Engg Physics Experiments

RIGIDITY MODULUS OF A MATERIAL

EXPT. NO.: 4

AIM OF THE EXPERIMENT

To determine of Rigidity Modulus of a material by static method.

APPARATUS

1. Rigidity modulus - static apparatus.(Barton's Apparatus)
2. ½ kg / 1 kg slotted weights 8-10 in number.
3. Two scale pans of equal weights.
4. Screw gauge.
5. Slide calipers

WORKING FORMULA:

$$\text{Rigidity Modulus, } \eta = \frac{360}{\pi^2}\frac{LgD}{r^4}\left(\frac{M}{\theta}\right)$$

Where, η is the rigidity modulus of the material.
L is the length of the wire from upper fixed end to the position of the pointer.
r is the radius of the wire.
D is the diameter of the cylinder.
θ is the angle of twist in degree.
g is the acceleration due to gravity.

PROCEDURE:

1. Measure the lengths of the wire from the upper fixed point to the position of the pointers by a meter scale. Considering the total length of the wire ℓ, fix the scales and Pointers nearly at L/3, L/2 and 2L/3 from the upper fixed point (Chuck). Measure the exact distance L_1, L_2 and L_3
2. Measure the diameter (d) of the wire by screw gauge and diameter (D) of the cylinder by slide calipers.
3. Wind two strings over the cylinder in the same direction and pass it over the pulleys and connect pans to both the free ends. Both the strings should remain parallel to each other and horizontal.
4. With no load on the scale pans, adjust the three pointers over the three scales to read 0 – 0. However, due to defects developed with use, both ends of the pointer may not read 0 – 0 at the same time. Hence take the mean of reading for both ends. Call it the initial reading when no loads are added.
5. Put equal weights of ½ kg / 1 kg each on both the pans simultaneously. Note the readings on both the ends of the pointer for each scale.
6. Thereafter increase the load on each pan at ½ kg / 1 kg interval and note the corresponding readings on the three scales.
7. Then remove the masses in likewise steps from each hanger and record the readings of the pointer against respective lengths in the same table.
8. Take the average value of the scale readings for each load while load increasing and decreasing. Tabulate all observations. Subtract the initial scale reading from this to get the twist for that load.

9. Plot a graph taking the load along the X-axis and corresponding twist along the Y-axis. For each scale, the plot will be a straight line passing through the origin, i.e. you will get three straight lines with different slopes.

10. Calculate η for each length and hence find out the mean.

OBSERVATIONS:

A. Material of the wire is Iron.

B. Determination of the radius of the specimen wire

TABLE-I

Pitch = 0.05 cm, L.C.= 0.002 Cm.

No.of Obs.	I.C.S.R. I	NCR N	F.C.S.R. F	Diff. I~F D	P.S.R PXN	C.S.R. DXL.C	Total in cm	Mean Diameter (d) in cm
1	0	8	3	42	0.4	0.042	0.447	0.445
2	48	8	2	46	0.4	0.046	0.446	
3	42	8	2	45	0.4	0.045	0.445	
4	42	8	2	45	0.4	0.045	0.445	

The radius of the wire (r) = Mean diameter / 2
= 0.2225 cm.

C. Determination of the diameter of the cylinder.

TABLE-II

L.C= 0.01 cm

No.of Obs.	M.S.R. in cm	V.C.	V.S.R. V.C.XL.C in cm	Total M.S.R. + V.S.R. in cm	Mean Diameter (D) in cm.
1	4	0	0	4	4
2	4	0	0	4	
3	4	0	0	4	
4	4	0	0	4	

D. Distance from the upper fixed point to the pointers.

L_1 = 50.2 cm, L_2 = 66.8 cm, L_3 = 84.5 cm.

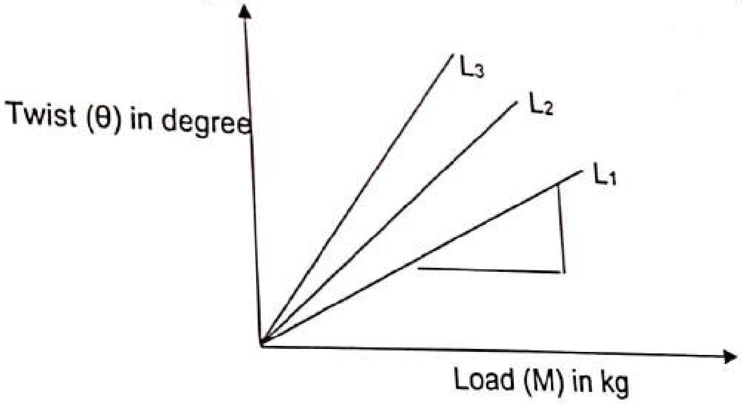
E. Determination of twist (θ)

TABLE –III

Length of the wire in cm.	No. of obs.	Load on each par in Kg. M	Scale reading in degree		Mean in degree	Twist θ in degree
			Load increasing	Load decreasing		
	1	0	0	2	1	
	2	0.5	2	6	4	
L_1 = 50.2	3	1	6	7	6.5	
	4	1.5	9	10	9.5	9.16
	5	2	12	13	12.5	
	6	2.5	17	17	17	
	1	0	0	2		
	2	0.5	4			
L_2 = 84.5	3	1	11			
	4	1.5	16			
	5	2	21			
	6	2.5	28			

GRAPH:

Draw graph between load (M) taken in X-axis and twist (θ) taken in Y-axis for each length of the wire. From graph, Calculate (M/θ) for each length.



CALCULATION

For length L_1, $\eta_1 = \frac{360}{\pi^2}\frac{L_1 g D}{r^4}\left(\frac{M}{\theta}\right)_1$

For length L_2 and L_3, calculate η_2 and η_3 respectively. Then calculate mean η in dyne/cm^2

WORK SHEET

Expt. No- 01
Date- 20/01/25

AIM OF THE EXPERIEMENT

To determine of Rigidity Modulus of a material by static method.

OBSERVATIONS

Material of the wire is iron.

Determination of the radius of the specimen wire

TABLE-I

L.C.= 0.001 Cm.

Pitch = 0.05 cm.

No.of Obs.	I.C.S.R. I	N	F.C.S.R. F	Diff. I~F	P.S.R PXN	C.S.R. DXL.C	Total in cm	Mean Diameter (d) in cm
1	0	8	3	47	0.4	0.047	0.447	0.445
2	48	8	2	46	0.4	0.046	0.446	
3	47	8	2	45	0.4	0.045	0.445	
4	47	8	2	45	0.4	0.045	0.445	

The radius of the wire (r) = Mean diameter / 2
= 0.2225 cm.

Determination of the diameter of the cylinder.

TABLE-II

L.C= 0.01 cm

No.of Obs.	M.S.R. in cm	V.C.	V.S.R. V.C.XL.C in cm	Total M.S.R. + V.S.R. in cm	Mean Diameter (D) in cm.
1	4	0	0	4	4
2	4	0	0	4	
3	4	0	0	4	
4	4	0	0	4	

Distance from the upper fixed point to the pointers.

L_1 = 50.2 cm, L_2 = 66.8 cm, L_3 = 84.5 cm.

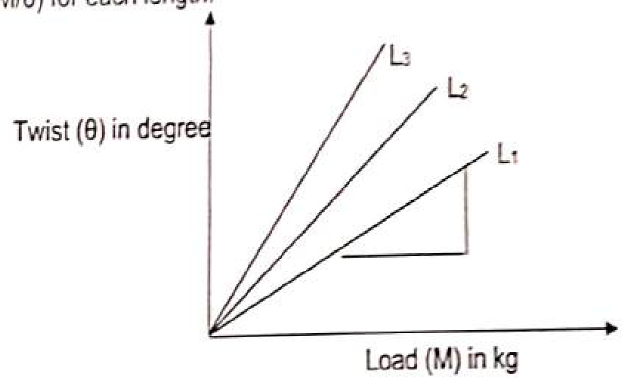
Determination of twist (θ)

TABLE –III

Length of the wire in cm.	No. of obs.	Load on each par in Kg. M	Scale reading in degree		Mean in degree	Twist θ in degree
			Load increasing	Load decreasing		
L_1 = 50.2	1	0	0	2	1	9.15
	2	0.5	2	6	4	
	3	1	6	7	6.5	
	4	1.5	9	10	9.5	
	5	2	12	13	12.5	
	6	2.5	17	17	17	
L_2 = 84.5	1	0	0	2	1	15.66
	2	0.5	4	9	6.5	
	3	1	11	11	11	
	4	1.5	16	17	16.5	
	5	2	22	21	21	
	6	2.5	28	28	28	

GRAPH:

Draw graph between load (M) taken in X-axis and twist (θ) taken in Y-axis for each length of the wire. From graph, Calculate (M/θ) for each length.



