Physics Lab Internal Exam – Experiments 1 to 7

1. Laser – Wavelength using Diffraction Grating

Aim:
To determine the wavelength of laser light using a diffraction grating.

Apparatus:
Laser source, diffraction grating, screen, optical bench, scale.

Formulae:

- $\lambda = \sin(\theta) / (n \times N)$
- $\theta = \tan^{-1}(xn / D)$

Diagram: Laser → Grating → Diffraction pattern on screen.

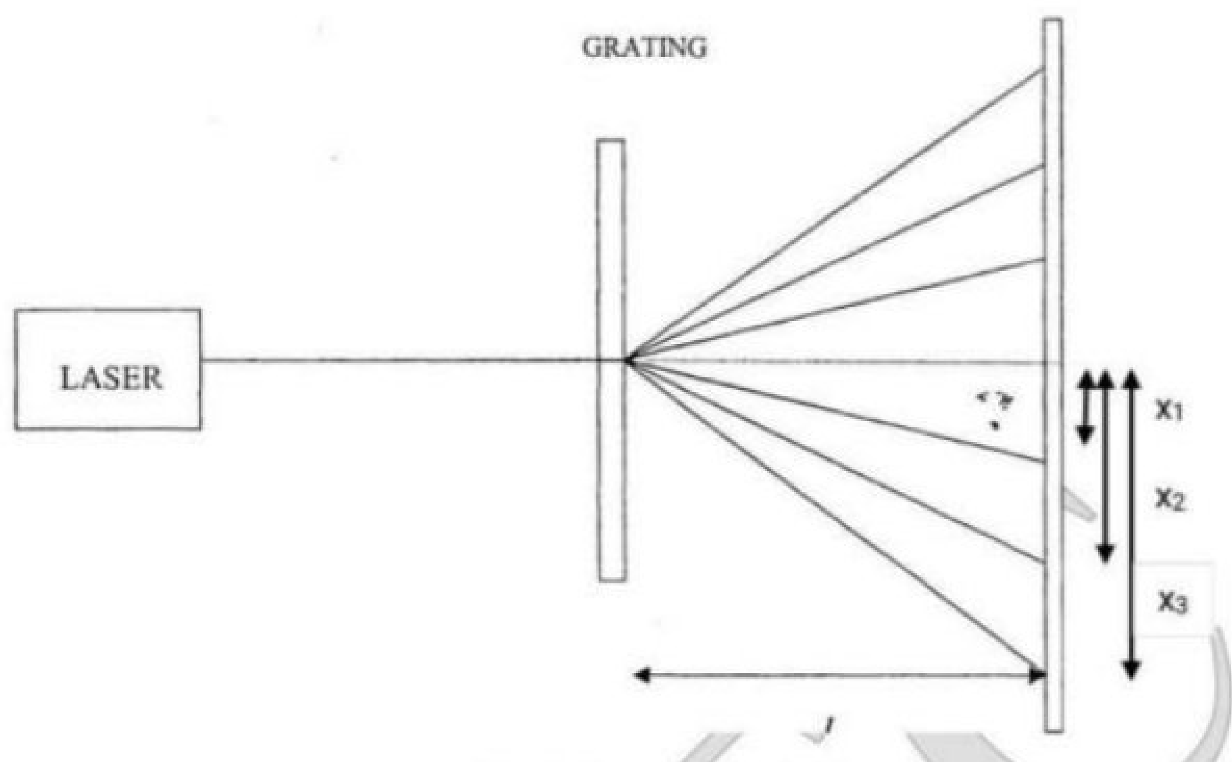

Fig. 1. Experimental Setup

Tabular Column:

Wavelength Calculation Table (Diffraction/Interference)

S.No	D (cm)	X_1 (LHS)	X_2 (RHS)	Mean X_n	$\sqrt{(X_n^2 + D^2)}$	$\sin\theta = X_n / \sqrt{(X_n^2 + D^2)}$	$\lambda = \sin\theta / nN$

Procedure:

1. Mount the laser on the optical bench.
2. Place the diffraction grating in front of the laser.
3. Position the screen at a known distance (D).

4. Switch on the laser and observe the diffraction spots.
5. Align central maximum with scale zero.
6. Measure distances (xn) of first, second, third order maxima.
7. Calculate angle $\theta = \tan^{-1}(xn/D)$.
8. Use $\lambda = \sin(\theta)/(nN)$ to compute wavelength.
9. Repeat for LHS and RHS and take average.
10. Tabulate and conclude with final λ.

Precautions:

- Do not view laser directly with eyes.
- Perform in a dark room for clear visibility.

RESULT:

Wavelength of laser light is …………

Applications:

1. Used in CD/DVD reading and writing.
2. Used in barcode scanners.
3. Used in fiber optic communications.
4. Used in scientific measurements like interferometry.

OBSERVATION

S NO	n order of spectrum	D (cm)	X_1 LHS	X_2 RHS	Mean X_n	$\sqrt{X_n^2 + D^2}$	$\sin\theta = \frac{x_n}{\sqrt{x_n^2 + D^2}}$	$\lambda = \frac{\sin\theta}{n.N}$
1	1	40	3	3	3	40.112	0.075	7.6220×10^{-5}
2	2	40	5.8	6.1	5.950	40.440	0.147	7.4695×10^{-5}
3	3	40	8.7	9.3	9	41	0.022	7.4526×10^{-5}
4	1	50	3.5	3.5	3.5	50.122	0.070	7.1138×10^{-5}
5	2	50	7.3	7.2	7.250	50.072	0.145	7.3679×10^{-5}
6	3	50	10.7	11	10.850	51.164	0.212	7.1816×10^{-5}

$\lambda = \frac{\sin\theta}{m.N} = \frac{0.075}{1 \times 984} = 7.6220 \times 10^{-5}$

$= \frac{0.147}{2 \times 984} = 7.4695 \times 10^{-5}$

$= \frac{0.022}{3 \times 984} = 7.4526 \times 10^{-5}$

$\lambda = \frac{\sin\theta}{m.N} = \frac{0.070}{1 \times 984} = 7.1138 \times 10^{-5}$

$= \frac{0.145}{2 \times 984} = 7.3679 \times 10^{-5}$

$= \frac{0.212}{3 \times 984} = 7.1816 \times 10^{-5}$

Wavelength of laser light $= \frac{7.6220 + 7.4695 + 7.4526 + 7.1138 + 7.3679 + 7.1816}{6}$

$= \frac{44.2074}{6} = 7.3679$

The experiment is repeated for atleast three P values (15 cm, 20 cm, 25 cm)

The value of x_n is calculated for each case using the formula $\theta = \tan^{-1}(x_n)$

Knowing the values of θ, N, & n, the wavelength of laser light can be calculated using the formula $\lambda = \frac{\sin\theta}{nN}$

$N = \frac{2500}{2.54} = 984$

Result :

Wavelength of laser light is 7.367 A

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2. Optical Fiber – Numerical Aperture and Acceptance Angle

Aim:
To determine the numerical aperture (NA) and acceptance angle of a fiber optic cable.

Apparatus:
Laser source, fiber optic cable, screen, scale.

Formulae:

- $NA = w / \sqrt{4L^2 + w^2}$
- $\theta max = \sin^{-1}(NA)$

Diagram:
Laser coupled into optical fiber with spot on screen.

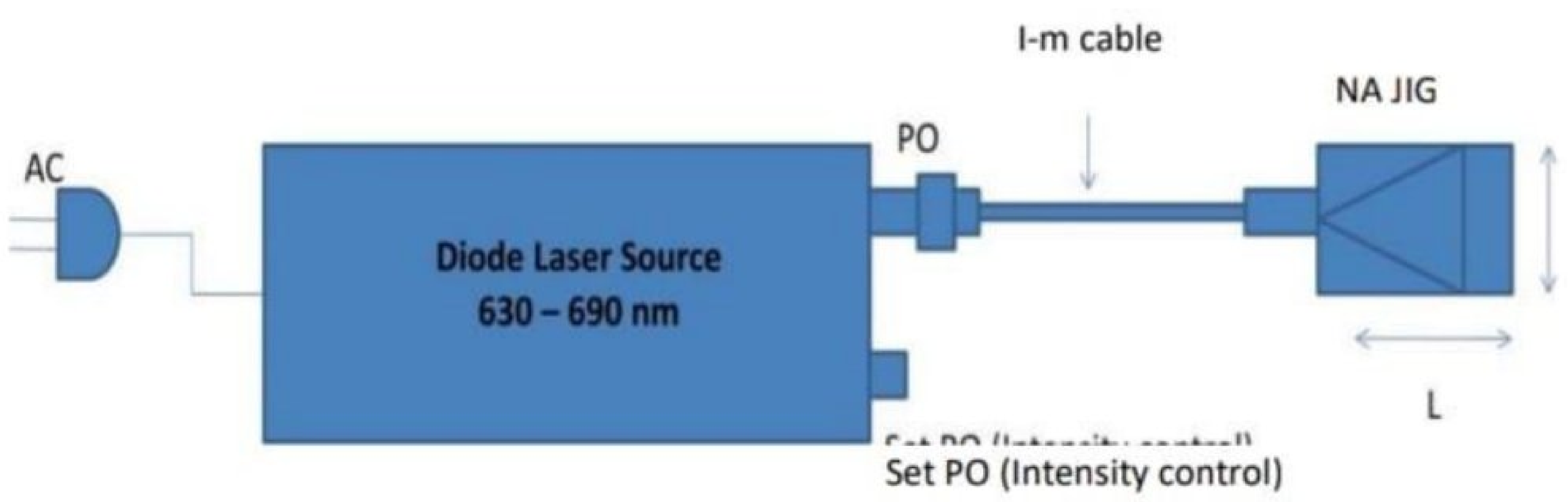

Figure: Set up for NA measurement

Tabular Column:

Optical Fibre (NA Calculation Table)

S.No	Distance from fibre end (L)	Diameter of spot (w)	$NA = w / \sqrt{4L^2 + w^2}$	$\theta_{max} = \sin^{-1}(NA)$

Procedure:

1. Connect fiber to laser source.
2. Place screen at distance L from fiber end.
3. Turn on laser and adjust for maximum spot intensity.

4. Measure diameter w of laser spot on screen.
5. Repeat for different L values (e.g., 10 cm, 15 cm).
6. Use formula to calculate NA for each case.
7. Calculate acceptance angle using $\theta = \sin^{-1}(NA)$.
8. Repeat and record average values.
9. Ensure fiber is straight and aligned.
10. Tabulate observations and draw conclusions.

Precautions:

- Avoid sharp bends in the fiber.
- Align fiber and screen carefully for accurate spot size.

Expected Graph:
Not needed – direct calculations.

Result:

Numerical aperture of the given fibre optic cable (NA) = …;

Acceptance angle of the fibre = …

Applications:

1. Used in internet and telephone communication.
2. Used in endoscopy in medical field.
3. Used in sensors for pressure, temperature.
4. Used in defense and aerospace data links.

