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KAMMAVARI SANGHAM (R) - 1952

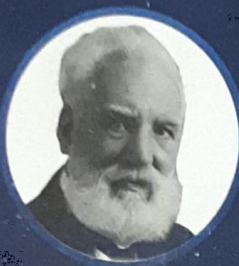
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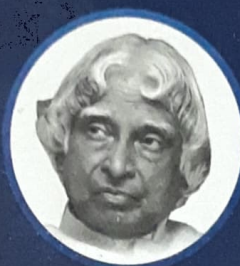
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#14, Raghuvanahalli, Kanakapura Main Road, Bengaluru - 560109



GRAHAM BELL



A P J ABDUL KALAM



MARIE CURIE



SRINIVASA RAMANUJAN



DENNIS RITCHIE



J R D TATA



THOMAS ALVA EDISON

**"Tell me and I'll forget;
Show me and I may
remember; Involve me
and I'll understand"**

PRACTICAL RECORD

NAME : PREMA . G

SEM / BRANCH : II / ECE

SUBJECT & CODE : ENGG. PHYSICS 18PHYL26

USN :

1	K	S	2	0	E	C	0	6	8
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Laboratory Certificate

This is to certify that Mr./Ms. PREMA . G
has satisfactorily completed the course of experiments in
ENGINEERING PHYSICS laboratory, Code 18PHY126
prescribed by Visvesvaraya Technological University, Belagum for the
II Semester B.E. ECE Branch
in this college during the academic year 20.20.. - 20.21..

Name of the Candidate : PREMA . G

USN : 1KS20EC068 Subject (with code) 18PHY126
ENGINEERING PHYSICS
LABORATORY

Internal assessment marks awarded :

30	10	40
30	10	40

Signature of Staff Incharge

Date : 29/9/2021

Signature of Head of
DEPT. OF SCIENCE AND HUMANITIES
K. S. INSTITUTE OF TECHNOLOGY
BENGALURU - 560 109

INSTRUCTIONS FOR MAINTAINING THE PRACTICAL RECORD

1. Record should be written neatly in black ball point pen on the right side page only, left side pages being reserved for diagrams and graphs in pencil.

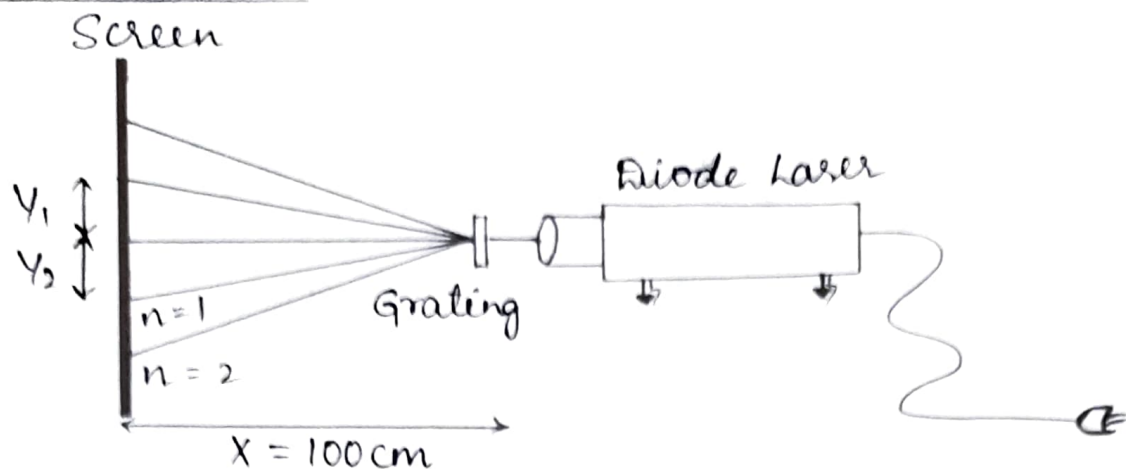
2. Record should contain

- Number and name of Experiment
- The date
- Principle
- Procedure
- Observation calculation (to be entered on the left hand side pages in neat tabular forms wherever applicable)
- Results

CONTENTS AND EVALUATION

Sl. No.	Date of Conducting Experiment	Date of Submission	Page No.	Title of the Experiment	Assessment Marks			Signature Staff with Date
					Experiment 10 Marks	Record 5 Marks	Total	
01	24-08-21	27-08-21	1-4	DIFFRACTION GRATING	10	10	30	
02	24-08-21	27-08-21	5-10	TORSIONAL PENDULUM	10	10	30	10/9/21
03	24-08-21	27-08-21	11-14	DIELECTRIC CONSTANT	10	10	30	
04	27-08-21	1-09-21	15-18	IV CHARACTERISTICS OF PHOTO DIODE	10	10	30	
05	27-08-21	1-09-21	19-22	FERMI ENERGY OF COPPER	10	10	30	10/9/21
06	27-08-21	1-09-21	23-26	TRANSISTOR CHARACTERISTIC	10	10	30	
07	1-09-21	3-09-21	27-30	SERIES PARALLEL RESONANCE	10	10	30	
08	1-09-21	3-09-21	31-34	YOUNG'S MODULUS BY SINGLE CANTILEVER	10	10	30	10/9/21
09	1-09-21	3-09-21	35-40	SPRING CONSTANT	10	10	30	
10	3-09-21	7-09-21	41-46	NEWTON'S RING EXPERIMENT	10	10	30	
11.	3-09-21	7-09-21	47-50	ACCEPTANCE ANGLE AND NUMERICAL APERTURE	10	10	30	10/9/21

OBSERVATION :



FORMULA : $\lambda = \frac{\sin \theta}{nN} m$

No. of lines per meter on the grating
 $N = 2.2 \times 10^4 \text{ lines/m.}$

Distance between the grating and the screen
 $X = 100 \text{ cm.}$

Order of diffraction n	Distance between central maximum of the n^{th} order $Y_1(L)$ maximum $Y_2(R)$		Average $Y = \frac{Y_1 + Y_2}{2}$ (cm)	Deviation $\theta = \tan^{-1}\left(\frac{Y}{X}\right)$	$\lambda = \frac{\sin \theta}{nN}$ (m)
1	1.3	1.4	1.35	0.77	609.09 nm
2	2.6	2.7	2.65	1.51	597.72 nm
3	4.0	4.1	4.05	2.31	610.60 nm
4	5.0	5.4	5.2	2.97	588.63 nm

mean $= \lambda \Rightarrow \underline{\underline{601.5 \text{ nm}}}$

AIM: To determine the wavelength of LASER beam using diffraction grating.

APPARATUS: Diffraction grating, grating holder, diode laser (semiconductor laser), screen fixed with graph sheet and meter scale.

PROCEDURE: The experiment arrangement is made as shown in the figure. Distance between the grating and the screen is adjusted to 1 meter (x). The laser beam is incident normally on the grating. Diffraction pattern is obtained on the screen. The screen is adjusted such that the central bright maximum coincides with the '0' of the scale fixed on the screen. The separation between central bright maximum and first order maximum to the left of diffraction pattern (say y_1) is measured. Same is repeated to first order maximum to the right of the screen (say y_2).

Procedure is repeated by taking readings for up to fourth order and readings are tabulated. Angle of deviations (θ) for each order is calculated. Wavelength of laser beam is determined using the formula

$$\lambda = \frac{d \sin \theta}{nN}$$

3

Calculation :

$$\lambda_1 = \frac{\sin(0.77)}{(1)(2.2 \times 10^4)} = \frac{0.0134}{2.2 \times 10^4} = 6.0909 \times 10^{-7} = 609.09 \text{ nm}$$

$$\lambda_2 = \frac{\sin(1.51)}{(2)(2.2 \times 10^4)} = \frac{0.0263}{44000} = 5.9772 \times 10^{-7} = 597.72 \times 10^{-9} \text{ m}$$

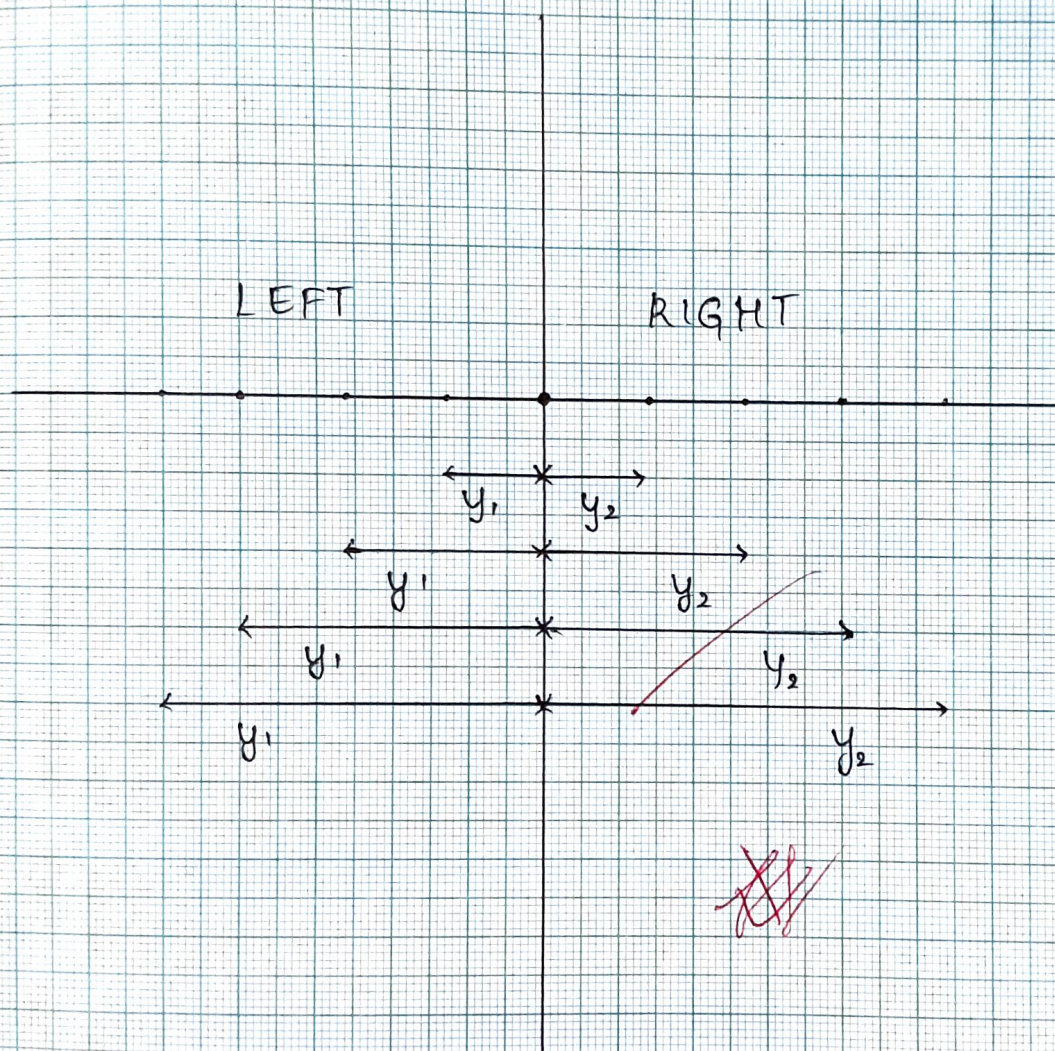
$$\lambda_3 = \frac{\sin(2.31)}{(3)(2.2 \times 10^4)} = \frac{0.0403}{66000} = 6.1060 \times 10^{-7} = 610.60 \text{ nm}$$

$$\lambda_4 = \frac{\sin(2.97)}{(4)(2.2 \times 10^4)} = \frac{0.0518}{88000} = 5.8863 \times 10^{-7} = 588.63 \text{ nm}$$