CALCULATION

For length L_1, $\eta_1 = \frac{360}{\pi^2}\frac{L_1 g D}{r^4}\left(\frac{M}{\theta}\right)_1$

For length L_2 and L_3, calculate η_2 and η_3 respectively. Then calculate mean η in dyne/cm^2

For length, $L_1 = 50.2$ cm

$$n_1 = \frac{360}{\pi^2}\frac{L_1 g D}{R^4}\left(\frac{M}{\theta}\right)_1$$

$$n_1 = \frac{360}{\pi^2} \times \frac{50.2 \times 980 \times 4}{(0.2225)^4} \times \frac{1500}{9.16}$$

$$n_1 = 4.795 \times 10^{11} \text{ dyne/cm}^2$$

For length, $L_2 = 84.5$ cm

$$n_2 = \frac{360}{\pi^2}\frac{L_2 g D}{R^4}\left(\frac{M}{\theta}\right)_2$$

$$n_2 = \frac{360}{\pi^2} \times \frac{84.5 \times 980 \times 4}{(0.2225)^4} \times \frac{1500}{15.66}$$

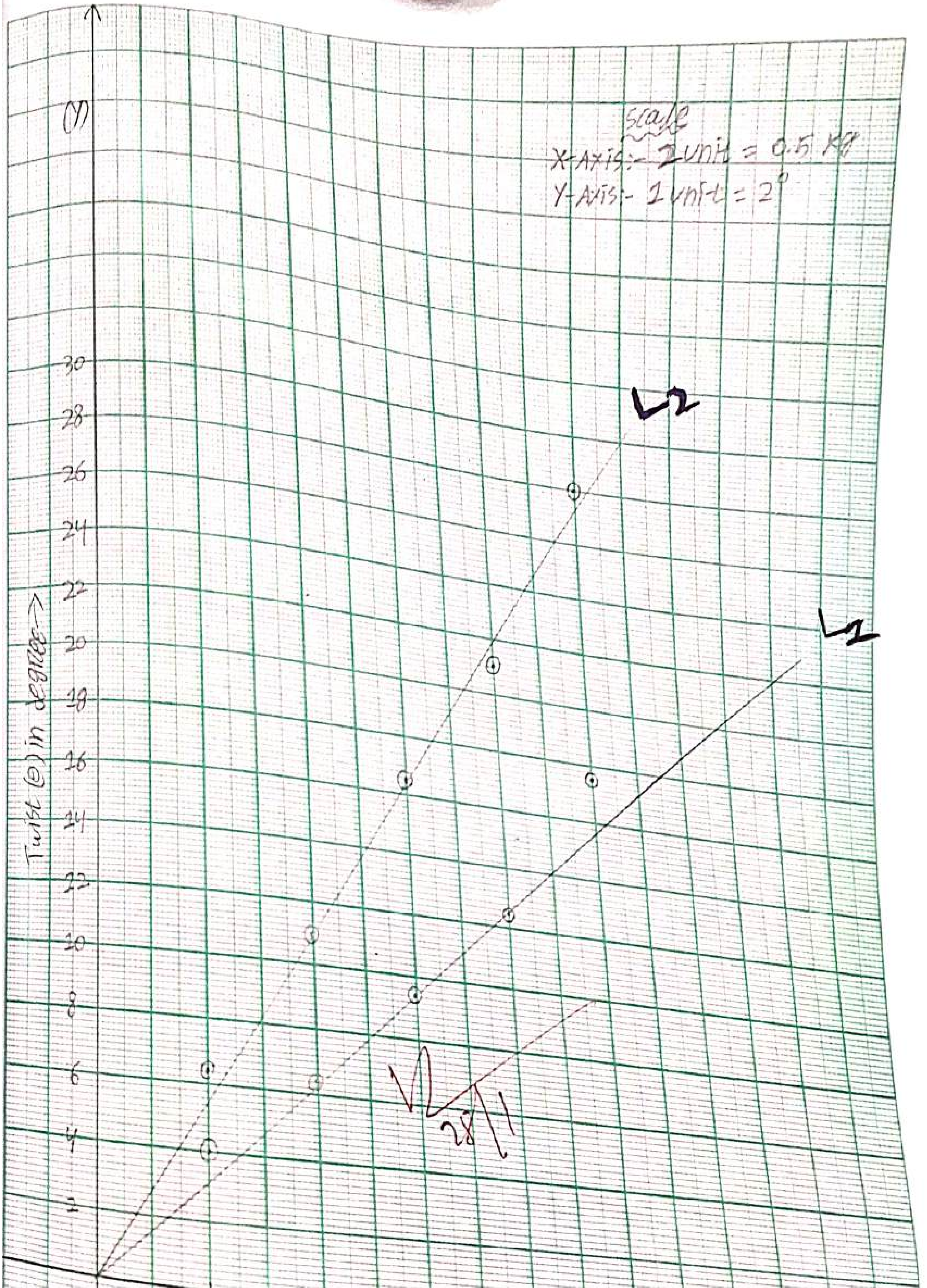
$$n_2 = 4.721 \times 10^{11} \text{ dyne/cm}^2$$

The mean Rigidity Modulus $= \frac{n_1 + n_2}{2}$

$$= \frac{4.795 \times 10^{11} + 4.721 \times 10^{11}}{2}$$

$$= 4.758 \times 10^{11} \text{ dyne/cm}^2$$

conclusion:-
The Rigidity modulus of a material by static method is 4.758×10^{11} dyne/cm².



(Y)
Scale
X-Axis:- 1 unit = 0.5 Kg
Y-Axis:- 1 unit = 2°
L2
L1
Twist (θ) in degree →
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0.5
1.0
1.5
2.0
2.5
3.0
3.5
(X)
Load (M) in Kg →
28/1

KATER'S PENDULUM

EXPT. NO. - 01

AIM OF THE EXPERIMENT: To determine the value of acceleration due to gravity using Kater's Pendulum.

APPARATUS REQUIRED:

1. Kater's Pendulum.
2. Stop Watch.
3. Sharp Knife edges.
4. Metre Scale
5. Telescope.
6. Spirit Level

THEORY:

The value of acceleration due to gravity is given by

$$g = \frac{8\pi^2}{\left(\frac{T_1^2 + T_2^2}{L_1 + L_2}\right) + \left(\frac{T_1^2 - T_2^2}{L_1 - L_2}\right)}$$

Where g = Acceleration due to gravity.

T_1= Time period about the knife edge K_1

T_2= Time period about the knife edge K_2

L_1= Distance of the knife edge K_1 from centre of gravity (CG).

L_2= Distance of the knife edge K_2 from centre of gravity (CG).

PROCEDURE:

1. Suspend the pendulum from knife edge K_1 and focus the telescope to a sharp mark at the lower tip of the pendulum.
2. Oscillate the pendulum freely with small amplitude about K_1 and note down the time for 20 numbers of oscillations.
3. Suspend the pendulum from knife edge K_2 and note down the time period for 20 numbers of oscillations. This time is likely to be different from the previous one.
4. Shift the heavy mass W_2 to a little distance in one direction and release. Note down the time for 20 numbers of oscillations about K_1 and K_2. If the difference in the time decreases then heavier mass should be shifted in the same direction. Otherwise it should be shifted in opposite direction.
5. This process is repeated until the difference in time for 20 oscillation about the two knife edges are nearly equal to 0.
6. Now the time for 40, 60, 80 and 100 oscillations about both knife edges are taken and calculate the time period T_1 & T_2.
7. To note the position of CG of the pendulum, balance the pendulum horizontally on the wedge and mark the balance point. Then the distance of the balance point from K_1 & K_2 which give L_1 & L_2.