Observation Table :

S.No	Distance of the spot from fibre end (L)	Diameter of spot in circles: covered	W	$NA = \frac{W}{\sqrt{4L^2+W^2}}$	$\theta_{max} = \sin^{-1}(NA)$
	mm				
1	5 → 0.5	3	15	0.8321	56.3151
2	10 → 1.0	4	20	0.7071	44.9995
3	15 → 1.5	5	25	0.6402	39.8067
4	20 → 2.0	6	30	0.6000	36.8699
5	25 → 2.5	7	35	0.5735	34.9947
6	30 → 3.0	8	40	0.5547	33.6901
				$NA = \frac{3.9076}{6} = 0.6513$	$\theta = \frac{246.6760}{6} = 41.1127$

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{15}{\sqrt{4(5)^2+(15)^2}} = \frac{15}{\sqrt{100+225}} = \frac{15}{\sqrt{325}} = 0.8321$$

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{20}{\sqrt{4(10)^2+(20)^2}} = \frac{15}{\sqrt{400+400}} = \frac{15}{\sqrt{800}} = 0.7071$$

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{25}{\sqrt{4(15)^2+(25)^2}} = \frac{25}{\sqrt{900+625}} = \frac{25}{\sqrt{1525}} = 0.6402$$

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{30}{\sqrt{4(20)^2+(30)^2}} = \frac{30}{\sqrt{1600+900}} = \frac{30}{\sqrt{2500}} = 0.6000$$

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{35}{\sqrt{4(25)^2+(35)^2}} = \frac{35}{\sqrt{2500+1225}} = \frac{35}{\sqrt{3725}} = 0.5735$$

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{40}{\sqrt{4(30)^2+(40)^2}} = \frac{40}{\sqrt{3600+1600}} = \frac{40}{\sqrt{5200}} = 0.5547$$

$$\theta_{max} = \sin^{-1}(NA) = \sin^{-1}(0.8321) = 56.3151$$

$$= \sin^{-1}(0.7071) = 44.9995$$

$$= \sin^{-1}(0.6402) = 39.8067$$

$$= \sin^{-1}(0.6) = 36.8699$$

$$= \sin^{-1}(0.5735) = 34.9947$$

$$= \sin^{-1}(0.5547) = 33.6901$$

$$NA = \mu_0 \sin \theta_{max} = \frac{W}{\sqrt{4L^2+W^2}}$$

where is the refractive index of the medium for air $\mu_0 = 1$, hence $NA = \sin\theta_{max}$ and θ max is the acceptance (maximum-ray) angle of the fibre.

Result

1. Numerical aperture of the given fibre optic cable = 0.6513
2. Acceptance angle of the fibre = 41.1127

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3. P-N Junction Diode – V-I Characteristics

Aim: To study the V-I characteristics of a diode and determine forward and reverse resistance.

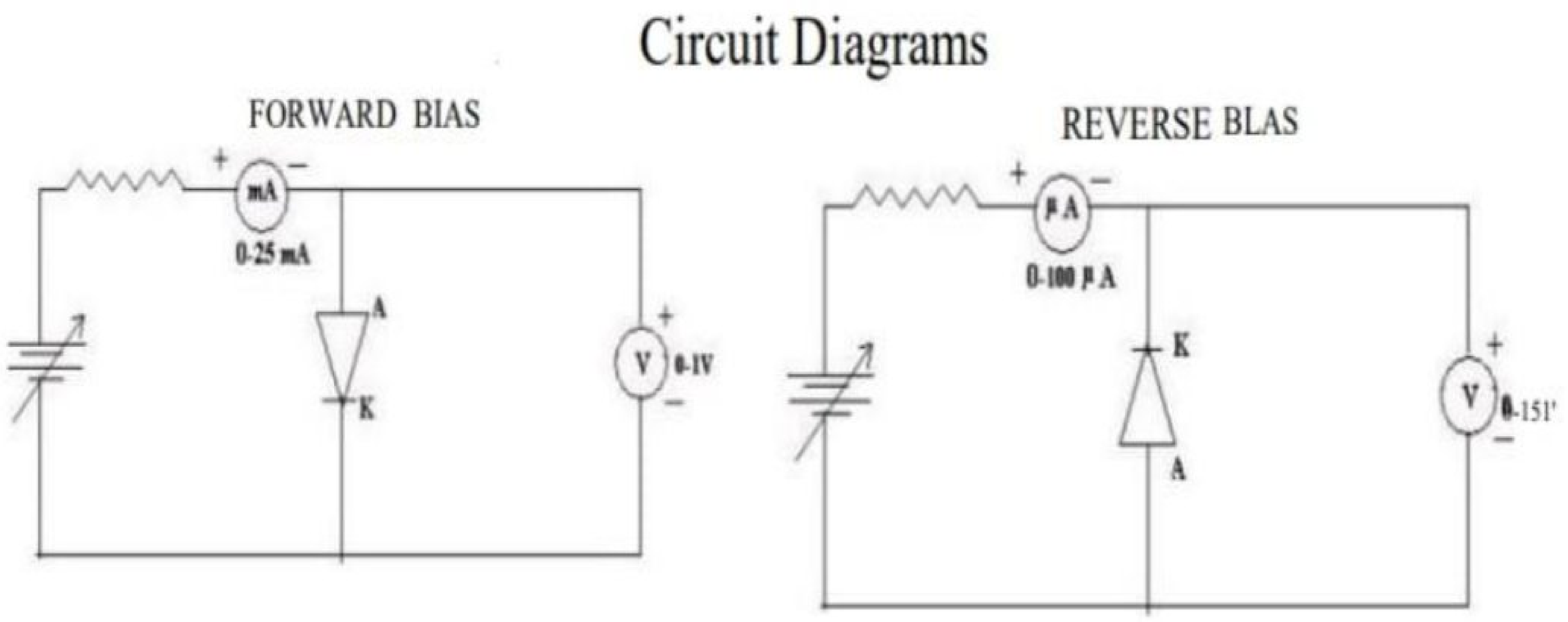
Apparatus: Diode kit, DC power supply, Voltmeter, Ammeter, Connecting wires.

Formulae:

• Forward resistance = V/I in forward bias

• Reverse resistance = V/I in reverse bias

Diagram: Circuit for forward and reverse bias of diode.



Tabular Column: Voltage (V) | Current (mA / µA)

Diode V-I Characteristics Table

S.No	Forward Bias Voltage (V)	Forward Bias Current (mA)	S.No	Reverse Bias Voltage (V)	Reverse Bias Current (µA / pA)

Procedure:

1. Set up the circuit for forward bias using the diode kit.

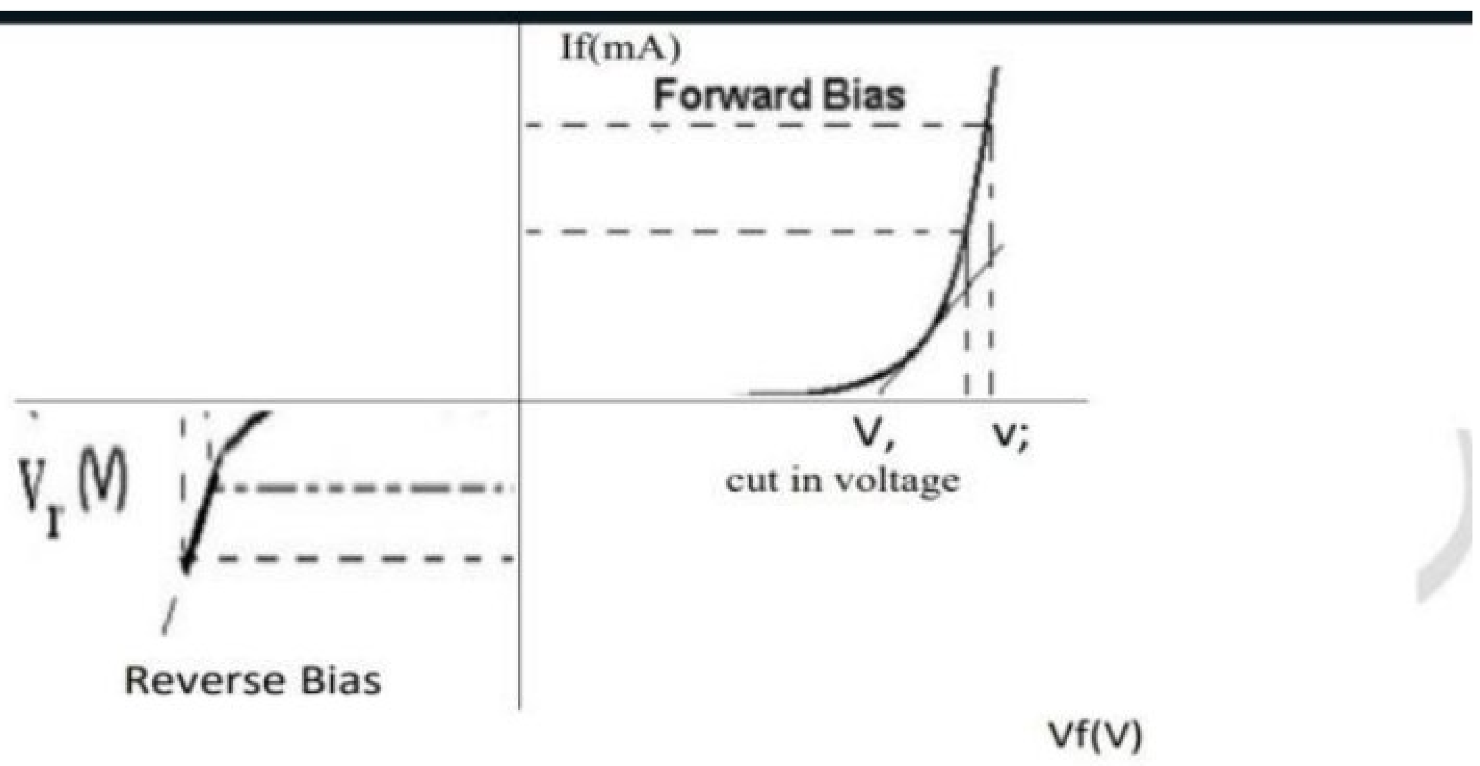
2. Gradually increase voltage and note current values.
3. Continue until diode starts conducting.
4. Record readings up to safe limits.
5. Disconnect and rewire for reverse bias configuration.
6. Increase voltage and note small reverse current.
7. Avoid exceeding breakdown voltage.
8. Plot V-I curves for both forward and reverse bias.
9. Determine Forward and Reverse Resistance from slope.
10. Conclude based on conduction behavior.

Precautions:

• Do not exceed voltage ratings of the diode.

• Check connections before powering the circuit.

Expected Graph: V-I curve showing forward conduction and reverse blocking.



