date: 2079/12/07
Class: B.E. civil
Roll No.: 11
Shift:
Experiment No.: 06
Group: C
Sub.:
Set:

Object of the Experiment (Block Letter)

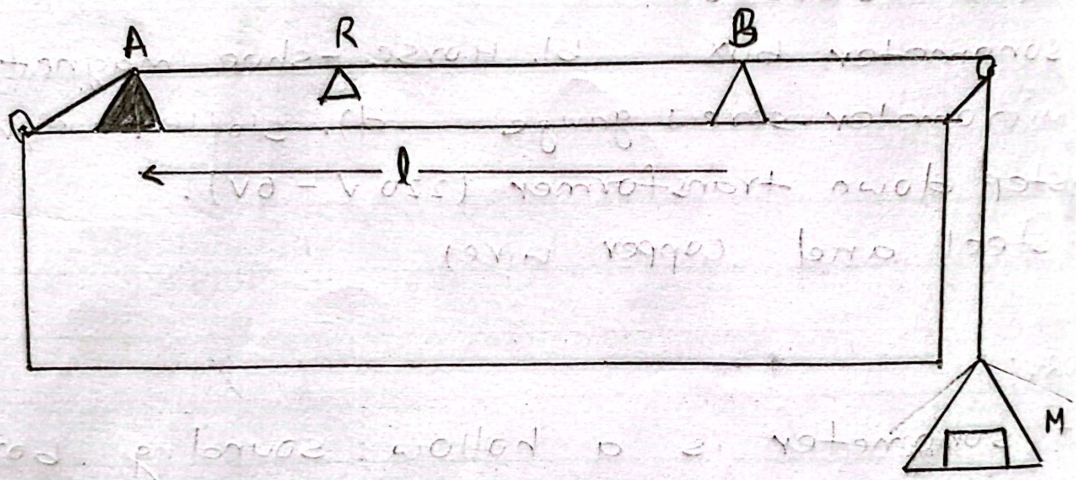
DETERMINATION OF THE FREQUENCY OF A-C - MAINS AND COMPARE THE MASS PER UNIT LENGTH OF THE TWO GIVEN WIRES.

APPARATUS REQUIRED:

a). sonometer box b). Horse-shoe magnet
c). Micrometer screw gauge d). slotted weights with hanger
e). step down transformer (220 V - 6V).
f). steel and copper wires

THEORY:

A sonometer is a hollow sounding box, whose one end of which is fixed at one end and the other end passes through a pulley fixed at the other end of box. The vibrating length of the wire can be adjusted by means of two sharp knife edges, over which the wirepasses, The horse-shoe magnet is placed at the middle of the wire. An alternating current of low voltage is passed through the wire. ~~An alternating current~~ When a current carrying conductor is placed ~~in an~~ uniform magnetic field, it will experience a magnetic force and is deflected. According to Fleming's left hand rule, if the current flows from left to right and magnetic field is directed in the



Fig! sonometer

Scanned with CamScanner

direction opposite to our face, the wire experiences upward force and is deflected upward. After next half cycle of a.c., the current flows from right to left and the wire is deflected downward and so on. In this way, the wire moves up and down and its vibrations are maintained.

When the wire resonates, the frequency of a.c. mains is equal to the frequency of vibration of the string.

According to law of transverse vibration of string, the frequency of fundamental mode is,

$$f = \frac{1}{2l}\sqrt{\frac{T}{\mu}} \quad \text{--- (i)}$$

where, l is ~~the~~ length of the vibrating segment of the wire.

$T = mg$, is the tension in the wire, m is mass placed in the pan and μ is mass per unit length of wire.

If d be the diameter of the wire, then area of cross-section of wire $= \frac{\pi d^2}{4}$.