OBSERVATIONS:

TABULATION

TABLE – 1 for Adjustment:

No of Observations	Adjustment done by shifting	No of the oscillations observed	Time for oscillation about K_1 in second	Time for oscillation about K_2 in second	Remark

TABLE – 2 for Time Period:

No of Observations	Oscillations about knife edges K_1 and K_2 N	Time for oscillation in second			Time Period T = t / N in second
		t_1	t_2	Mean t	

Measurement of L_1 and L_2

Position of the knife edge K_1 on the bar from C.G = ...cm

Position of the knife edge K_2 on the bar from C.G = ...cm

CALCULATION:

From Table – 2, find the time period, T_1 = s for K_1 and time period T_2 = s for K_2 and also note the corresponding value of L_1 and L_2.

From the formula $$g = \frac{8\pi^2}{\left(\frac{T_1^2 + T_2^2}{L_1 + L_2}\right) + \left(\frac{T_1^2 - T_2^2}{L_1 - L_2}\right)}$$

We get the value of g = ……… cm/sec^2

PERCENTAGE OF ERROR:

CONCLUSION:

WORK SHEET

Exp No- 02

Date- 27/01/25

AIM OF THE EXPERIMENT: To determine the value of acceleration due to gravity using Kater's Pendulum.

OBSERVATIONS:

TABLE – 1 for Adjustment:

No of Observations	Adjustment done by shifting	No of the oscillations observed	Time for oscillation about K_1 in second	Time for oscillation about K_2 in second	Remark
1		20	34.56	34.79	On
		20			
		20			
		20			

TABLE – 2 for Time Period:

No of Obs.	Position of Knife	No of oscillations	Time for oscillation in second			Time Period $T = t / N$ in second
			t_1	t_2	Mean t	
1	K_1	30	52.23	52.40	52.315	1.743
2	K_2	30	52.33	52.17	52.25	1.741
3	K_1	40	69.49	69.52	69.505	1.737
4	K_2	40	69.45	69.49	69.47	1.736
5	K_1	50	86.93	86.89	86.91	1.738
6	K_2	50	87.22	87.11	87.165	1.743

Measurement of L1 and L_2

Position of the knife edge K_1 on the bar from C.G, L_1 =....32.... cm

Position of the knife edge K_2 on the bar from C.G, L_2 = ...45...cm

Calculation:

Mean time period for K_1 = 1.74 s

Mean time period for K_2 = 1.745

The value of $g = \dfrac{8\pi^2}{\left(\dfrac{T_1^2 + T_2^2}{L_1 + L_2}\right) + \left(\dfrac{T_1^2 - T_2^2}{L_1 - L_2}\right)}$ = 1004.042 cm s^{-2}

For 50 oscillations:

$K_1 = 1.738$ s

$K_2 = 1.743$ s

$g = 986.674$ cm s^{-2}

Percentage of error:

percentage error for g original value $= \frac{23.377}{980.665} \times 100 = 2.38\%$

percentage error for g for 50 oscillation $= \frac{6.009}{980.665} \times 100 = 0.61\%$

Conclusion:

The value of acceleration due to gravity using Kater's pendulum is 986.674 cms^{-2} and the percentage of error is 0.61%.

Jyotsnai 28/1/25

Name – Rajesh Rana

Roll No – 24CSEAIML015

Group - G1

SONOMETER

Experiment- 03

AIM OF THE EXPERIMENT: To verify the laws of transverse vibration of a stretched string using Sonometer.

APPARATUS REQUIRED:

1. Sonometer.
2. Tuning Fork.
3. Weights
4. Rubber Pad.
5. Wires/ Strings & Scale

THEORY:

First Law: The length of the string & the frequency of vibration of a stretched string is inversely proportional to keeping tension constant.
Mathematically, $n \alpha 1/L$

i.e. nL = constant.

Second Law: The frequency of vibration of a stretched string is directly proportional to the square root of the tension.
Mathematically, $n \alpha T^{1/2}$, $n \alpha 1/L = T/L^2$ = a constant.

Third Law: The frequency of vibration of a stretched string is inversely string proportional to the square root of mass per unit length of the string.
Mathematically, $n \alpha 1/m^{1/2}$ & , $n \alpha 1/L = mL^2$ = a constant

PROCEDURE:

(A) To verify the law of length:

1. Put a fixed load say 2 kg on the hanger. Keep the two movable bridges as close as possible in the middle of the wire. In the space between the bridges, place a tiny bit of paper (called rider) on the string (recommended size 1cm x 0.1cm) Take the tuning fork of freq. 256 Hz.
2. Keep its stem while vibrating on the wooden box close to the string. Increase the distance between the bridges B_1 and B_2 slowly. At one stage, the paper – rider will start vibrating. Adjust the position of one of the bridges till vibration is maximum and may be the rider is thrown off. Measure the distance 'ℓ' between the bridges. Increase the gap then reduce it till the paper-rider is thrown off again. Measure the distance between the bridges. Repeat it three times and take the average of the three readings.
3. Keeping the tension constant the experiment is to be repeated by taking four more tuning forks with frequency 256Hz, 288Hz, 312Hz and 344Hz.

(B) To verify law of Tension:

1. Keep the hanger of 1kg in position.
2. Take the tuning fork of frequency 256Hz. Then determine the resonant length (ℓ) following the procedure described earlier, i.e. determine the length at which the paper rider is thrown off. Repeat it three times and note the mean value of ℓ.
3. Add ½ kg load to the hanger and repeat the earlier observation. Note the mean length, ℓ.
4. Likewise, take at least 6 observations by increasing load at ½kg interval.
5. Draw a graph for load (M) versus ℓ^2. It will be a straight line passing through the origin.[Note T = Mg].

(C) For verification of Law of mass per unit length :

The aim here is to show ℓ^2 m = constant.

1. Use at least three different wires. Determine mass per centimetre of each wire.
2. Put a load of 2kg on the first wire. Determine the resonant length of the wire for this load using a tuning fork of frequency 256 Hz. Repeat it thrice and take the mean.
3. Replace the first wire by the second wire. Keeping the tension fixed, repeat the observation and note the resonant length of the wire thrice and take the mean.
4. Repeat everything for any number of strings available.

TABULATIONS

TABLE -1 Verification of first law

Load 2kg fixed

No. of Obs.	Frequency (n) (Hz)	Resonant length (ℓ) of the string in cm.			$1/\ell$ in cm^{-1}	n x ℓ Hz. cm.
		I	II	Mean ℓ in cm		

In each case, the product $n\ell$ is found to be constant. A graph for n versus $1/\ell$ may be drawn which will be a straight line.

GRAPH

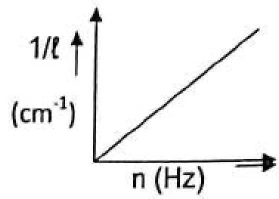
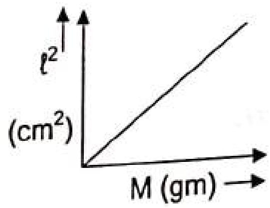


TABLE-II

Frequency 256 Hz fixed

No. of Obs.	Load (M) kg	Resonant length (ℓ) in cm		Mean ℓ cm	ℓ^2 cm^2	$\frac{M}{\ell^2}$ gm /cm^2
		I	II			



GRAPH

TABLE -III

No. of the string	M gm/cm	Resonant length (cm)		Mean ℓ in cm	ℓ^2 in cm^2	ℓ^2m cm^{2}gm
		I	II			
1						
2						
3						
4						

Calculate ℓ^2m for each wire. ℓ^2m is constant.

CONCLUSION

WORK SHEET

Expt. No- 03
Date- 03/03/25

AIM OF THE EXPERIMENT: To verify the laws of transverse vibration of a stretched string using Sonometer.

TABULATIONS

TABLE -1 Verification of first law

Fixed load

	No. of Obs.	Frequency (n) (Hz)	Resonant length (ℓ) of the string in cm. I	II	Mean ℓ in cm	$1/\ell$ in cm^{-1}	$n \times \ell$ Hz. cm.
500g	1	341	4.8	4.9	4.85	0.206	1653.85
	2	288	6.3	6.4	6.35	0.157	1828.8
1000g	3	341	7.2	7.3	7.25	0.137	2472.25
	4	288	8.7	8.8	8.75	0.114	2520

In each case, the product $n\ell$ is found to be constant. A graph for n versus $1/\ell$ may be drawn which will be a straight line.