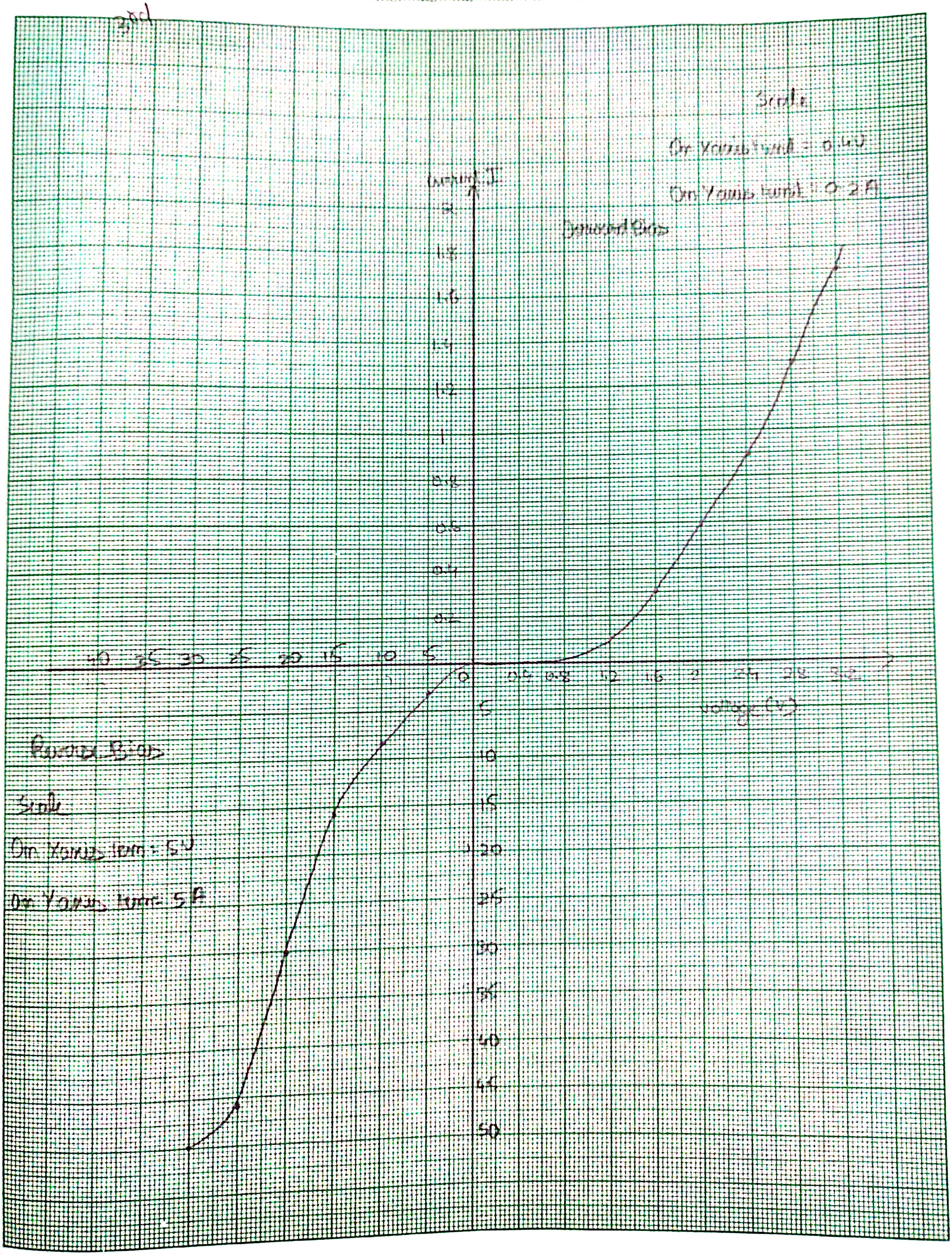
Result:

1) The V-I Characteristics of given junction diode have been verified.

2) Forward Resistance-------- ; Reverse bias Resistance... ...

Application:

1. Used in rectifiers to convert AC to DC.
2. Used in signal demodulation circuits.
3. Used in over-voltage protection circuits.
4. Used in LED and photodiode applications.


2nd
Scale
On X axis 1 unit = 0.4V
On Y axis 1 unit = 0.2A
current I
Forward Bias
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
40 35 30 25 20 15 10 5 0 0.4 0.8 1.2 1.6 2 2.4 2.8 3.2
Voltage (V)
Reverse Bias
Scale
On X axis 1cm = 5V
On Y axis 1cm = 5A
5
10
15
20
25
30
35
40
45
50

...on & Calculations

Forward Bias | Reverse Bias

S.NO	Observations voltage (V)	Forward Bias Current mA	S.NO	Observation Voltage (V)	Reverse Bias Current (μA)
1	0.4	0.1	1	5	0.3
2	0.8	0	2	10	0.8
3	1.2	0.1	3.	15	1.6
4	1.6	0.3	4	20	3.0
5	2.0	0.6	5	25	4.6
6	2.4	0.9	6	30	5.0
7	2.8	1.3			
8	3.2	1.7			

Forward Bias

Slope of Forward Bias

$(x_1, y_1) = (1.6, 0.3)$

$(x_2, y_2) = (2.0, 0.6)$

$$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0.6 - 0.3}{2 - 1.6} = \frac{0.3}{0.4} = \frac{3}{4} = 0.75$$

Reverse Bias

Slope for Reverse Bias

$(x_1, y_1) = (5, 16)$

$(x_2, y_2) = (20, 30)$

$$\text{slope } m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{30 - 16}{20 - 15} = \frac{14}{5} = 2.8$$

Procedure :

1. Connect the circuit for the respective forward or reverse bias conditions as shown in the figure
2. By varying the voltages note down the values of current and voltage
3. Plot a graph by the obtained values
4. Plotted graph should resemble the V>I . Characteristics graph given

Result

1) The V-I characteristics of given junction diode have been verified
2) Forward Resistance = 0.75×10^{-3} ; Reverse Bias Resistance : 2.8×10^{-6}

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4. Solar Cell – V-I Characteristics

Aim: To draw the V-I characteristics of a solar cell and calculate the fill factor (FF) and series resistance (Rs).

Apparatus: Solar Cell, Voltmeter, Microammeter, Potentiometer, Connecting wires.

Formulae:

Fill Factor $\frac{Im\,V_m}{IscV_0c}$

• Series Resistance Rs = ½ [ΔV1/ΔI1 + ΔV2/ΔI2]

Diagram: Equivalent circuit and V-I graph of solar cell.

Circuit Diagram:

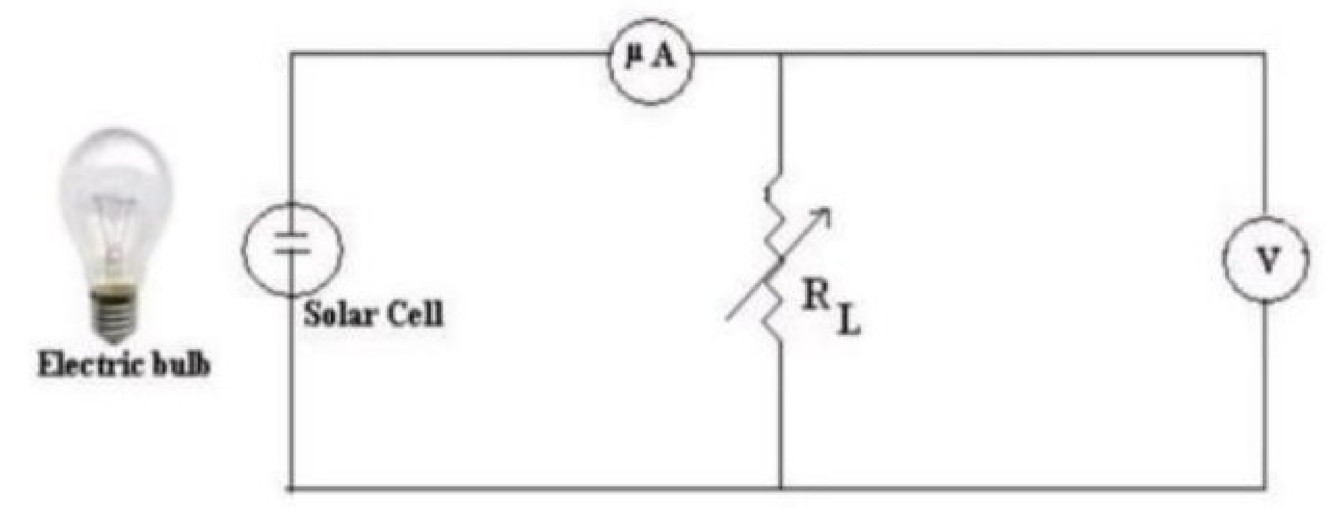


Figure – 1(a): equivalent circuit of solar cell.

Tabular Column: Voltage (V) | Current (µA)

V-I Characteristics Table (Multiple Sets)

S.No	Voltage (V)	Current (A)	S.No	Voltage (V)	Current (A)	S.No	Voltage (V)	Current (A)

Procedure:

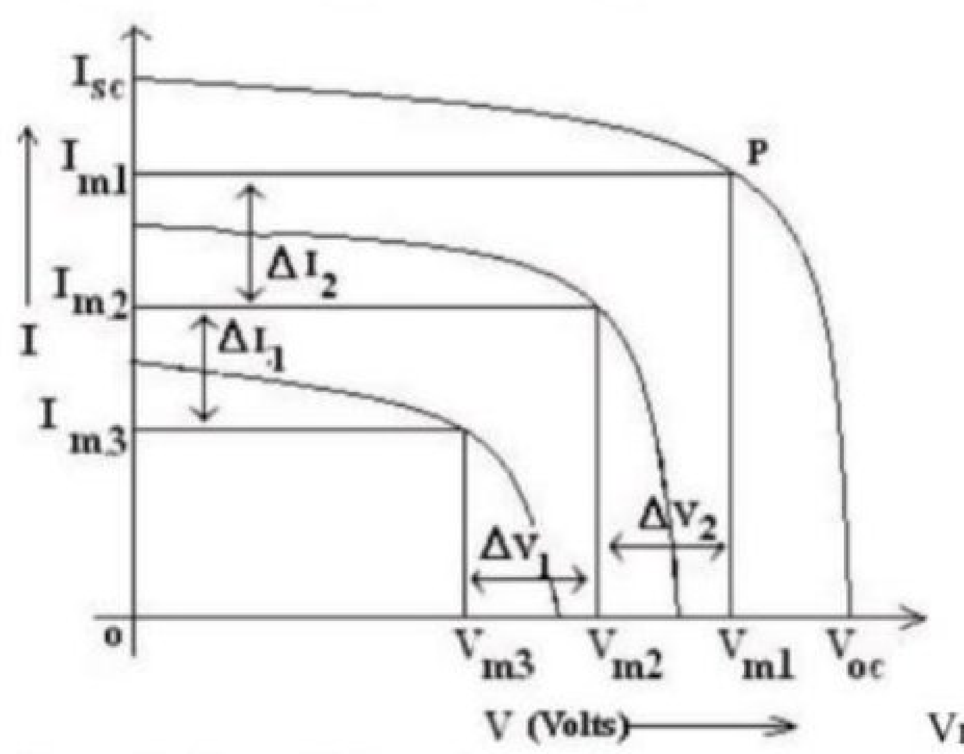
1. Connect the circuit as shown in the diagram.
2. Place the light source at a fixed distance (e.g., 15 cm) from the solar cell.
3. Adjust the potentiometer to get zero voltage and maximum current – this is Isc.
4. Gradually increase the resistance using the potentiometer.
5. For each resistance, record the voltage (V) and current (I).
6. Continue till you reach maximum voltage (Voc) and minimum current.
7. Disconnect the load to measure open circuit voltage Voc.
8. Repeat the experiment by changing the distance of the light source (20 cm, 25 cm).
9. Plot the V-I curve and find Vm and Im for each curve.
10. Use the graph to calculate Fill Factor and Series Resistance.

Precautions:

• Light source must be perpendicular to the cell.

• Avoid parallax error while taking readings.

Expected Graph: V-I characteristics showing Voc and Isc.



Vm's and 1m's (i.e. {AVI, AV2, A A bas shown in figure 2) from the graph.

