Experiment No. 1

Title : **Frank - Hertz Experiment**

Objective : To verify the considerations

1) It is possible to excite atoms by low energy electron bombardment.
2) The energy transferred from electrons to the atoms always had discrete values.
3) The values so obtained for the energy levels were in agreement with spectroscopic result.

Apparatus : Frank-Hertz set up consists of

1) Argon filled tetrod
2) Fillament Power Supply : 3.3 - 5.3 V continuously variable
3) Power Supply for $V_{G1}k$: 1.3 - 5 V continuously variable
4) Power Supply for $V_{G2}A$: 1.3 - 5 V continuously variable
5) Power Supply for $V_{G2}k$: continuously variable

Prelab Questions :

1) Discuss in brief the operating principle of Frank-Hertz experiment.
2) What do you mean by inelastic collisions?

Circuit Diagram :

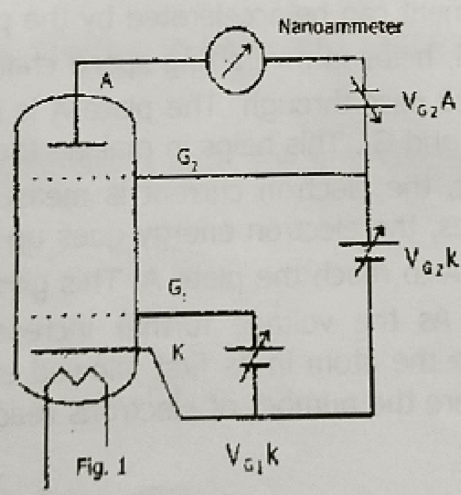


Fig. 1

First we have to install the apparatus in the following way.

1. Before the power is switched 'ON' make sure all the control knobs are at their minimum position and Current Multiplier knob at 10^{-7} position.
2. Switch 'ON' the power.
3. Turn the Manual-Auto Switch to Manual, and check that Scanning Voltage Knob is at its minimum position.
4. Turn Voltage Display Selector to $V_{G1}k$ and adjust the $V_{G1}k$ knob until voltmeter reads 1.5V.
5. Turn Voltage Display Selector to $V_{G2}A$ and adjust the $V_{G2}A$ knob until the voltmeter read 7.5

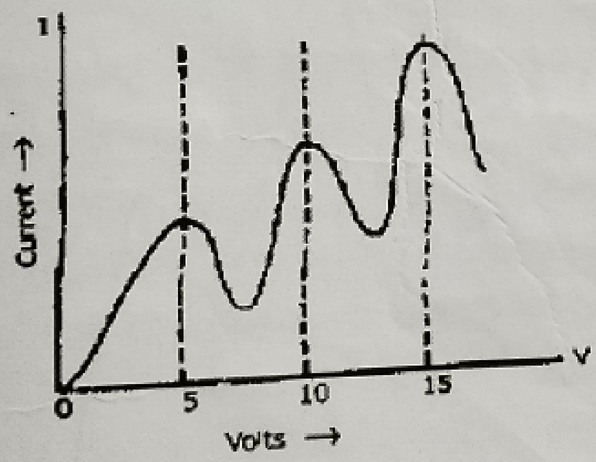
When you have finished step 1 to 5, you are ready to do the experiment with following parameters.

Filament Voltage	:	*2.6 V*
$V_{G1}k$	:	*1.5 V*
$V_{G2}A$	:	*7.5 V*

Observation Table :

Obs. No.	V_{G2k} (V)	I_A (A)	Obs. No.	V_{G2K} (V)	I_A (A)	Obs. No.	V_{G2K} (V)	I_A (A)
1	0	0	16	30	18.4	31	60	24.1
2	2	0	17	32	16.9	32	62	33
3	4	0	18	34	12.3	33	64	35.8
4	6	0.1	19	36	11.8	34	66	30.4
5	8	0.1	20	38	18.2	35	68	18.5
6	10	0.7	21	40	23.6	36	70	16.7
7	12	3.25	22	42	23.9	37	72	27.6
8	14	6.75	23	44	17.8	38	74	38.3
9	16	9.7	24	46	11	39	76	40.5
10	18	12.5	25	48	15.5	40	78	34.3
11	20	11.6	26	50	25.5	41	80	23.3
12	22	11.2	27	52	29.8	42		
13	24	10.5	28	54	27.2	43		
14	26	12.6	29	56	17.8	44		
15	28	16.4	30	58	12.5	45		

Graph:

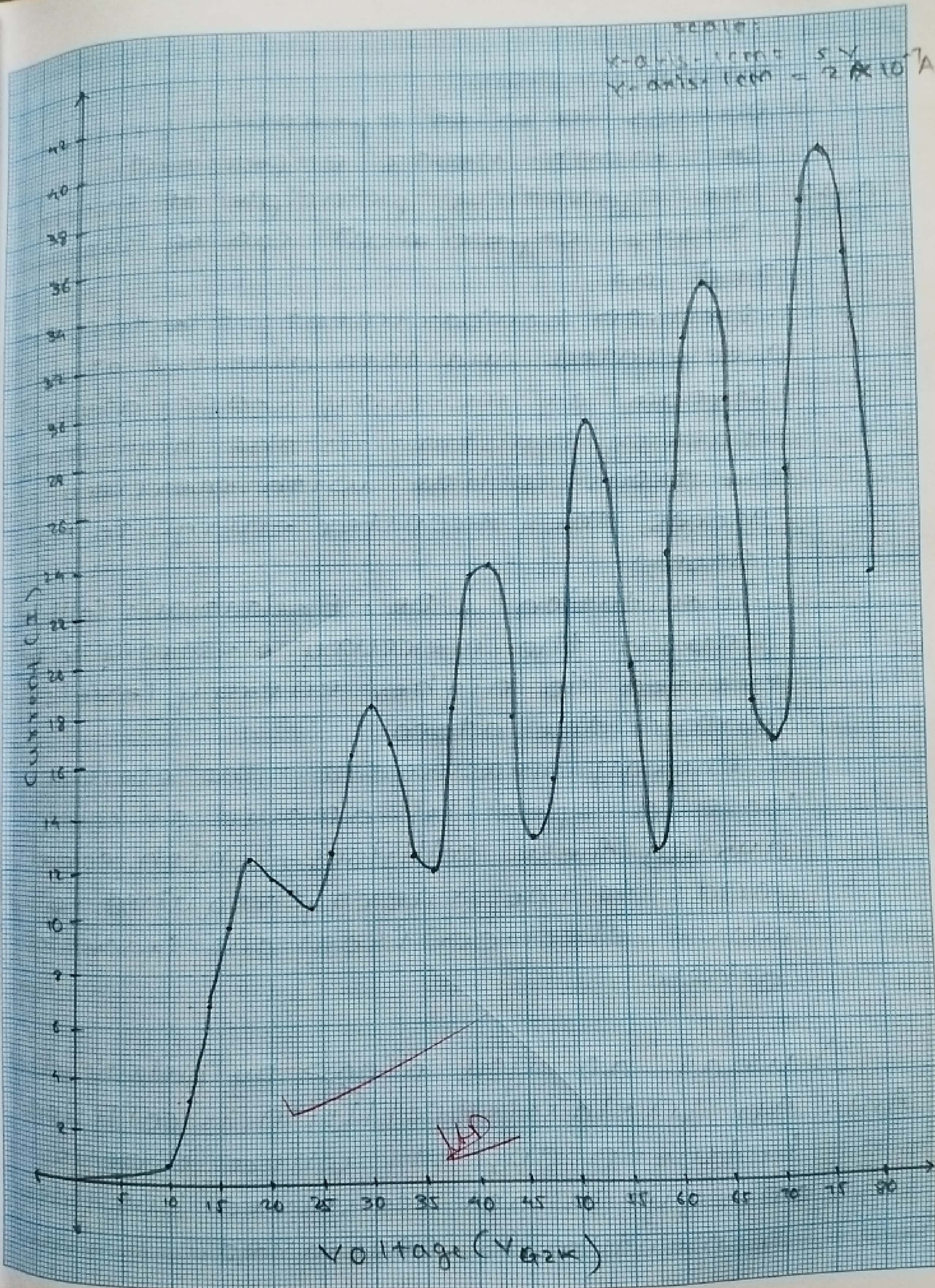


Conclusions: ① From the graph it can be concluded that it is possible to excite the atoms by low energy electron bombardment.