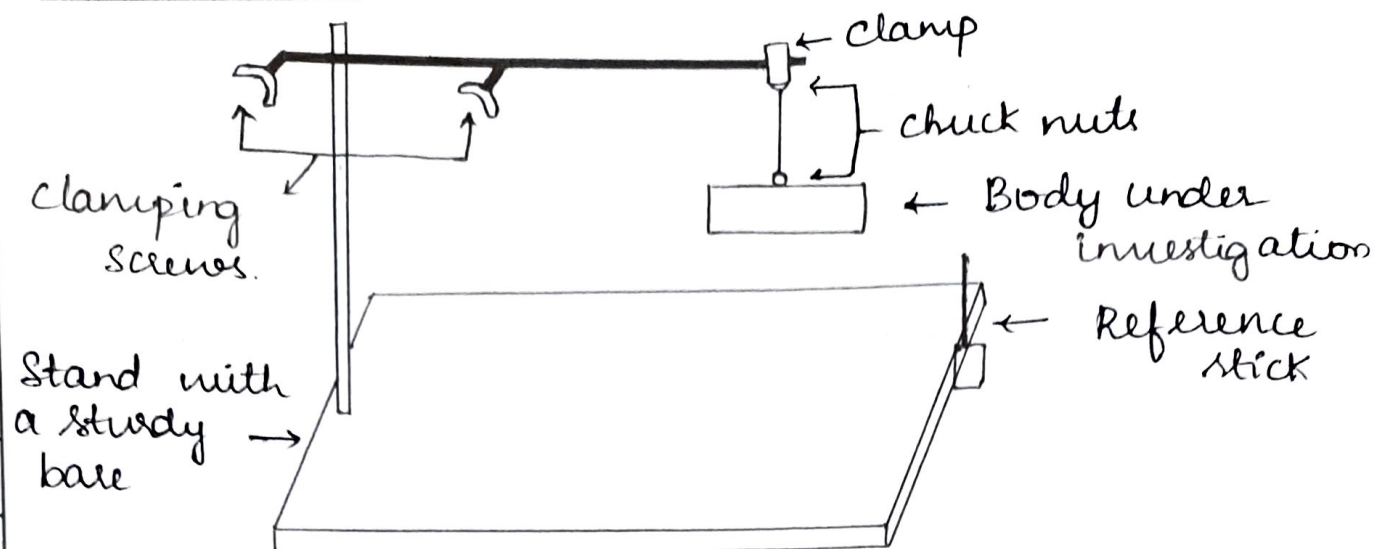
where n is order of diffraction pattern,
 $N = 2.2 \times 10^4$ lines / m. The wavelength average
is determined from the table.

RESULT : The wavelength of LASER beam is
given by $\lambda = 601.5 \text{ nm}$.

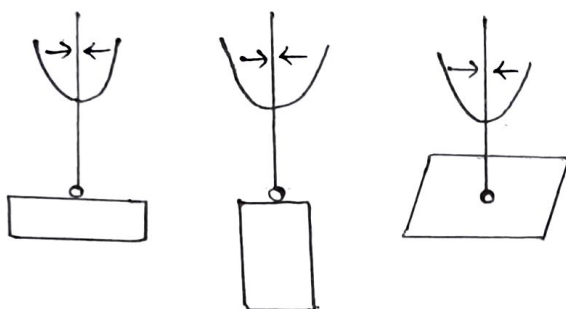
DIFFRACTION PATTERN.



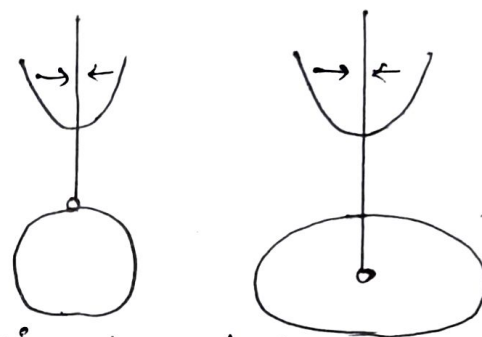
OBSERVATION:



TORSIONAL PENDULUM



Rectangular body



Circular plate.

Formula : The rigidity modulus of the material of the wire :

$$\eta = \frac{8\pi l}{\gamma^4} \left(\frac{I}{T^2} \right)_{\text{mean}} \quad \text{N/m}^2$$

Measurement of Dimensions

- (a) Mass of the rectangular plate $M_1 = 1.1028 \text{ kg}$
- (b) Length of the rectangular plate $L = 0.165 \text{ m}$
- (c) Breadth of the rectangular plate $B = 0.095 \text{ m}$
- (d) Mass of the circular plate $M_2 = 1.208 \text{ kg}$
- (e) Radius of the circular plate $R = \frac{0.485}{2\pi} = 0.07719 \text{ m}$

AIM: to determine the rigidity modulus of the material of the given suspension wire, by setting up a torsional pendulum.

APPARATUS REQUIRED: Rectangular plate, circular plate, and stand with clamp. steel wire fixed between check nuts, reference stick, thread, meter scale, stop clock.

PROCEDURE:- The masses M_1 and M_2 of the rectangular and circular plates respectively, are found by weighing them each in a rough balance upto accuracy of $\pm 1\text{ gm}$. The length L , the Breadth B , of the rectangular plate, and also the circumference C of the circular plate (with the help of a thread), are found by using a meter scale, to an accuracy of $\pm 1\text{ mm}$. The moment of inertia values of the two bodies about the respective axes are evaluated by using the corresponding equations listed in tab - column I.

The experiment wire whose both ends are tightly fastened to two check nuts is taken. One of the check nuts is firmly clamped to the stand. The rectangular plate is screwed on to the other check nut (fig 1), without permitting the wire to undergo any twisting while the

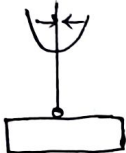
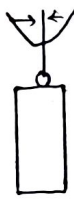
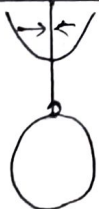
EVALUATION OF THE RIGIDITY MODULUS OF THE MATERIAL OF THE SUSPENSION WIRE:

Diameter of the wire $d = 0.062 \text{ cm}$

Measurement of radius of the suspension wire r

$$\text{radius } r = d/2 = 3.1 \times 10^{-4} \text{ m}$$

$$\text{length of the wire} = l = 21 \text{ cm} \Rightarrow 0.21 \text{ m}$$

	Axis through CG	Symbolic Representation	Moment of Inertia I		Time for 10 oscillation (sec)		Mean t (sec)	period $T = t/10$	T^2 (sec) and I/T^2
			concerned Equation	Value (Kg m^2)	Trial 1	Trial 2			
Rectangular Body	perpendicular to the length		$\frac{M_1 L^2}{12}$	25019.775 2.50×10^{-3}	40s	40sec	40	4.0	16 δ 1.563×10^{-4}
	perpendicular to the breadth		$\frac{M_1 B^2}{12}$	0.744×10^{-3}	24s	24s	24	2.4	5.76 δ 1.2916×10^{-4}
	perpendicular to the plane		$\frac{M_1 (L^2 + B^2)}{12}$	3.33×10^{-3}	47s	47s	47	4.7	22.09 δ 1.507×10^{-4}
Circular Body	The diameter		$\frac{M_2 R^2}{4}$	1.799×10^{-3}	35s	35s	35	3.5	12.25 δ 1.468×10^{-4}

body is fixed to it. A convenient reference mark at the edge of the body is identified [for Example in fig 1, it is one of its edges]. The reference stick is placed just next to it. The body is given a gentle rotation, so that it oscillates stick is placed just next to the wire as its axis, without any wobbling motion. At the moment when the body reference mark crosses the reference stick, a stop clock is started. The oscillation is counted as one, when the body reference mark crosses the reference stick again in the same direction. Time take 't' for completing 10 oscillations is found under two trials. The body is then gently removed from the check nut.

The same procedure is repeated for all the axes of oscillations of the rectangular and circular plates, listed in tab column I.

Mean value of 't' is found from which the case. Mean value of (I/T^2) is found out. period T and hence T^2 are determined. The value of (I/T^2) is found out in each case. Mean value of (I/T^2) is found out.