Observations & Calculations:

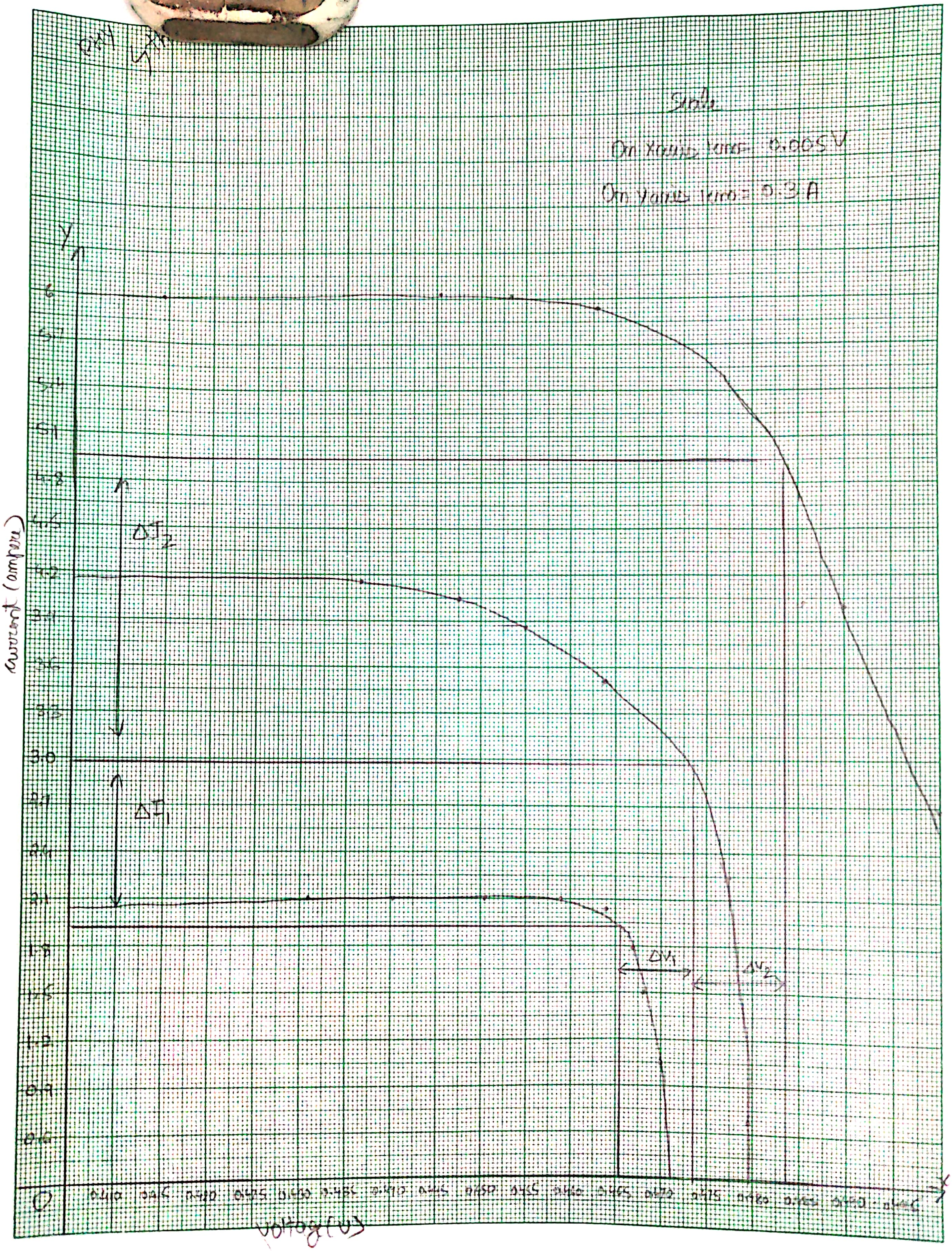
RESULT:

I. Fill factor (F) =

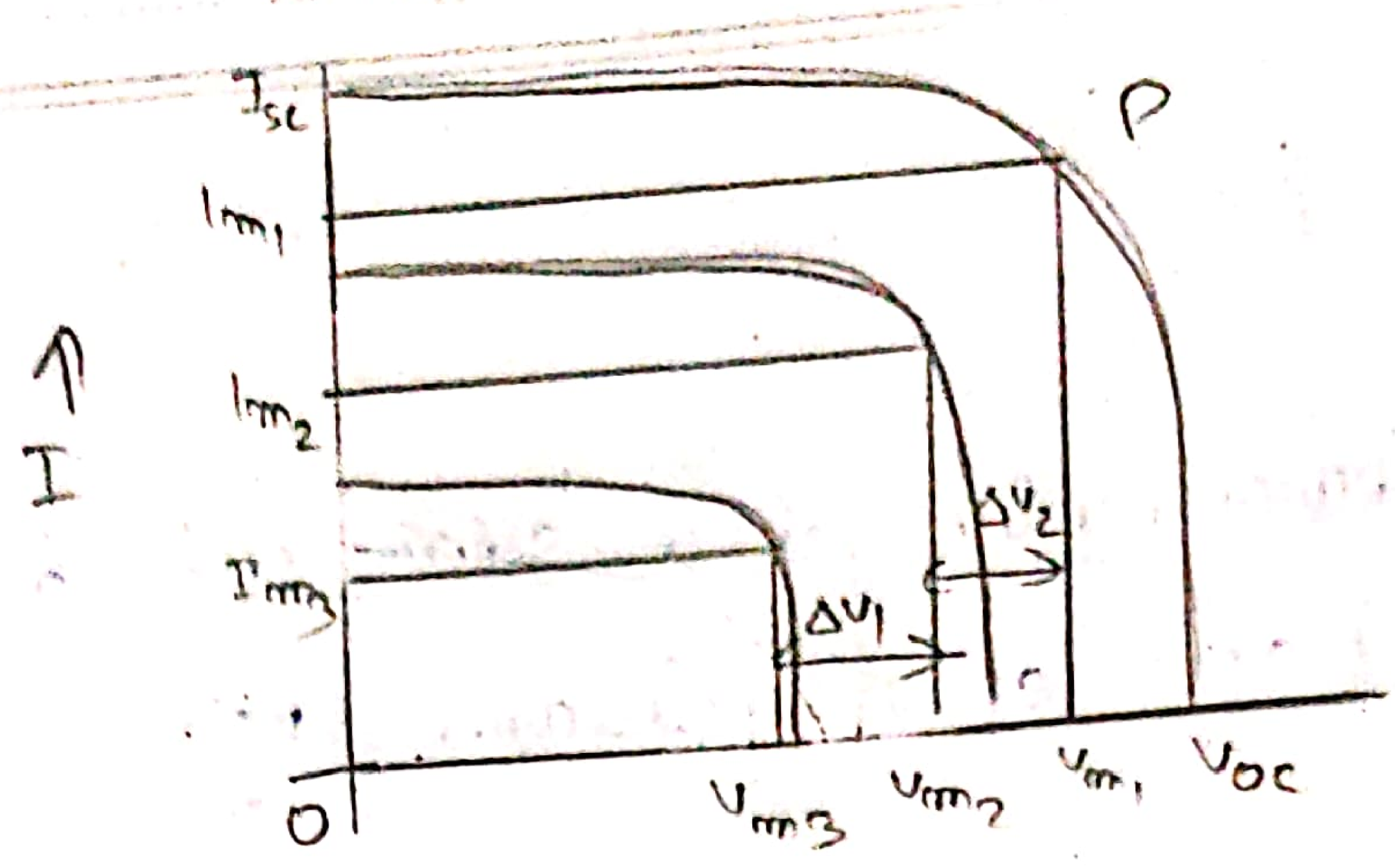
2. Series Resistance (Rs) =

Application:

1. Used in solar calculators and solar-powered toys.
2. Used in solar panels to power homes and streetlights.
3. Used in space satellites for electricity generation.
4. Used in remote areas for water pumping and lighting.



On X axis 1 mm = 0.005 V
On Y axis 1 mm = 0.3 A
Y
X
current (ampere)
voltage (V)
ΔI_2
ΔI_1
ΔV_1
ΔV_2



V_{oc} =		I_{sc} =
S.NO	Voltage V	Current μA
1	0.414	6.0
2	0.417	5.8
3	0.421	5.4
4	0.424	5.2
5	0.426	5.0
6	0.427	4.8
7	0.430	4.6
8	0.432	4.4

V_{oc} =		I_{sc} =
S.NO	Voltage V	Current μA
9	0.435	4.2
10	0.438	4.0
11	0.439	3.8
12	0.441	3.6
13	0.443	3.4
14	0.446	3.2
15	0.449	3.0
16	0.451	2.8

V_{oc} =		I_{sc} =
S.NO	Voltage V	Current μA
17	0.454	2.6
18	0.458	2.4
19	0.460	2.2
20	0.463	2.0
21	0.468	1.8
22	0.471	1.6
23	0.473	1.4
24	0.475	1.2
25	0.477	1.0
26	0.480	0.8
27	0.486	0.6

$I_{m_1} = 1.9$, $I_{m_2} = 3.0$, $I_{m_3} = 5.0$

$V_{m_1} = 0.465$, $V_{m_2} = 0.474$, $V_{m_3} = 0.483$

$I_{sc_1} = 2.0$
$V_{oc_1} = 0.471$

$I_{sc_2} = 4.1$
$V_{oc_2} = 0.480$

$I_{sc_3} = 6.0$
$V_{oc_3} = 0.500$

$$FF_1 = \frac{I_{m_1} V_{m_1}}{I_{sc_1} V_{oc_1}} = \frac{1.9 \times 0.465}{2.0 \times 0.471}$$

$FF_1 = 0.937$

$$FF_2 = \frac{I_{m_2} V_{m_2}}{I_{sc_2} V_{oc_2}} = \frac{3.0 \times 0.474}{4.1 \times 0.480}$$

$FF_2 = 0.722$

$$FF_3 = \frac{I_{m_3} V_{m_3}}{I_{sc_3} V_{oc_3}} = \frac{5.0 \times 0.483}{6.0 \times 0.5}$$

$FF_3 = 0.805$

Fill factor $= \dfrac{FF_1 + FF_2 + FF_3}{3}$

$= \dfrac{0.937 + 0.722 + 0.805}{3}$

$= 0.821$

Series Resistance

$R_1 = \dfrac{\Delta V_1}{\Delta I_1} = \dfrac{0.474 - 0.465}{3.0 - 1.9} = \dfrac{0.01}{1.1} = 9.09 \times 10^{-3}\ \Omega$

$R_2 = \dfrac{\Delta V_2}{\Delta I_1} = \dfrac{0.483 - 0.474}{5.0 - 3.0} = \dfrac{9 \times 10^{-3}}{2} = 2.25 \times 10^{-3}\ \Omega$

$R = \dfrac{R_1 + R_2}{2} = \dfrac{9.09 + 2.25}{2} = 6.67 \times 10^{-3}\ \Omega$

graphs between V and I. Select a point 'P' on each curve and draw perpendicular lines from P onto both axes, such that the area covered by the rectangle is maximum. Note the V_m and I_m from each curve and the calculate the fill factor for each curve, then find out the average fill factor. To find out the series resistance, find the difference between two consecutives V_m's & I_m's (ie (ΔV_1, ΔV_2, ΔI_1 & ΔI_2 as shown) in figure 2) from the graph

Result

1. Fill factor (F) = 0.821 (dimension less because its a ratio)
2. Series Resistance (R_s) = $5.67 \times 10^{-3}\ \Omega$

5. Energy Band Gap of a Semiconductor (Four Probe Method)

Aim:
To determine the electrical conductivity and energy band gap (Eg) of a semiconductor using the Four Probe Method.

Apparatus:
Four probe setup, semiconductor sample, constant current power supply, digital voltmeter, temperature controller with heater and thermometer.

FORMULA:

The energy band gap of the semiconductor Eg is given by

$$\boldsymbol{Eg = \frac{2 \cdot 3026 \times k \times log\ 10\rho}{{}^{1}/_{T}\ (in\ kelvin)}\ (in\ ev)}$$

Where Eg — Band gap of the material

T — Temperature in kelvin

K — Boltzmann constant, K — 8.6x10^{-5} eV/K.

Diagram:
Four-point probe placed on a semiconductor wafer connected to power supply and voltmeter.