② Since electron current is not increasing continuously, it indicates electron loses energy to the atom and atom absorbs energy in discrete quantas which are multiples of $h\nu$.

Postlab Question:

1) What do you mean by Electronic transitions?
2) How inelastic collision of accelerated electrons with the atoms confirms the existence of atomic energy levels?


scale:
Voltage (VG2K)

Experiment No. 2

Title : **Planck's Constant**

Objective : To verify the considerations

1) The emission process depends strongly on frequency of radiation.
2) For each metal there exists a critical frequency such that light of lower frequency is unable to liberate electrons.
3) The emission of electron is strictly proportional to the intensity of this radiation.

Apparatus:

1. Planck's Constant measuring Set-up, PC-101
2. A Set of Filters: (i) Red,(ii) Yellow I (iii) Yellow II (iv) Green, (v) Blue
3. Lens Cover

MAJOR COMPONENTS OF SETUP

a. Photo Sensitive Device: Vacuum photo tube.

b. Light Source: Halogen tungsten lamp 12V/35W.

c. Color Filters: Red (635nm), Yellow – I (570nm), Yellow – II (540nm), Green (500nm) & Blue (460nm).

d. Accelerating Voltage : Regulated Voltage Power Supply

Output : ± 15 V continuously variable through multi-turn pot

Display : 3 ½ digit 7-segment LED Accuracy : ±0.2%

e. Current Detecting Unit : Digital Nanoammeter

It is high stability low current measuring instrument

Range : X 1μA, 0.1μA, 0.01μA & 0.001μA with 100% over ranging facility

Resolution : 1nA at 0.001μA range Display : 3½ digit 7-segment LED Accuracy : ± 0.2%

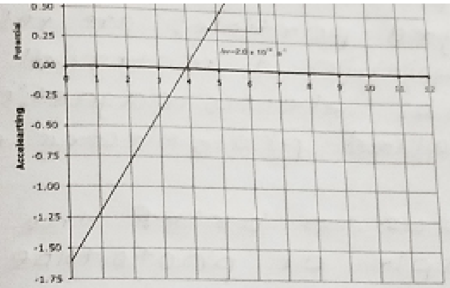
f. Power Requirement: 220V ± 10%, 50Hz.

installation of phototube; the room should be only dimly lit.

3. The instrument should be kept in dust proof and moisture proof environment, if there is dust on the phototube, color filter, lens etc. clean it by using absorbent cotton with a few drops of alcohol.
4. The color filter should be stored in dry and dust proof environment.
5. After finishing the experiment remember to switch off power and cover the drawtube (4) with the lens cover (15) provided. Phototube is light sensitive device and its sensitivity decreases with exposure to light, due to ageing.

Observation Table:

Sr.No.	Wavelength (nm)	Frequency(ν) (10^{14})	Stopping potential (V_s)
1	Red (635)	4.72	−0.29 V
2	Yellow I(585)	5.13	−0.50 V
3	Yellow II (540)	5.56	−0.69 V
4	Green (500)	6.00	−0.79 V
5	Blue (460)	6.50	−1.02 V



CALCULATIONS

Planck's Constant:

$h = e\,\Delta V_s/\Delta \nu$ Where e is the charge of electron

By putting the value of ΔV_s & $\Delta \nu$ from graph

$h = 1.602 \times 10^{-19} \times \left(\frac{0.79-0.5}{6-5.263}\right) \times 10^{-14}$

$= 1.602 \times 10^{-19} \times 0.3935 \times 10^{-15}$

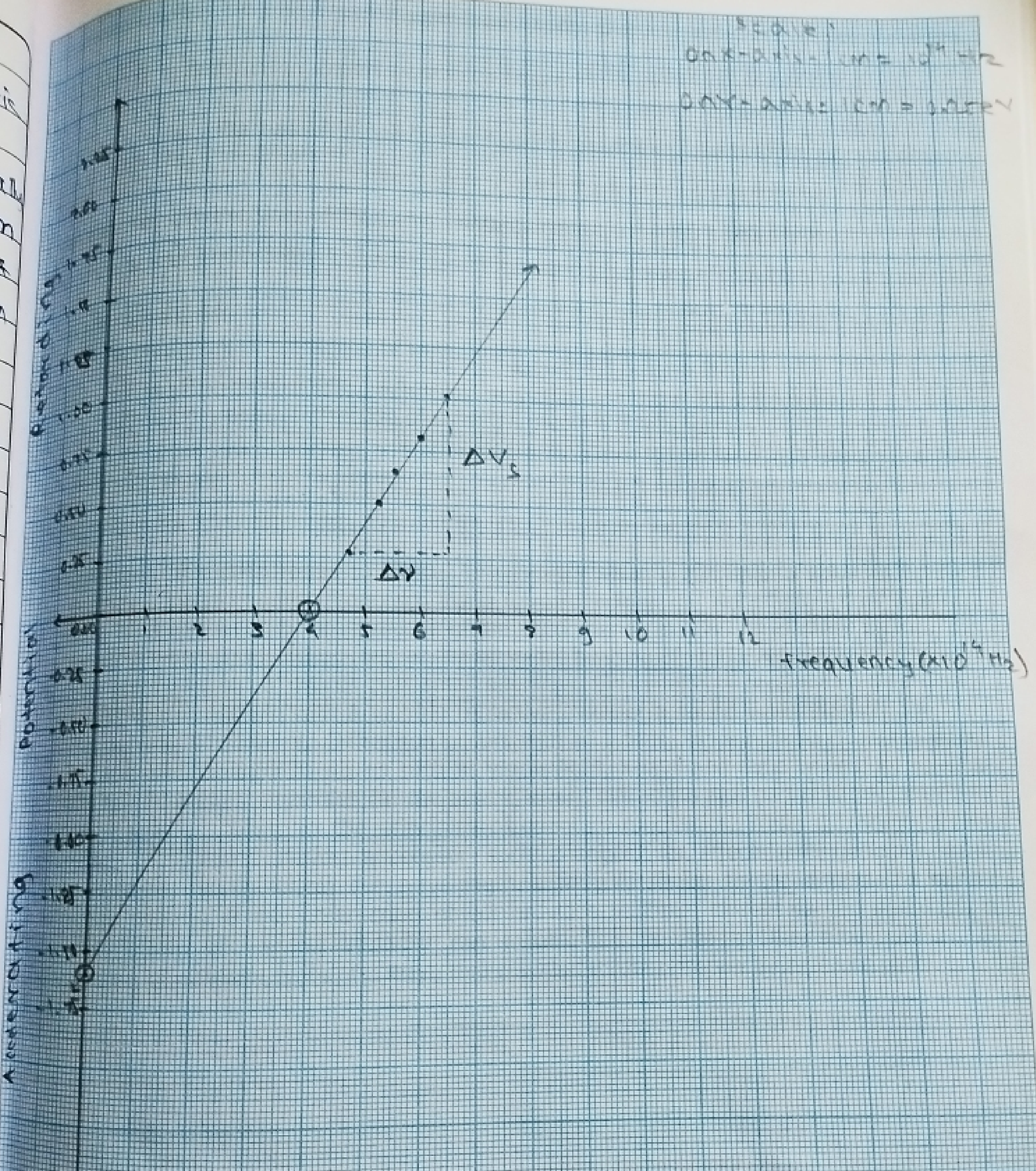
$= 6.304 \times 10^{-34}$ Joules sec.