volume of wire = Area of cross-section × length

∴ Mass of wire = volume × Density

$$= \frac{\pi d^2}{4} \times l \times \rho$$

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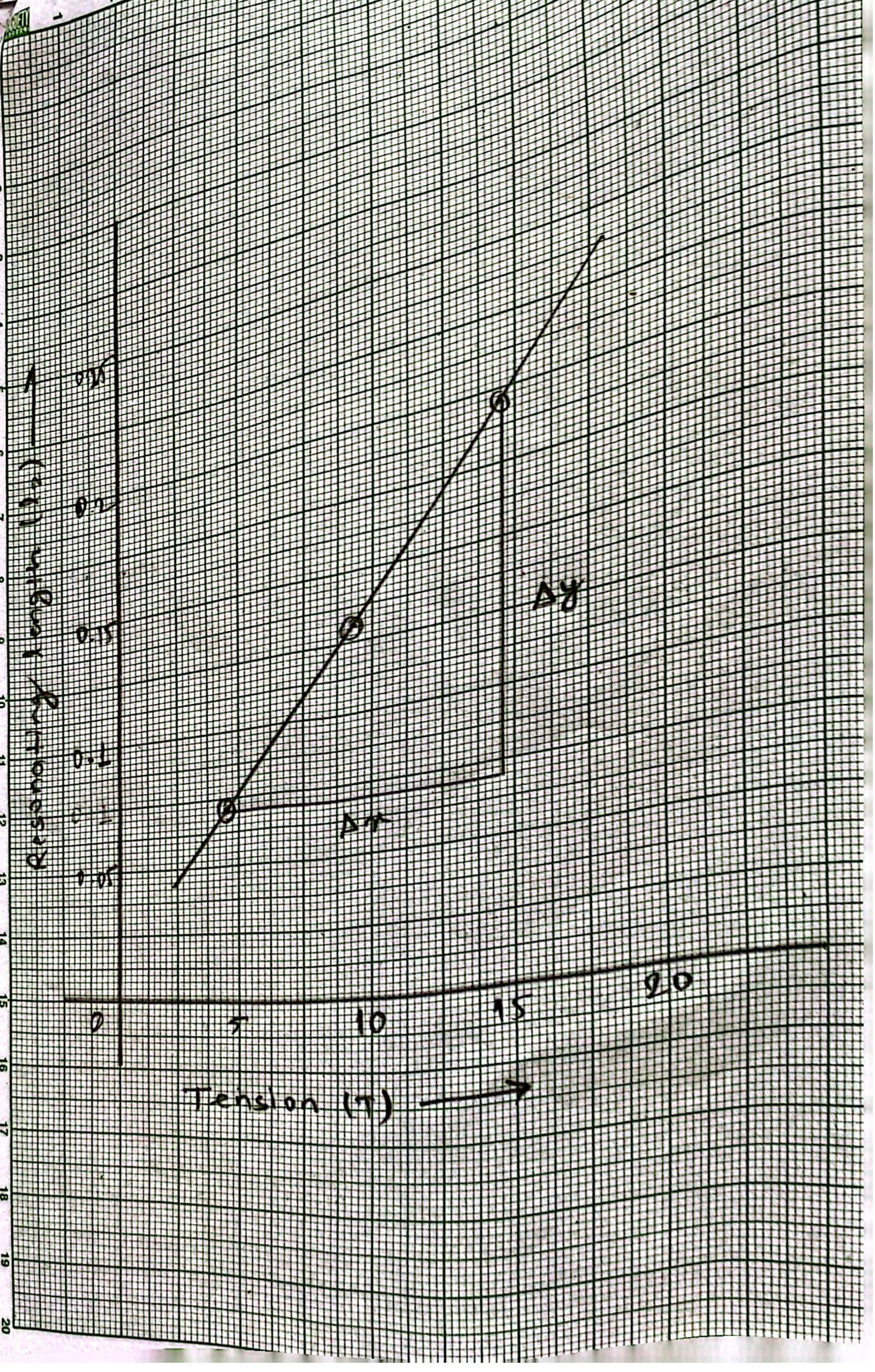
$\therefore$ Mass per unit length of wire $(M) = \frac{\pi d^2}{4} \times \rho$

