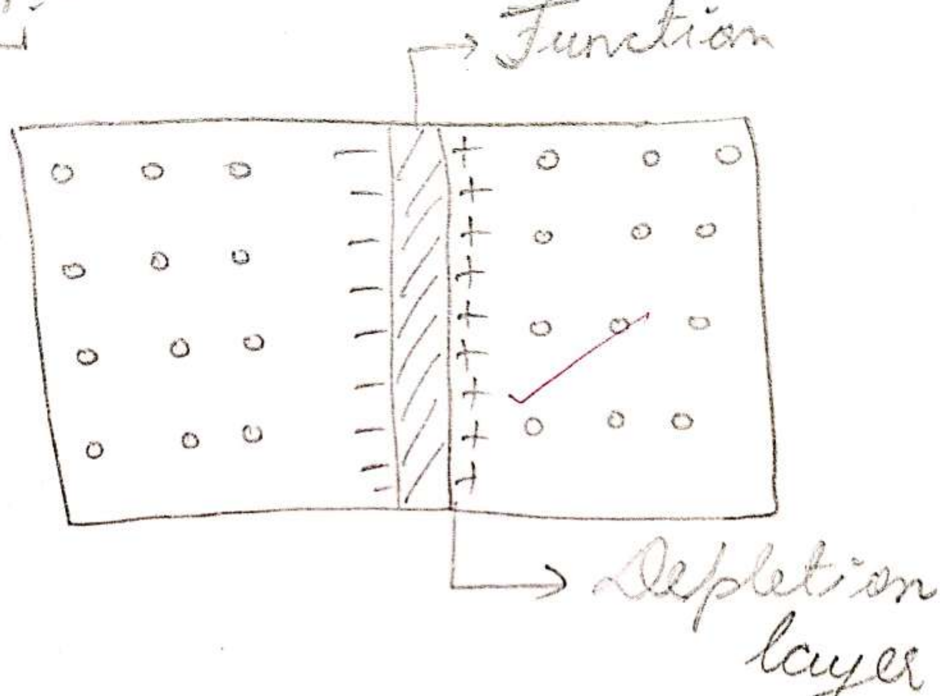
AIM → To study I-V characteristics of p-n junction diode.

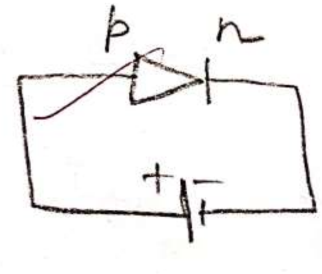
Diagram:-



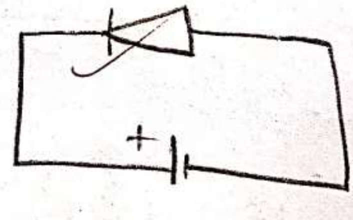
p-n junction diode

Symbols →

forward biased →



reversed biased →



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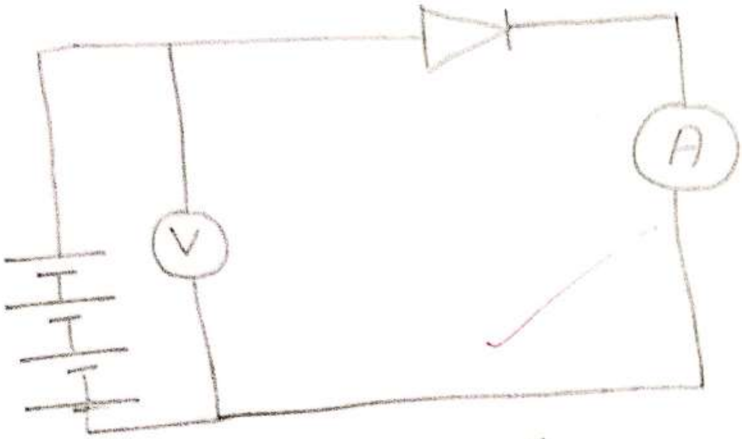
"Experiment - 1"

AIM:- To study I-V characteristics of a p-n junction diode.

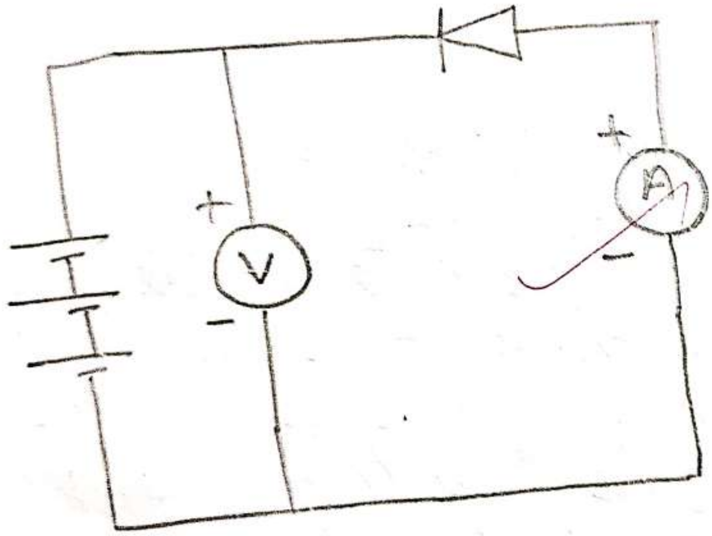
Apparatus:- A variable voltage supply, semi-conductor diode, milli-ammeter, micro-meter, connecting wires.

Theory:-

When a p-type crystal is joined with n-type crystal, the electrons from n-side are diffuse into n-side. As a result of which a region which is devoid of free charges known as depletion layer is formed. The resulting arrangement is called semi-conductor diode. When positive terminal of a battery is connected to p-type & -ve terminal is connected to n-type. The diode is said to be forward biased. In this case holes from p-side tends to cross the junction from p to n & electrons from n-side tends to cross the junction from n to p.
If p-side is connected to



p-n diode in forward biasing



p-n diode in reverse biasing

S No	Forward bias		Reverse bias	
	Voltage (V)	Current (I)	Voltage (V)	Current (I)
1	0	0	0	0
2	0.25	0	2.5	2
3	0.50	0.2	5.0	3
4	0.75	1.8	7.5	4
5	0.80	2.8	12.0	6
6	0.90	3.6	12.5	8
7	1.25	6	20	18
8	1.50	8.2	24	20

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negative terminal of battery and n-side is connected to positive terminal of battery, the diode is said to be reverse biased.

Procedure:-

a) Forward characteristics:-

i) Electrical connection are to be made as shown in figure.

ii) Vary the voltage in small steps & measure corresponding current in milli-meter

iii) Plot a graph b/w applied voltage & forward current.

b) Reverse characteristics:-

i) Make the electrical connection as shown in figure.

ii) Vary the voltage in small steps & measure corresponding current in micro-ammeter.

iii) Plot a graph b/w applied voltage and reverse current.

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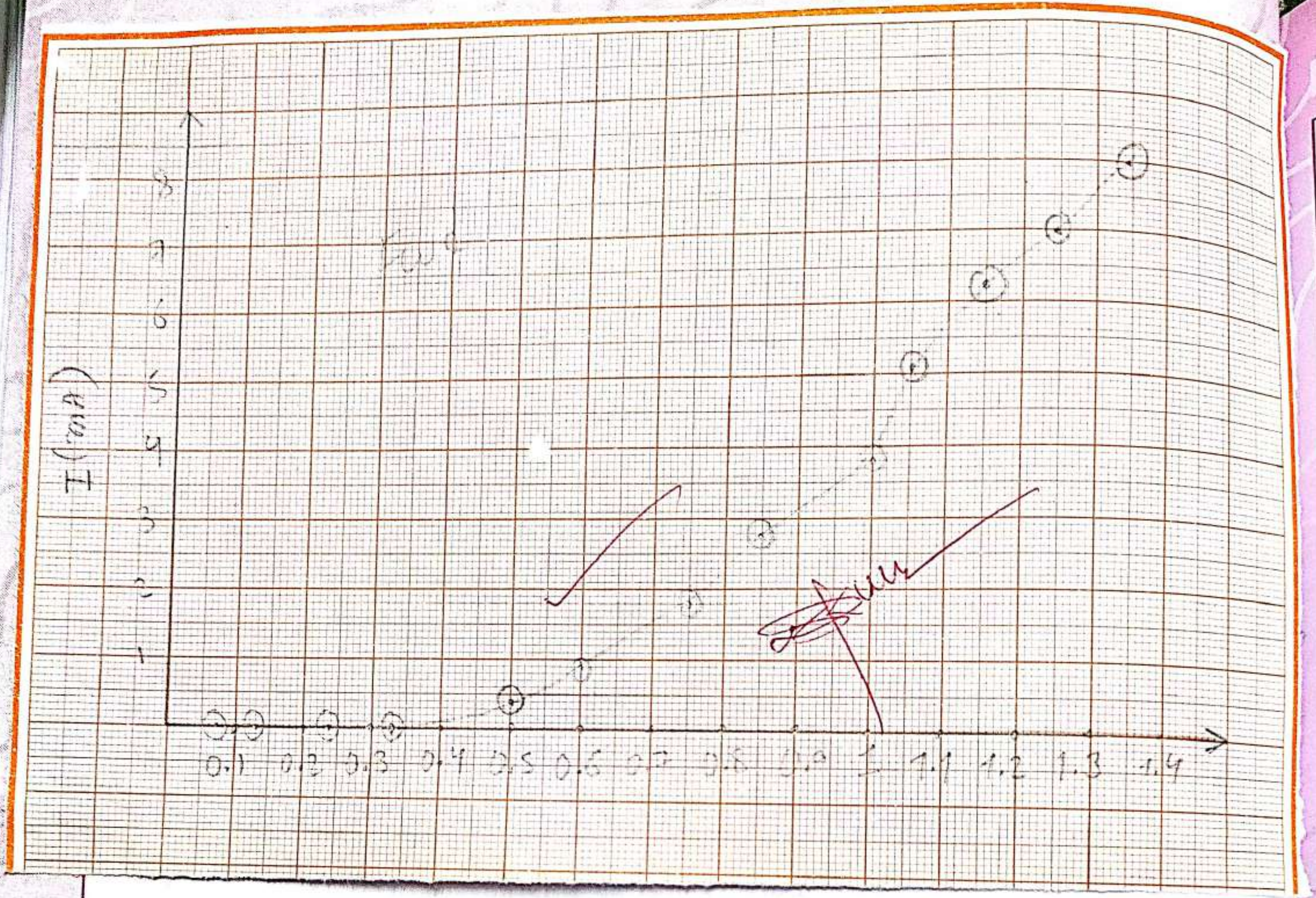