GRAPH

TABLE -2 Verification of second law

Fixed frequency

	No. of Obs.	Load (M) kg	Resonant length (ℓ) in cm I	II	Mean ℓ cm	ℓ^2 cm^2	$\frac{M}{\ell^2}$ gm /cm^2
341Hz	1	0.500	4.8	4.9	4.85	23.52	21.25
	2	1.000	7.2	7.3	7.25	52.56	19.02
	3	1.500	8.1	8.2	8.15	66.42	22.58
288Hz	4	0.500	6.3	6.4	6.35	40.32	12.40
	5	1.00	8.8	8.8	8.75	76.56	13.06
	6	1.500	9.7	9.8	9.75	95.06	15.77

GRAPH:

TABLE -3 Verification of first law

No. of obs.	Frequency (n) (in Hz)	Resonant length (l) of the string in cm.		Mean l in cm	$\frac{1}{l}$ in cm^{-1}	$n \times l$ Hz-cm.
		I	II			
5	341	8.1	8.2	8.15	0.122	2779.15
6	288	9.7	9.8	9.75	0.102	2808

CONCLUSION

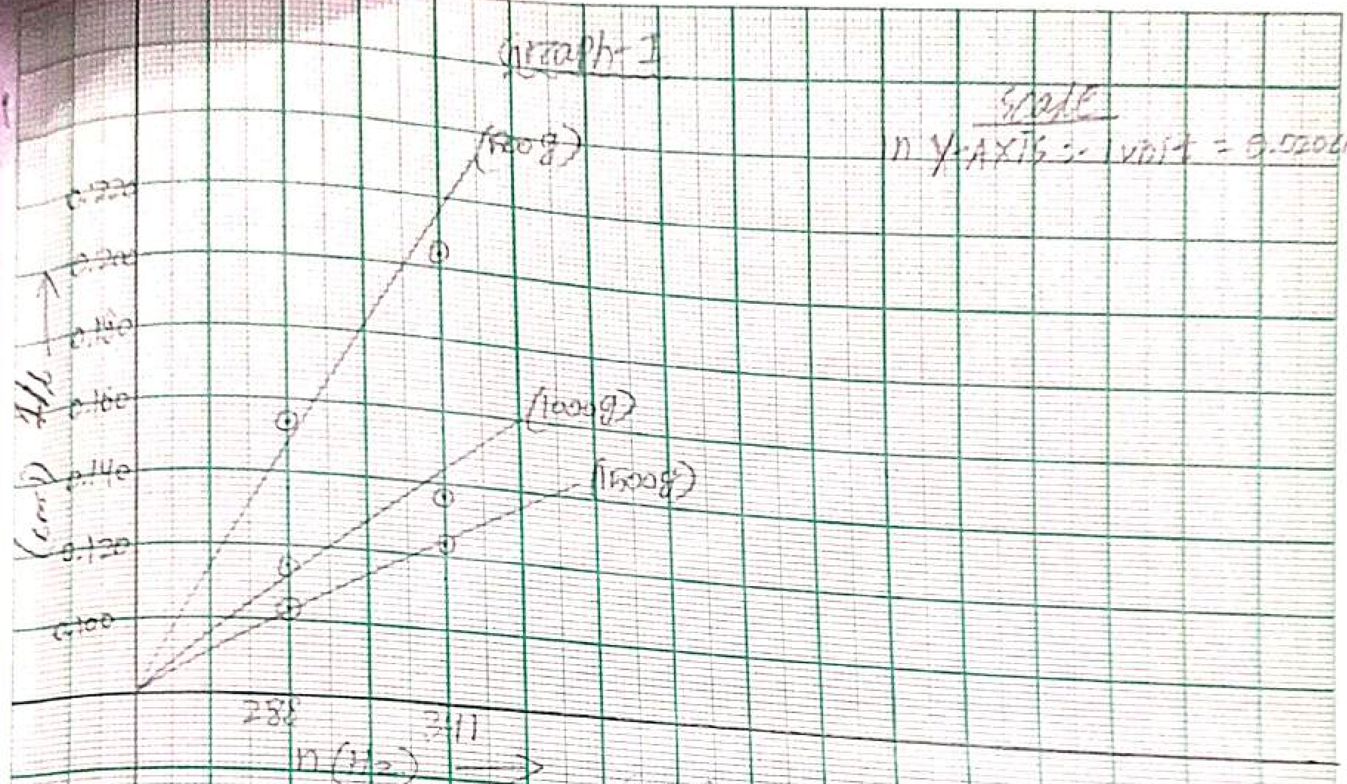
The laws of transverse vibration of a stretched string using sonometer is verified as in above tabulation 1, nL is constant and from tabulation -2, $\frac{m}{l^2}$ is constant.

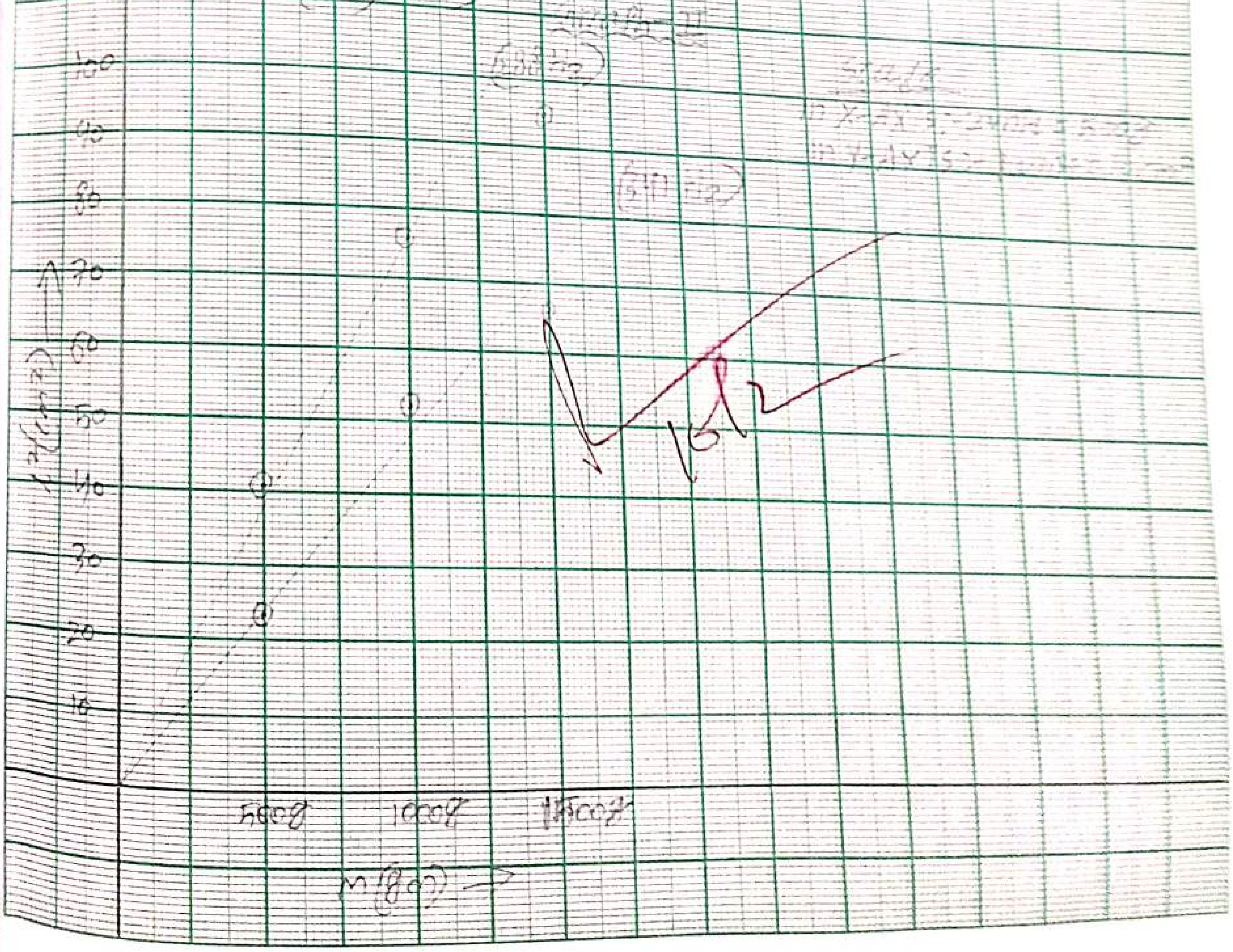
10/2/25

Name: Rajesh Rana

Roll No: 24CSEAIML025

Group: G1


Graph-I
Scale
In Y-AXIS :- 1 unit = 0.020 cm⁻¹
0.220
0.200
0.180
0.160
0.140
0.120
0.100
1/l (cm⁻¹)
(500g)
(1000g)
(1500g)
288
341
n (Hz)


Graph-II
(288 Hz)
(341 Hz)
Scale
100
90
80
70
60
50
40
30
20
10
l² (cm²)
500g
1000g
1500g
m (g)

NEWTON'S RING APPARATUS

EXPT. NO: 5

AIM OF THE EXPERIEMENT

Determination of wavelength of light by Newton's ring apparatus.