From Graph 1 intercept at $\nu = 0$ the value of $\varphi = 1.625$ V

Compared with accepted value of $h = 6.62 \times 10^{-34}$ Joules-sec. the results are well within accepted error range.

Result:

The most approximate value of Planck's constant from the given experiment is


Scale:
On x-axis: 1cm = 10^{14} Hz
On y-axis: 1cm = 0.25 eV
ΔV_s
$\Delta \nu$
1 2 3 4 5 6 7 8 9 10 11 12
frequency ($\times 10^{14}$ Hz)
Accelerating potential (V)

Experiment No. 3

Title : **Diffraction experiment with Laser**

Objective : To study diffraction of monochromatic light and use it to measure micron size dimensions

Apparatus : He-Ne laser, diffraction grating, human hair/thin wire, cardboard piece, screen and measuring tape

Prelab Questions:

1) Fundamentals of diffraction of waves
2) Young's double slit experiment
3) Diffraction grating, Diffraction of coherent monochromatic light
4) Concept of laser, working and operating principle of He-Ne laser and average human hair diameter

Theory:

Diffraction: Diffraction refers to various phenomena which occur when a wave encounters an obstacle. Italian scientist Francesco Maria Grimaldi coined the word "diffraction" and was the first to record accurate observations of the phenomenon in 1665. In classical physics, the diffraction phenomenon is described as the apparent bending of waves around small obstacles and the spreading out of waves past small openings. Similar effects occur when light waves travel through a medium with a varying refractive index or a sound wave through one with varying acoustic impedance. Diffraction occurs with all waves, including sound waves, water waves, and electromagnetic waves such as visible light, X-rays and radio waves. As physical objects have wavelike properties (at the atomic level), diffraction also occurs with matter and can be studied according to the principles of quantum mechanics. While diffraction occurs whenever propagating waves encounter such changes, its effects are generally most pronounced for waves where the wavelength is roughly similar to the dimensions of the diffracting objects. If the obstructing object provides multiple, closely spaced openings, a complex pattern of varying intensity can result. This is due to the superposition, or interference, of different parts of a wave that traveled to the observer by different path.

Procedure:

1. Fit the He-Ne lase on the stand.
2. Align the grating in-line of the laser beam.
3. Turn the laser ON and focus it on grating to form the diffraction pattern on the screen.
4. Record the distance between the central maximum and 1st order maxima for distance between grating and screen equal to L(cm).
5. Repeat it for different values of 'L'.

Sr. No.	Distance between Grating and Screen (L) (cm)	Distance between central maxima and 1st order maxima (y) (cm)		Mean (y) (cm)	$\theta = \tan^{-1}(y/L)$	$\sin\theta$	Grating element (a+b) $= \lambda/\sin\theta$
		LHS	RHS				
1.	5	2	2.4	2.2	23.74	0.4025	1.5721
2.	10	3.9	4	3.95	21.55	0.3673	1.7228
3.	15	6	6.1	6.05	21.96	0.3739	1.6924
4.	20	8.5	8.6	8.55	23.15	0.3929	1.6105
5.	25	10.6	10.7	10.65	23.07	0.3918	1.7490

Calculations $(a+b)_{avg} = 1.66936\ \mu m = 1.6694 \times 10^{-4}$ cm $(N = 15000)$

$$a+b = \frac{2.54}{N} = \frac{2.54}{15000} = 1.6933 \times 10^{-4} \text{ cm}$$

Result: $(a+b)_{avg} = 1.6694 \times 10^{-4}$ cm & $(a+b) = 1.6933 \times 10^{-4}$ cm

Grating element (a+b) = 1.6933×10^{-4} cm

Experiment No. 4

Bandgap of a Semiconductor by Four probe Method.

Objective:

To determine the resistivity and band gap of a semiconductor by four probe method.

Prelab Questions:

1) Discuss briefly the electronic conduction in solids.
2) Derive an expression for the concentration of intrinsic carriers.
3) Drive an expression for the conductivity of intrinsic semiconductor.
4) What do you mean by band gap? Classify solids on the basis of bandgap.

Apparatus:

1) Probes arrangement
2) Sample: Gee crystal in the form of chip/slice
3) Oven: for the variation of temperature of the crystal from room temperature to about 200^0 C
4) Four probes set-up consists of:
   i) Multi range digital voltmeter
   ii) Constant current generator.
   iii) Oven power supply
5) Thermometer ($0\ ^0$C to $200\ ^0$C)

Circuit Diagram:

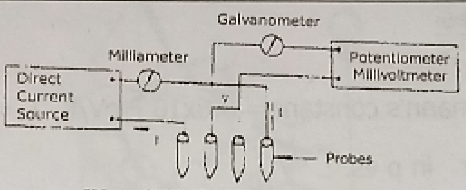


FIG. CIRCUIT USED FOR RESISTIVITY AND BAND GAP MEASUREMENTS

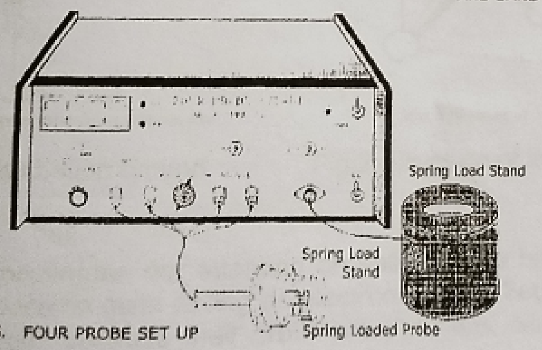
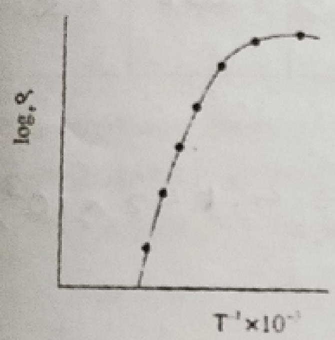


FIG. FOUR PROBE SET UP

Procedure:

1. Put the sample on the base plate of the four probe arrangement. Unscrew the pip holding the four probes and let the four probes and let the four probes rest in the middle of the sample. Apply a very gentle pressure on the probes and tighten the pipe in this position. Check the continuity between the probes for proper electrical contacts. **CAUTION:** The Ge crystal is very brittle. Therefore, use only the minimum pressure required for proper electrical contacts.
2. Connect the outer pair of probes (red/black) leads to the constant current power supply and the inner pair (yellow/green leads) to the probe voltage terminals.
3. Place the four probe arrangement in the oven and fix the thermometer in the oven through the hole provided.
4. Switch on the ac mains of four probe set-up and put the digital panelmeter in the current measuring mode through the selector switch. In this position LED facing mA would glow. Adjust the current to a desired value (Say 5 mA).
5. Now put the digital panel meter in voltage measuring mode. In this position LED facing mV would glow and the meter would read the voltage between the probes.
6. Connect the oven power supply. Rate of heating may be selected with the help of a switch Low or High as desired. Switch on the power to the oven. The glowing LED indicates the power to the oven is 'ON'

Graph: Plot a graph between $\log_e \rho$ Vs $T^{-1} \times 10^{-3}$



Observations:

1) Current (I) = ...5.....mA (Constant)

2) Distance between probes(S) = ..0..2.. cm

3) Thickness of the crystal (W) = .0...0.5... cm

Observation Table:

S. No.	Temperature (^0C)	Voltage (V)	Temperature (T) (K)	ρ (Ω-cm)	$T^{-1} \times 10^{-3}$ (K^{-1})	$Log_e ρ$
1.	30	447	303	19.04	3.30	2.94
2.	40	431	313	18.36	3.19	2.91
3.	50	392	323	16.69	3.09	2.81
4.	60	338	333	14.39	3.003	2.66
5.	70	276	343	11.75	2.91	2.46
6.	80	217	353	9.24	2.83	2.22
7.	90	168	363	7.15	2.75	1.96
8.	100	126	373	5.36	2.68	1.67
9.	110	94	383	4.004	2.61	1.38
10.	120	71	393	3.025	2.54	1.106
11.	130	54	403	2.3	2.48	0.83
12.	140	42	413	1.782	2.42	0.5817
13.	150	32	423	1.3632	2.36	0.3092

Calculations:

$$\text{slope} = \left(\frac{1.96 - 1.38}{2.75 - 2.61}\right) \times 10^{-3} = 4.142 \times 10^{3}$$

$$\therefore E_g = \text{slope} \times 2K_B$$

$$= 4.142 \times 10^{3} \times 2 \times 8.625 \times 10^{-5}$$

$$= \underline{0.706}\ eV$$

Result:

The band gap of a given semiconductor (Ge) is 0.7 eV

Post lab Q

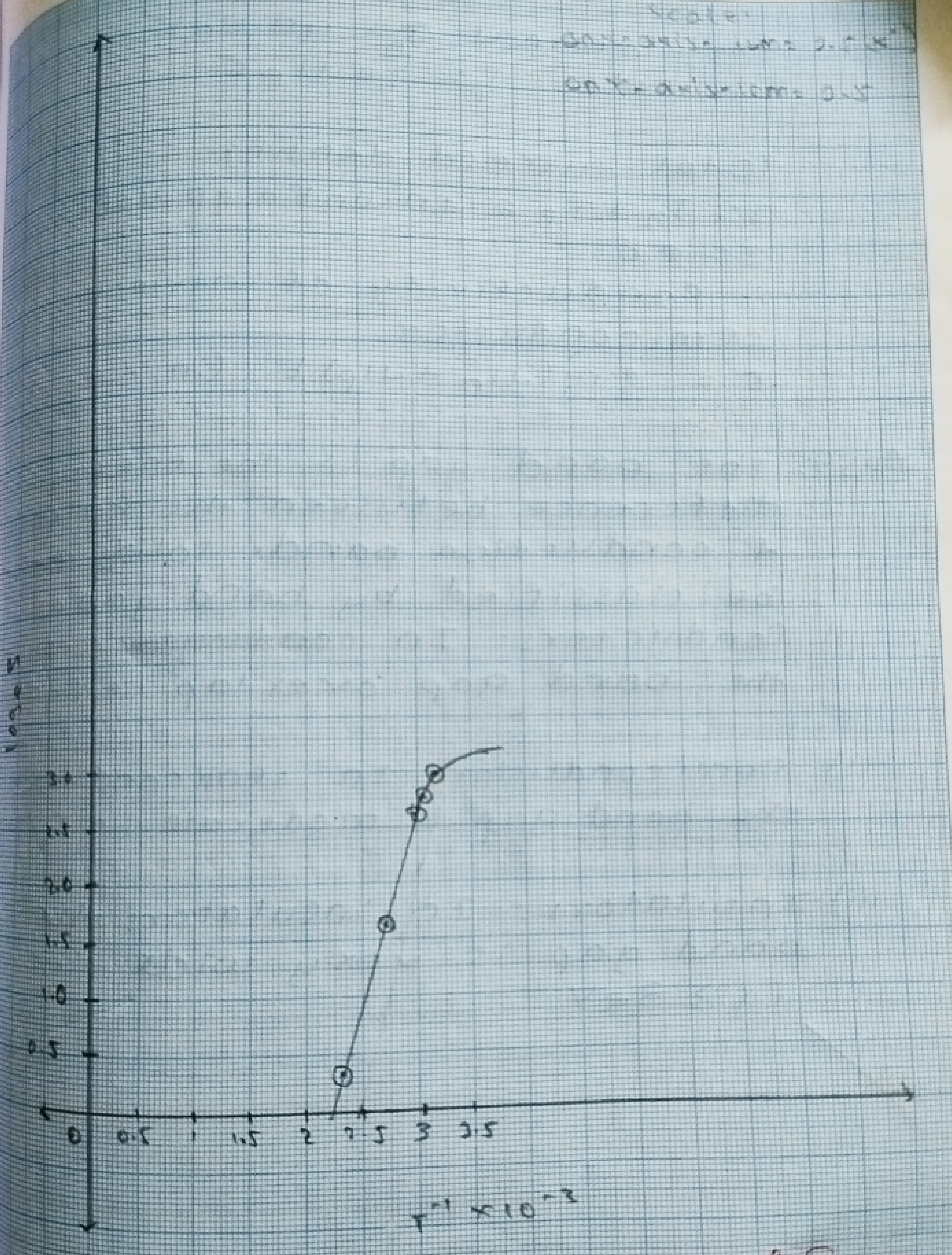
1)
2)
3)
4)

Ans 1) Th... mea... of m... apply...

Ans 2) The... as tem... temper... vity ... temper... coeff...

Ans 3) T... typica... disp...

Ans 4) ... decre... pho...


Scale:
on Y-axis 1cm = 0.5
on X-axis 1cm = 0.5
log k
3.0
2.5
2.0
1.5
1.0
0.5
0
0.5
1.5
2
2.5
3
3.5
$T^{-1} \times 10^{-3}$

Experiment No.5

Hall Effect In a Semiconductor

Objective :

1) To determine Hall-coefficient of a semiconductor
2) To determine the sign of majority carriers in the semiconductor
3) To determine the concentration of the majority carriers.
4) To determine the mobility of the majority carriers in the materials.

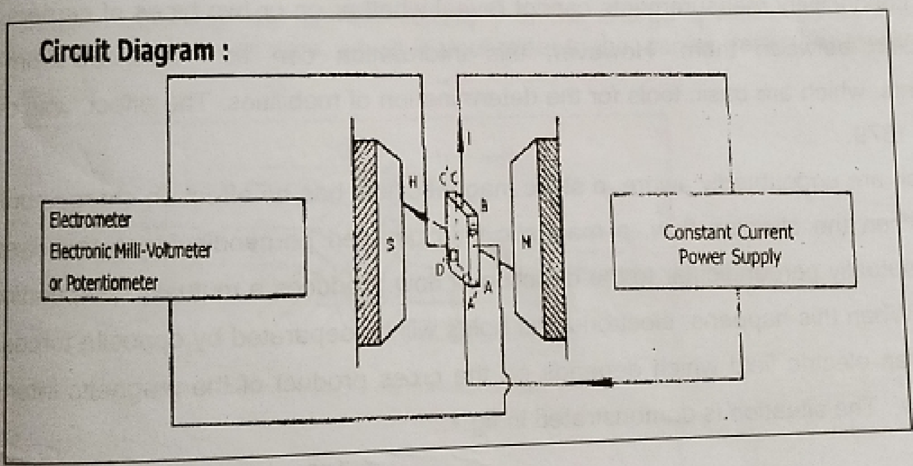
Prelab Questions :

1) Describe 'Hall Effect' in detail.
2) Derive an expression for Hall co-efficent (R_H).
3) Which parameters can be obtained using Hall effect and how they can be measured ?