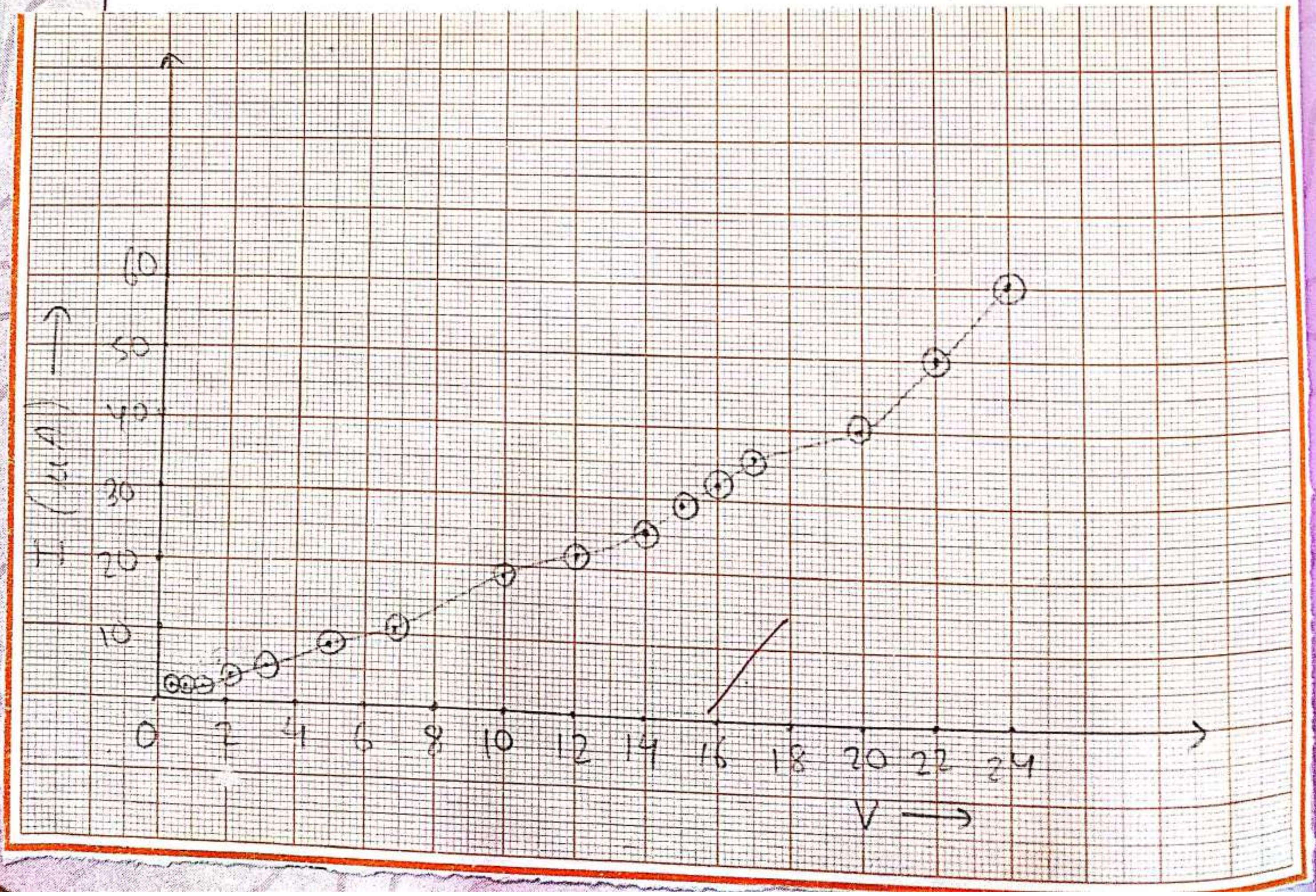

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Observations:- On left side Table- 1

Precautions:-

i) To avoid damage of diode due to over heating current should not be passed through it for longer time.

ii) Voltage should be below safety limit of diode.

iii) Connections should be properly checked.

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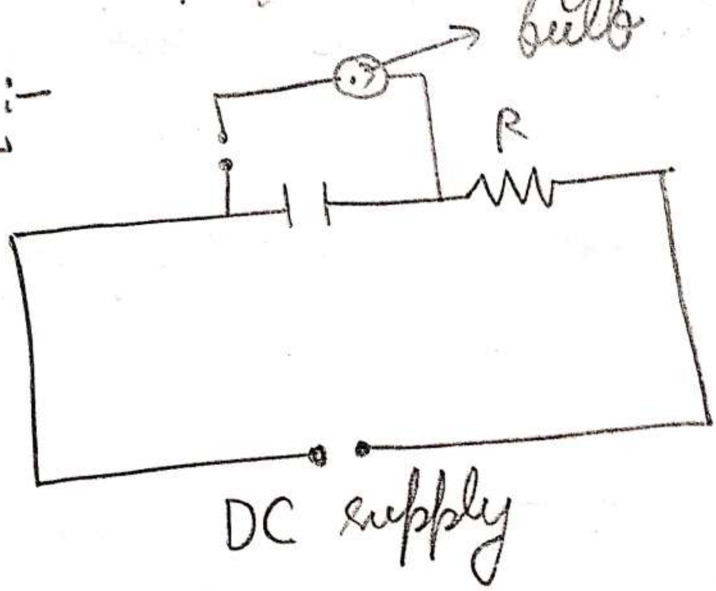
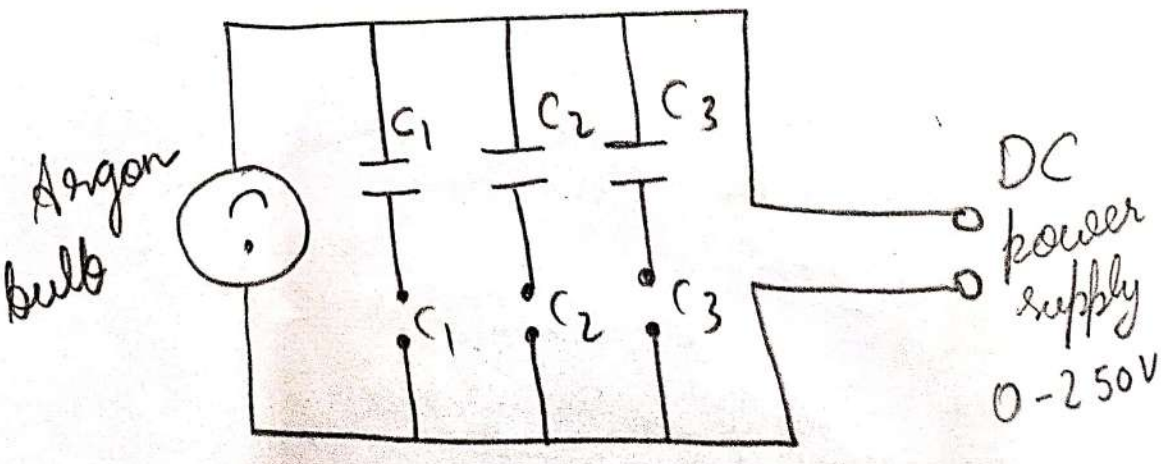
Aim → To find flashing & quenching potential of argon bulbs and to find capacitance of unknown capacitor.

Apparatus required → A capacitor of unknown capacitance, 3 capacitor of known capacitance, resistance of few mega ohm, a argon flashing bulb, DC power supply, one way keys.

DIAGRAM:-





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"Experiment-2"

AIM - To find the flashing and quenching of Argon bulb and to find capacitance of unknown capacitor

Theory :- The growth of charge in RC circuit is $q = q_0 (1 - e^{-t/RC})$ — (1)

If V_0 is the potential corresponding to the maximum charge q_0 & V corresponding to instantaneous charge q, then :

$$q_0 = CV_0$$
$$q = CV$$
$$CV = CV_0 (1 - e^{-t/RC})$$
$$V = V_0 (1 - e^{-t/RC}) \quad \text{— (2)}$$

If an argon bulb is placed in parallel with the condenser and supply voltage is increased and a supply voltage is increased starting from zero, at striking potential (V_S), the bulb begins to flash to glow as soon as the argon lamp flashes it begins to conduct charge through it.