APPARATUS:

1. Newton's ring apparatus.
2. Traveling microscope.
3. Sodium vapour lamp.
4. Reading Lens.
5. Spherometer and Torch Light.

WORKING FORMULA:

Wavelength (λ) of the Monochromatic light

$$\lambda = \frac{D_n^2 - D_m^2}{4R(n-m)}$$

Where, D_n is the diameter of n^{th} ring.

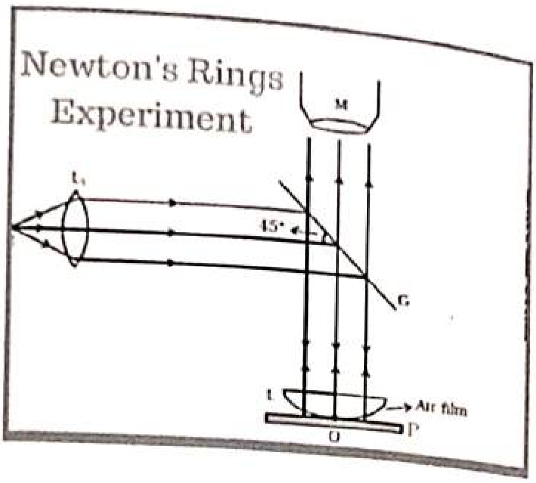
D_m is the diameter of the m^{th} ring.

R is the radius of curvature of the surface of the lens in contact with glass plate.

PROCEDURE:

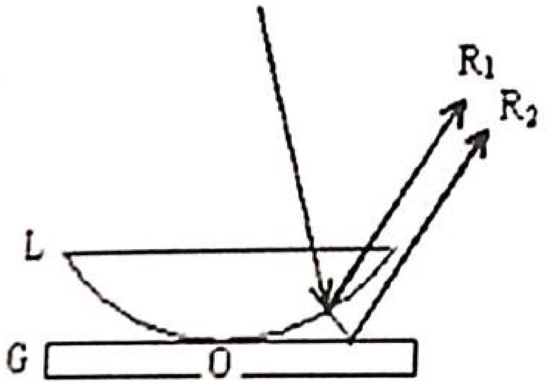
1. Adjust the holder containing the lens – glass plate combination in such a way that the glass plate will touch the lens at the center. Then it is placed on the horizontal bed of a traveling microscope.
2. Place a glass plate inclined at an angle of 45° just above the Newton's ring apparatus such that the rays of the sodium vapour lamp strike the glass plate and reflect normally on the plane of the apparatus.
3. The circular rings with alternate bright and dark colour will appear in the field of view of the microscope, which focus properly to get the best possible pattern.

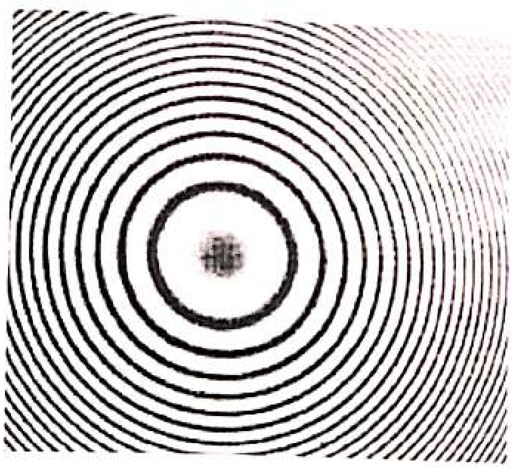
Figure-1



*In case a built-in apparatus with the lens, inclined glass plate and microscope are available, the operation 1-3 need not be carried out separately.

Figure-2





4. Adjust the microscope so that the point of intersection of the cross-wires coincides with the center of the central dark spot and it moves along the diameter of the ring system when the microscope tube is displaced in the horizontal direction. Starting with the central dark ring as the n^{th} ring, move the microscope towards the left side such that the center of the cross-wires is on the (n+20)th dark ring and tangential to it. Note both the main scale and circular scale readings.

5. Move the microscope tube horizontally to the right, and take readings by setting the cross wire successively on the (n+20)th, (n+18)th, (n+16)th .... (n+4)th dark ring i.e. alternate. Then move the microscope in the same direction and cross the central dark spot and go to the ring on the right side. Placing the cross wire in tangential position, note the readings for (n+4)th ring to (n+20)th ring in alternatively.

6. Determine the radius of curvature (R) of the spherical surface which is in contact with glass plate (G) with the help of a spherometer.

OBSERVATIONS:

i) Radius of curvature (R) of lens (L_1) in contact with glass plate is 94 cm (appx.).

ii) Determination of L.C of the Traveling microscope:
10 complete rotation of circular scale = 1cm of main scale.
1 complete to rotation of circular scale = 0.1cm of main scale.
Thus, pitch = 0.1cm.
Least count (LC) = $\dfrac{\text{Pitch}}{\text{No. of divisions on circular scale}} = \dfrac{0.1}{100}$

LC = 0.001 cm

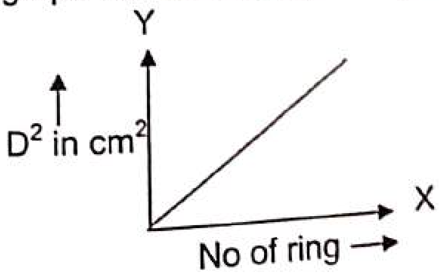
TABULATION: Determination of diameter of rings

L.C. = 0.001cm

No.of ring n	Micro meter reading: On Side 'a'				On Side 'b'				Diameter of the ring	Diameter²
	Linear scale reading (cm)	Circular scale division N	Circular scale reading (cm) N x LC	Total L.S.R + C.S.R (cm)	Linear scale reading (cm)	Circular scale division N	Circular scale reading (cm) N x L.C	Total L.S.R. + C.S.R. cm.	D = (a-b) cm	D^2 in cm^2

GRAPH:

Draw a graph with the number of ring on X-axis and corresponding square of diameter on Y-axis. The graph will be a straight line passing through origin.



From the graph read the values of D^2_m and D^2_n corresponding to the values of m and n.

RESULT :

In the graph shown, if $n = 20$ & $m = 4$

Then, using the formula, $\lambda = \dfrac{D^2_{20} - D^2_4}{4R\,(20 - 4)}$ = ______________ A°

STANDARD VALUE:

The wavelengths of the sodium –D lines are 5890A° and 5896 A°. [1A° = 10^{-10}m = 10^{-8}cm]

WORK SHEET

AIM OF THE EXPERIEMENT

Expt. No- 04
Date- 10/02/25

Determination of wavelength of light by Newton's ring apparatus.