Apparatus :

Hall effect set-up (Digital), DHE-21 which consists of (i) digital voltmeter (0-200 mV) and (ii) Constant current power (0-20 mA) supply, Hall probe (Ge crystal) Hall probe (Indium Arsenide), Constant current power supply for Digital Guass meter (0-4 A), Digital Gauss meter (0-2 K guass & 0-20 K guass), Electromagnet (EMU-75 or EMU-50 V)

Circuit diagram :



Observations :

Sample : Extrinsic

Thickness (t) : 0.05 m

Resistivity (ρ) : ......7... Ω cm

Conductivity (σ) : 14.28 $\Omega^{-1}m^{-1}$

Observations Table

I)At constant Magnetic field B = 5780 guass = 0.578 wb/m^2

Sr.No.	Current I (mA)	Hall Voltage $V_H(mV)$
1.	0	0
2.	0.5	4.6
3.	1.0	11.0
4.	1.5	15.0
5.	2.0	19.2
6.	2.5	24.2
7.	3.0	28.0
8.	3.5	31.0
9.	4.0	33.3

II)At constant current I = 3 mA = 3 $\times 10^{-3} A$

Sr. No	~~Sr.No.~~ Current	Magnetic Field		Hall voltage $V_H(mV)$
		guass	wb/m^2	~~0~~
1.	0	0	0	~~4.6~~ 0
2.	0.5	1120	0.112	~~11.0~~ 12.2
3.	1.0	2260	0.228	~~15.0~~ 23.8
4.	1.5	3480	0.348	~~19.2~~ 35
5.	2.0	4680	0.468	~~24.2~~ 45.3
6.	2.5	5780	0.578	~~28.0~~ 54.5
7.	3.0	6600	0.660	~~31.0~~ 65.8
8	3.5	7280	0.728	~~33.3~~ 75
9.	4.0	7810	0.781	85.6

Calculations :

1) Hall co-efficient

$$R_{H_1} = m_1 \times \frac{t}{B} = 6 \times \frac{t}{B} = \frac{6 \times 0.0006}{0.092} = 0.02$$

$$R_{H_2} = m_2 \times \frac{t}{B} = 0.0\ldots$$

$$R_{He} = \frac{R_{H_1} + R_{H_2}}{2} = \frac{0.084}{2} = 0.042$$

2) Carrier concentration (n or p)

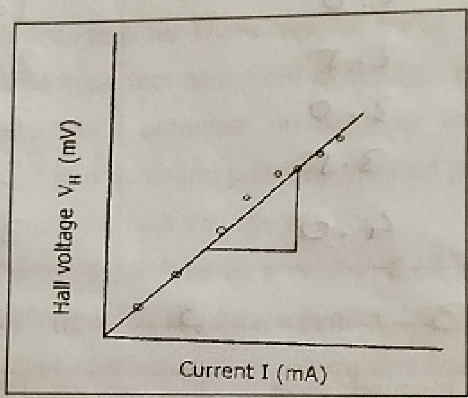
$$\rho_H = \frac{1}{n_i q} \Rightarrow n_i = \frac{1}{R_H q} = \frac{10^{19}}{0.042 \times 1.6} = 14.88 \times 10\ldots$$

3) Carrier Mobility

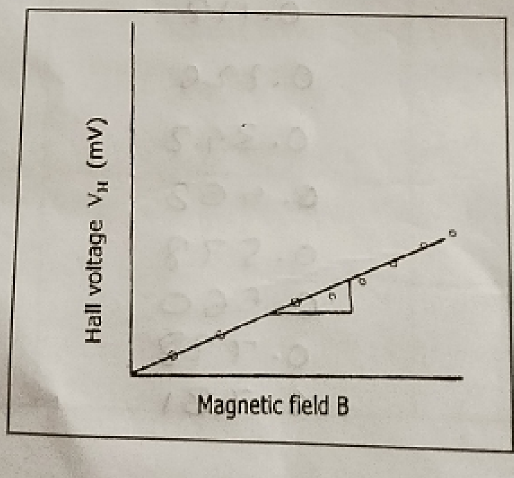
$$\mu = \sigma R_H = 14.28 \times 0.042 = 0.608$$

Graph :

I) Hall voltage V_H (mV) vs current I (mA) :



II) Hall voltage v_H (mV) vs Magnetic field (B) :



Result:

Polarity of the Hall Voltage	-ve
Majority Carriers	electrons
Type of given Semiconductor	n-type
Value of Hall co-efficient	$0.042\ m^3/C$
The concentration of the majority carriers	$1488 \times 10^{19}\ m^{-3}$
The mobility of charge carriers	$0.802\ m^2/Vs$

Postlab Questions :

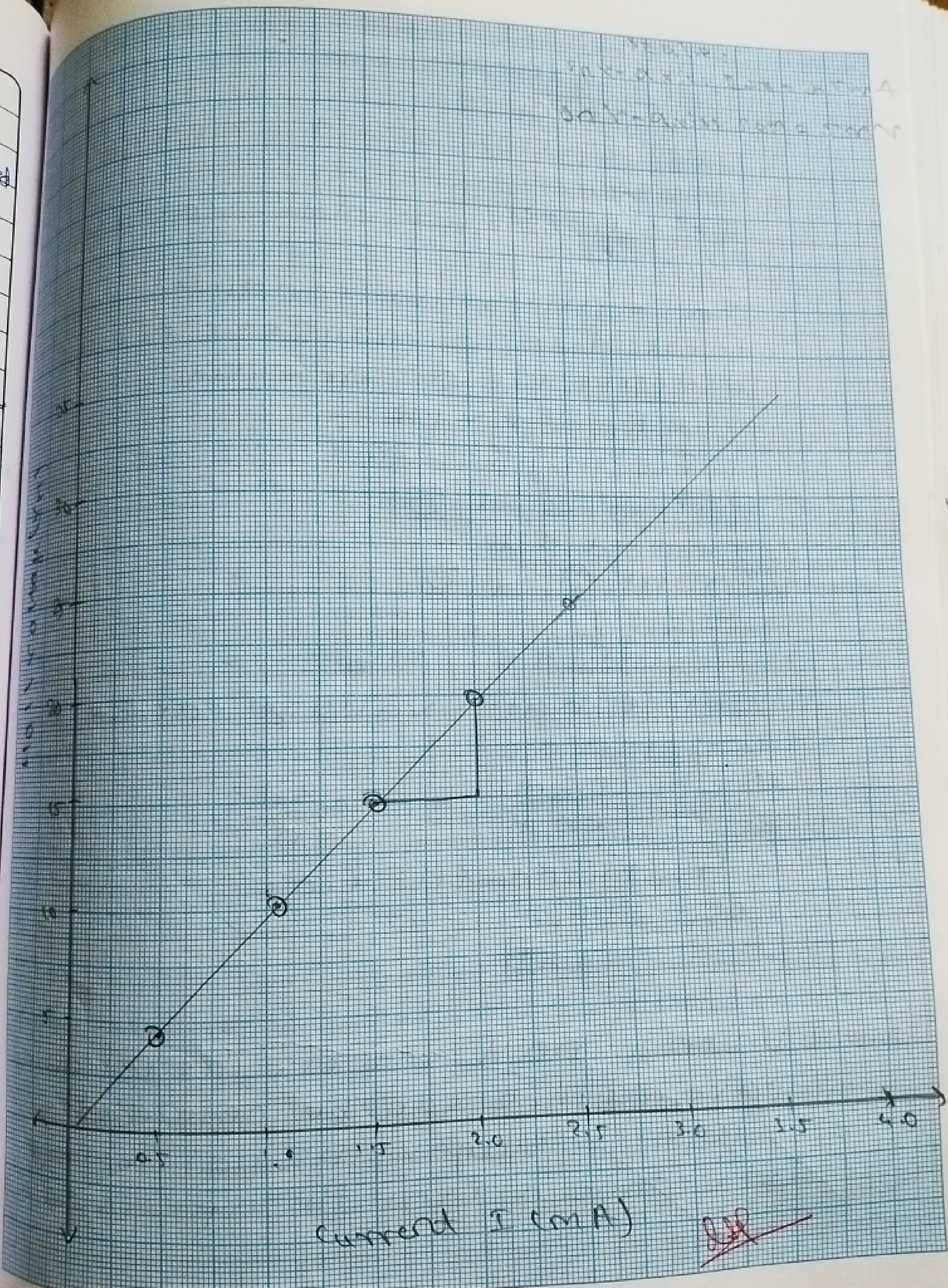
1) What is Hall Field and Hall voltage ? How are they produced in the material?
2) What will happen to the voltage, if current through the crystal reversed in its direction?
3) What will happen if the direction of the applied magnetic field reversed?
4) Can Hall effect be observed in conductors?