The condenser then again begin

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OBSERVATION :-

SNO	Known capacitor	Time for 20 flashes	
		without C_0	with C_0
1	C_1 (0.5 Ω)	9	12
2	C_2 (1 Ω)	18	21
3	$C_1 + C_2$ (1.5 Ω)	26	29

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to charge till flashing potential V_s is reached again & it begins to glow again thereby become conducting. The process is thus repeated.

from eq^n - 2

$$V_C = V_s \left(e^{-t_1/RC}\right)$$

$$t_1 = -CR \log_e \left(\frac{V_c}{V_s}\right)$$

$$V_C = V_S \left(1 - e^{-t_2/RC}\right)$$

$$t_2 = -CR \log_e \left(1 - \frac{V_c}{V_s}\right)$$

$$t = t_1 + t_2$$

$$t = KC$$

$$K = \left[-R \log_e (V_c/V_s) - R \log_e \left(1 - \frac{V_c}{V_s}\right)\right]$$

Thus graph b/w t & c will be straight line.

Procedure:-

Following procedures needed to be taken:-

i) Connect the capacitor, by inserting key K,

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and switch on the power supply. Adjust DC supply voltage so that bulb start flashing and quenching. Note flashing time for 20 flashes. Switch off power supply without disturbing voltage setting knob.

ii) Put plug in key (K_3) so that unknown capacitor C_0 is in parallel with C_1. C_0 and C_1 are in parallel, therefore, the total capacity with bulb is $[C_1 + C_0]$. Again switch on the power supply and note time for 20 flashes.

iii) Now repeat the experiment with capacity C_2, $(C_2 + C_0)$, C_3, $(C_3 + C_0)$. Then with $(C_1 + C_2 + C_0)$ each time taking the time for 20 flashes.

Calculations:-

$C_0 = C_a - 1 =$

$C_0 = C_b - 1 =$

$C_0 = C_c - 1 =$

$C_0 = C_d - 1 =$

$C_0 = C_e - 1 =$

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Calculation :-

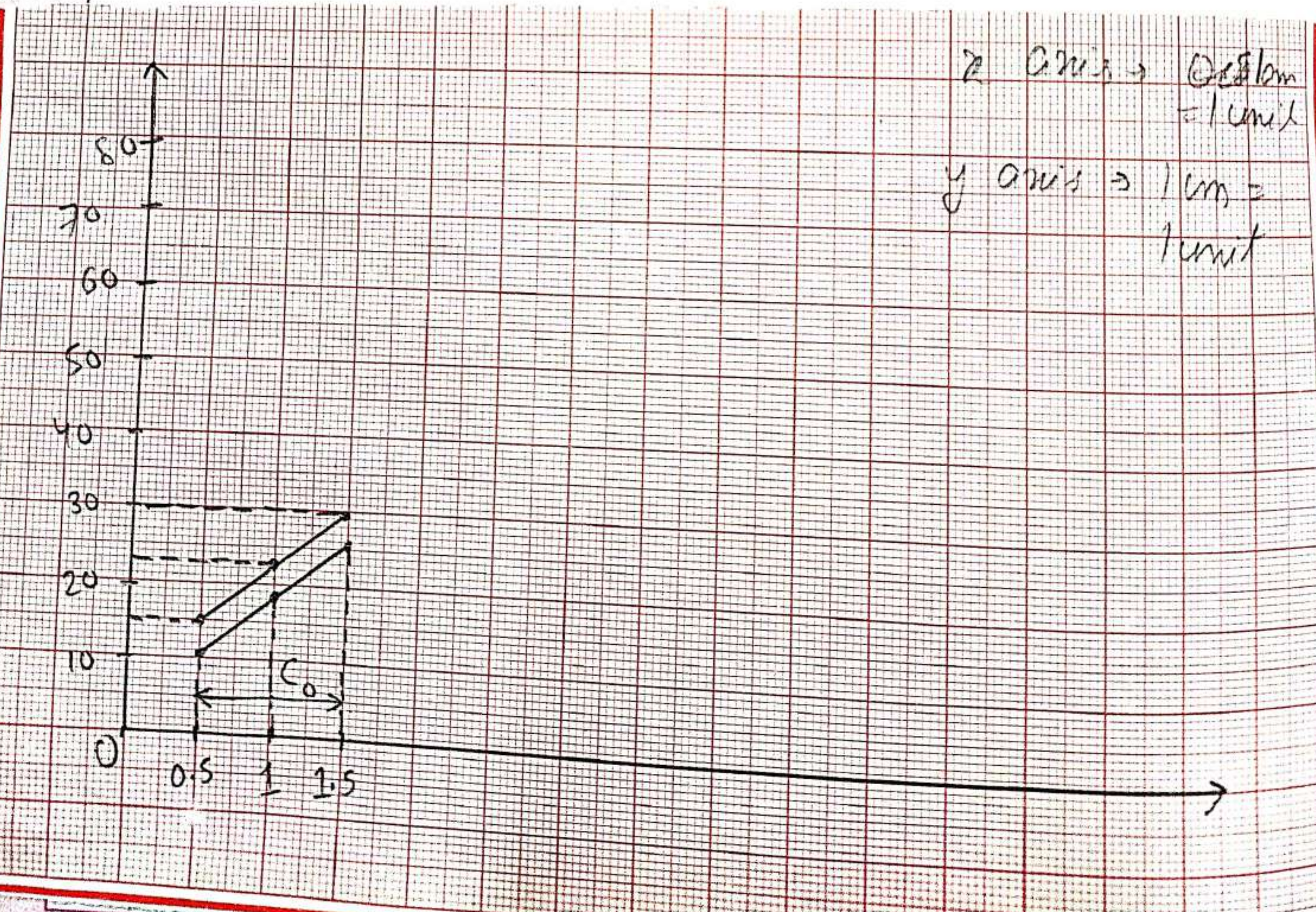
$C_0 = C_a - 0.5 = 0.5 - 0.5 = 0$

$C_0 = C_b - 0.5 = 1 - 0.5 = 0.5$

$C_0 = C_c - 0.5 = 1.5 - 0.5 = 1$

mean $\rightarrow C_0 = \frac{0 + 0.5 + 1}{3} = \frac{1.5}{3} = \frac{15}{30} = \frac{1}{2} = 0.5$

Result :- Capacity of $C_0 = 0.5$ uf



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C_0 least count of stop-watch = $\frac{}{6}$

=

Precautions:-

i) Check all the wires are working.
ii) Wires must be neat & clean.
iii) Connection needed to be tight.
iv) Avoid any personal error.

Sources of error:-

i) Connections may be loose
ii) Wires may not be clean.
iii) Connections may not be correct.
iv) Any personal error.

Result:-

Capacity of C_0 =

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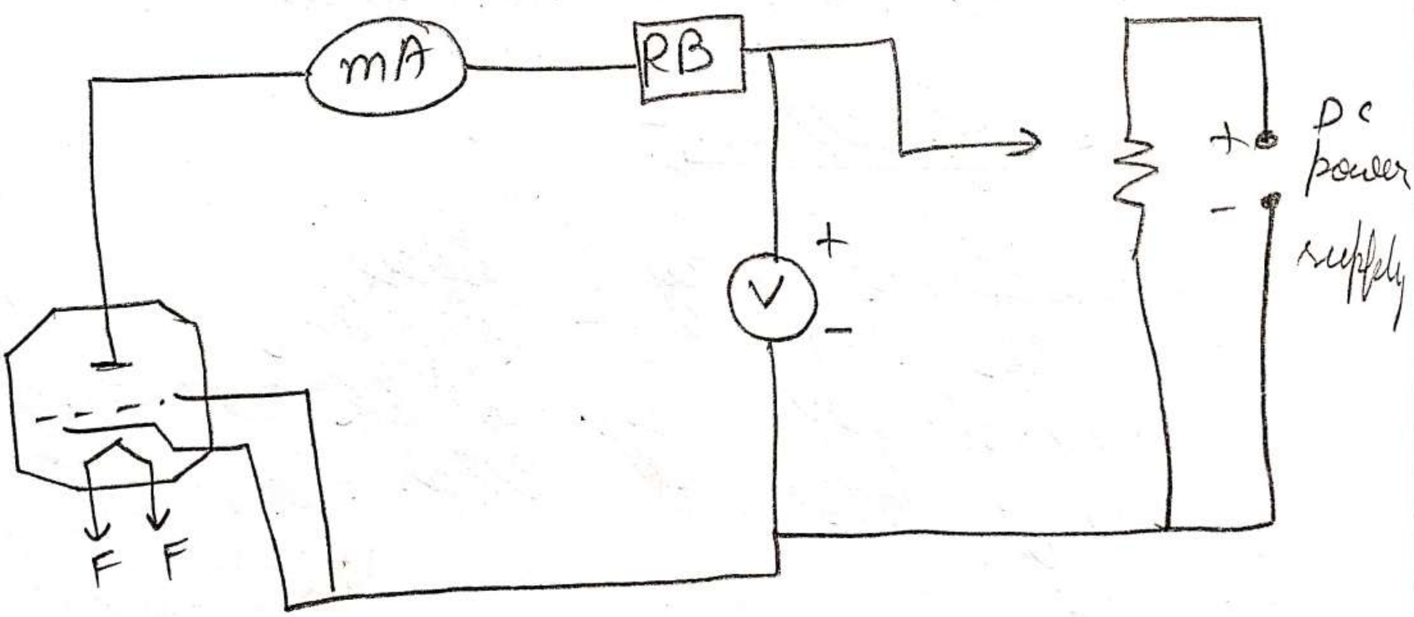
AIM:- To find ionisation potential of mercury using thyraton valve / tube.