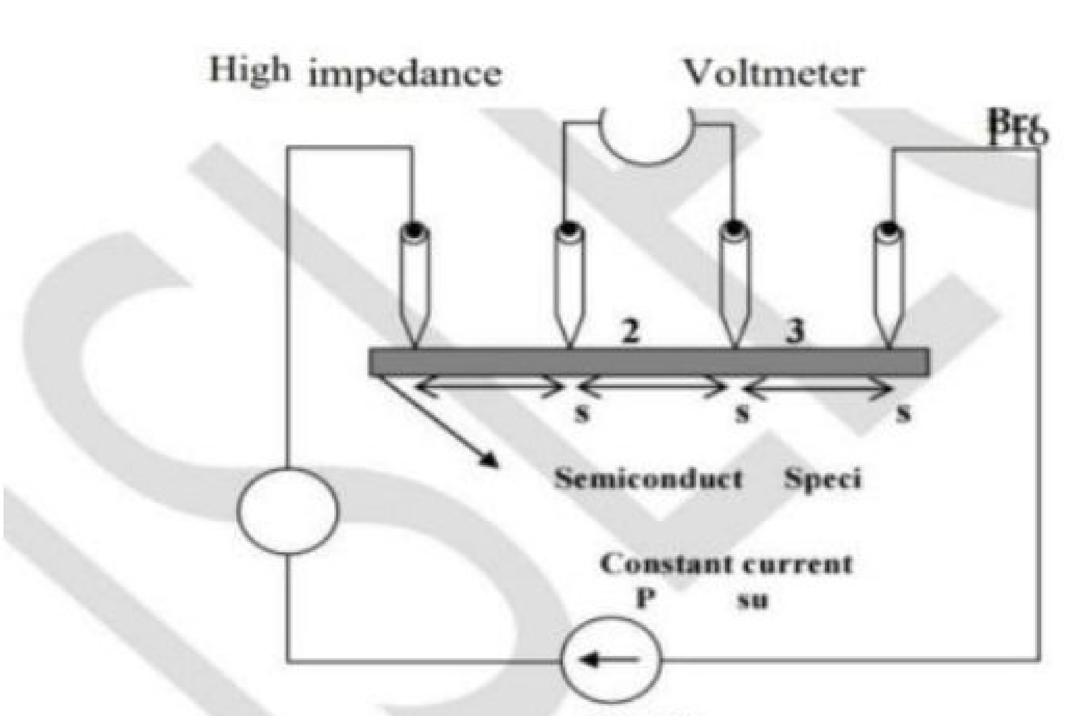


Fig (1)

Tabular Column:

Temp (°C)	Temp (K)	$1/T \times 10^3$ (K^{-1})	Voltage (mV)	ρ (Ω·cm)	$\log_{10} \rho$

Resistivity vs Temperature Table

S.No	Temperature (°C)	Temperature (K)	$1/T \times 10^{-3}$ (K^{-1})	Voltage (mV)	ρ (Ω·cm)	$\log_{10} \rho$

Procedure:

1. Connect the four probes to the semiconductor sample as per circuit diagram.
2. Set a constant current using the power supply.
3. Heat the sample gradually and note the **voltage drop** across the inner probes at various temperatures.
4. Use thermometer to measure temperature of the sample and convert to Kelvin.
5. For each temperature, calculate resistivity ρ\rhoρ.
6. Compute **$\log_{10} \rho$** and **1/T** for all readings.
7. Plot a graph of **$\log_{10} \rho$ vs 1/T**.
8. Determine slope (m) of the graph.

   Calculate band gap using:

$$Eg = \frac{2{\cdot}3026 \times k \times \log 10\rho}{1/_{T}(in\ kelvin)} (in\ ev)$$

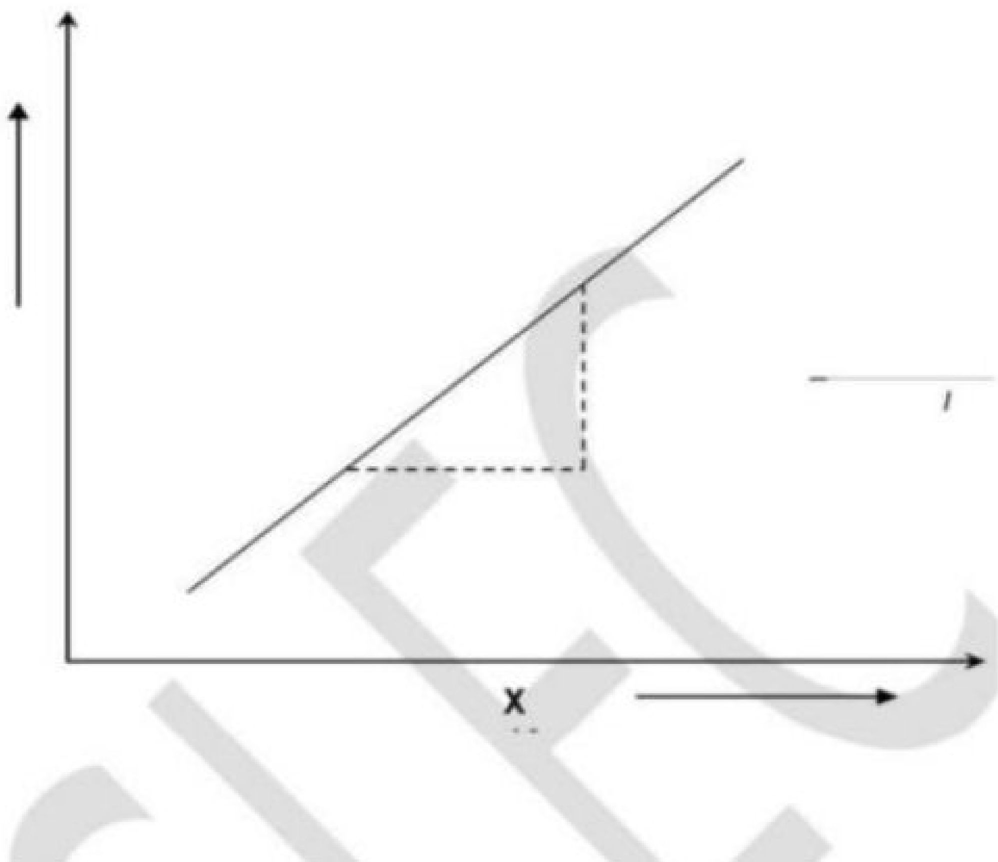
9. Record result and conclude.

Precautions:

- Handle the semiconductor crystal carefully – it is brittle.
- Let the sample cool down between trials.
- Use gloves while handling heated equipment.

Expected Graph:

A straight line when $\log_{10}(\rho)$(y axis) is plotted against 1/T (in K^{-1})(x axis).



Result:

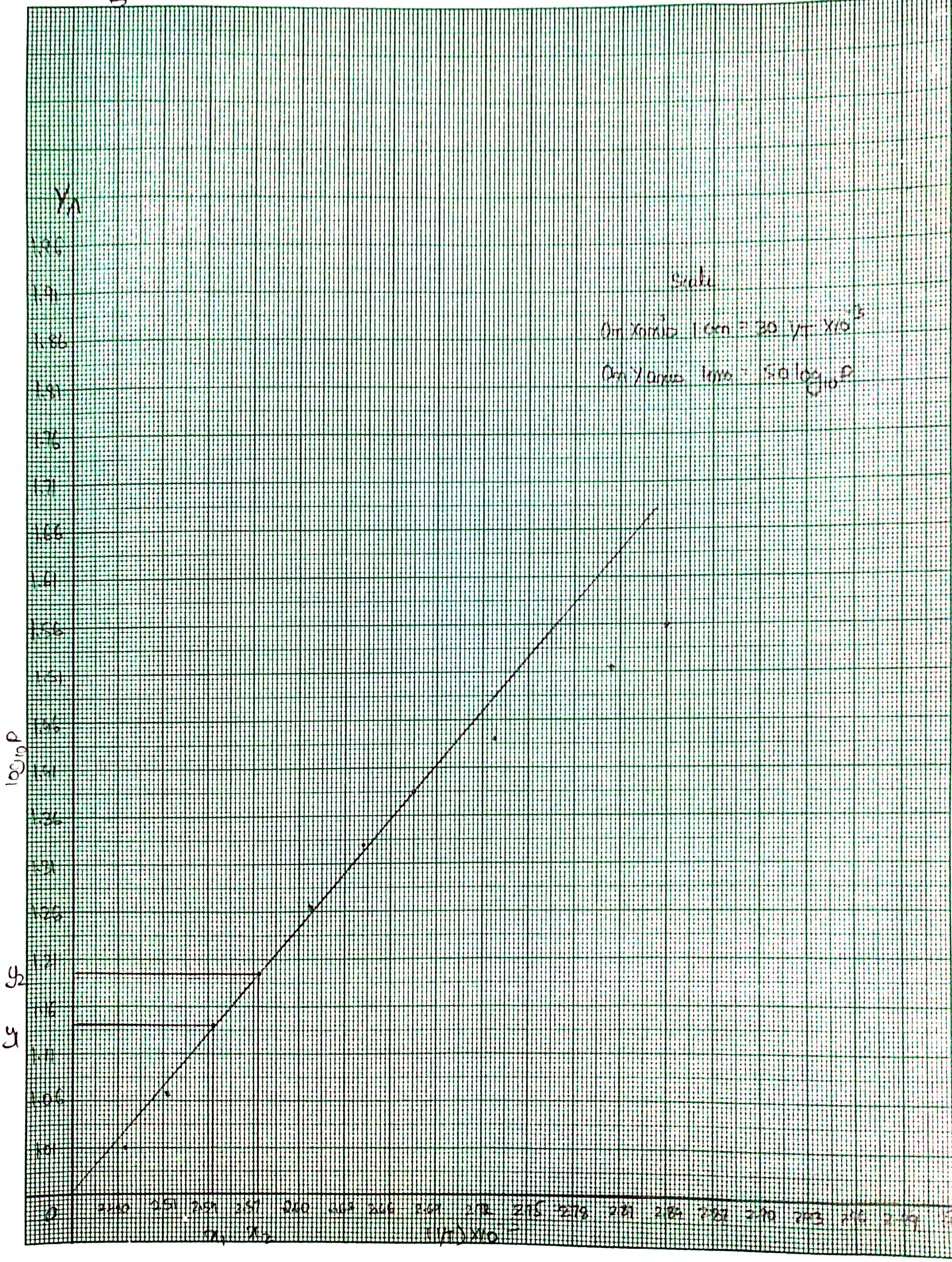
The energy band gap of the semiconductor is ………….ev

Electrical conductivity at room temperature is............(ohm^{-1} cm^{-1}

Applications:

1. Determines if material is suitable for electronic devices.
2. Helps classify semiconductors (e.g., Silicon, Germanium).
3. Used in research of temperature effects on conductivity.
4. Used in designing thermistors and sensors.