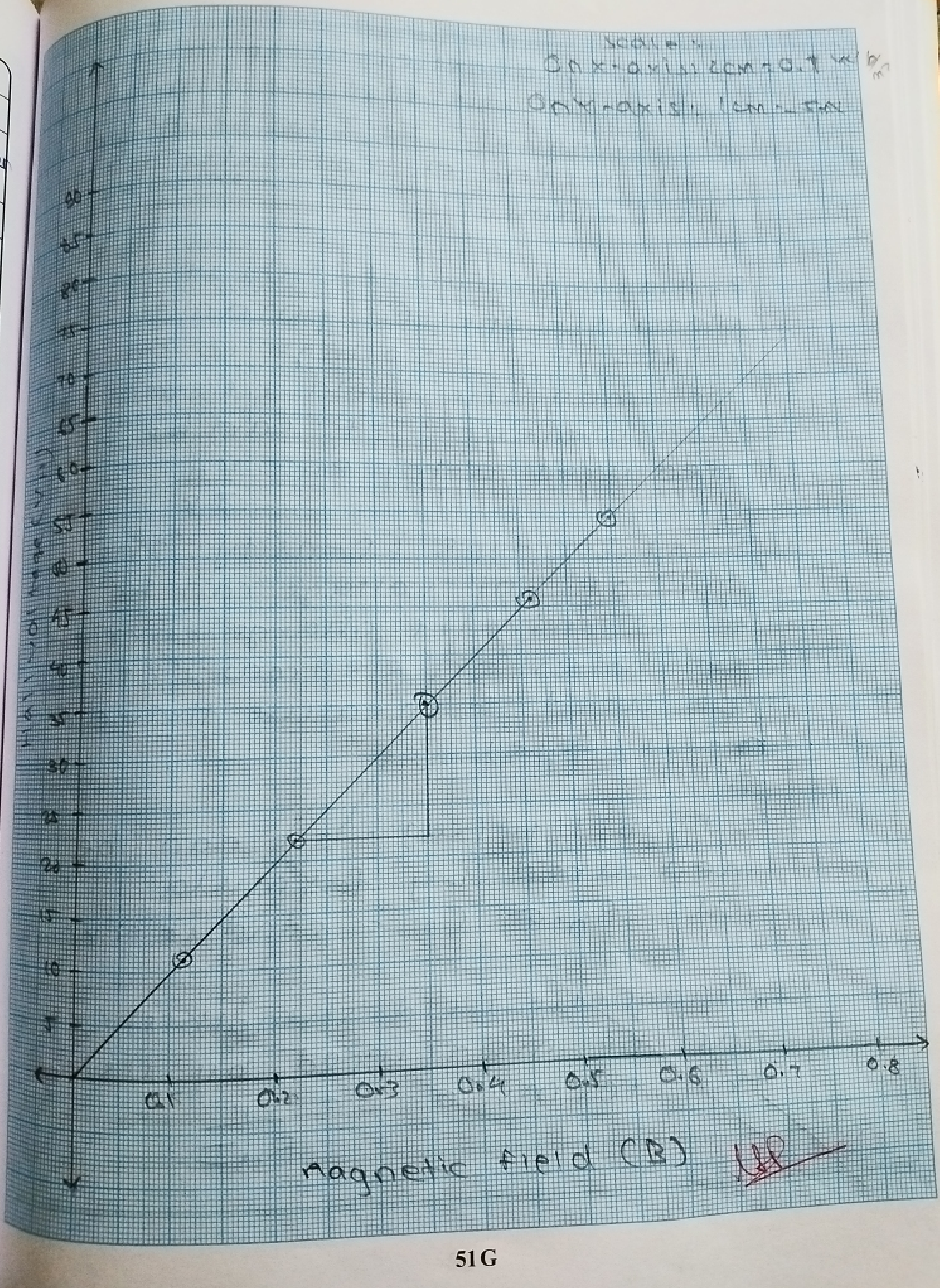
Ans1) when current is passed through semiconductor & transverse magnetic field is applied to it, the charges ~~are~~ experience force along edges. This develope a field called as Hall field & potential difference is produced called as Hall voltage.

Ans2) If current through crystal is reversed, the Hall voltage will change its polarity.

Ans3) If the direction of applied magnetic field is reversed, then the polarity of Hall voltage is also reversed

Ans4) yes, hall effect can also be observed in conductors as well as semiconductors.


0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
5
10
15
20
25
30
35
Current I (mA)


Scale :
On x-axis : 2cm = 0.1 wb/m²
On Y-axis : 1cm = 5mv
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
magnetic field (B)

Experiment NO. 6

STUDY OF P-N JUNCTION

Aim : To determine reverse saturation current I_0 and Material constant η

Apparatus: P-N junction (Base-Emitter Junction of BC109C) and I-V measurement apparatus

Theory

For a P-N junction the I-V rectifier equation is $I = I_0(e^{\frac{qV}{\eta kT}} - 1)$

Where η is material constant or called as ideality factor

For ideal diode case $\eta = 1$.

But the I-V characteristic of practical diode is found out to be slightly different from ideal nature because of following reasons…

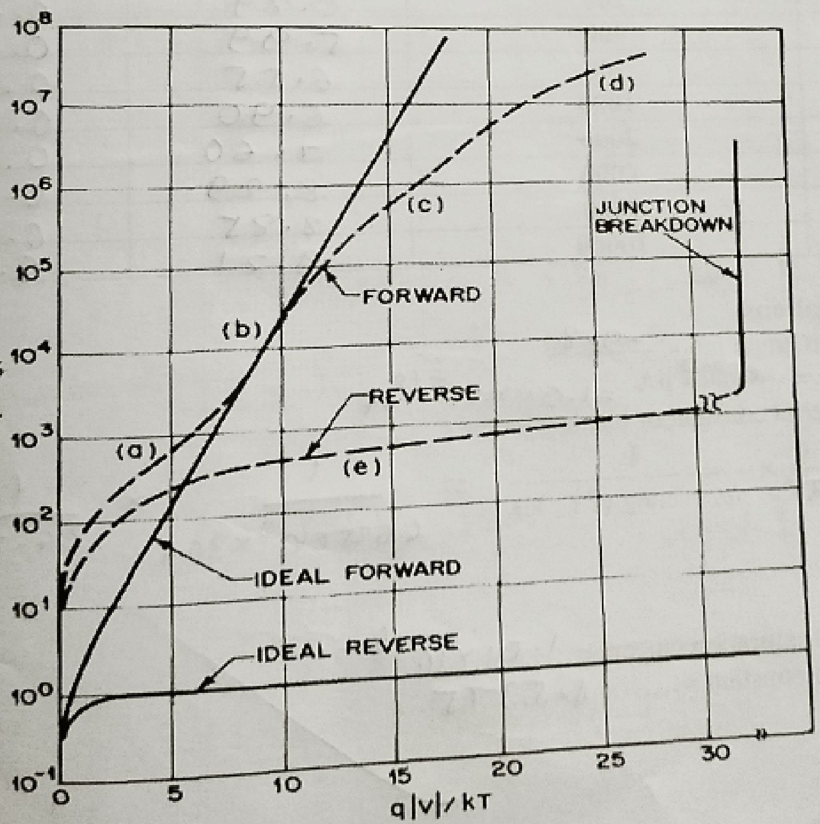
a) Surface effect : It is because of some ionic charges near semiconductor surface