Apparatus required:- A thyraton tube, a DC power supply, voltmeter, milli-ammeter, rheostat, connecting wires etc ~~or a~~

Diagram:-



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'Experiment - 3'

AIM:- To find ionisation potential of mercury using thyratron valve.

Theory:-

Ionisation potential is defined as the minimum amount of energy required in electron volts to just remove the electron from an atom.
The ionisation potential of mercury can be determined by filling a vapours of mercury in a diode or triode tube.
The hot cathode gas filled diode is known as phanotron and gas filled triode is known as thyratron.
When positive potential applied to plate is increased slowly. This is because the e- at anode gain enough energy to knock out e- from the atoms of the gas close to anode. This value of plate potential at which plate current shares marked increase is known as ionisation potential of gas.
If graph is plotted b/w plate potential &

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Observation:-

S.No.	Voltage	Current
	0	0
1	1.25	0.5
2	2.50	1.0
3	3.75	1.5
4	5.0	2.5
5	6.25	3.5
6	7.50	4.5
7	8.95	5.5
8	10	6.5
9	11.25	10.5
10	11.50	14.5
11		
12	11.75	Out of scale 40

plate current, the plate current at first increases slowly for increase in plate voltage and when the plate potential is equal to or greater than the ionisation potential there is a greater increase in plate current for the same increase in plate potential.

Procedure:-

i) Make connection as shown in circuit diagram.
ii) Switch on the power supply & apply suitable potential to filament FF.
iii) Apply plate potential of 1 Volt and note the corresponding plate current.
v) Increase the plate potential in steps of 0.5 V or less and note corresponding plate current till the plate current increases much more rapidly.
iv) Increase the plate potential by one volt and note increasing plate current till the plate potential is about 9V.
vi) Plot a graph b/w plate voltage and plate current along the x-axis and plate current along y-axis.

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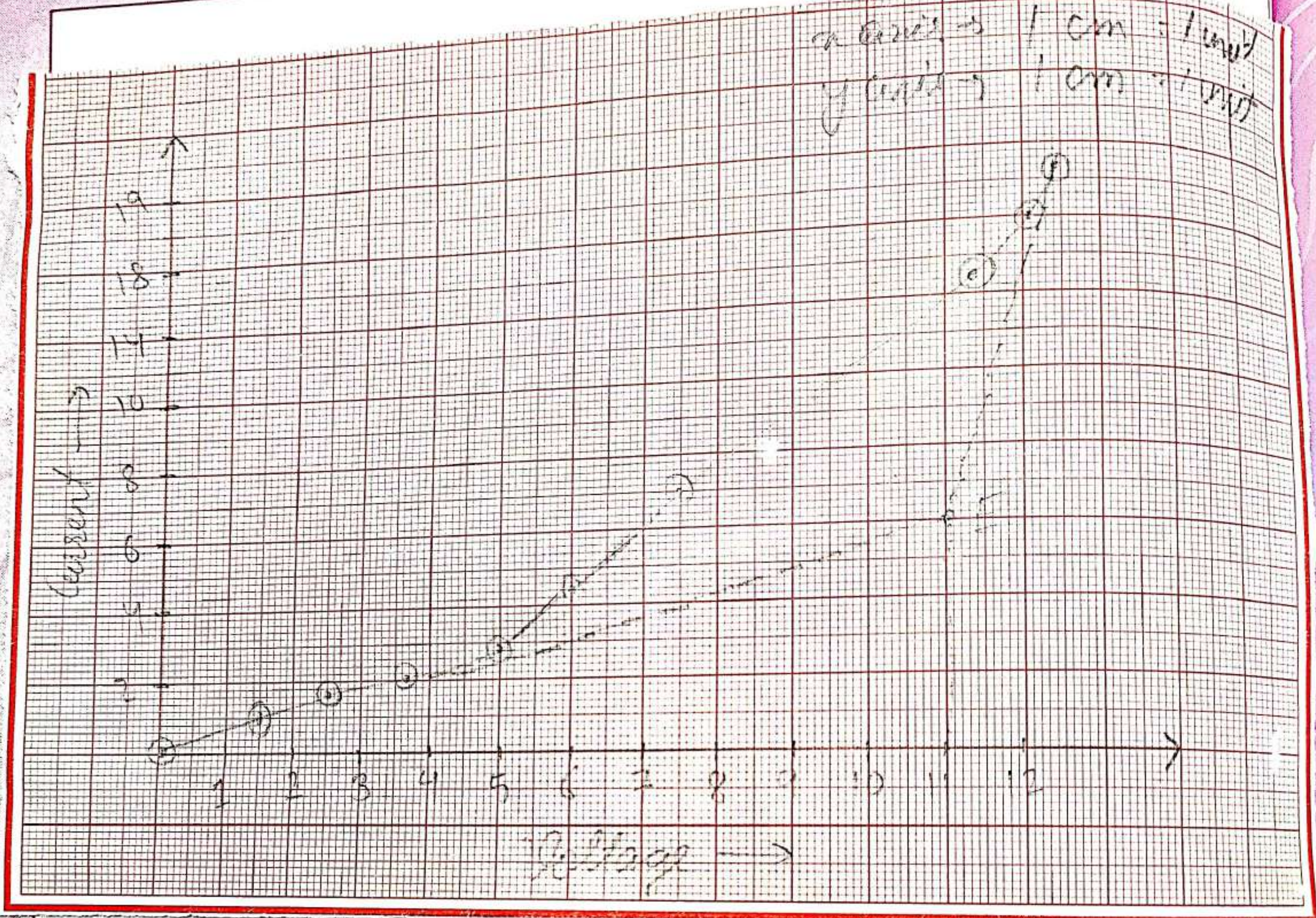

Result → Ionisation potential of mercury from the graph <u>11</u> volts

SV of mercury = 11.2 V

$$\% \text{ error} = \frac{SV - OV}{SV} \times 100$$

$$= 1.7\%$$

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Precautions:-

i) A gas filled mercury vapour triode/ diode must be used.
ii) The positive of the voltmeter and that of the milli-ammeter must be connected to positive of the DC supply.
iii) The plate potential should not exceed 13-15 volt.
iv) Avoid any personal errors.

Sources of error:-
i) May be a defect in mercury.
ii) Connection may not be ~~in~~ tight.
iii) The plate potential exceeds 13-15 volts.
iv) Any personal errors.

Result:-

Ionisation potential of mercury from the graph ___ volts.

S.V. of mercury =
Percentage error =

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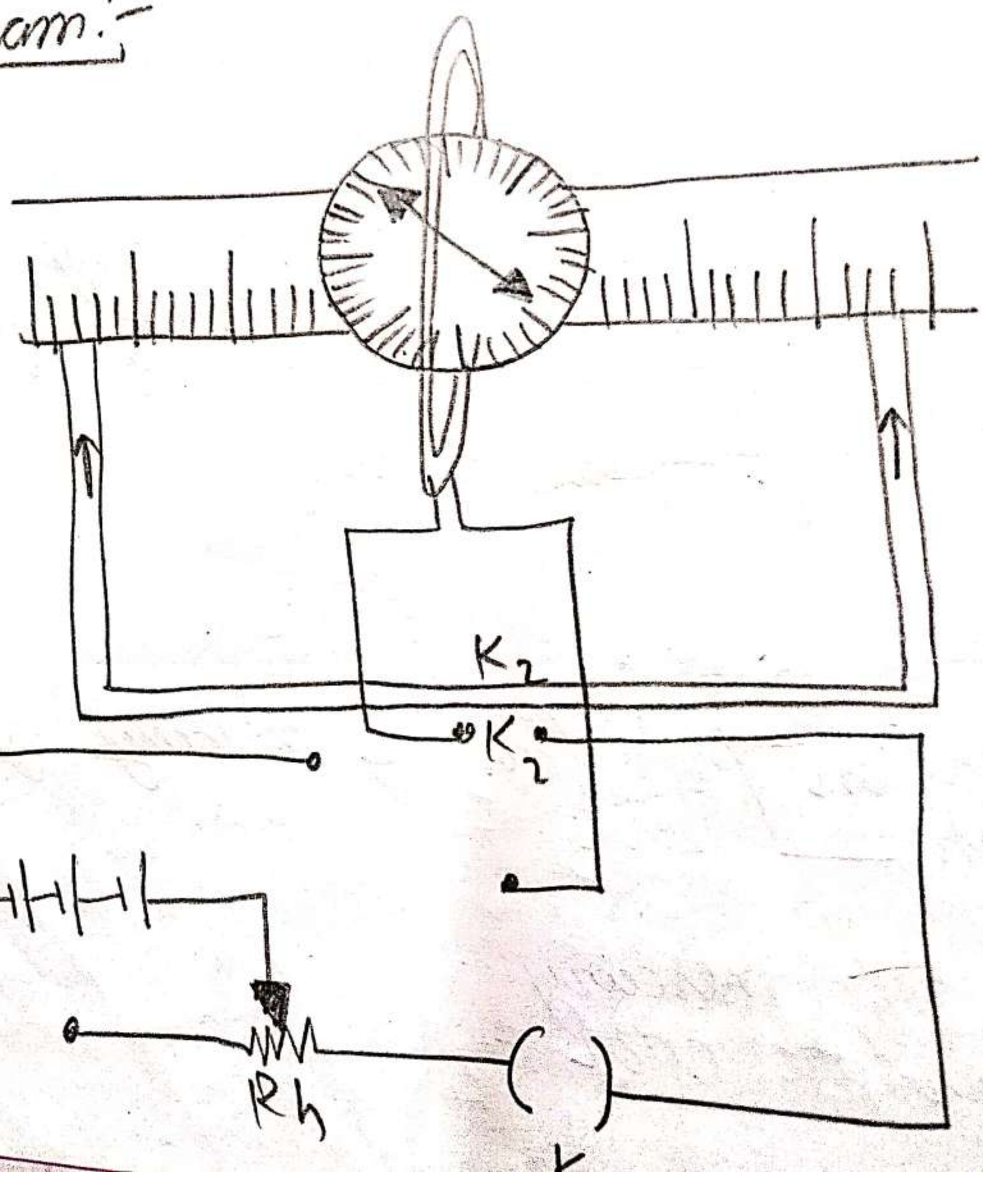
AIM:- To study the variation of magetic along the axis of a circular coil carrying current and to estimate the radius of a coil.