I/T^2 kgm^2/s^2
1.563×10^{-4}
1.2916×10^{-4}
1.507×10^{-4}
1.468×10^{-4}

$$(I/T^2)_{\text{mean}} = 1.4574 \times 10^{-4}$$

calculation: $\eta = \frac{8\pi l}{r^4} \left(\frac{I}{T^2} \right)_{\text{mean}} \quad \text{N/m}^2$

$$= \frac{8 \times \pi (0.21) [1.4574 \times 10^{-4}]}{(3.1 \times 10^{-4})^2}$$

$$= \frac{7.68807 \times 10^{-4}}{9.23521 \times 10^{-15}} \Rightarrow 0.8324 \times 10^{11}$$

$$\eta \Rightarrow 8.324 \times 10^{10} \text{ N/m}^2$$

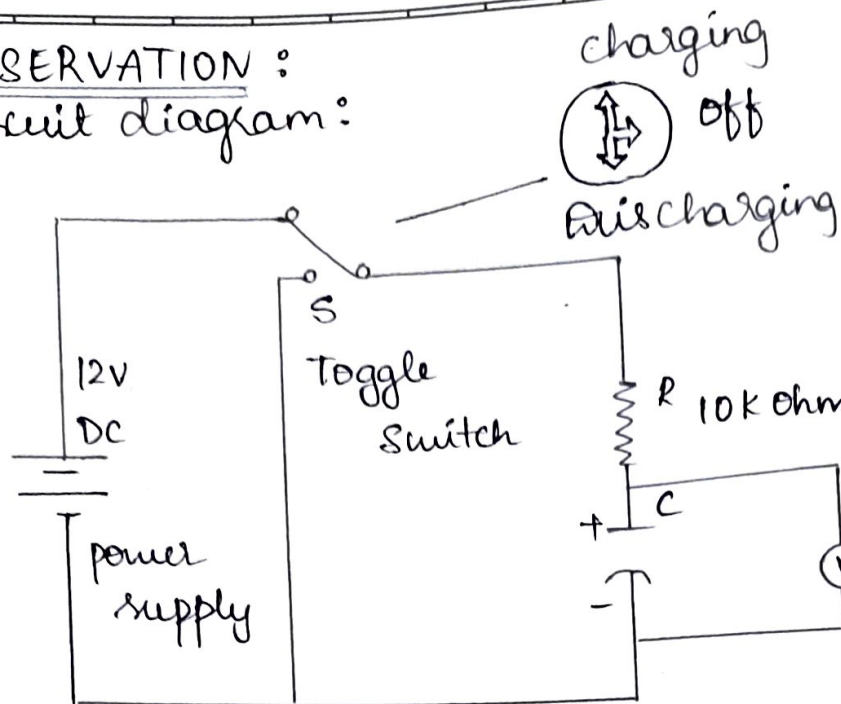
The radius ' r ' of the wire is found length "L" of the wire exposed between check nut to check nut is found out. The rigidity modulus ' η ' is evaluated by using the formula.

RESULT : The value of rigidity modulus of the material of the given suspension wire is found to be $\eta = 8.324 \times 10^{10} \text{ N/m}^2$

~~X/2/18~~

R-10
O-10
V.V-10

OBSERVATION :
circuit diagram:



V = Voltmeter
 C = Electrolytic Capacitor
 R = Resistor
 S = Toggle Switch

Time (t) (Sec)	Voltage (v)	
	charging	discharging
0	0	18.50
10	6.65	12.28
20	10.79	8.20
30	13.35	5.21
40	15.13	3.52
50	16.34	2.31
60	17.00	1.59
70	17.59	1.05
80	17.93	0.71
90	18.16	0.48
100	18.32	0.33
110	18.43	0.23
120	18.50	0.16

calculations:

from the Graph
 $T_{1/2} = 15 \text{ sec}$

Area of the Capacitor plates = $A = 35.15 \text{ mm}^2$

Distance between the plate = $d = 8.85 \text{ mm}$

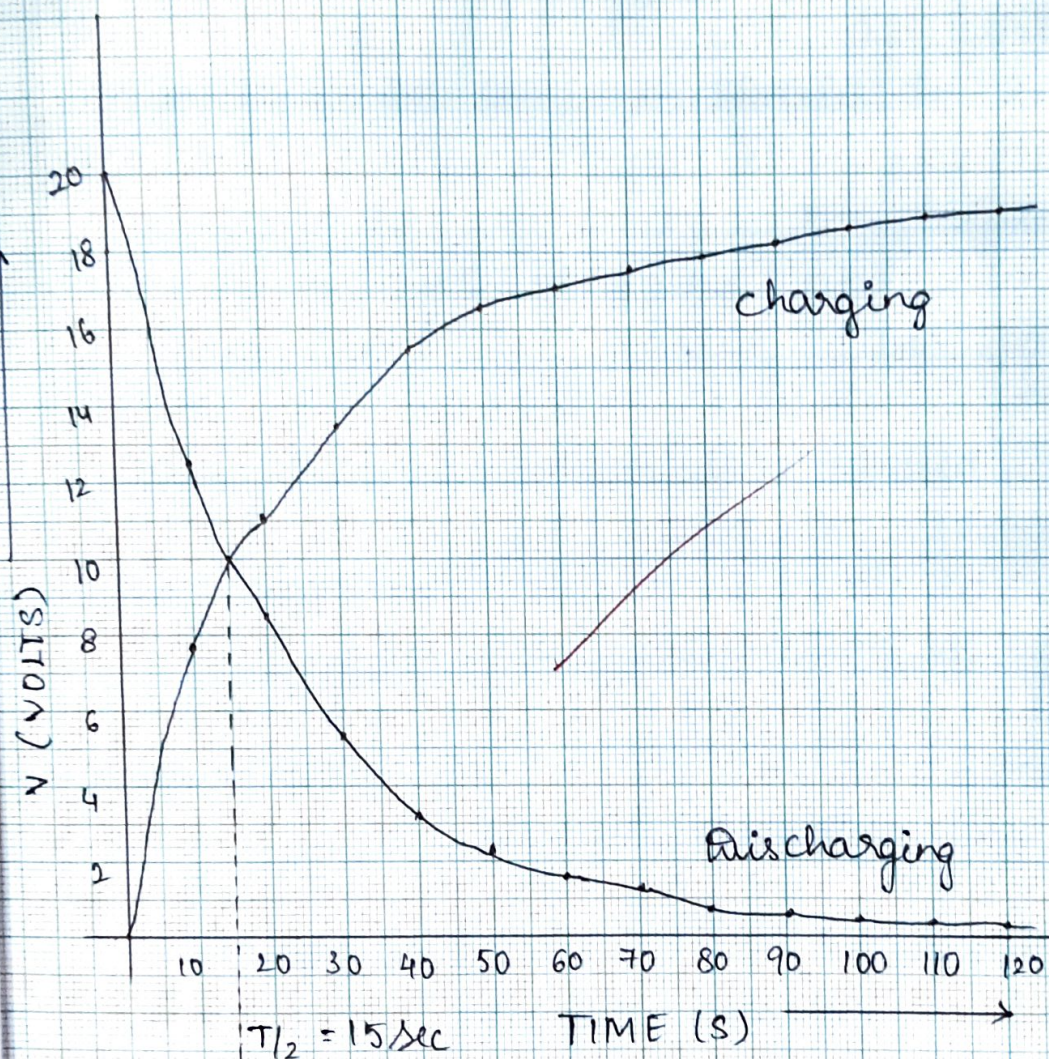
Resistance $R = 100 \text{ K}$

permittivity of free space $\epsilon_0 = 8.854 \times 10^{-12}$

$\epsilon_r = 6.1423$

AIM: to determine the dielectric constant of the dielectric material of the capacitor by the method of charging and discharging.

APPARATUS: 12V DC adaptor, Toggle switch (S), Electrolytic capacitor (C), Resistor (R), Connecting wire.



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Calculations :

$$\epsilon_r = \frac{1.44 \times 10^{-9} \times T^{1/2} \times d}{\epsilon_0 R A}$$

$$= \frac{1.44 \times 10^{-9} \times 15 \times 8.85 \times 10^{13}}{8.854 \times 10^{-12} \times 100 \times 10^2 \times 35.15 \times 10^{-3}}$$

$$= \frac{191.16 \times 10^{-9}}{3.11218 \times 10^{-5}} = 6.1423 \times 10^{-3} \times 10^{+3}$$

$$\epsilon_r = 6.1423$$

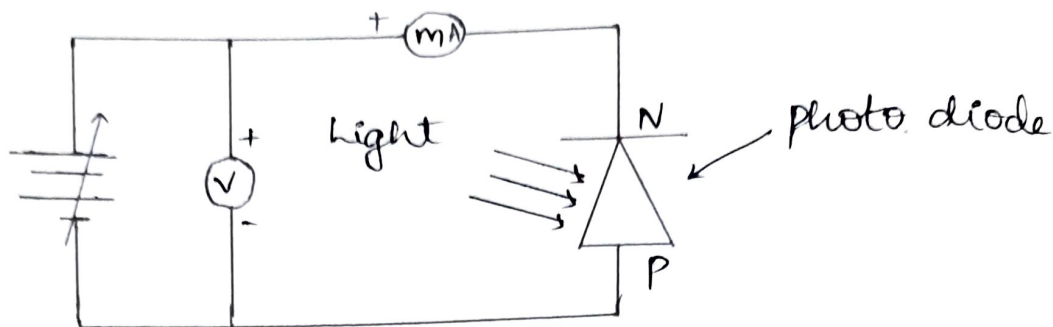
The reading are tabulated in the tabular column. A graph of voltage vs time is plotted on a single graph sheet for both charging and discharging. Time $T_{1/2}$ corresponding to the intersection of two curves is noted from the graph. The dielectric constant of the material of the capacitor is determined using the formula.

$\epsilon_r = \frac{1.44 \times 10^{-9} T_{1/2} d}{\epsilon_0 R A}$, where ϵ_0 is permittivity of free space, R is the resistance, A is area of the plate of the capacitor and d is the thickness of the dielectric material between the plates of the capacitor.

RESULT: The dielectric constant of electrolytic parallel plate capacitor is found to be $\epsilon_r = 6.1423$

~~27/6~~

R-10
D-10
V.V-10



Variation of PD voltage with current.