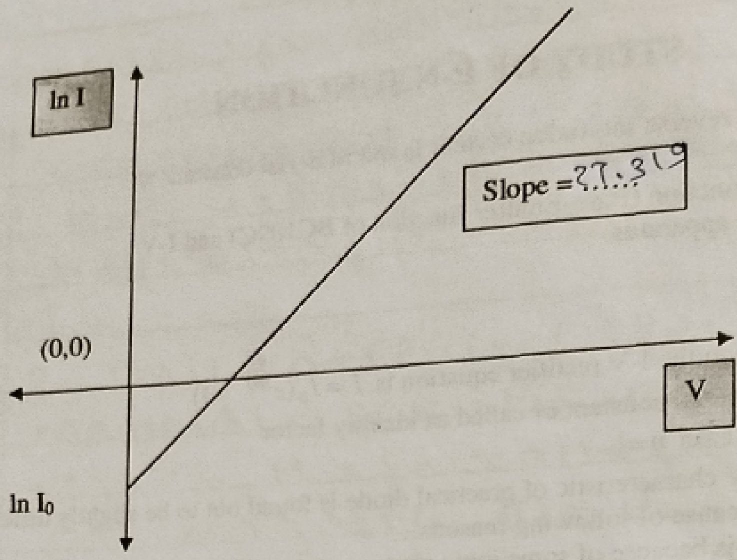
b) Generation-Recombination in depletion region

c) Tunneling of carriers between the states in bandgap

d) High injection case(Large forward bias)

e) Series resistance effect arising from high injection





Observation Table

Temp = 309 K

S.No.	Forward Current I (μA)	ln I	Diode voltage V(volts)
1	100	4.6	0.618
2	200	5.29	0.641
3	400	5.99	0.666
4	700	6.55	0.687
5	1000	6.90	0.700
6	2000	7.60	0.728
7	4000	8.29	0.751
8	7000	8.85	0.772
9	10000	9.21	0.786

Calculations

1) From graph $\ln I_0$ = -9.8

So I_0 = $e^{-9.8}$ μA $= 1.01 \times 10^{-10}$ A

2) Material constant or ideality factor

$$\eta = \frac{q}{KT} \times \frac{1}{slope(\ln I \_ v/s \_V)} = \frac{1}{6.625 \times 10^{9} \times 304} \times \frac{1}{24.75} = 1.5375$$

Result

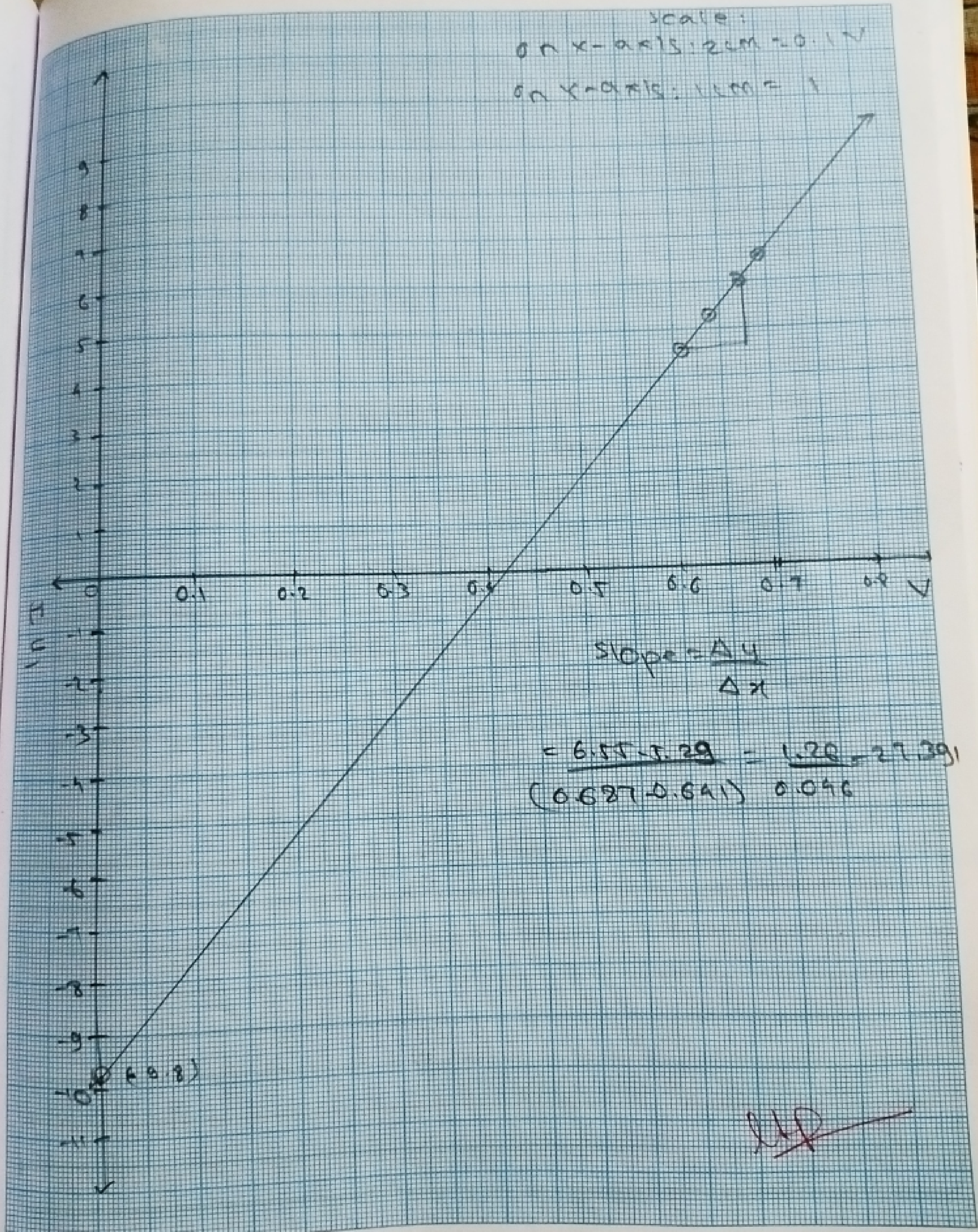
Reverse saturation current = 1.01×10^{-10} A

Material constant = 1.5375

K

lts)

375



Scale:
on x-axis: 2cm = 0.1V
on Y-axis: 1cm = 1
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
V
(9.8)
Slope = Δy / Δx
= 6.55 - 5.29 / (0.687 - 0.641) = 1.26 / 0.046 = 27.39

EXPERIMENT NO. 7

MAGNETORESISTANCE

Aim: Determine magnetoresistance of given semiconductor

Objective:

To determine the Magnetoresistance of a semiconductor by four probe method.

Apparatus:

1) Probes arrangement
2) Sample: Ge crystal in the form of chip/slice
3) Four probes set-up consists of:
   i) Multi range digital voltmeter
   ii) Constant current generator.

Introduction :

It is noticed that the resistance of the sample changes when the magnetic field is turned on. The phenomenon, called magnetoresistance, is due to the fact that the drift velocity of all carriers is not same. With the magnetic field on; the Hall voltage $V = E_y t = \vec{v}\vec{H}$ compensates exactly the Lorentz force for carriers with the average velocity; slower carriers will be over compensated and faster one undercompensated, resulting in trajectories that are not along the applied field. This results in an effective decrease of the mean free path and hence an increase in resistivity. Here the above referred symbols are defined as:

v = drift velocity;
E = applied electric field;
T = thickness of the crystal;
H = Magnetic field

Experimental Set-up for Magnetoresistance

1. Four Probe arrangement

It consists of 4 collinear, equally spaced (2mm) and individually spring loaded probes mounted on a PCB strip. Two outer probes for supplying the constant current to the sample and two inner probes for measuring the voltage developed across these probes. This eliminates the error due to contact resistance which is particularly serious in semiconductors. A platform is also provided for placing the sample and mounting the four probes on it.