Apparatus required - Steward and Gee type tangent galvanometer, a battery eliminator, rheostat, a reversing key, connecting wires, spirit level, etc.

Diagram:-



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'Experiment-4'

AIM :- To study the variation of magnetic field along the axis of a circular coil carrying current & to estimate the radius of coil.

Theory :-

The magnetic field along the axis of a circular coil carrying current is given as :-

$$F = \frac{\mu_0}{4\pi} \cdot \frac{2\pi n I a^2}{(x^2 + a^2)^{3/2}} \quad -(1)$$

where →

n = no. of turns of coil.
a = radius of coil.
I = current flowing in the coil.
X = dist. of a point on the axis from center of coil.

If F is $\perp^r$ to horizontal component of earth's magnetic field & θ is the deflection in tangent galvanometer on passing current I, then by tangent law

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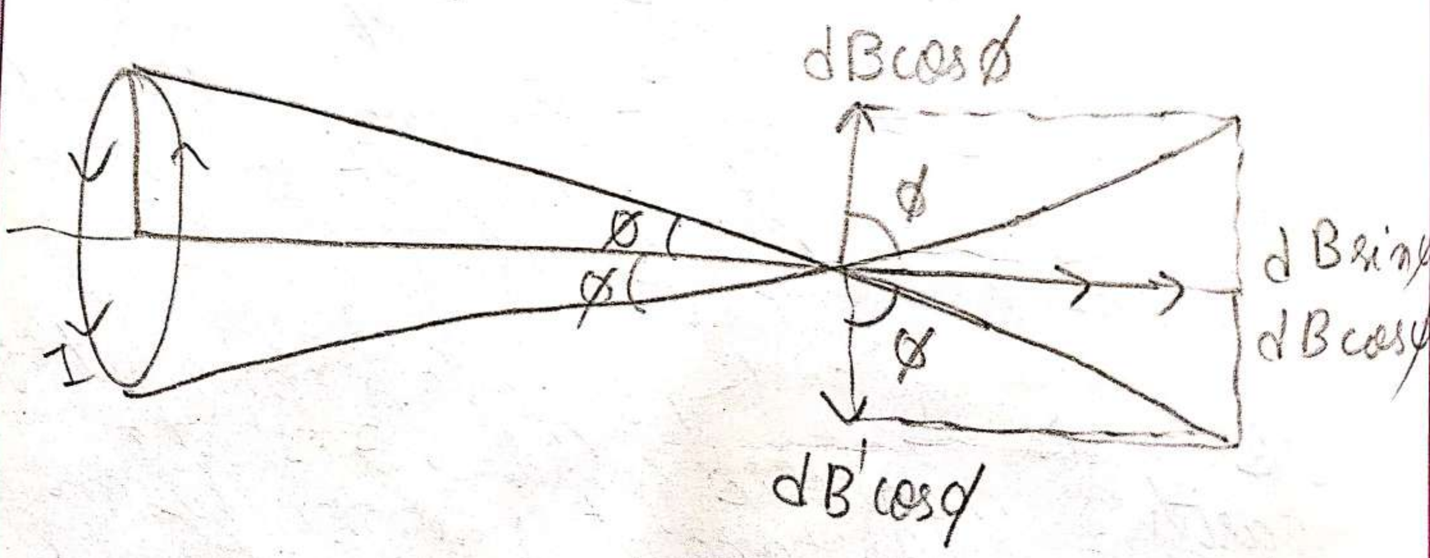
Observation table:-

Dist of magnetometer bar from central x(cm)	Deflection on right side				mean θ	tan θ	Deflection left side				Mean θ	tan θ
	Direct		Reverse				Direct		Rev.			
	θ_1	θ_2	θ_3	θ_4			θ_1	θ_2	θ_3	θ_4		
0 cm	78	78	80	80	79	51	74	74	76	75		3.48
5 cm	75	75	72	72	73.5	3.38	75	73	74	73	73.5	3.35
10 cm	65	65	64	64	64.5	2.10	64	64	60	61	62	1.90
15 cm	45	45	43	43	44	0.96	45	45	41	42	43	0.98



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$F = 4\tan\theta$ — (2)

from eq^n (1) & (2)

$$F = 4\tan\theta = \frac{\mu_0}{4\pi} = \frac{2\pi n a^2 i}{(x^2+a^2)^{3/2}}$$

$$F \propto 4\tan\theta \propto \frac{1}{(x^2+a^2)^{3/2}}$$

Thus graph b/w $\tan\theta$ & x will be similar to graph b/w F & x.

$$\frac{d^2F}{dx^2} = 0$$

from eq^n (3), we have

$$F = \frac{A}{(x^2+a^2)^{3/2}}, \text{ where } A = \frac{\mu_0 \cdot 2\pi n a^2}{4\pi} i$$

$$\frac{dF}{dx} = -3A(x^2-a^2)^{-5/2}$$

$$\frac{d^2F}{dx^2} = -3A\left[(x^2-a^2)^{-5/2} - 5x^2(x^2-a^2)^{-7/2}\right]$$

$$\frac{d^2F}{dx^2} = 0$$

$$\therefore -3A\left[(x^2-a^2)^{-5/2} - 5x^2(x^2-a^2)^{-7/2}\right] = 0$$

$$5x^2 = x^2 + a^2 \Rightarrow 5x^2 - x^2 = a^2$$

$$\boxed{x^2 = \frac{a^2}{4}} \Rightarrow \boxed{x = \pm\frac{a}{2}}$$

Thus, point of inflexion are at $x = \pm a/2$

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a = radius of circular current carrying coil.

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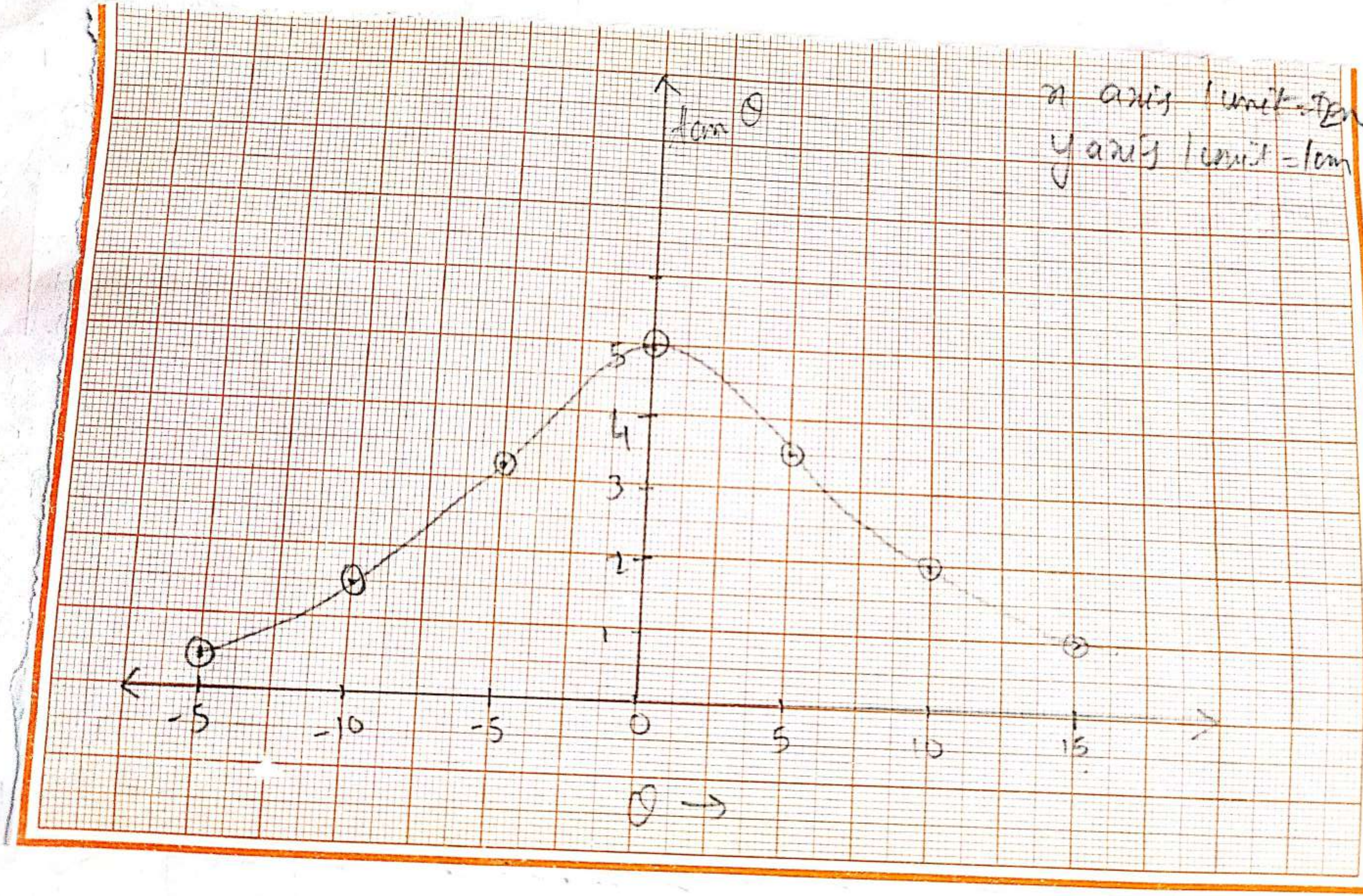