V_{PD} (V)	I_{PD} (mA)		
	Intensity 1	Intensity 2	Intensity 3
0	0	0	0
-0.2	1.19	1.02	0.84
-0.4	2.30	2.29	1.73
-0.6	2.95	2.86	1.92
-0.8	3.37	3.26	1.96
-1.0	3.56	3.41	1.98
-2.0	3.8	3.58	2.05
-3.0	3.94	3.68	2.09
-4.0	4.08	3.77	2.15
-5.0	4.23	3.85	2.19

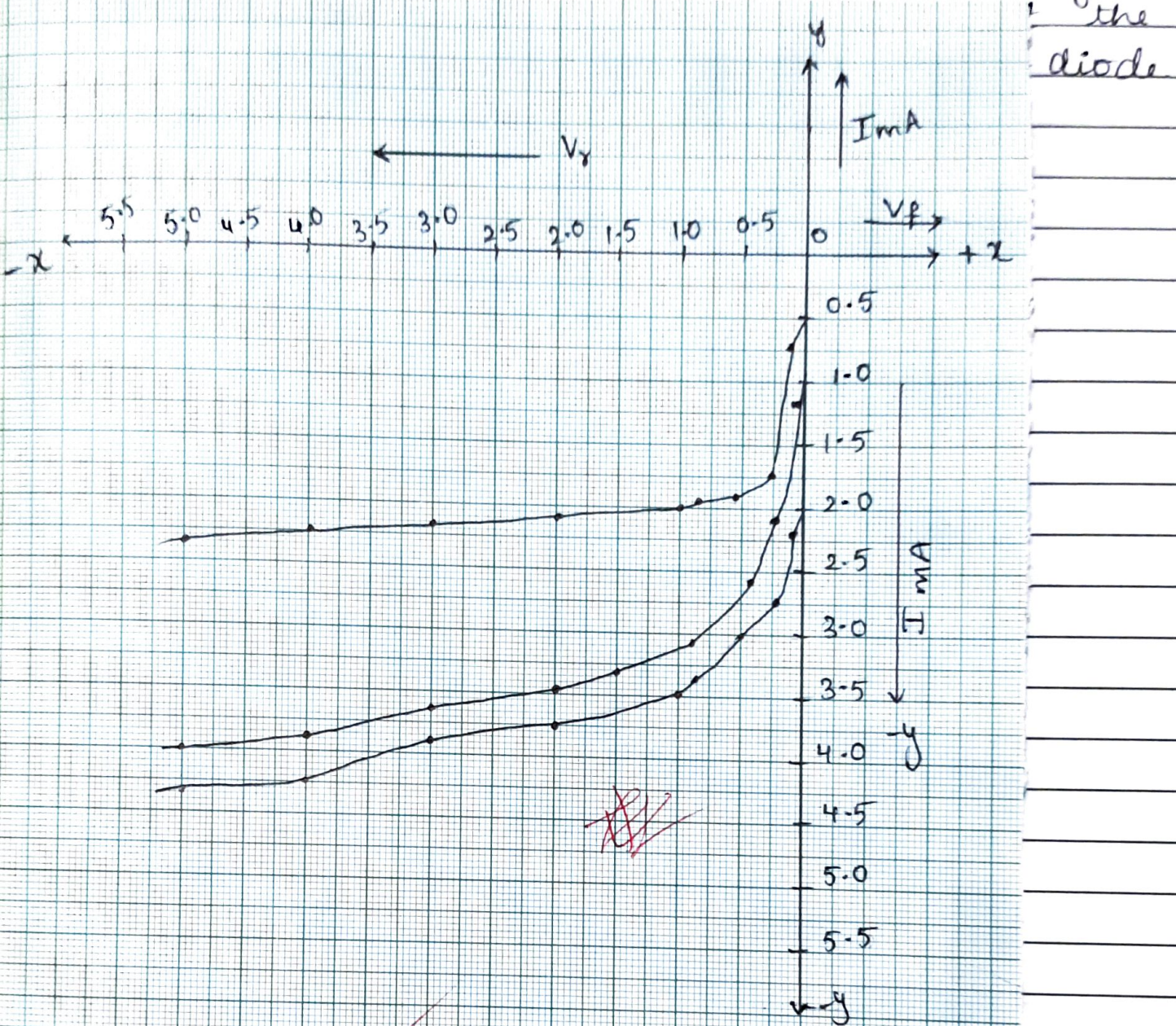
AIM: To study the IV characteristics of photodiode.

APPARATUS: Photo-diode (PN JUNCTION), Voltmeter, micro-ammeter, variable DC source and light source (electric bulb).

PROCEDURE: The circuit connection as made as shown in the diagram. The P-N Junction photo diode is reverse biased.

1. Set the voltage to 5V, adjust the light falling on the photodiode to maximum intensity and adjust the distance between light source and photodiode such that micro-ammeter reads maximum current and bring back the voltage to zero.
2. Now vary the voltage in steps as shown in the tabular column and note down the corresponding reverse bias current readings.
3. Repeat the experiment by decreasing the intensity range as before and tabulate the value in the tabular column.

4. Plot a graph of reverse bias voltage along the -ve X-axis and the corresponding

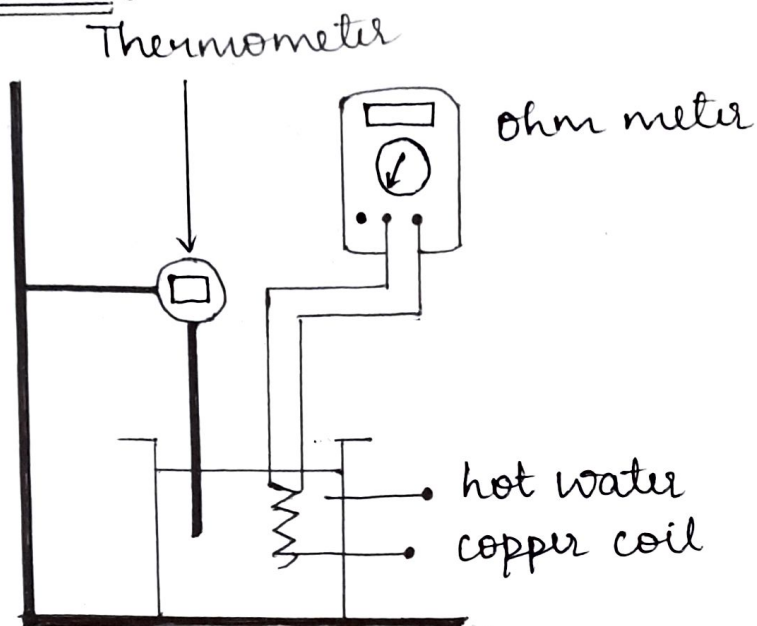


reverse current increases as the current through the diode increases due to the decrease of the resistance of diode junction with the increase of intensity of light.

~~17/21~~

R-10
0-10
V.V-10

OBSERVATION:



FORMULA: fermi energy $E_F = 1.37 \times 10^{-15} \sqrt{\frac{DAS}{L}} \text{ J}$

Sl. NO.	Temperature		Resistance
	T(°C)	T(K)	
1	92	365	7.2
2	87	360	7.1
3	82	355	7.0
4	77	350	6.9
5	72	345	6.8
6	67	340	6.7
7	62	335	6.6

CALCULATION:

The length of the copper wire $L = 11\text{m}$

The Diameter of the copper wire $d = 0.25\text{mm}$

Density of copper $D = 8.96 \times 10^3 \text{ Kg/m}^3$

Area of cross-section of the copper wire $= A = \frac{\pi d^2}{4}$
 $= 4.906 \times 10^{-8} \text{ m}^2$

AIM: To determine the fermi energy of copper by studying the variation of resistance with temperature.

APPARATUS: Copper coil, Thermometer, ohmmeter, Beaker and hot water.

PROCEDURE: The circuit connections are made as shown in the circuit diagram. The copper coil is immersed in the beaker filled with hot water. A thermometer is introduced into hot water, starting with the temperature of 85°C , the resistance (R) of the copper coil is measured using the digital thermometer. The resistance of the copper coil is measured for every 5°C fall in temperature (T) of water up to 60°C . A graph of Resistance (R) vs temperature (T) is plotted. The slope (S) is determined. Given the length (L) and the diameter (d) of the copper wire, the fermi energy of copper is calculated using the formula

$$E_f = 1.37 \times 10^{-15} \sqrt{\frac{DAS}{L}} \text{ J}$$

(where D is Density of copper $= 8.96 \times 10^3 \text{ Kg/m}^3$, L is the length of the copper wire, ' A ' is the area of cross-section of the wire and ' S ' is the slope).

$$\text{slope} = S = 0.02$$

Calculation :

$$A = \frac{\pi d^2}{4} = \frac{\pi \times (0.25 \times 10^{-3})^2}{4} = \pi \times 0.0625 \times 10^{-6}$$

$$A = 4.906 \times 10^{-08}$$

$$E_F = 1.37 \times 10^{-15} \sqrt{\frac{DAS}{L}} \text{ J}$$

$$= 1.37 \times 10^{-15} \sqrt{\frac{8.96 \times 10^3 \times 4.906 \times 10^{-08} \times 0.02}{11}}$$

$$= 1.37 \times 10^{-15} \sqrt{\frac{0.8791 \times 10^{-5}}{11}}$$

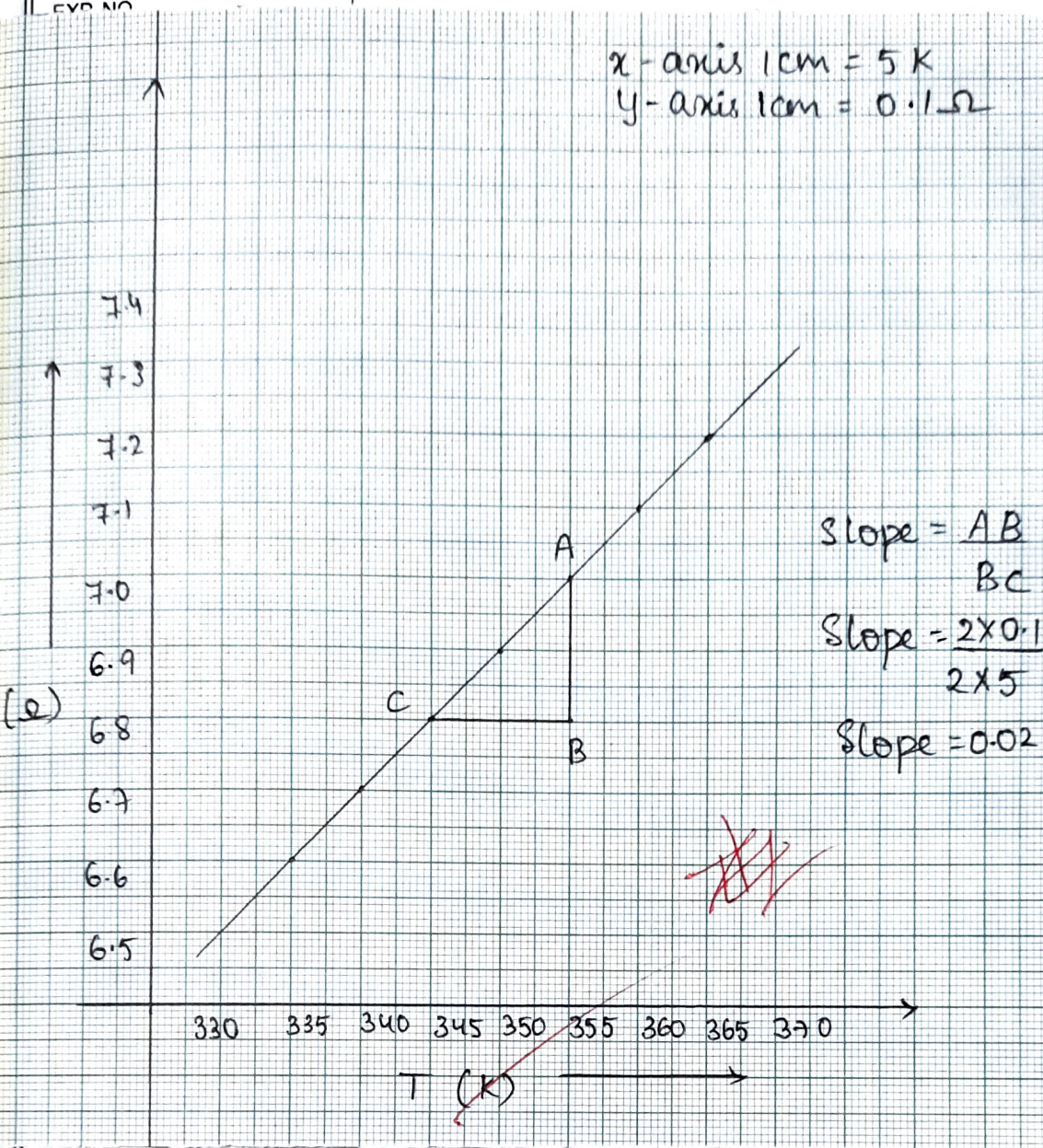
$$= 1.37 \times 10^{-15} \sqrt{7.9918 \times 10^{-7}}$$