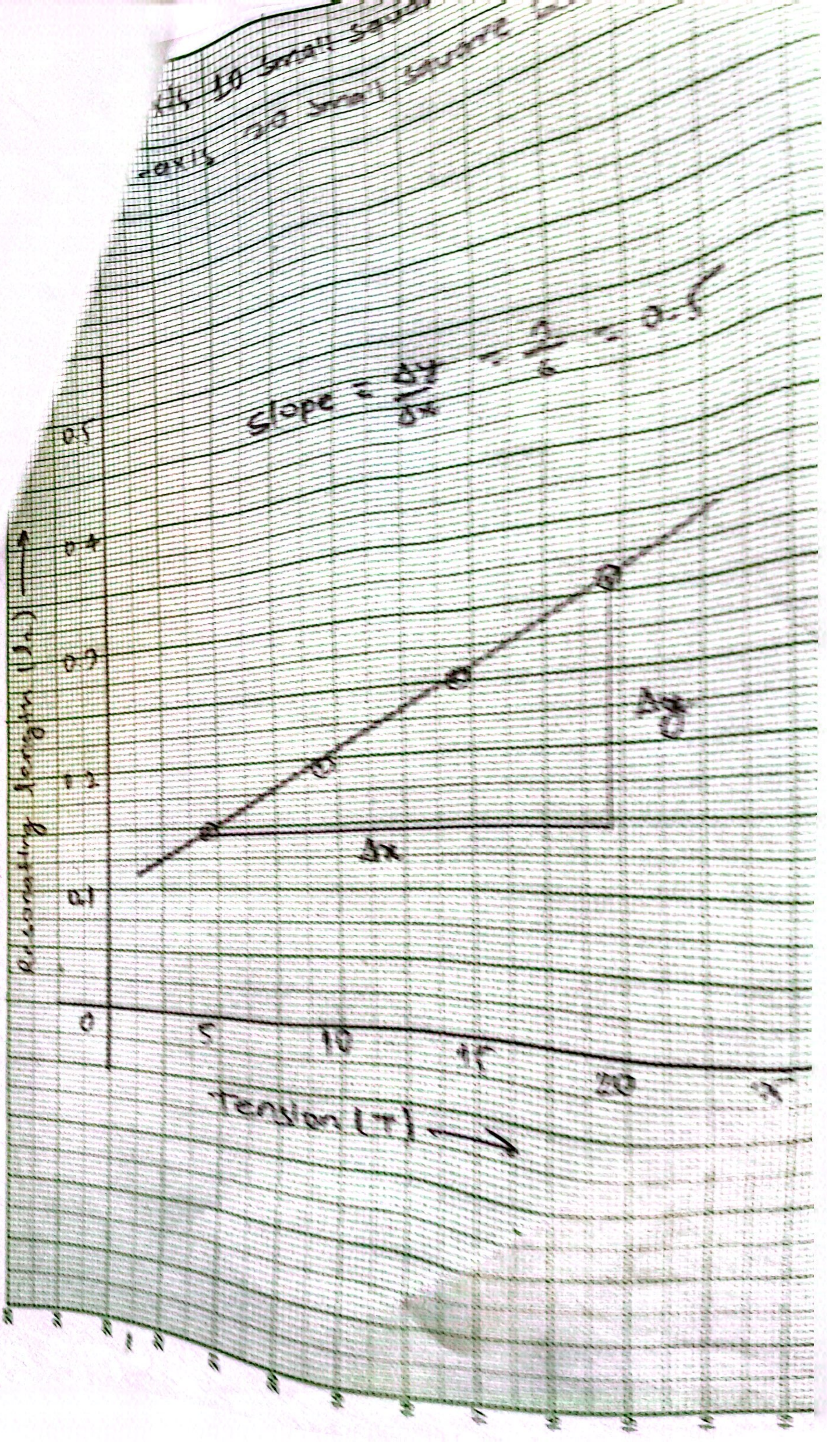
Here, ρ = density of material of wire.

PROCEDURE:

1) The sonometer is placed on the table and the wire is stretched with a hanger of 0.5 kg.
2) A horse-shoe magnet is placed on the box in exactly mid-way between the bridges so that its poles N and S lie in the wire with one on each side of it.
3). The secondary of the step-down transformer is connected across the wire though the rheostat and a key. The secondary voltage is about 6V.
4). The positions of the bridges are adjusted with the magnet exactly mid-way between then until the wire vibrate with maximum amplitude.
5). The distance between the bridges is noted.
6). procedures (4) and (5) are repeated with different tensions by increasing the weights in equal steps of 500 gm.
7). Measure the diameter of wire at least in three places and find the mean. Hence, the mass per unit length is determined using above formula.
8). Repeat the same observation for another type of wire.



0.25
0.2
0.15
0.1
0.05
0
5
10
15
20
Δy
Δx
Tension (T)


Slope = Δy/Δx
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
Δx
Δy
Tension (T)

OBSERVATIONS:

1. for steel wire

Diameter of wire (d) = 1.04 mm = 1.04×10^{-3} m

Density of material of wire (ρ) = 7850 kg/m^3

Mass per unit length of wire (M) = 6.7×10^{-3} kg/m

S.N.	Total load (m) (kg)	Resonating length l (m)	Tension (T) = mg	f (Hz)	mean (f₁)
1.	0.5	0.28	4.9	46.61	
2.	1	0.362	9.8	52	50.33
3.	1.5	0.485	14.7	51.14	

2. For copper wire

Diameter of wire (d) = 0.8 mm = 0.8×10^{-3} m

Density of material of wire (ρ) = 8900 kg/m^3

Mass per unit length of wire (μ) = 4.47×10^{-3} kg/m

S.N.	Total load (m) (kg)	Resonating length l (m)	Tension (T) = mg	f (Hz)	Mean (f₂)
1.	0.5	0.39	4.9	42.7	
2.	1	0.44	9.8	53.62	
3.	1.5	0.49	14.7	58.1	51.03
4.	2	0.57	19.6	54.41	
5.	2.5	0.69	24.5	53.02	

RESULTS :

The frequency of A.C. mains $(f) = \frac{f_1 + f_2}{2} = 50.68$ Hz

standard value of $f = 50$ Hz

% error $= \left| \frac{50.68 - 50}{50} \right| \times 100\% = 1.36\%$

Frequency from graph of T and $t^2 = 51.215$ Hz

CONCLUSION :

Thus, we can determine the frequency of AC mains and compare the mass per unit length of the wire.

PRECAUTION :

1. Don't hand extra weight.
2. Gently use the sonometer.