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Procedure:-

i) Level the stewart and Gree type Galvanometer with the help of its sliding bench.
ii) Rotate the whole apparatus and set the coil perpendicular to bench, this set coil in magnetic meridian. Rotate the compass box till ends of aluminium pointers lies on 0-0 lines.
iii) Adjust the value of steady current with the help of rheostat such that deflection is nearly b/w 70-75 when compass needle is at the center read both ends of pointer for direct and reverse current.
iv) Repeat the observation exactly in same manner on other side of sliding bench.
v) Plot a graph b/w x & tan θ and mark point of inflexion. The distance both these points gives radius of coil.

Precautions:-

i) Box should be exactly horizontal.
ii) Parallax should be removed while taking reading.
iii) Current should be constant throughout the observations.
iv) There should be no magnetic material lying near the coil.

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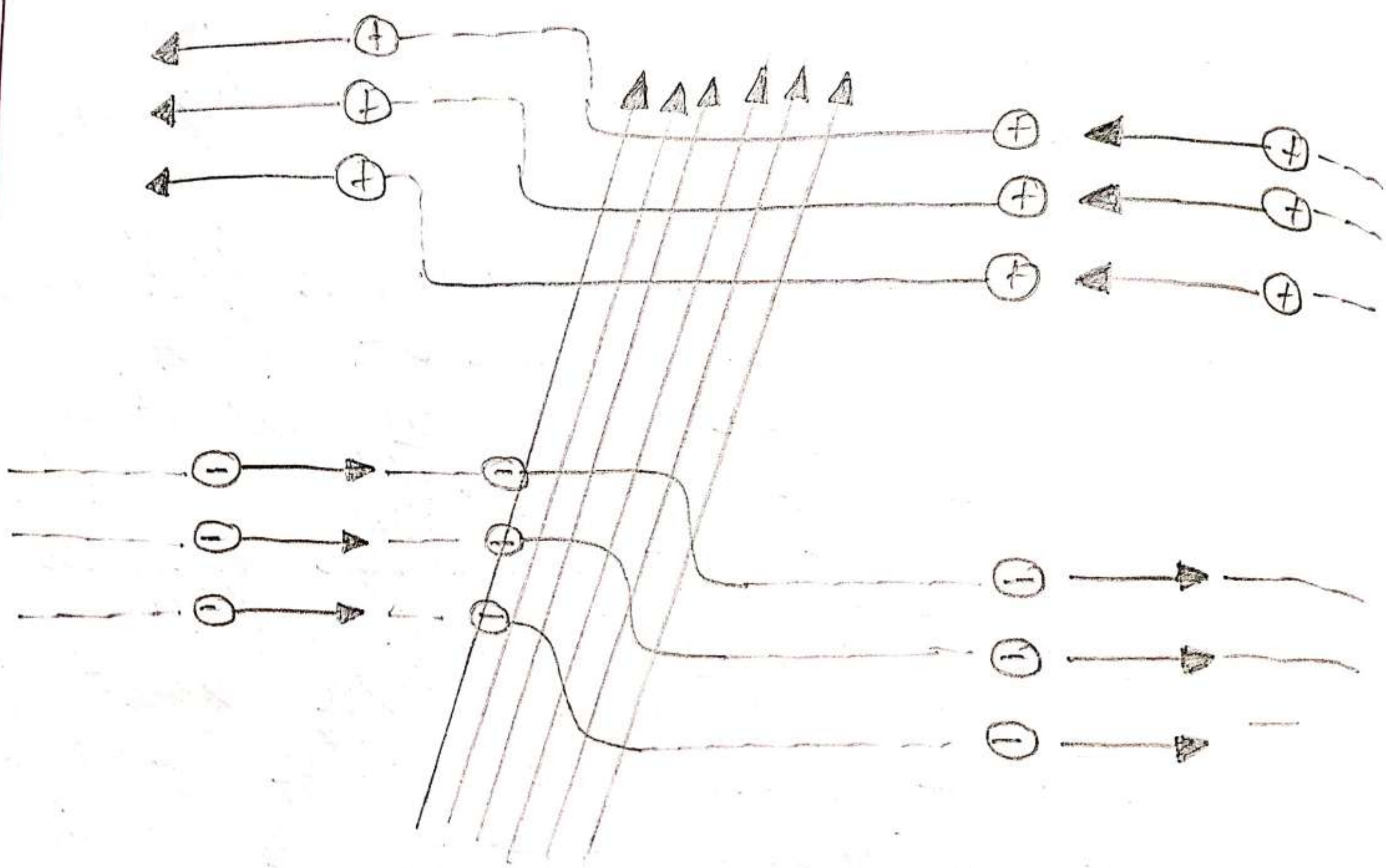
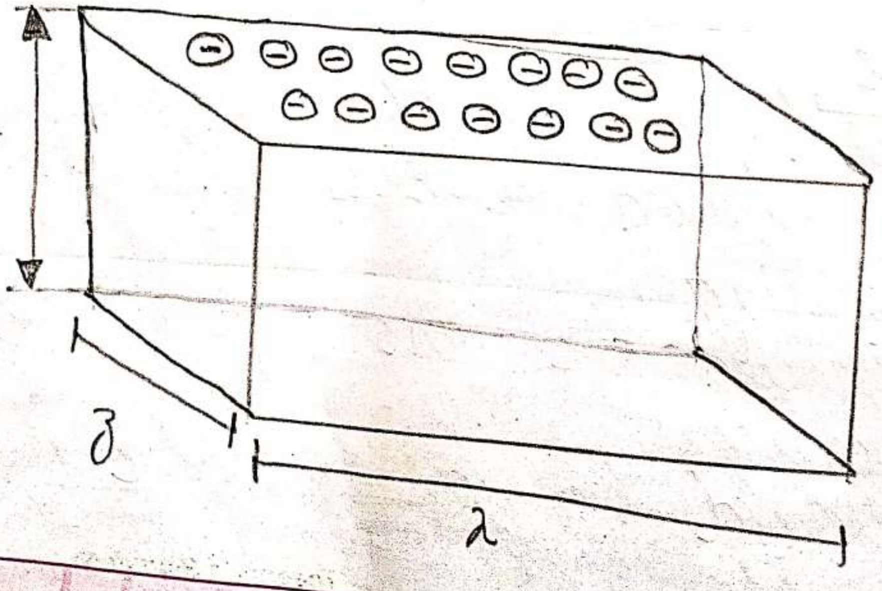
Diagram:-



$I = I_{xy}$



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"Experiment - 6"

AIM :- To measure the Hall coefficient of Specimen and calculation of charge carrier concentration.

Theory :- As a static magnetic field has no effect on charges unless they are in motion. When a magnetic field $\perp^r$ to a flow of charge is applied, it produces a force and force of charge. Due to this force, electrons and holes get separated which is then produces electric field E_h gives $E_h = R(J \times H)$.