$$E_F = 12.193 \times 10^{-19} \text{ J}$$

$$E_F = \frac{12.193 \times 10^{-19}}{1.69 \times 10^{-19}} \text{ eV} \Rightarrow 7.214 \text{ eV}$$

$$E_F = 12.193 \times 10^{-19} \text{ J}$$

$$E_F = 7.214 \text{ eV}$$

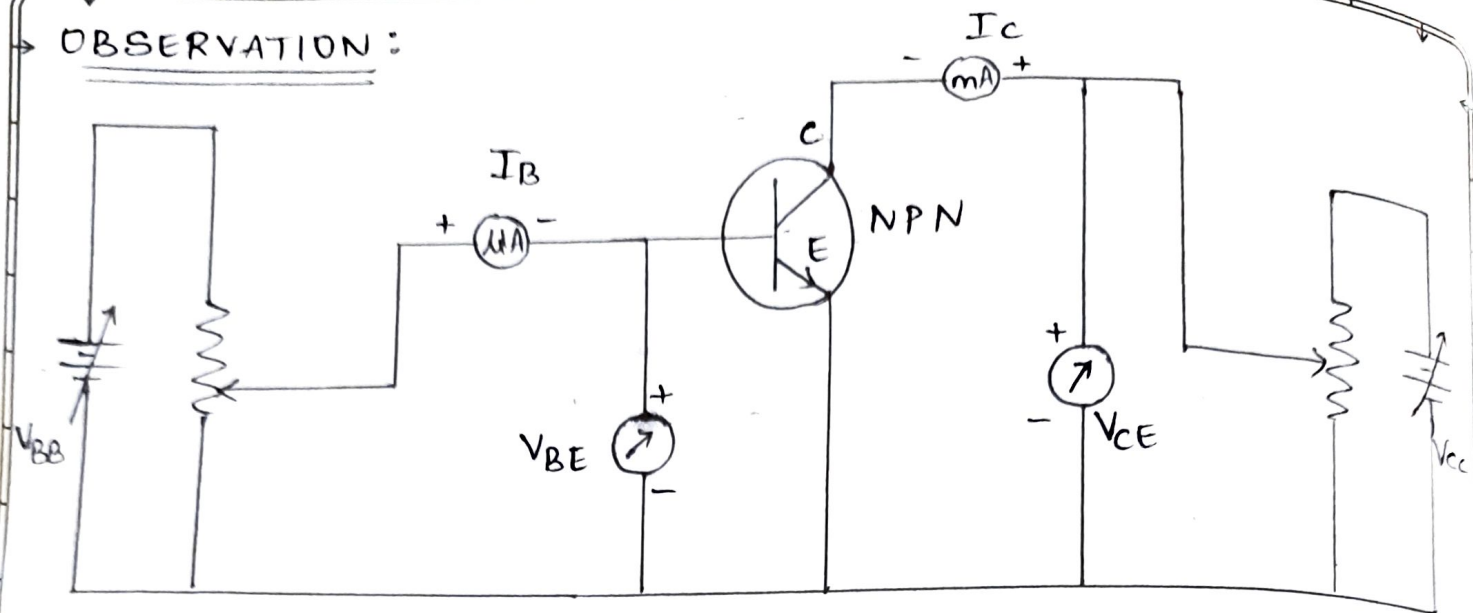


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RESULT : The fermi energy of copper is found to be $E_f = \underline{7.214 \text{ eV}}$

~~119~~
 R-10
 O-10
 V.V-10

OBSERVATION :



To study INPUT characteristics

$V_{CE} = 2\text{V}$	$V_{BE}(\text{V})$	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
	$I_B(\mu\text{A})$	0.0	0.0	0.0	0.0	4.1	19.8	40.5	68.3

To study OUTPUT characteristics

$I_{B1} = 50\mu\text{A}$	$I_C(\text{mA})$	0	0.5	1	2	3	4	5	6	7	8
$I_{B2} = 75\mu\text{A}$	$I_C(\text{mA})$	0.0	5.4	5.5	5.5	5.6	5.7	6.0	6.1	6.2	6.4
	$I_C(\text{mA})$	0.0	9.9	9.9	10.0	10.1	10.2	10.3	10.6	10.8	11.1

AIM: To study input and output characteristic of the given NPN Transistor in CE mode and to find α and β of the transistor and also the knee voltage for silicon.

APPARATUS: Transistor, DC Regulated power supplies, DC micro ammeter, DC milliammeter, DC voltmeter, circuit board and patch cords.

PROCEDURE: The electrical connections are made as shown in the circuit diagram. The voltmeter is connected across collector-emitter junction and V_{CE} is adjusted for 2 volts. The voltmeter is now connected across emitter-base junction and V_{BE} is increased in terms of 0.1 volts up to 0.8 volts and corresponding value of base current I_B are recorded. A graph obtained is as shown in the fig 1. The straight line portion of the curve is extrapolated so as to intersect the X-axis. The value of V_{BE} corresponding to point of intersection is the knee voltage.

The voltage meter or voltmeter is connected across collector-emitter junction. The base

To find current amplification factor β of the transistor :

β of the transistor is given by

$$\beta = \frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}} = \frac{(11.1 - 6.4) \times 10^{-3}}{(75.0 - 50) \times 10^{-6}} = 188$$

$\beta = 188$

α of the transistor is given by α

$$\alpha = \frac{\beta}{\beta + 1} = 0.99$$

current I_B is adjusted for $50 \mu A$. The collector-emitter junction voltage V_{CE} is varied in steps of 1 volt till 8 volts and corresponding value of collector current I_C is recorded. The experiment is repeated by adjusting I_B for $75 \mu A$. The graph of I_C against V_{CE} is plotted for both the values of I_B . The graph obtained is as shown in the fig. 2. horizontal lines are drawn to meet y-axis at I_{C1} and I_{C2} from the point where the vertical lines intercepts the curve. The value of current amplification factor β is determined using the formula

$$\beta = \frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}}$$

$$\alpha = \frac{\beta}{\beta + 1}$$

I_C is collector current, I_B is base current, β is current Amplification factor.

RESULT : The Knee voltage of the transistor is found to be $= 0.53V$

The β of the transistor is found to be $\beta = 188$
 The α of the transistor is found to be $\alpha = 0.99$

~~11/9~~

R-10
 0-10
 V.V-10

OBSERVATION :

Series Resonance circuit:

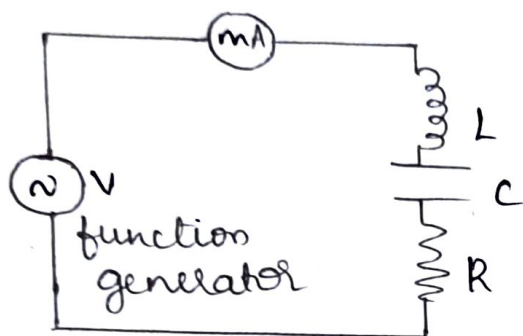


fig 1.

Parallel Resonance circuit:

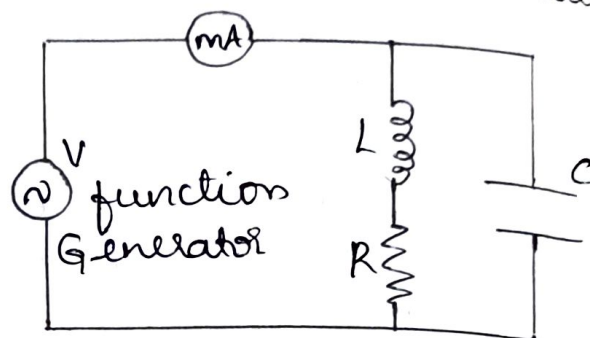


fig 2.

frequency 'f' in KHz	Series current 'I' in mA	Parallel current 'I' in mA
1.0	2.7	7.16
1.5	4.20	3.48
1.6	6.8	3.00
1.7	8.2	2.39
1.8	10.0	2.00
1.9	11.3	1.53
2.0	13.2	1.26
2.1	14.1	1.1
2.2	14.0	1.03
2.3	13.1	1.13
2.4	11.8	1.33
2.5	10.7	1.61
3.0	6.6	3.27
3.5	4.7	4.84
4.0	3.7	6.36
4.5	3.1	7.78
5.0	2.71	9.14