2. Sample: Ge Crystal (n-type) dimensions : 10 x 10 x 0.5mm.

3. Magnetoresistance Set-up, Model DMR-11

Observation

Probe current (Constant for all readings), I = 2 mA

Sample resistance without magnetic field, R = 85.55 Ω [For Ge n-type crystal]

Observation Table II

Si. No.	Electro-magnet Current (A)	Magnetic Field H (kG)	Voltage V_m (mV)	$R_m = V_m / I$ (Ω)	ΔR/R
1	0	0	171.1	85.55	0
2	0.5	340	171.2	85.6	0.0006
3	1.0	700	171.3	85.65	0.0012
4	1.5	1090	171.5	85.75	0.0023
5	2.6	1460	171.9	85.95	0.0047
6	2.5	1840	172.4	86.2	0.0076
7	3.0	2220	173.0	86.5	0.0111
8	3.5	2590	173.6	86.8	0.0146
9	4.0	2930	174.3	87.15	0.0187
10					

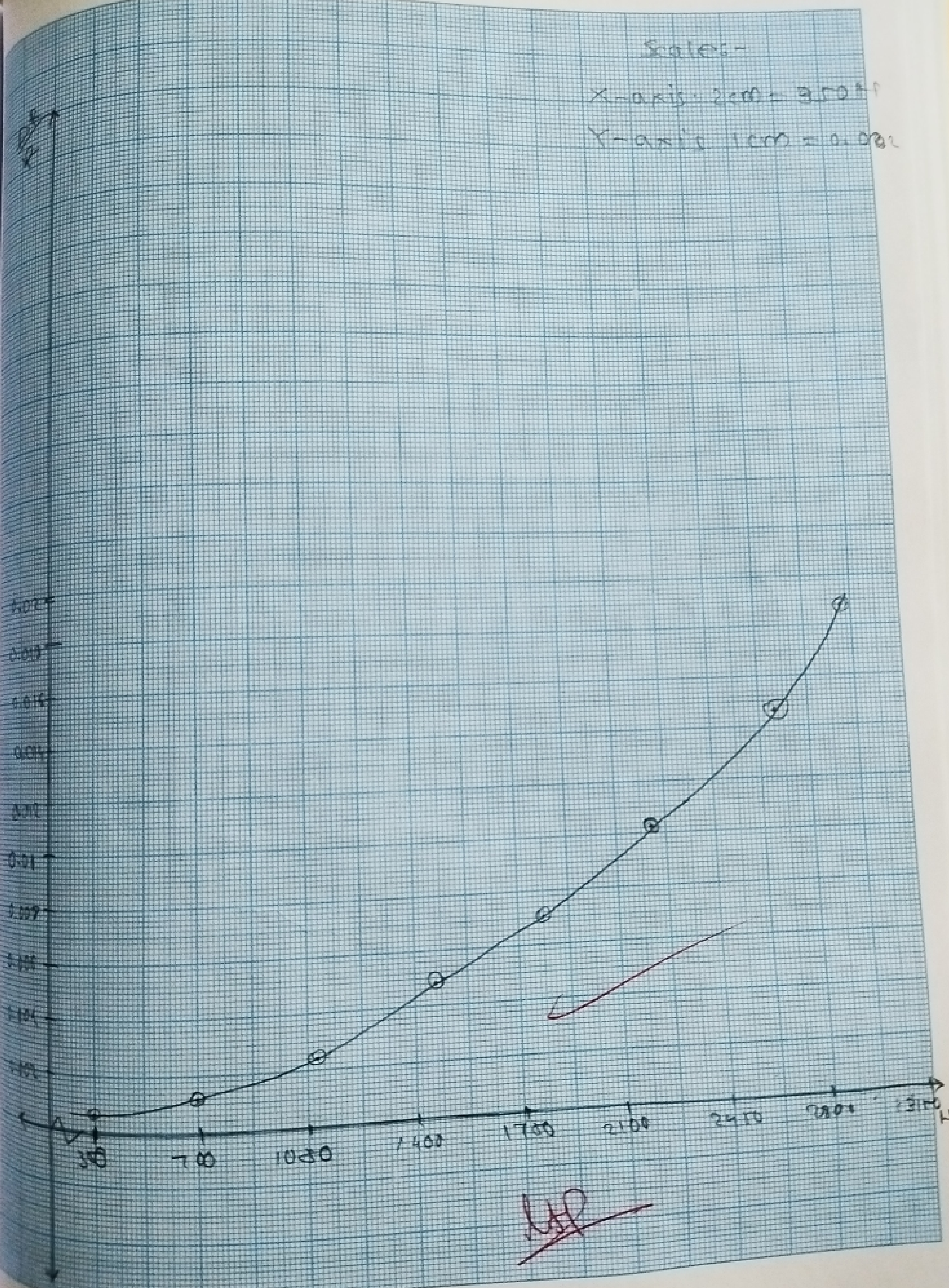
Calculations:

Formula $\Delta R/R = (R_m - R)/R$

$$\frac{\Delta R}{R} = \frac{(R_m - R)}{R} = \frac{(85.75 - 85.55)}{85.55} = \frac{0.2}{85.55} = 0.0023$$

RESULT:

(1) The resistance of semiconductor increases with an increase in the magnetic field.



Scale:-
X-axis: 2cm = 350 H
Y-axis: 1cm = 0.002
350
700
1050
1400
1750
2100
2450
2800
3150
H

EXPERIMENT NO. 8

DIELECTRIC CONSTANT

INTRODUCTION

A dielectric is a material having electrical conductivity low in comparison to that of a metal. It is characterized by its dielectric constant. Dielectric constant is measured as the ratio of the capacitance C of an electrical condenser filled with the dielectric to the capacitance C_0 of the evacuated condenser i.e.

$$\varepsilon = \frac{C}{C_0}$$

FRONT PANEL DESCRIPTION:

Front panel comprises of

i) Digital Volt meter (DVM), that measures the voltage across the dielectric cell (DC) or standard capacitor (SC).

ii) Switch S_1 to select di-electric cell or standard capacitor.

iii) Switch S_2 to select one of the standard capacitors SC_1, SC_2, SC_3

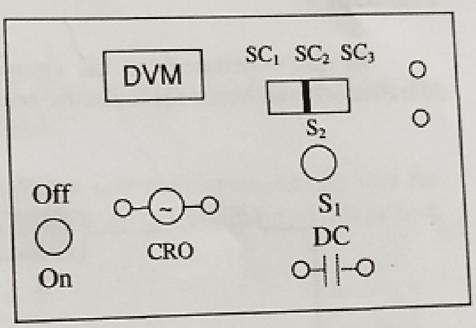


Fig. 1

Observation Table :

Dielectric Material	Glass	Plywood	PZT
Thickness of the sample (d) (mm)	4.66	2.8	1.08
Radius of the sample (r) (mm)	38	38	12
Standard capacitor position	SC1	Sc1	Sc2
V_{SC} (volt)	0.98	0.96	1.04
V_{DC} (volt)	1.11	1.30	2.38
$C_0 = \frac{r^2}{36d}$ (nf) $\frac{\varepsilon_0 A}{d}$ (f)	8.607×10^{-12} F	14.325×10^{-12} F	3.70×10^{-12} F
$C = \frac{V_{SC}}{V_{DC}}$ (pf)	44.144×10^{-12} F	36.92×10^{-12} F	5.881×10^{-9} F
ε	5.1288	2.577	1589.4

Result / Conclusion:

The Dielectric Constant of

i. Glass is 5.1288

ii. Plywood is 2.577

iii. PZT is 1589.4