If we consider a bar of semi-conductor having dimensions x, y & z in which J is directed along x axis and H along z-axis then E_h will be along y.

$$R = \frac{(V_h / y)}{JH}, \quad R = \frac{(V_h / y)}{\left(\frac{I}{zy}\right) \times H}, \quad R = \left(\frac{V_h z}{IH}\right)$$

$V_h \rightarrow$ Hall voltage appearing b/w the two surface $\perp^r$ to y and $J = I/yz$

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S.no	Magnetic gauss field		Mean	Hall voltage		Mean
	Direct	Reverse		Direct	Reverse	
1.	0.4	0.42	0.41	0.10	2.1	1.45
2.	0.63	0.56	0.575	0.20	4.1	0.25
3.	0.70	0.67	0.085	0.32	4.6	2.45
4.	0.90	0.90	0.9	1.6	4.8	3.2
5.	1.20	1.22	1.21	2.7	6.5	4.6
6.	1.50	1.39	1.285	3.9	6.7	5.3
7.	1.53	1.54	1.59	4.2	7.3	5.75
8.	1.90	1.84	1.84	5.1	8.05	6.075

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a) Hall Effect in case of one type of Carriers

In metals and doped semi-conductors are type of carrier dominates. The magnetic field force on the carrier is $f_m = e(v \times H)$.

$$F_H = eE_h$$

So, $f_m = F_h$

i.e magnetic force = Hall field force

$\therefore \quad v \times H = E_h$

From example (1)

$$R = \frac{E_h}{J \times H} = \frac{V \times H}{J \times H} = \frac{v \times H}{J \times H} = \frac{vH}{HG} = \frac{v}{J}$$

$$R = \frac{v}{nqv} = \frac{1}{nq}$$

Further $J = \sigma E$

Or $nqv = \sigma E$

$$\sigma = \frac{nqv}{E} = nq\mu \quad (\mu = v/E)$$

$$\mu = \frac{\sigma}{nq} = R\sigma, \text{ where } \mu \text{ is mobility of charge carriers.}$$

$$\mu = R\sigma.$$

P.T.O.

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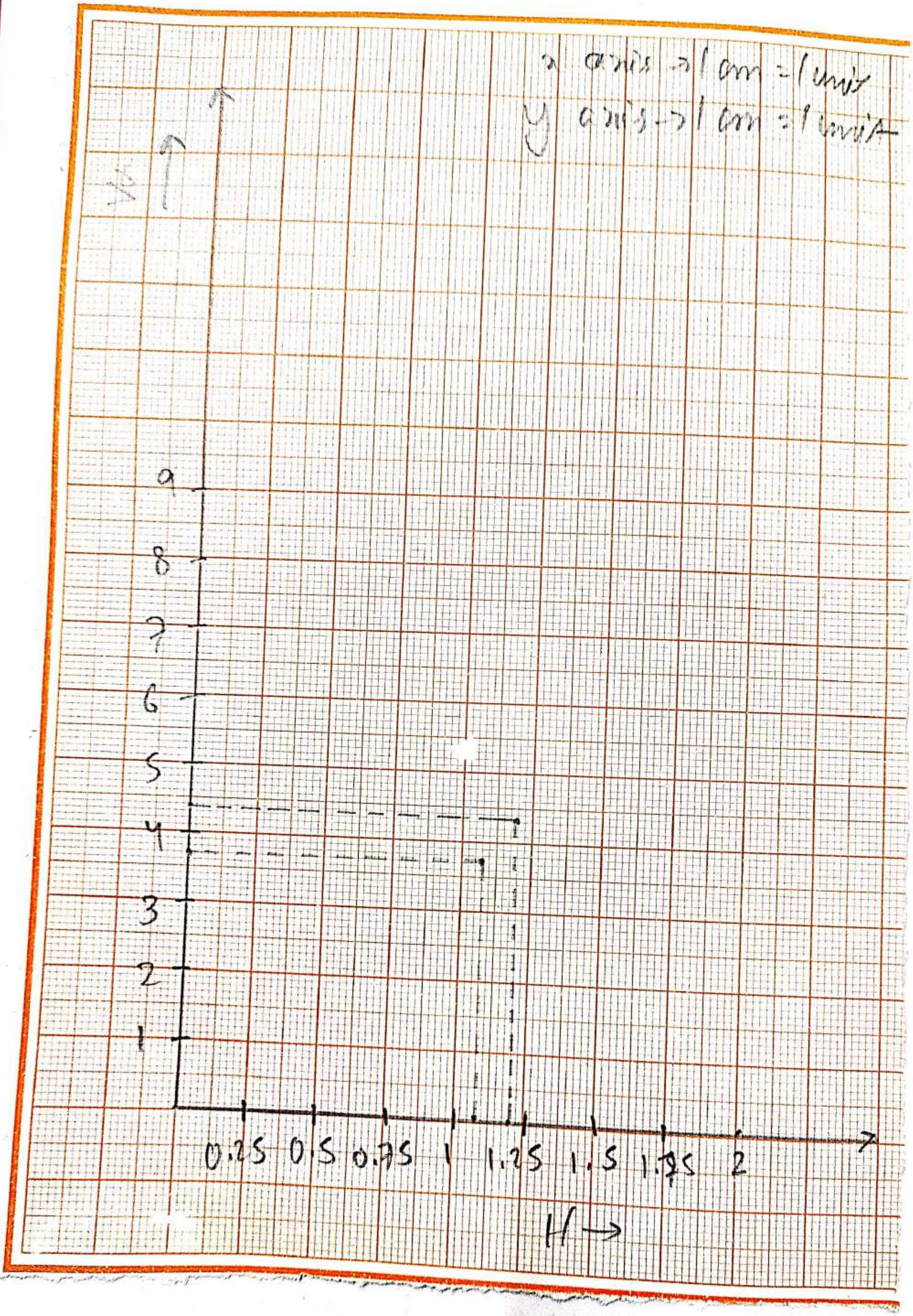

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b) Hall effect in case of two types of charge carriers.

In intrinsic & lightly doped semi-conductor there are two types of charge carriers. Hall voltage of p-carriers will be of oppositive sign from the n-type carriers.

$$R = \frac{\mu_h^2 p - \mu_e^2 n}{q(\mu_h p + \mu_e n)^2}$$

where μ_h & μ_e are the mobilities of holes and electrols; p and n are the carrier densitites of holes and electrons respectively.

$$R = \frac{0 - \mu_e^2 n}{q \mu_e^2 n^2} = -\frac{1}{nq} \Rightarrow R = -\frac{1}{nq}$$

Procedure:-

i) Switch 'No' the Hall effect set up and adjust constant current power supply.
ii) Switch over the display to voltage side.
iii) Switch ON the electro-magnet power supply and adjust the current to any desired value.
iv) Measure the Hall voltage as a function of magnetic field keeping a suitable

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value of current as constant and plot a graph.

v) Measure magnetic field by the galvanometer.

Calculations:-

a) Plot a graph b/w hall voltage & current.

$$\text{Slope of graph} = \frac{\Delta V_h}{\Delta H}$$

$$\text{Hall coefficient, } R = \frac{\Delta V_h \times z}{\Delta H \times I}$$

b) Find the type of semi-conductor wheather it is p-type or n-type.

c) Charge carrier concentration, $n = \frac{1}{Rq}$.

Precautions:-

i) Current through the sample, should not be large enough to cause heating.

ii) Hall probe must be current in the probe and magnetic field would be $\perp^r$ to each other.

iii) It is necessary that current should adjust every time or use constant current power supply.

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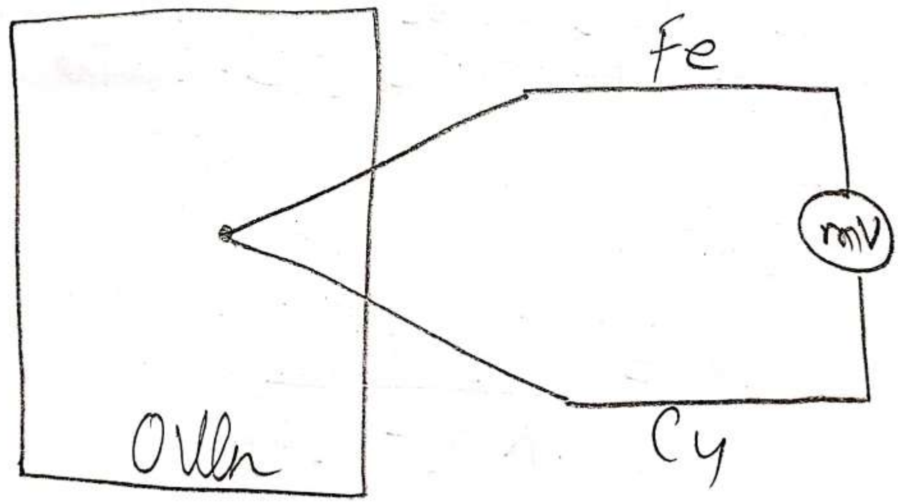
AIM:- To plot a graph b/w the temp. of that function & thermo-emf for a thermo-couple using potential.

Apparatus:- A thermo-couple oil bath, a heater, two thermometers, galvanometer, one way key, resistance box, potentiometer, jockey, post office box, cell or battery.



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"Experiment - 8"

AIM:- To plot graph b/w the temperature of hot junction and thermo-emf for a thermo couple using potentio-meter

Theory:- A thermo-couple, an oil bath, a heater, two thermometers, galvanometer, one way key, resistance box, potentio-meter, jockey, post office box, cell or battery, ice funnel, beaker, volt-meter.

When two wires of different materials joined at their free ends with galvanometer in b/w, the arrangement is thermocouple. When two junctions of thermocouple are kept at diff. temp., thermo emf is produced known as seeback effect. In case of Cu-Fe thermocouple current flows from Cu to Fe through hot junction as described, thermo emf produced is given by

$$e = A\theta + B\theta^2$$

where A & B are constants. The variation of e with Cθ is as shown in fig. The thermo emf produced is calculated using potentiometer.