TABULATION: Determination of diameter of rings

L.C. = 0.001cm

No.of ring N	Micro meter reading								Diameter of the ring	Diameter ^{2}
	On Side 'a'				On Side 'b'					
	Linear scale reading (cm)	Circular scale division N	Circular scale reading (cm) N x LC	Total L.S.R + C.S.R (cm)	Linear scale reading (cm)	Circular scale division N	Circular scale reading (cm) N x L.C	Total L.S.R. + C.S.R. cm.	D = (a~b) cm	D^2 in cm^2
n+25	5.4	4	0.004	5.404	4.9	24	0.024	4.924	~~0.48~~	0.2304
n+20	5.3	61	0.061	5.361	4.8	1	0.001	4.801	0.56	0.3136
n+15	5.2	12	0.012	5.212	4.7	35	0.035	4.735	0.477	0.2275
n+10	5.1	54	0.054	5.154	4.6	85	0.085	4.685	0.469	0.2199
n+5	5.0	12	0.012	5.012	4.6	45	0.045	4.645	0.367	0.1346
n	4.9	9	0.009	4.909	4.5	10	0.01	4.51	0.349	0.1592

0.0937
0.0929

lw

GRAPH

CALCULATION: $\lambda = \dfrac{D_n^2 - D_m^2}{4R(n-m)} = \dfrac{0.18662}{4000} = 2.3325 \times 10^{-5}\ cm = 2332\ Å$

CONCLUSION:
The wavelength of light by Newton's ring apparatus is 2.3325×10^{-5} or 2332Å

Low Value
Spatnaik 24/2/25

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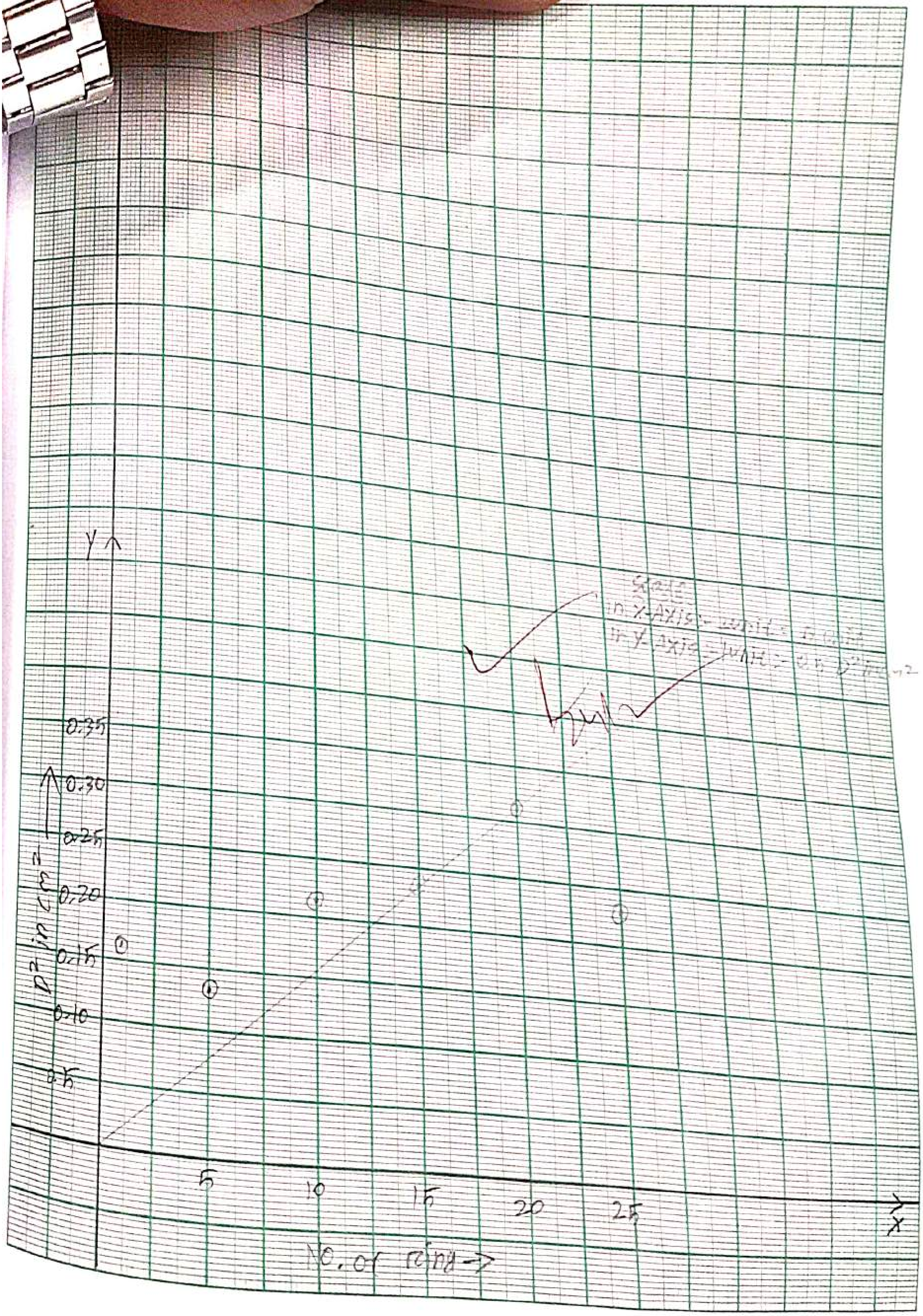


Scale
Y
0.35
0.30
0.25
0.20
0.15
0.10
0.5
D^2 in cm^2
5
10
15
20
25
X
No. of ring

RESISTIVITY OF A SEMICONDUCTOR

EXPT NO - 10

AIM OF THE EXPERIMENT: To determine the resistivity of a semiconductor by using four-probe method.

Apparatus Required:

1. Four Probe arrangements
2. A thin Ge crystal with smooth surface (wafer).
3. Oven with its power supply
4. Constant current generator
5. Digital panel meter measuring current and voltage.

THEORY:

The resistivity of the sample $\rho = \dfrac{\rho_0}{f(W/S)}$ (1)

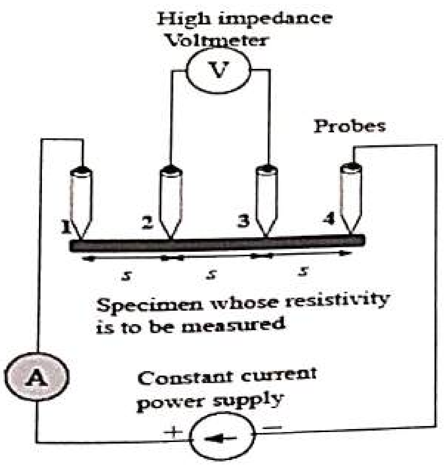
Where ρ is the resistivity of the semiconductor

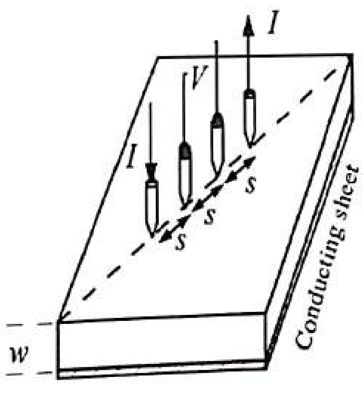
W is the thickness of the semiconductor

S is the distance between two probes.

By taking the value of $f(W/S) = 1$, we get resistivity, $\rho = \rho_0 = \left(\dfrac{V}{I}\right) 2\pi S$ 1.507 (2)

A high impedance source is used to supply the current (I) through the outer two probes. The voltmeter measures the floating potential difference (V) developed across the inner two probes and by using eq.(2), the resistivity (ρ) is calculated. Then the variation of resistivity of the sample can be studied at different temperatures by heating the oven.





PROCEDURE:

1. Load the sample in the sample space. Mount the four probes on the sample (wafer) carefully.
2. Switch on the power supply to pass a constant current through the outer two probes. Measure the voltage developed across the middle two probes.
3. Place the four probe arrangement inside the oven which is connected to a heater (0 – 200^{0}C) and insert a thermometer in the given hole at the top of the oven.
4. Heat the oven by rotating heat control switch in clockwise direction.
5. Note down the temperature in thermometer and the corresponding voltage in voltmeter.
6. At different temperature (T) values, find the resistivity (ρ) of the sample by using eq. (2).
7. Plot a graph between temperature (T) and resistivity (ρ) of the semiconductor.