DATE

EXPT. TITLE: SERIES PARALLEL
RESONANCE

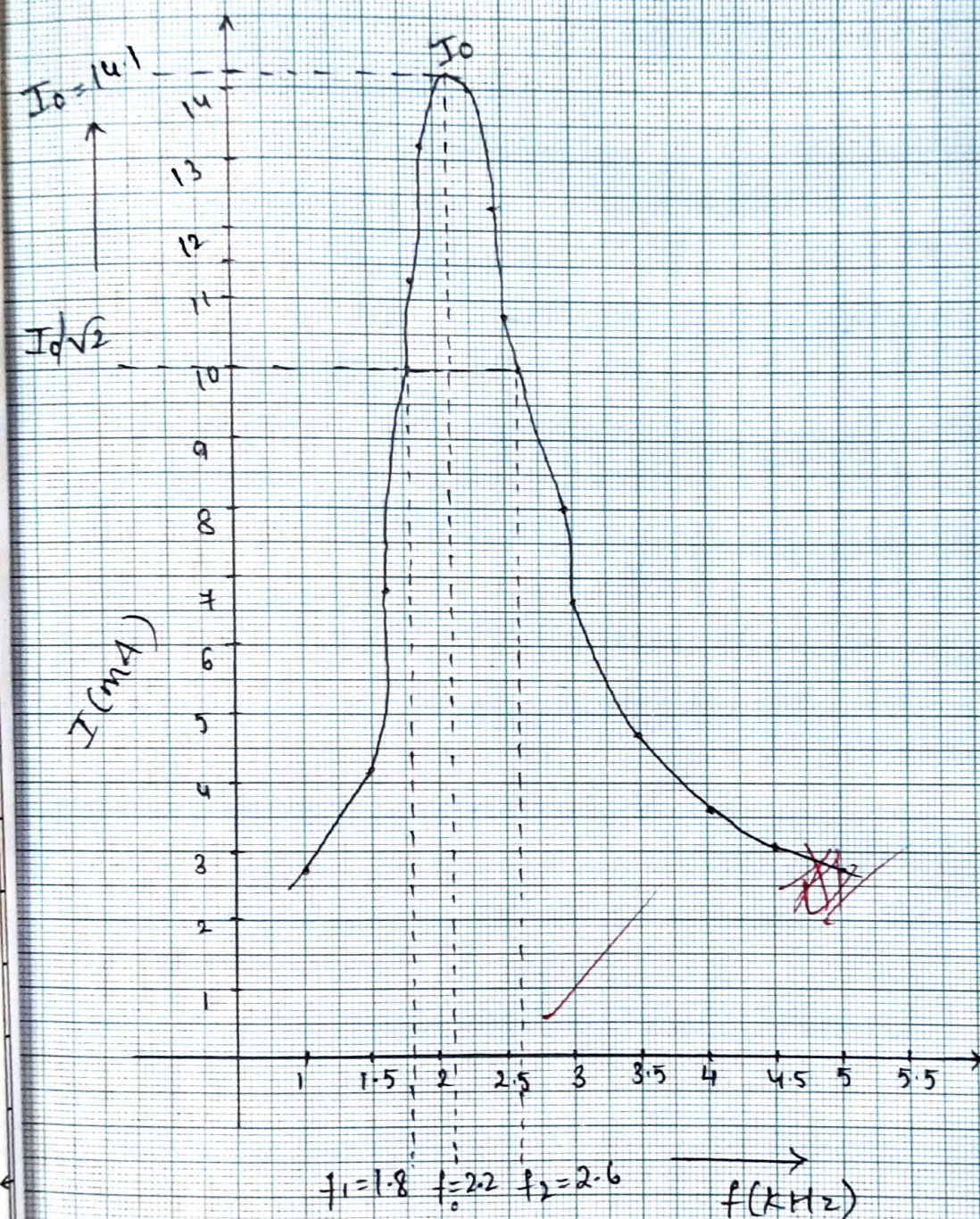
EXP. NO. 07

PAGE NO.

28

AIM: To study the frequency response of Series LCR and parallel LCR circuit and to determine the following

SERIES: Resonant frequency f_0 , Bandwidth BW, Quality factor Q and Inductance L.



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and patch

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shown is
in steps
5000 Hz.

are recorded
maximum
5000 Hz

of 100 Hz.
y is plotted
fig 2. The
Quality
f of
Inductor

Series Resonance circuit:

$$\text{Resonant frequency} = f_0 = 2.2 \text{ kHz}$$

$$\text{Bandwidth BW} = (f_2 - f_1) = 0.8 \text{ kHz}$$

$$\text{Capacitance} = C = 0.047 \mu\text{F}$$

$$\text{Inductance} = L = \frac{1}{4\pi^2 f_0^2 C} = 111.35 \text{ mH}$$

$$\text{Quality factor} = Q = \frac{f_0}{f_2 - f_1} = 2.75$$

Calculation:

$$L = \frac{1}{4\pi^2 f_0^2 C} = \frac{1}{4\pi^2 \times (2.2 \text{ k})^2 \times (0.047) \times 10^{-6}}$$

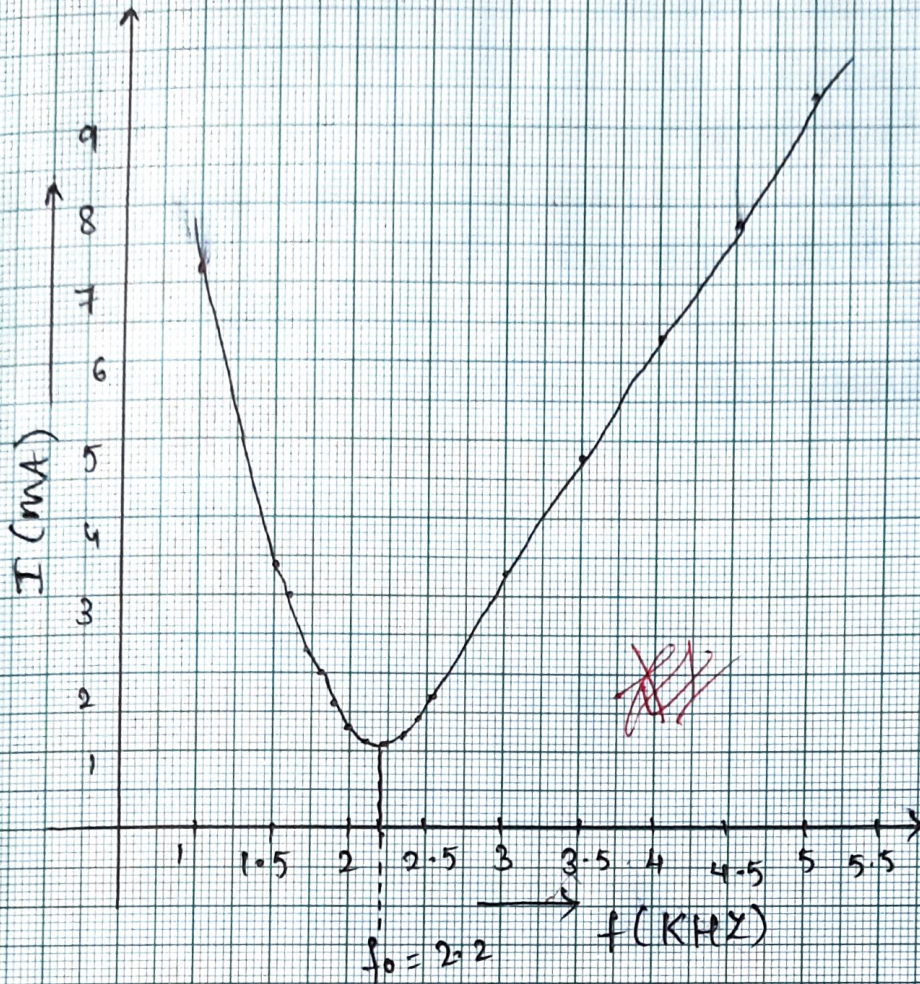
$$= \frac{1}{8980050.437} = 1.1135 \times 10^{-7} \times 10^6$$

$$L = 111.35 \times 10^{-3} \text{ H}$$

$$Q = \frac{f_0}{f_2 - f_1} = \frac{2.2 \text{ k}}{0.8 \text{ k}} = 2.75 \text{ Hz}$$

Parallel Resonance circuit:

$$\text{Resonant frequency } f_0 = 2.2 \text{ Hz}$$



parallel with
 ination is
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RESULT :

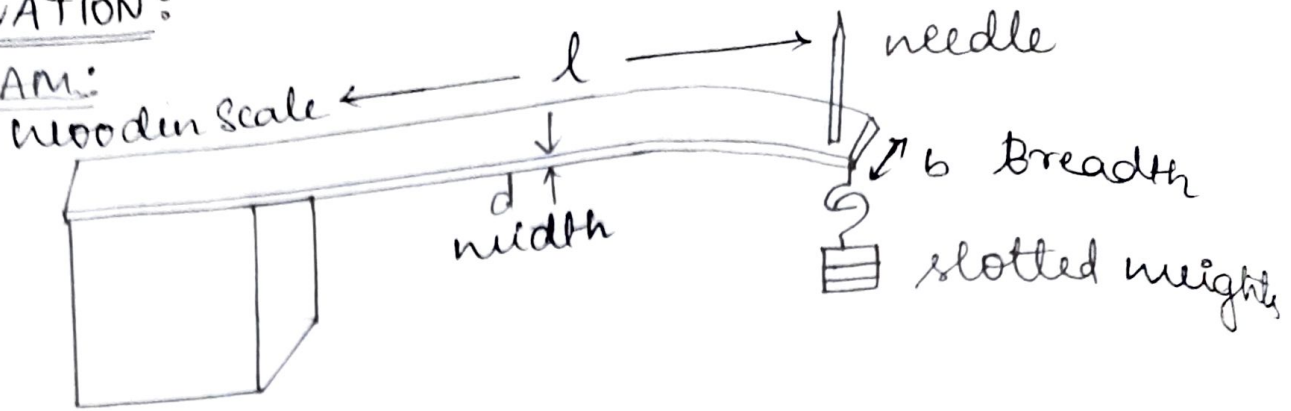
	series	parallel
Resonant frequency f_0	2.2K Hz	2.2K Hz
Band width BW	0.8 Hz	
Quality factor Q	2.75	
The Inductance L	111.35 mH.	

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R-10
 O-10
 VV-10

OBSERVATION:

DIAGRAM:



Travelling Microscope:

$$LC = \frac{\text{value of 1 MSD}}{\text{total no. of VSD}} = \frac{1}{100} = 0.01$$

$$TR = MSR + (CVD) \times LC$$

DATE

EXPT. TITLE: YOUNG'S MODULUS BY

PAGE NO. 38

EXP. NO. 08

SINGLE CANTILEVER.

AIM: to determine the young's modulus of the material of the given beam by the method of single cantilever.

APPARATUS: Single cantilever setup, slotted weights, travelling microscope, reading lens and lamp

FORMULA:
$$Y = \frac{4mg l^3}{bd^3 y} \text{ Nm}^{-2}$$

where, M = Mass producing the elevation (in kg).

g = acceleration due to gravity ($= 9.8 \text{ m/s}^2$).

l = distance between the needle and fixed end (in m).

b & d = breadth and thickness of the wooden scale (in m)

y = mean elevation produced (in m).

PROCEDURE: The tip of the needle (inverted image) on the single cantilever is made to coincide with the intersection of the cross wire of the travelling microscope (with no load in the hook). Note down the readings of the travelling microscope in the tabular column as the no load reading.