5th


Y
Scale
On X axis 1 cm = 30 1/T x10^-3
On Y axis 1cm = 5.0 log10 P
log10 P
y2
y1
x1
x2
1/T x10
1.96
1.91
1.86
1.81
1.76
1.71
1.66
1.61
1.56
1.51
1.46
1.41
1.36
1.31
1.26
1.21
1.16
1.11
1.06
1.01
0
2.51
2.54
2.57
2.60
2.63
2.66
2.69
2.72
2.75
2.78
2.81
2.84
2.87
2.90
2.93
2.96
2.99

S.NO	Temperature in °c	Temperature in Kelvin	$1/T \times 10^{-3}$	Voltage (mV)	ρ (Ω, cm)	$\log_{10} \rho$
1	130	403	2.481	10.6	10.389	1.016
2	125	398	2.512	12.0	12.057	1.081
3	120	393	2.544	14.0	13.845	1.141
4	115	388	2.577	16.0	15.823	1.199
5	110	383	2.610	18.5	18.296	1.262
6	105	378	2.645	21.3	21.064	1.323
7	100	373	2.680	24.5	24.229	1.384
8	95	368	2.717	28.0	27.691	1.442
9	90	363	2.754	32.0	31.647	1.500
10	85	358	2.793	36.3	35.897	1.600
11	80	353	2.832	37.5	37.086	1.569
12	75	348	2.873	28.0	27.691	1.442
13	70	343	2.915	2.0	1.997	0.296
14	65	338	2.958	1.8	1.779	0.250
15	60	333	3.003	1.7	1.681	0.225

$$E_g = \frac{2.302 \times K \times \log_{10} P \text{ (in eV)}}{1/T \text{ (in K)}}$$

$$E_g = 2 \times 2.302 \times 1.75 \times 8.6 \times 10^{-5} \times 10^{3}$$

$$= \frac{2 \times 2.302 \times 1.75 \times 8.6}{100}$$

$$= \frac{69.2902}{100}$$

$E_g = 0.6929$ → energy gap

$$\rho = \frac{\rho_0}{f(w/s)}$$

$$\rho_0 = \frac{V}{I} \times 2\pi$$

$$\rho_0 = \frac{23}{2.50} \times 2 \times 3.14$$

$$\rho_0 = 9.2 \times 2 \times 3.14$$

$$\boxed{\rho_0 = 57.776}$$

Now,

$$\rho_0 = \frac{57.776}{2.54} = 22.746$$

Electrical Conductivity $(\sigma) = \frac{1}{\rho}$

$$= \frac{1}{22.746} = 0.043 \text{ ohm}^{-1}\text{ cm}^{-1}$$

$\sigma = 0.043$ ohm^{-1} cm^{-1}

7. Note down the change in the voltage for every -5°c decrement in the temperature til it reaches 70°c, in observation & Tabular column

8. Switch off the ~~switch~~ constant current power supply & temperature controller unit

9. Plot the graph between $\log_{10} P$ Vs $T^{-1} \times 10^{-3}$, which is a straight line and find the slope

Result

The energy band gap of the semi conductor is 0.5929 ev

electrical conductivity at room temperature is 0.043 (ohm^{-1} cm^{-1})

6. Thermistor – Temperature vs Resistance

Aim: To study resistance vs temperature and evaluate constants A and B.

Apparatus: Thermistor, thermometer, oil bath, heater, Wheatstone bridge, voltmeter.

Formulae:

• R = A * e^(B/T)

• log(R) = log(A) + B/T

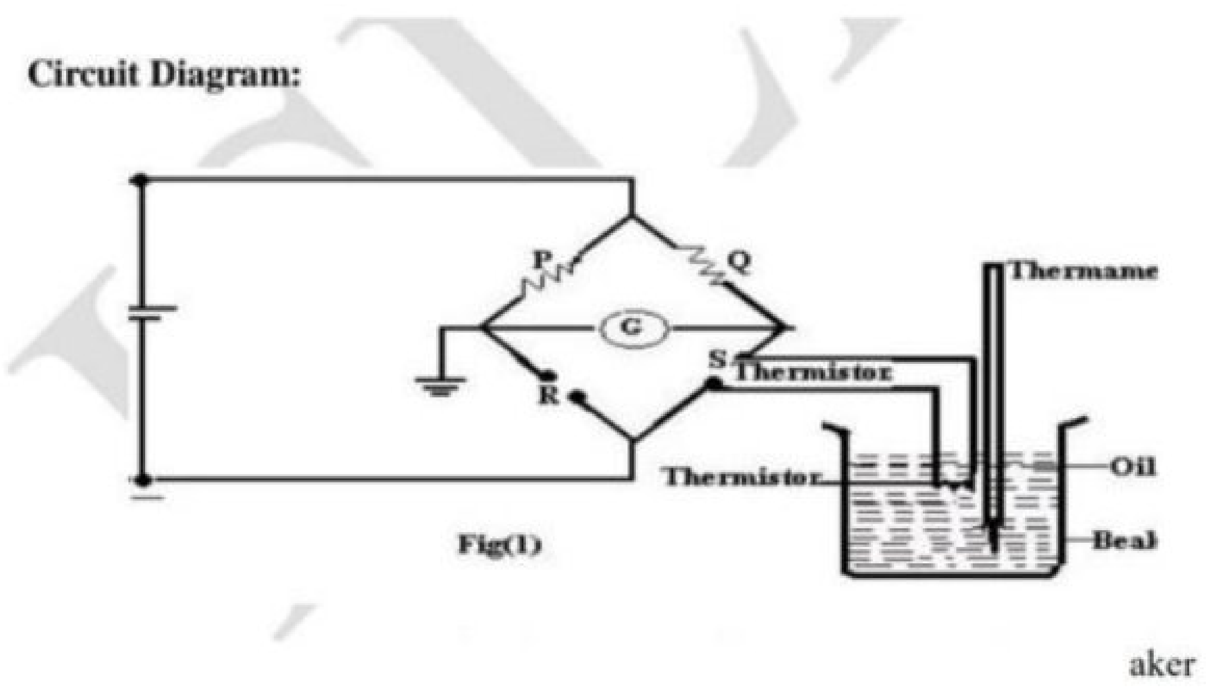
EVALUATION OF CONSTANTS 'A' AND 'B'

The resistance of the thermistor is given by R — $Ae^{B}/^{T}$ -----(1)

Taking logarithms on both sides we get loge R = loge A + B ------- (2)

Log10R- Log10A + Blog10e

Diagram: Wheatstone bridge with thermistor setup.



Tabular Column:

Resistivity vs Temperature Table

S.No	Temperature (°C)	Temperature (K)	$1/T \times 10^{-3}$ (K^{-1})	Voltage (mV)	ρ (Ω·cm)	$\log_{10} \rho$

Procedure:

1. Set up the Wheatstone bridge circuit with the thermistor.
2. Place thermistor in beaker with oil.
3. Raise temperature slowly and measure R at intervals of 5°C.
4. Cool down and record R at same intervals.
5. Convert temperature to Kelvin and calculate 1/T, log R.
6. Plot R vs T and log R vs 1/T.
7. Determine constants A and B from graph.
8. Ensure stable heating and cooling.
9. Avoid overheating the thermistor.
10. Record and tabulate values properly.

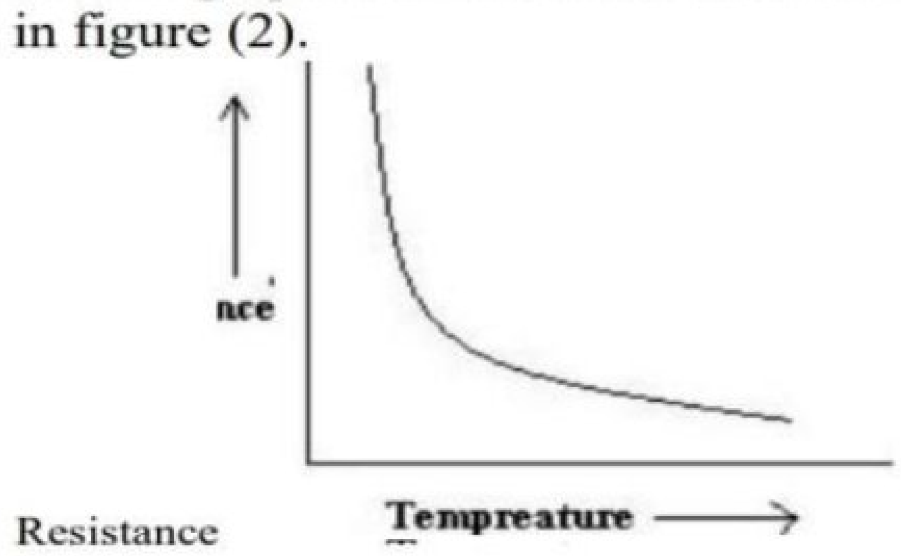
Precautions:

• Keep heating arrangement away from circuit.

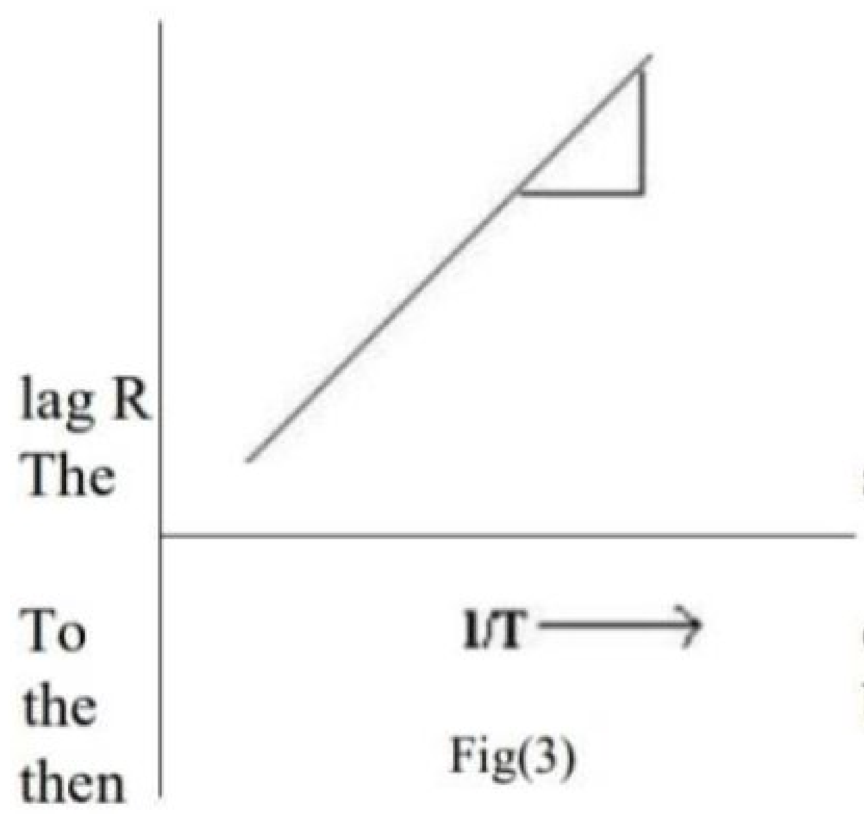
• Record readings while temperature decreases slowly.

Expected Graph: Exponential decrease of R with increase in T; linear log R vs 1/T graph.

Draw a graph between resistance and absolute temperature. It should be as sh
in figure (2).



Fig(2)
Temperature Char of Thermistor



The slope of the line gives B.

To calculate the constant A take the logarithm to base 10 of the formula (l).
the
then

Fig(3)

RESULTS:

The Temperature characteristics of given thermistor is drawn and

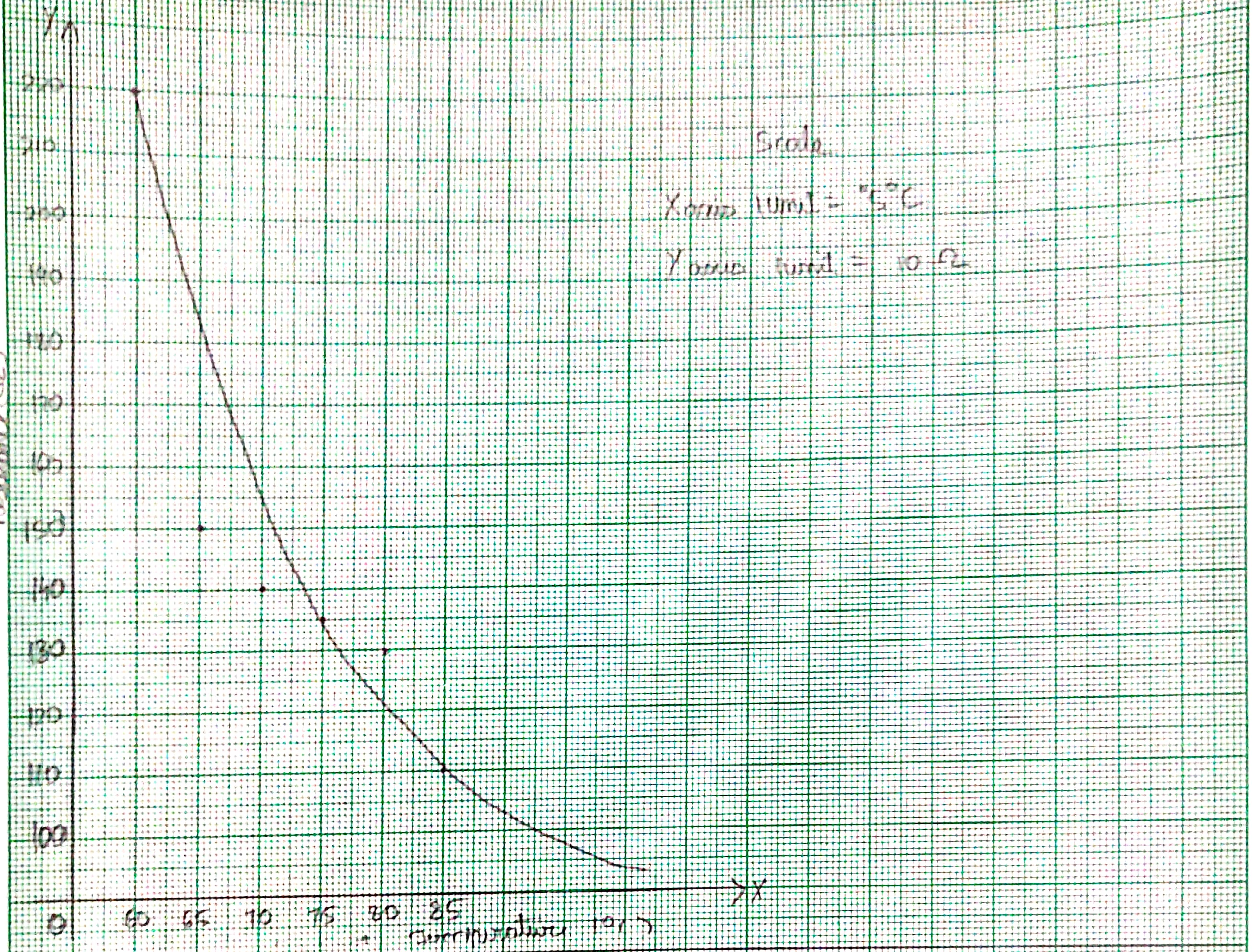
1. The value of Constant A —------------ Ω

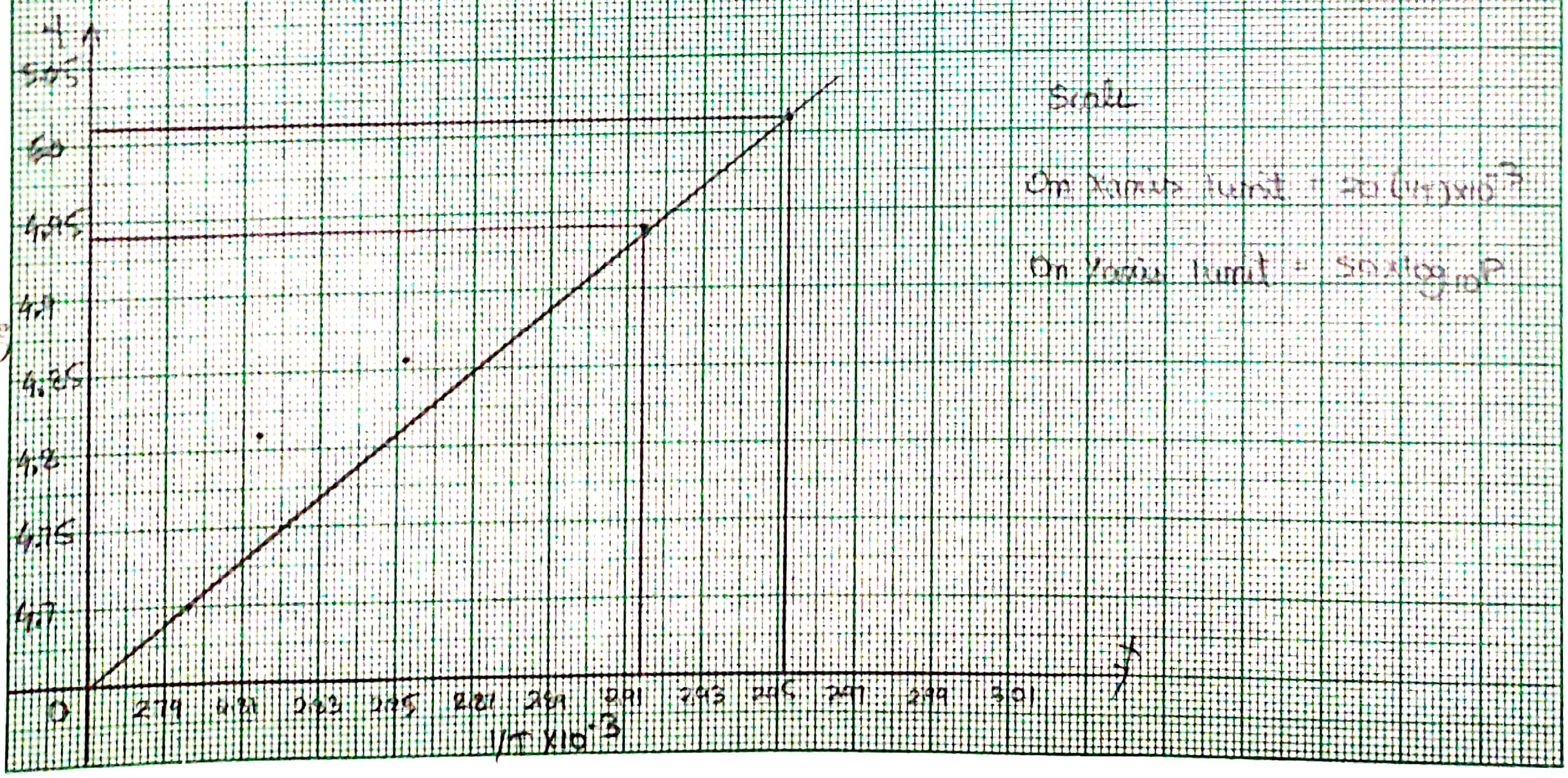
2. The value of Constant B=-------------

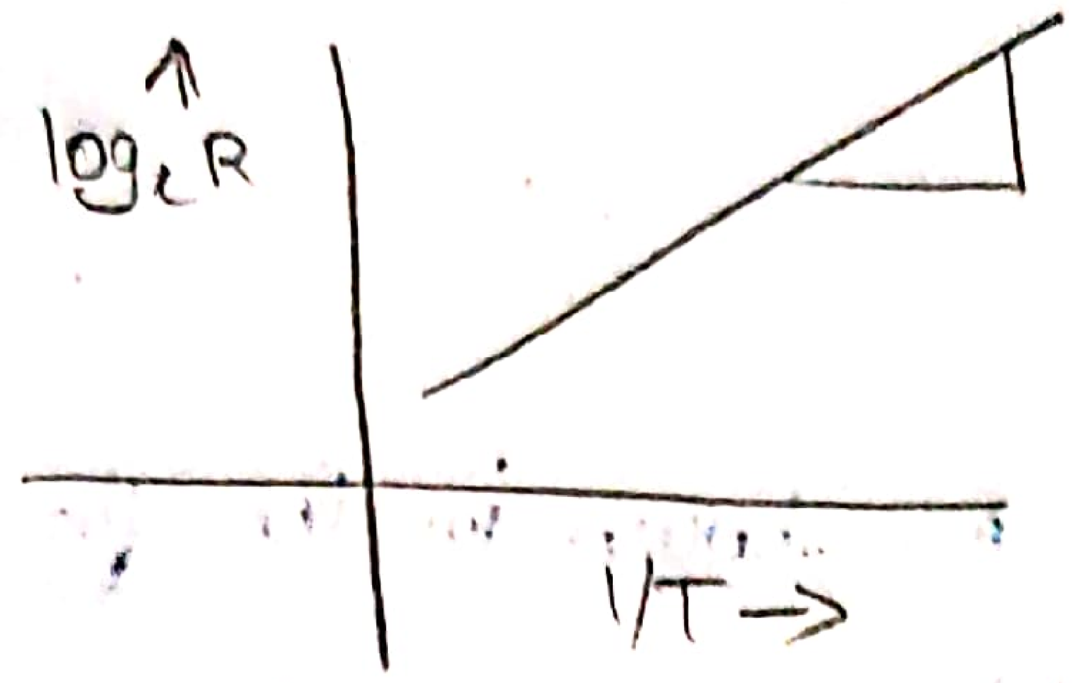
Application:

1.Used in temperature sensors in air conditioners.
2. Used in battery chargers for thermal protection.
3. Used in fire alarms and oven controls.
4. Used in measuring temperature in scientific labs.

Exp 6


Scale
X axis 1 unit = 5°C
Y axis 1 unit = 10 Ω
Resistance (Ω)
0
50
55
70
75
80
85
X
Y


Scale
On X axis 1 unit = 20 (1/T) x10⁻³
On Y axis 1 unit = 50 x log₁₀P
1/T x10⁻³
0
4.7
4.75
4.8
4.85
4.9
4.95
5.0



fig(3)

Observation :

S.NO.	Temperature of Thermistor		$1/T$	Resistance of Thermistor	$\log_e R$
	$T^\circ C$	T(Kelvin)	$\times 10^{-3}$	(R)	
1	85	358	2.793	110	4.700
2	80	353	2.832	130	4.867
3	75	348	2.873	135	4.905
4	70	343	2.915	140	4.941
5	65	338	2.958	150	5.010
6	60	335	3.003	220	5.393

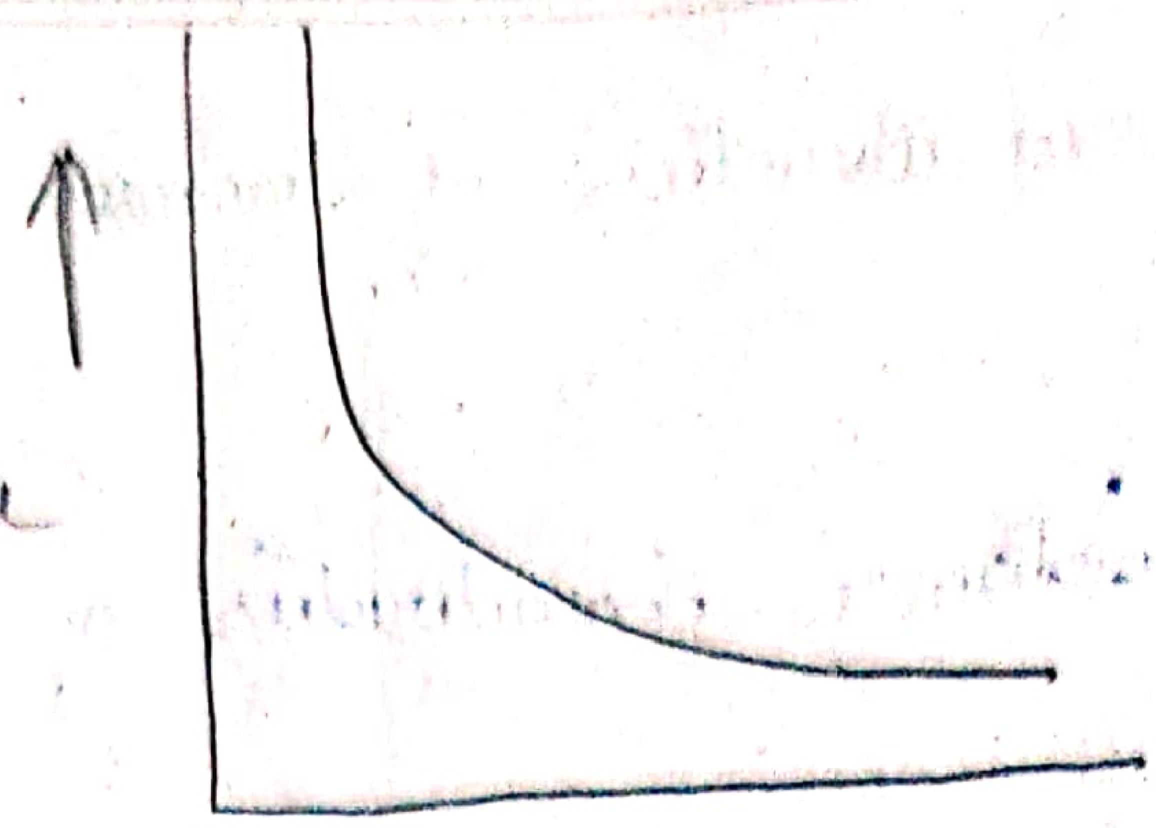


fig 2

The Temperature chart of Thermistor

Slope $= \frac{y_2 - y_1}{x_2 - x_1} = \frac{5.010 - 4.941}{2.958 - 2.915} = 1.604 \times 10^3$