S = 2.4 mm = 0.24 cm

I = 5 mA = 0.005A

TABULATION:

No of obs.	Temperature in ^{0}C	Temperature in K (x)	Voltage (mV) During Heating	Voltage (mV) During Cooling	Mean voltage in V	Resistivity in Ω m (y)
1	37	310	4.5	4.5	0.0045	1.3563
2	40	313	4.6	4.6	0.0046	1.38644
3	43	316	4.7	4.7	0.0047	1.41658
4	46	319	4.8	4.9	0.00485	1.46179
5	49	322	4.9	5.0	0.00495	1.49193
6	52	325	5.0	5.1	0.00505	1.52207
7	55	328	5.2	5.3	0.00525	1.58235
8	58	331	5.3	5.4	0.00535	1.61249
9	61	334	5.4	5.5	0.00545	1.64263
10	64	337	5.5	5.6	0.00555	1.67277
11	67	340	5.6	5.7	0.00565	1.70291
12	70	343	5.7	5.7	0.0057	1.71798

Graph

CONCLUSION:

WORK SHEET

AIM OF THE EXPERIMENT: To determine the resistivity of a semiconductor by using four-probe method.

Expt. No.: 05
Date: 24/02/25

OBSERVATION:

TABULATION:

No of obs.	Temperature in ^{0}C	Temperature in K	Voltage (mV) During Heating	Voltage (mV) During Cooling	Mean voltage in V	Resistivity in Ω m
1	37	310	4.5	4.5	0.0045	1.3563
2	40	313	4.6	4.6	0.0046	1.38644
3	43	316	4.7	4.7	0.0047	1.41658
4	46	319	4.8	4.9	0.00485	1.46179
5	49	322	4.9	5.0	0.00495	1.49193
6	52	325	5.0	5.1	0.00505	1.52207
7	55	328	5.2	5.3	0.00525	1.58235
8	58	331	5.3	5.4	0.00535	1.61249
9	61	334	5.4	5.5	0.00545	1.64263
10	64	337	5.5	5.6	0.00555	1.67277
11	67	340	5.6	5.7	0.00565	1.70291
12	70	343	5.7	5.7	0.0057	1.71798

GRAPH Plot a graph between temperature (T) and resistivity (ρ) of the semiconductor

CONCLUSION: In this experiment, the resistivity of a semiconductor was determined using the four-probe method by measuring its resistance at different temperatures. The results show that as temperature increases, the resistivity also increases.

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10/3/25

EXPT. NO. - 6

PLANE DIFFRACTION GRATING

AIM OF THE EXPERIMENT:- Determination of number of lines or grating element in a plane diffraction grating.

APPARATUS REQUIRED:-

1. Spectrometer.
2. Grating Plate.
3. Sodium Vapour Lamp.

THEORY:-

The grating equation is $(a+b)\,\text{Sin}\theta_n = n\lambda$

Where θ_n is the angle of diffraction for nth order.

λ is the wave length of sodium light (= $5893A^0$)

n is the order of diffraction.

(a + b) is the grating element

Then number of lines per cm, $N = 1/(a + b)$

PROCEDURE:

1. Adjust the Spectrometer by a Spirit level and following Schuster's method.
2. Place the grating plate on the prism table in front of the spectrometer and then focus lens to the sodium vapour lamp till a vertical, thin of higher intensity is obtained.
3. Move the telescope to the right side to obtain the first order of diffracted ray and do the same step on the left side.
4. Further move the telescope to the left side to obtain the second diffracted line and do the same step on the right side.

OBSERVATIONS:

(i) **Least count of the spectrometer :**

The least count of the spectrometer is the difference between one main scale division and one vernier scale division.

Here, 20 M.S.R. = 10^0 and 1M.S.R = 30^1. Again, 30 V.S.D. = 29 M.S.D. Then LC = 1'

(ii) Reading of the spectral lines:

Considering the First order spectrum both sides.

TABLE – I

L.C. = 1'

Spectral line	Reading from vernier - I				Reading from vernier -II			
	M.S.R.	V.C.	V.S.R	Total	M.S.R.	V.C	V.S.R.	Total

(iii) Determine number of lines of the grating.

TABLE – II

Taking $\lambda = 5890A^0$ and $5896A^0$

Order of Spectrum 'n'	Line	Reading of the scales				Angle of diffraction 'θ'			$N = \frac{\sin\theta}{n\lambda}$	Mean Lines /cm N	Grating element a + b $= \frac{1}{N}$ in cm
		Vernier I		Vernier II							
		Left θ_1	Right θ_2	Left θ_3	Right θ_4	Ver I $\frac{\theta_2-\theta_1}{2}$	Ver II $\frac{\theta_4-\theta_3}{2}$	Mean 'θ'			
n = 1	D_1										
	D_2										

RESULT

Grating element $(a + b) = 1.953 \times 10^{-3}$ cm

STANDARD VALUE:

No. of lines of plane diffraction grating,

$N \cong$ 5,200 lines/cm & $(a + b) = 1.9 \times 10^{-3}$ cm

CONCLUSION:

WORK SHEET

Expt. No- 06
Date- 10/03/25

AIM OF THE EXPERIMENT:- Determination of number of lines or grating element in a plane diffraction grating.

OBSERVATIONS:

(i) **Least count of the spectrometer :**

The least count of the spectrometer is the difference between one main scale division and one vernier scale division.

Example 20 M.S.R. = 10^0 and 1M.S.R = 30^1.

Again, 30 V.S.D. = 29 M.S.D.

Then LC = 1^1

(ii) **Reading of the spectral lines:**

Considering the First order spectrum both sides.

TABLE – I

L.C. = 1^1 or 30^1

Spectral line	Reading from vernier - I				Reading from vernier -II			
	M.S.R.	V.C.	V.S.R	Total	M.S.R.	V.C	V.S.R.	Total
Left N=1	5°	5	5'	5°5'	185°	27	27'	185°27'
Right N=1	42°	17	17'	42°17'	221°	21	21'	221°21'

(iii) Determine number of lines of the grating.

TABLE – II

Taking λ = 5890A^0 and 5896A^0

Order of Spectrum 'n'	Line	Reading of the scales: Vernier I Left θ_1	Vernier I Right θ_2	Vernier II Left θ_3	Vernier II Right θ_4	Angle of diffraction 'θ': Ver I $\frac{\theta_2-\theta_1}{2}$	Ver II $\frac{\theta_4-\theta_3}{2}$	Mean 'θ'	N = $\frac{\sin\theta}{n\lambda}$	Mean Lines /cm N	Grating element a + b = $\frac{1}{N}$ in cm
n = 1	D_1	5°5'	42°17'	185°27'	[illegible]	18°36'	17°57'	18°16'30"			
	D_2										
n = 2	D_1										
	D_2										

Result

Grating eleme'nt (a + b) = 1.953 x 10^{-3} cm

STANDARD VALUE:

No. of lines of plane diffraction grating,
N ≅ 5,200 lines/cm & (a + b) = 1.9 x 10^{-3} cm

CONCLUSION:

Calculation :- $d = \frac{\lambda}{\sin\theta} = \frac{5890 \times 10^{-8}}{\sin(18°16'30")} = 1.878 \times 10^{-4}$

Lines per inch = $\frac{2.54}{1.878 \times 10^{-4}}$ = 13525.02 LPI

%error = $\frac{15000 - 13525.02}{15000} \times 100 = 9.83$

Conclusion: The lines per greating element in the given grating plate is determined to be 13525.02 LPI

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Jyotsna
17/3/25

PLANCK'S CONSTANT

EXPT. NO -8

AIM OF EXPERIMENT:

To determine the Planck's constant using Photo-voltaic cell by following reverse photo-electric effect.

APPARATUS REQUIRED:

1. Planck's constant kit
2. Vacuum photo tube
3. Light source
4. Colour filters(Red, orange, green, blue)

THEORY:

Using Einstein's photo electric equation,

The maximum possible kinetic energy of the electron is given by

$$KE_{Max} = E - W_0 \tag{1}$$

Where, E = energy of the photon

W_0 = work function of the metal used in photocell

We know $E = h\nu$ and $W_0 = h\nu_0$

Then Equation (1) becomes,

$$KE_{Max} = h\nu - h\nu_0 = h(\nu - \nu_0) \tag{2}$$

Again, $KE_{Max} = eV_S$

Where, e = charge of electron = 1.6 X 10^{-19} C

V_S = stopping potential

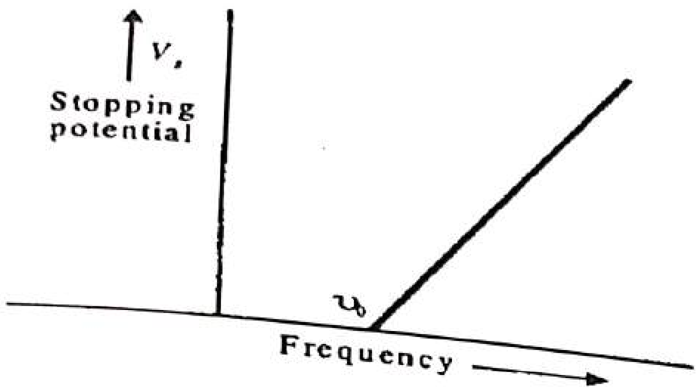
Then equation (2) becomes,

$$eV_S = h(\nu - \nu_0) \tag{3}$$

$$\Rightarrow V_S = \frac{h}{e}(\nu - \nu_0) \tag{4}$$

From equation (4) the stopping potential (V_S) is directly proportional to frequency (ν) of incident radiation. The value of Planck's constant (h) is obtained from slope of the graph between ν vs V_s.