Now add some weight to the hook (say 50 gm)

TABULAR COLUMN TO FIND ELEVATION

load in hanger (g)	wood Increasing			wood Decreasing			Mean R_1 (cm)	wood in hanger (g)			wood Increasing			wood Decreasing			Mean R_2 (cm)	Elevation $y = R_1 - R_2$ (cm)
	MSR (cm)	CVD	Total (cm)	MSR (cm)	CVD	Total (cm)					MSR (cm)	CVD	Total (cm)	MSR (cm)	CVD	Total (cm)		
0	7.75	5	12.75	7.75	35	42.75	7.7	150			7.5	20	7.52	7.55	03	7.55	7.52	0.24
50	7.65	38	45.65	7.7	0	7.7	7.69	200			7.45	1	7.45	7.45	40	7.45	7.47	0.22
100	7.60	10	17.6	7.6	3-2	39.16	7.62	250			7.3	25	7.37	7.35	25	7.37	7.37	0.24

Mean elevation $y = 0.233 \times 10^{-3}$

CALCULATION: $\alpha = \frac{4mg l^3}{bd^3 y}$

$$\alpha = \frac{4 \times 150 \times 10^{-3} \times 9.8 \times (20 \times 10^{-2})^3}{-2.845 \times 10^{-2} \times (0.605 \times 10^{-2})^3 \times 0.233 \times 10^{-2}} = \frac{44040000 \times 10^{-9}}{0.1467 \times 10^{-10}}$$

$$\alpha = \frac{0.04704 \times 10^{10}}{0.1467} = 3.2 \times 10^{11} \text{ N/m}^2$$

$\alpha = 3.2 \times 10^{11} \text{ N/m}^2$

Now add some weight to the hook (say 50 gm). Again coincide the tip of the needle to the intersection of the cross wire and corresponding readings are noted in the tabular column. This is repeated up to 250 gm in steps of 50 gm every time and corresponding readings are noted in the tabular column.

The experiment is repeated by decreasing the load in the weight hanger in steps of 20g and the corresponding reading are taken and are tabulated. The elongation or deflection of the cantilever beam 'y', for load 'M' in kg is found out from the tabular column. By using the breadth (b) and thickness (d) of the bar, the young's modulus of the material of the beam is calculated.

RESULT: Young's modulus of the material of the beam is found to be

$$Y = 3.2 \times 10^{11} \text{ N/m}^2$$

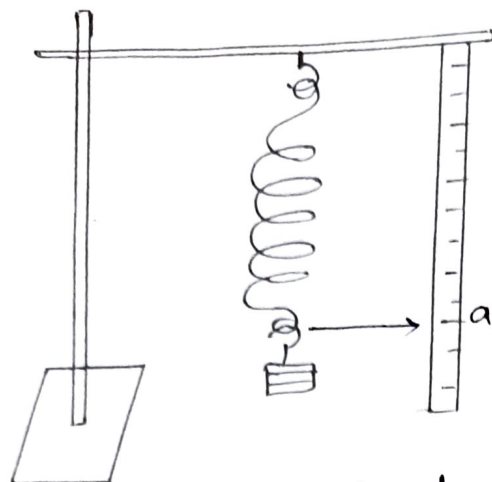
3/9

R-10

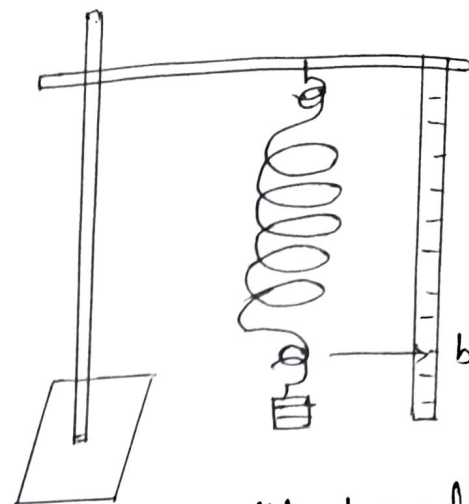
O-10

V.V-10

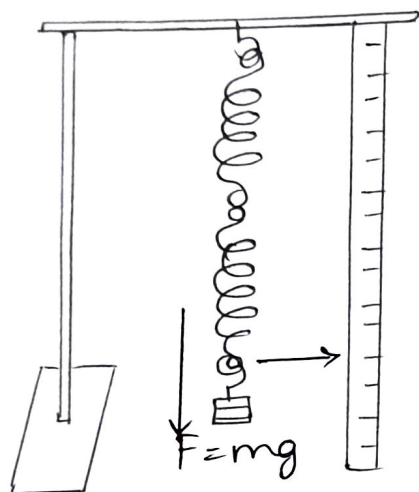
DIAGRAM:



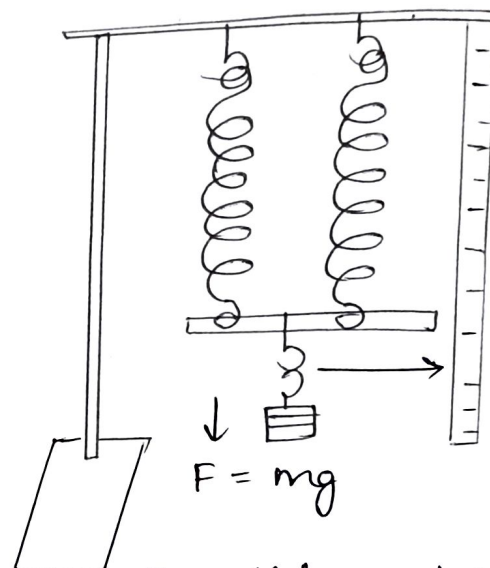
with Initial Load



with load



Series combination



Parallel combination

TABULAR COLUMN:

to find K_1

Pointer reading with initial load (w), $a =$ cm

Trail No.	load in gm	pointer reading 'b' in cm	Spring stretch ($x = b - a$) in cm	Force, F $F = mg$ in N	Spring constant $K_1 = F/x$ in N/m
01	$w + 50$	10.3	3.2×10^{-2}	490×10^{-3}	15.3125
02	$w + 100$	13.5	6.4×10^{-2}	980×10^{-3}	15.3125
03	$w + 150$	17.0	9.9×10^{-2}	1470×10^{-3}	14.848

AIM: To determine the spring constants in series and parallel combination.

APPARATUS: Spring, Scale, Rigid stand, Slotted weights, etc.

FORMULA: (1) Spring constants. $K = \frac{F}{x}$ in Nm^{-1}

where, F = Force applied ($=mg$) in N.

x = Displacement produced in the spring in m.

(2) Spring constant for series combination of springs

$$K_{\text{series}} = \frac{K_1 * K_2}{K_1 + K_2} \text{ in } \text{Nm}^{-1}$$

(3) Spring constant for parallel combination of springs

$$K_{\text{parallel}} = K_1 + K_2 \text{ in } \text{Nm}^{-1}$$

PROCEDURE: hang the spring to be given rigid stand with dead load and note down the position 'a' of the pointer on the scale with initial load. Add some more load into the weight hanger (say 50gm) and note down the position 'b' of the pointer on the scale with final load. Repeat the same for some more loads in steps of 50gm and tabulate the

to find K_2

15.05

Pointer reading with initial load (w), $a =$ cm

Trial NO	load in gm	Pointer reading 'b' in cm	Spring stretch ($x = b - a$) in cm	Force, F $F = mg$ in N	Spring constant $K_2 = F/x$ in N/m
1	$w + 50$	7.8	2.1×10^{-2}	490×10^{-3}	23.333
2	$w + 100$	10.9	5.2×10^{-2}	980×10^{-3}	18.846
3	$w + 150$	14.4	8.7×10^{-2}	1470×10^{-3}	168.90

Average $K_2 = 18.89$ N/m

To verify series combination of spring

Pointer reading with initial load (w), $a =$ cm

Trial NO.	load in gm	Pointer reading 'b' in cm	Spring stretch ($x = b - a$) in cm	Force F , $F = mg$ in N	Spring constant $K_{series} = F/x$ in N/m
1	$w + 50$	24.1	5.8×10^{-2}	490×10^{-3}	8.448
2	$w + 100$	30.5	12.2×10^{-2}	980×10^{-3}	8.033
3	$w + 150$	37.5	19.2×10^{-2}	1470×10^{-3}	7.656

Average series = 8.04 N/m

Theoretical calculation, $K_{series} = \frac{K_1 K_2}{K_1 + K_2}$ in N/m

To verify series combination law of springs:

Hang the springs in series combination as shown in the diagram. With the initial load, note down the position 'a' of the pointer on the scale. Add some more load into the weight hanger (say 50 gm) and note down the position 'b' of the pointer on the scale with final load. Repeat the same for some more loads in steps of 50 gm and tabulate the reading in the tabular column. Find out the average spring constant ' k_{series} '.

To verify parallel combination law of springs:

Hang the springs in parallel combination as shown in the diagram. With the initial load, note down the position 'a' of the pointer on the scale. Add some more load into the weight hanger (say 50 gm) and note down the position 'b' of the pointer on the scale with final load. Repeat the same for some more load in steps of 50 gm and tabulate the reading in the tabular column. Find out the average spring constant ' $k_{parallel}$ '.

to verify parallel combination of springs

Pointer reading with initial load (w), $a =$ cm

Trial No.	load 'm' in gm	Pointer reading 'b' in cm	Spring stretch ($x = b - a$) in cm	Force, F ($F = mg$) in N	Spring Const, $K_{parallel} = K_1 + K_2$ in N/m
1	$w + 50$	7.6	1.2×10^{-2}	490×10^{-3}	40.833
2	$w + 100$	9.7	3.3×10^{-2}	980×10^{-3}	29.696
3	$w + 150$	11.1	4.7×10^{-2}	1470×10^{-3}	31.276

$$\text{Average } K_{parallel} = 33.932 \text{ N/m}$$

Theoretical Calculation, $K_{parallel} = K_1 + K_2$ in Nm^{-1}

calculate the theoretical value of K_{series} and $K_{parallel}$ and compare the value with Experimental values.