$= 1604$ Kelvin

$R = Ae^{B/T}$

Taking log on B.S

$\log_{10} R = \log_{10} A + \frac{B}{T}(0.4343)$

$\log_{10} A = \log_e R - B/T\,(0.4343)$

$\log_{10} A = 4.905 - \frac{1604}{348}(0.4343)$

$\log_{10} A = 2.903$

$A = 10^{2.903} = 799.8342\ \Omega$

Now draw a graph with $\log_e R$ on the y-axis and $1/T$ on the x-axis. A straight line graph is obtained with negative intercept on the y-axis (as shown in fig. 3)

Calculate the constant A take the logarithm the base 10 of the formula (1)

$$\log_{10} R - \log_{10} A \pm B \log_{10} e$$

$$\log_{10} A - \log_{10} (0.4343) \rightarrow 3$$

Hence take the value of R corresponding to some temperature TK and substitute in eq (3) along with the value of B already evaluated

Results

The temperature characteristics of given thermistor is drawn and

1) The value of Constant A = 799.8342 Ω

2) The value of constant B = 2.903

7. Hall Effect – RH, Carrier Density, and Mobility

Aim:
To determine Hall Coefficient (RH), carrier density (n), and mobility (μ) of a semiconductor.

Apparatus:
IC regulated power supply, electromagnets, Hall sensor, Gauss meter, digital voltmeter.

Formulae:

- Hall Coefficient (RH) = $\frac{VH \ x \ Z}{I \ x \ B}$

  Where VH/I = Slope of 2KG graph
  Z = Thickness of crystal
  B = Magnetic field (2KG in this case)

- Carrier density (n) = 1 / (RH × q)

  Where q = 1.6* 10 ^-19

- Carrier mobility (μ) = RH * x

  Where x = 0.447

Diagram:
Hall probe placed between magnetic poles.

Tabular Column:
Hall Effect Table

S.No	Hall Current (I, mA)	Hall Voltage (V, mV)

Procedure:

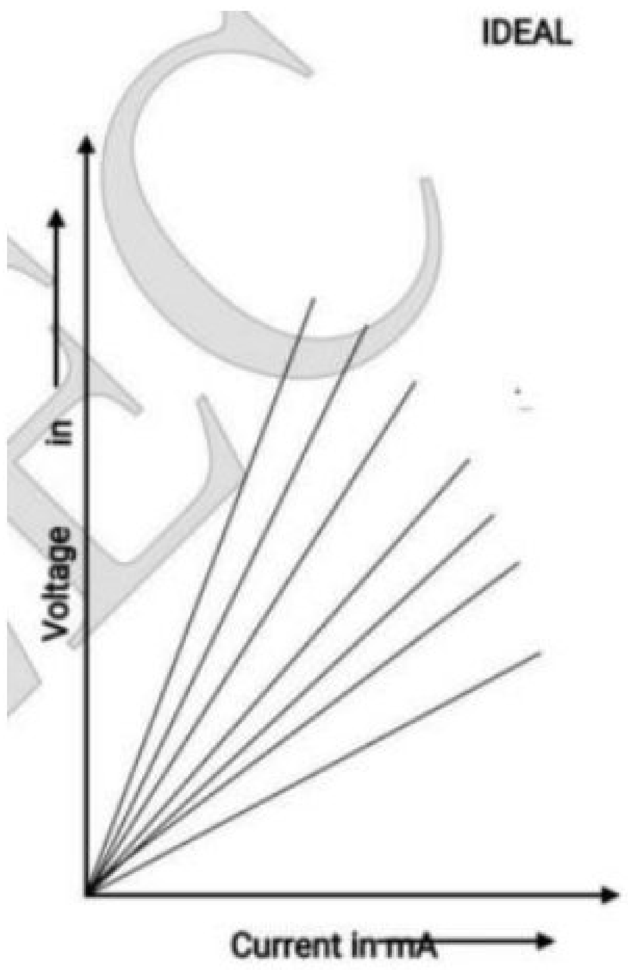
1. Connect IC supply to electromagnet coils.
2. Calibrate Gauss meter and set magnetic field B.
3. Insert Hall probe between poles and measure VH.

4. Apply constant current I through the sample.
5. Record Hall voltage for varying current steps.
6. Plot VH vs I and find slope = VH/I.
7. Use formula to calculate RH, n, and μ.
8. Repeat for different B values for accuracy.
9. Ensure accurate placement of Hall probe.
10. Tabulate results and conclude.

Precautions:

- Keep Hall probe perpendicular to magnetic field.
- Do not exceed 10 mA through crystal.

Expected Graph:
VH vs I – straight line.



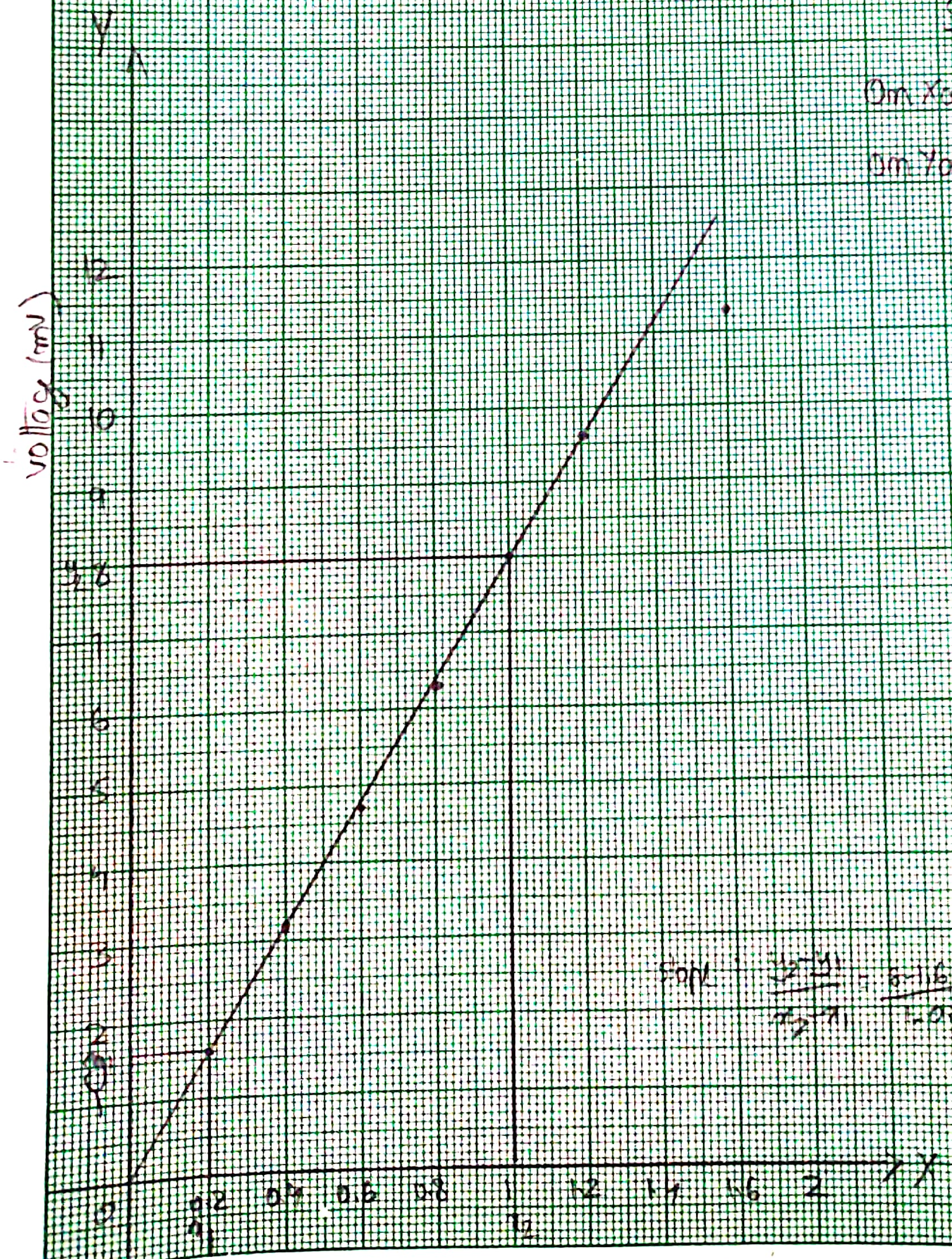
RESULT:

1. **Hall Coefficient (RH) = …………….**
2. **Carrier Density (n) = …………….**
3. **Carrier Mobility (μ) = ………….**

Applications:

1. Used in magnetic field sensors (Hall sensors).
2. Used in brushless DC motors.
3. Used in measuring carrier type and density.
4. Used in automotive and mobile phones for position sensing

7th



Scale

On X axis 1cm = 0.2 mV

On Y axis 1cm = 1 mA

Slope $= \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{8 - 1.6}{1 - 0.2} = \dfrac{6.4}{0.8} = 8$

Calculations

R_H = Hall coefficient

$$R_H = \frac{V_H \times Z}{I \times B}$$

V_H / I = slope

Z = thickness = 0.7mm

$= 7 \times 10^{-2}$ cm

B = 1.750 kg gauss

$= 1.750 \times 10^3$ gms gauss

$$R_H = \frac{8 \times 7 \times 10^{-2}}{1.750 \times 10^3} = 3.2 \times 10^{-4}$$

Carrier Density (n) $= \dfrac{1}{R_H \times q} = \dfrac{1}{3.2 \times 10^{-4} \times 1.6 \times 10^{-19}} = 1.95 \times 10^{22}$

R_H = Hall coefficient

q = electron charge $= 1.6 \times 10^{-19}$

Carrier Mobility (μ) $= R_H (\sigma)$

$= 3.2 \times 10^{-4} \times 0.447$

$\sigma = 0.447$

$= 1.43 \times 10^{-4}$

Hall voltage at constant magnetic field

7. Plot the graph between current (I) and hall voltage (VB) which is a straight line & find the slope.

8. Repeat the above steps from 3 to 7 for different values of magnetic fields say 0.75 Kg, 1Kg, 1.25 Kg, 1.75 Kg & 2Kg.

NOTE:

1. There may be some voltage even outside the magnetic field. This is due to the imperfect alignment of the four contacts of the crystal and is generally known as the "Zero Field Potential". In all the cases this error should be subtracted from the Hall voltage Reading.

2. Gap between the magnetic cores should remain fixed for one set of readings.

Result:

1. Hall Coefficient (RH) = 3.2×10^{-4} $cm^3 col^{-1}$ cm^3/C
2. Carrier Density (n) = 1.95×10^{22} cm^3 carrier/cm^3
3. Carrier Mobility (μ) = 1.43×10^{-4} cm $volt^{-1}$ sec^{-1} $cm^2/V.S$

2/8/25