GRAPH:



PROCEDURE:

1. Make the connection properly as per the figures (reverse biasing connection)
2. Switch on the power supply using ON-OFF switch i.e. provided on the Planck's constant kit.
3. Initially keep the voltage and current at zero.
4. Place the light source and photo cell facing each other and switch ON the light source such that the emitter gives sufficient deflection.
5. Insert any one of the filters (red, orange, green, blue) in the window provided in the photo cell. Wait 2-3 minutes before taking any reading.
6. Note down the reading of the ammeter for V=0Volt. Start increasing the voltage in small steps and note down the increasing current values. For a particular value of voltage, the current value becomes zero and that voltage is called stopping potential for that particular filter.
7. Take other filters one by one and repeat the above steps.
8. Plot a graph between stopping potential and frequency of the light source using different filters. Find the value of the Planck's constant using the slope of the graph and charge of the electron.

OBSERVATION:

e = charge of electron = 1.6×10^{-19} C

c = velocity of light = $3 \times 10^{8}\ ms^{-1}$

Wave length: Red colour = 6700×10^{-10}m

Green colour = 5000×10^{-10}m

Orange colour = 6400×10^{-10}m

Blue colour = 4050×10^{-10}m

TABULATION:

Table 1: To determine the stopping potential keeping the position of the light source fixed

No. Of Obs.	Filter 1		Filter 2		Filter 3		Filter 4	
	Voltage (V)	Current (μA)	Voltage (V)	Current (μA)	Voltage (V)	Current (μA)	Voltage (V)	Current (μA)

Table 2: Frequency with corresponding potential

No. of Obs.	Filter used	Wave length λ (m)	Frequency v (Hz)	Stopping potential V_s (Volt)
1	Red			
2	Orange			
3	Blue			
4	Green			

CALCULATION:

Planck's constant (h) = e x slope of the graph

PERCENTAGE OF ERROR:

CONCLUSION:

WORK SHEET

Expt. No.: 07
Date: 17/03/2

AIM OF EXPERIMENT:

To determine the Planck's constant using Photo-voltaic cell by following reverse photo-electric effect.

TABULATION:

Table 1: To determine the stopping potential keeping the position of the light source Fixed

No. Of Obs.	Filter 1		Filter 2		Filter 3		Filter 4	
	Voltage (V)	Current (μA)	Voltage (V)	Current (μA)	Voltage (V)	Current (μA)	Voltage (V)	Current (μA)

Table 2: (Frequency with corresponding potential)

No. of Obs.	Filter used	Wave length λ (m)	Frequency ν (Hz)	Stopping potential V_s (Volt)
1	Red	6700×10^{-10}	4.477×10^{14}	0.364
2	Orange	6400×10^{-10}	4.687×10^{14}	0.548
3	Green	5000×10^{-10}	6×10^{14}	0.648
4	Blue	4050×10^{-10}	7.4×10^{14}	0.862

CALCULATION:

Planck's constant (h) = e x slope of the graph = $1.6\times10^{-19}\times\frac{0.498}{2.5}\times10^{-14} = 3.187\times10^{-34}$ J.S

PERCENTAGE OF ERROR:

CONCLUSION: we have determined the plank's constant using reverse photo-electric effect and it comes out to be 3.187×10^{-34} J.S

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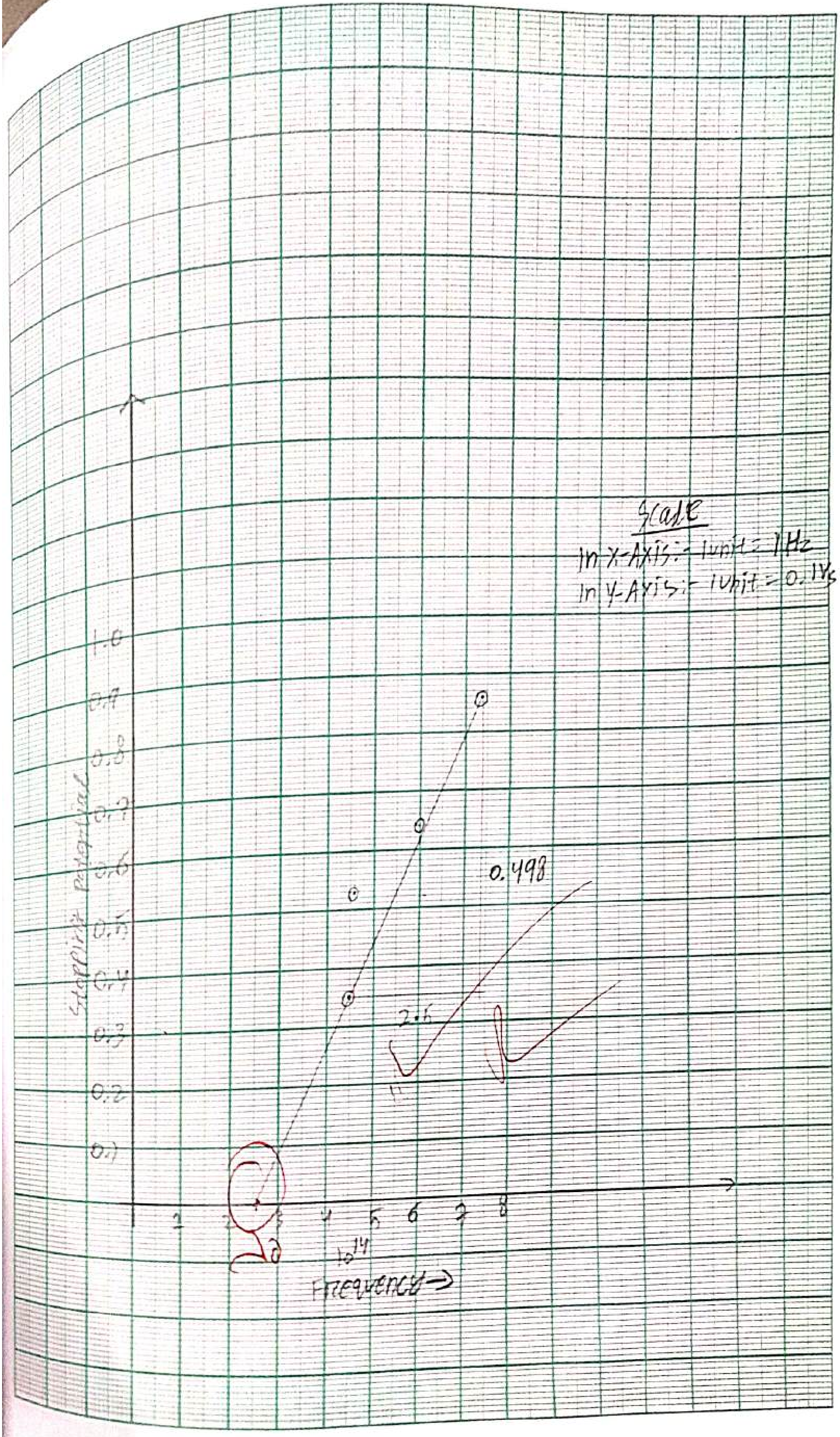
Scale
In X-Axis:- 1unit = 1Hz
In Y-Axis:- 1unit = 0.1Vs
0.498
2.6
Stopping potential
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
1 2 3 4 5 6 7 8
10^14
Frequency→