RESULT: The spring constants for the spring are found to be, $K_1 = \text{N/m}$, $K_2 = \text{N/m}$

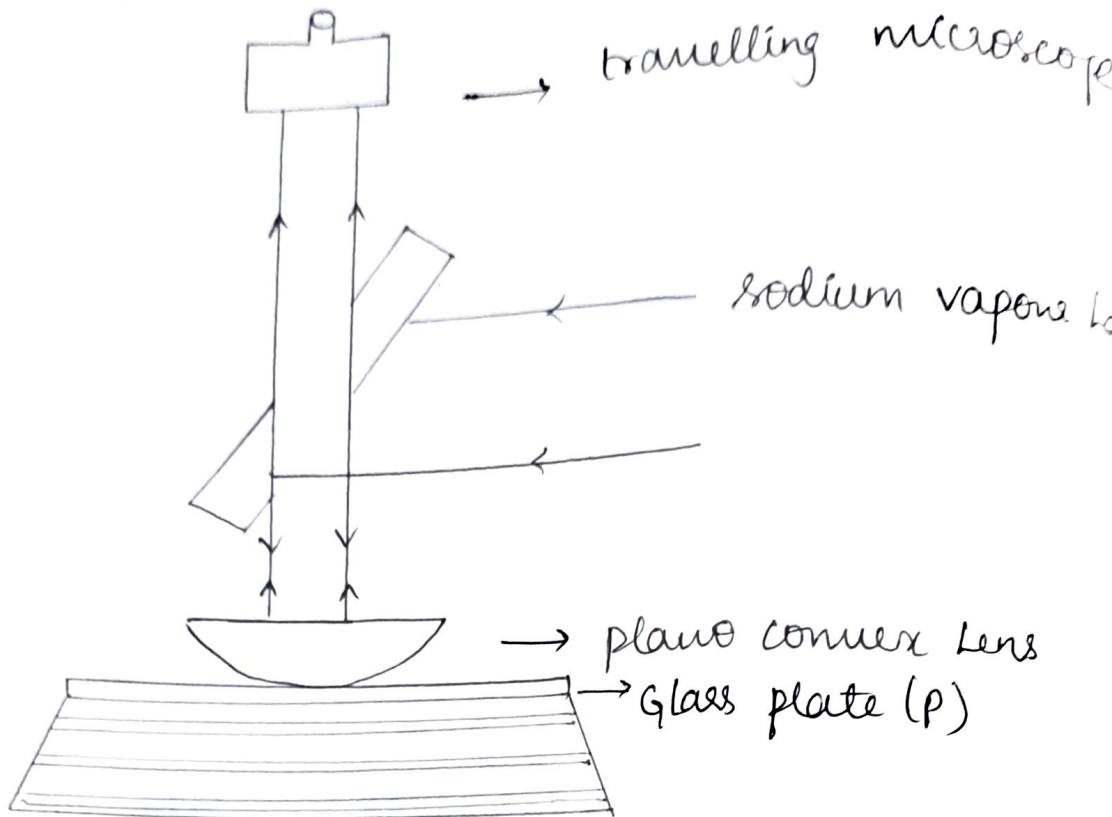
The spring constants for the combination of spring are found to be

combination	Theoretical	Experimental
series	$K_{series} = 8.378 \text{ N/m}$	$K_{series} = 8.045 \text{ N/m}$
parallel	$K_{parallel} = 33.948 \text{ N/m}$	$K_{parallel} = 33.932 \text{ N/m}$

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R-10
D-10
V.V-10

OBSERVATION:

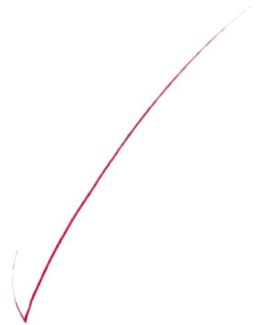


Least count of travelling microscope, LC

$$LC = \frac{\text{Value of one PSD}}{\text{total number of HSD}} = \frac{1\text{mm}}{100} = 0.001\text{cm}$$

HSD = head scale division

PSD = pitch scale division.



AIM: to determine the radius of curvature of the surface of the lens, by forming Newton's rings.

APPARATUS: Newton's ring set, sodium vapour lamp & plane mirror.

PROCEDURE: The apparatus consists of a light source (sodium vapour lamp). The parallel rays are incident on a plane glass plate through the magnifying glass inclined at 45° to the path of incident rays. Alternate bright & dark rings are observed through a travelling microscope.

The point of intersection of cross wire in the microscope is brought to the center of ring system; the cross wires is perpendicular to the line of travel of the microscope. The wire may be set tangential to any one ring and starting from the center of the ring system, the microscope is moved on to one ring and starting from the center of the ring system, the microscope is moved on to one side, say left, across the field of view counting the number of rings. After passing beyond 12th ring, the direction of motion of the microscope is

TABLE 1 :

Ring NO.	LEFT			RIGHT		
	PSR (cm)	HSR	TR = PSR + (HSR X LC) (cm)	PSR (cm)	HSR	TR = PSR + (HSR X LC) (cm)
12	3.7	60	3.76	3.1	73	3.173
10	3.7	38	3.73	3.2	6	3.20
08	3.7	20	3.72	3.2	24	3.22
06	3.6	92	3.692	3.2	46	3.24
04	3.6	55	3.656	3.2	72	3.27
02	3.6	25	3.62	3.3	0	3.3

TABLE : 2

Ring NO. m	Left (TR)	Right (TR)	D_m (cm)	D_m^2 (cm ²)	Ring NO n	Left (TR)	Right (TR)	D_n (cm)	D_n^2 (cm ²)	$D_m^2 - D_n^2$ (cm ²)
12	3.76	3.173	0.587	0.34	06	3.692	0.452	0.204	3.692	0.136
10	3.76	3.20	0.53	0.2809	04	3.27	0.386	0.148	3.656	0.1329
08	3.72	3.22	0.5	0.25	02	3.3	0.32	0.1024	3.62	0.1476

$$\text{mean} = D_m^2 - D_n^2 = \underline{0.1388 \text{ cm}^2}$$

R = Radius of curvature of the surface of the lens in contact with the glass plate (P)

$$R = \frac{(D_m^2 - D_n^2)}{4(m-n)\lambda} = \underline{9.81 \text{ m}}$$

reversed and the cross wire is set at the 12th dark ring, tangential to it. The pitch scale and the head scale reading on the microscope scale are noted. Similarly, the readings with the cross-wires set on 10th, 8th, 6th, 4th, and 2nd dark rings are noted. The microscope is moved in the same direction and the reading corresponding to the 2nd, 4th, 6th, 8th, 10th and 12th dark ring on the right sides are noted.

Reading are to be taken with the microscope moving in one & the same direction to avoid errors due to backlash.

The observations are recorded in table 1 and the total reading is entered into table 2. The difference between the left and right total reading gives the diameter of the rings. The diameter of 12th, 10th and 8th rings are denoted by D_m . The diameters of 6th, 4th and 2nd dark rings are denoted by D_n . where the differences between m and n is 6. The wavelength (λ) of the source used is 5890Å. Substituting these value in the formula below we can determine the radius of curvature, R of the lens.

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

where D_m and D_n are the diameter of the m^{th} and n^{th} dark rings.

λ is the wavelength of the source ($5890\text{\AA}$).

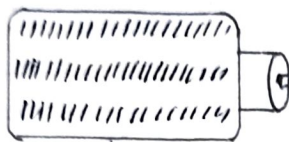
The value of D_m and D_n are very small and occurs to the second power in equation. Hence they are to be measured carefully with the travelling microscope. Care is to be taken in moving the microscope to travel in a direction without moving back and forth while taking readings. This is very essential since the variation in the diameter of the rings is in the second decimal place and any back and forth movement of the microscope will result in wrong readings.

RESULT: The experiment on Newton's ring was conducted and the radius of curvature of the lens is found to be 9.81 m

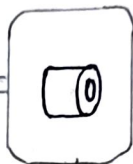
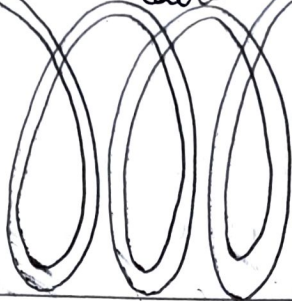
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$R-10$
 $0-10$
 $V.V-10$

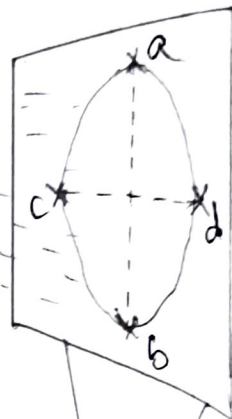
Laser source



Optical fiber cable



Screen



TABULAR COLUMN:

Trail No.	L (in cm)	Horizontal Diameter D_1 (in cm)	Vertical Diameter D_2 (in cm)	Mean Diameter D (in cm)	Acceptance angle $\theta_0 = \tan^{-1}\left(\frac{D}{2L}\right)$	Numerical aperture NA $NA = \sin \theta_0$
1	3	2	2	2	18.434	0.3162
2	6	3.5	3	3.25	15.154	0.2614
3	9	5	4	4.5	14.036	0.2425
4	12	8	5	6.5	15.154	0.2614

$$(\theta)_{\text{mean}} = 15.6945$$

$$(NA)_{\text{mean}} = 0.2703$$

AIM: to determine the acceptance angle and numerical aperture of the given optical fiber.

APPARATUS: Laser source, optical fiber, screen, Scale.

PRINCIPLE: The sine of the acceptance angle of an optical fiber is known as the numerical aperture of the fiber. The acceptance angle can also be measured as the angle spread by the light signal at the emerging end of the optical fiber. Therefore, by measuring the diameter of the light spot on a screen and by knowing the distance from the fiber end to the screen, we can measure the acceptance angle and thereby the numerical aperture of the fiber.

Formula: The Acceptance angle, $\theta_0 = \tan^{-1} \left(\frac{D}{2L} \right)$

where D - the diameter of the bright circle formed on screen,

L - the distance between the optical fiber end and screen

Numerical Aperture,

$$NA = \sin \theta_0$$

PROCEDURE: switch on the laser source and adjust the distance between output end of the optical fiber and screen 'L' (say 5cm). place a graph sheet on the screen and observe the circle formed on the graph sheet. Mark the points 'a', 'b', 'c', & 'd' on the inner bright circle as shown in the diagram. Note down the horizontal D_1 diameter and vertical diameter D_2 of the inner bright circle in the tabular column. Repeat the above steps for different value of L (for 3cm, 4cm, ---). find the Acceptance angle from the tabular column and hence the Numerical aperture.

RESULT: The angle of acceptance and Numerical aperture of the given optical fiber are found to be

$$\theta_0 = \underline{15.6945}$$

$$NA = \underline{0.2703}$$

~~15.6945~~

R-10
O-10
V.V-10