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S.No	Temp. of hot junction	Temp Emf
1	20	0
2	30	1.1
3	40	2.6
4	50	4.3
5	60	5.8
6	70	7.2
7	80	8.4

Calculation:-

Resistance of potential wire = 25 Ω

Emf of battery in begining = 2.021 V

" " " " end = 2.125 V

Mean emf (ε) = 2.073 V

Resistance taken out from RB = 2000 Ω

Length of potential wire = 480 cm

$$K = \frac{4.97 \times 10^{-6}}{2.029 \times 1400}$$

$$= 0.00006145 \times 10^{-6}$$

$$= 0.6145 \times 10^{-10} \ NCm^{-1}$$

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If e be the emf of external battery, R, is the resistance of potentiometer wire & R is resistance in series with battery then current through potentiometer wire = $\frac{E}{R+R_1}$

Potential drop across the potentiometer wire = $\frac{ER_1}{R+R_1}$ (volts).

If l is the total length of wire in cms. Then, potential gradient along length of potentiometer wire = $\frac{ER_1}{R+R_1} \times \frac{l}{e}$ volt/cm

Procedure:-

i) To start with, find the resistance of a potentiometer wire using slide wire bridge.

ii) Find emf of cell using volt-meter. Make the connections as shown in fig.

iii) The terminal of potentiometer wire is connected and marked as zero and the terminal where negative end of a battery through resistance and key K is connected is marked as other end.

iv) Connect thermocouple with its positive terminal to zero end of potentiometer

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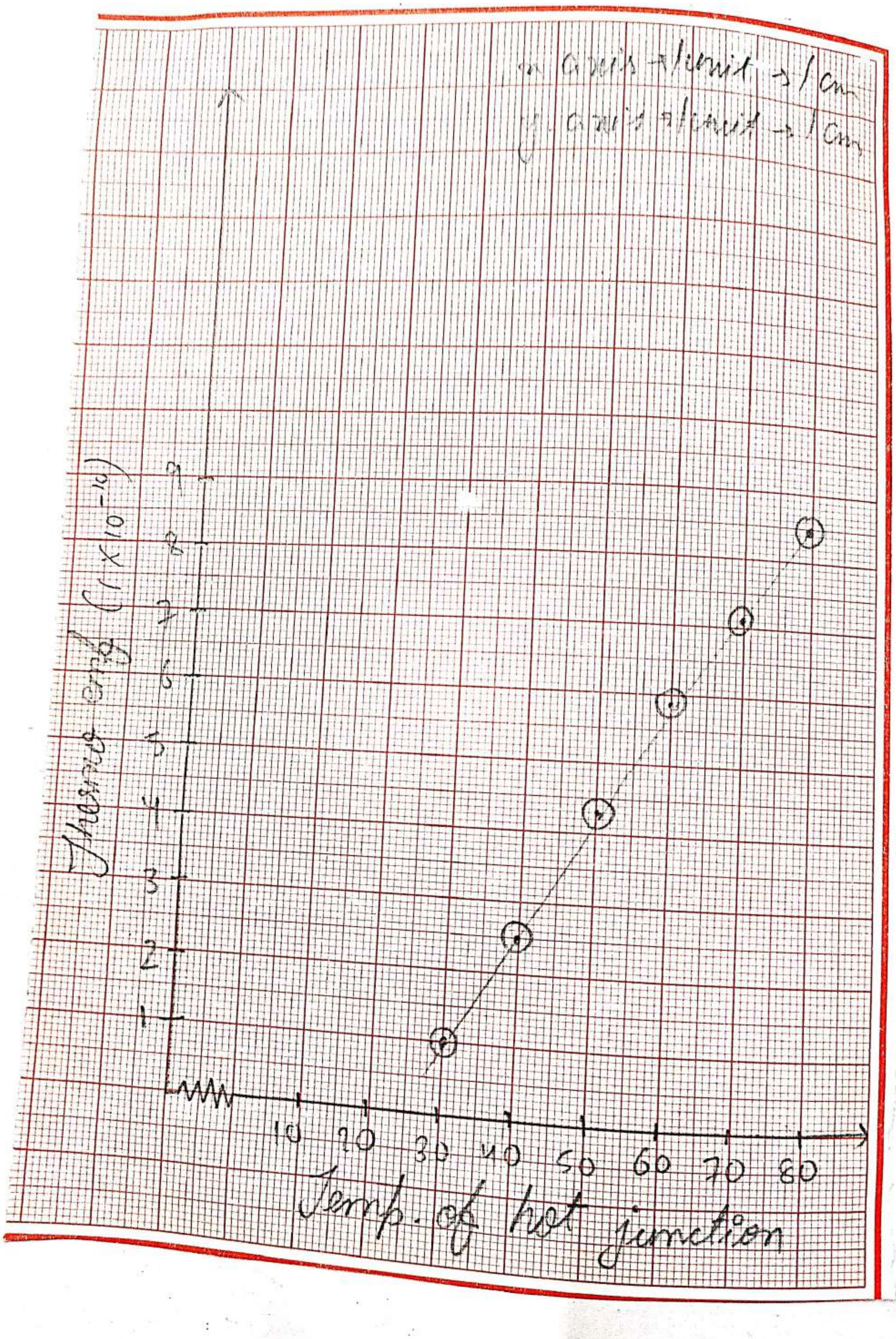

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and negative terminal to jocky through galvanometer. Press jockey at one end of potentiometer wire and note the direction of deflection If the direction of deflection gets converted the connections are correct, otherwise tightens the plugs of resistance box so that balance point lies on last wire of potentiometer.

v) Stop heating oil bath and note balancing length with decrease in temp. at difference of 10°C till temp. of hot junction fails to room temp.

vi) Note the emf of cell / battery at the end of observation.

vii) Plot a graph b/w temp. of hot junction & thermo emf. developed.

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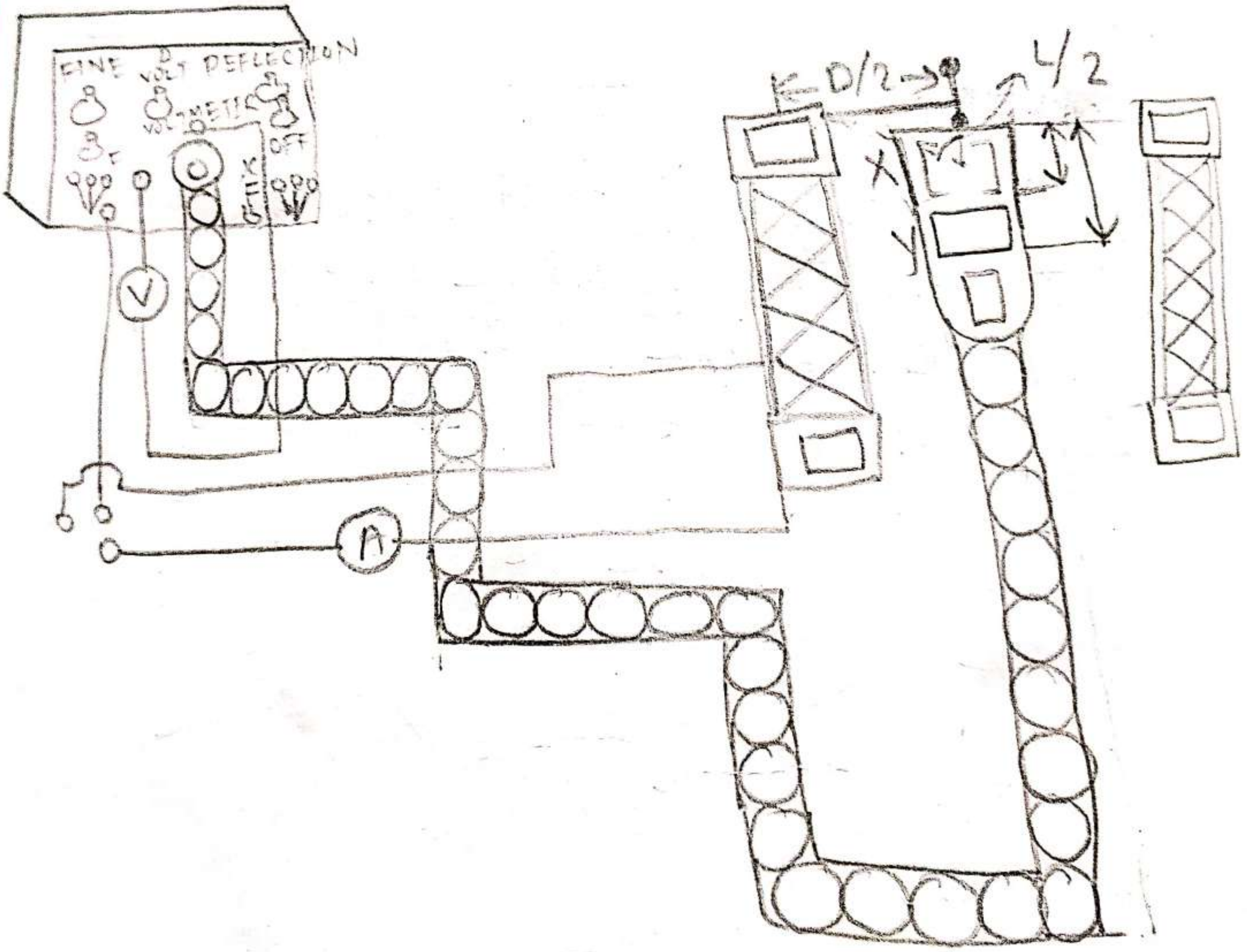
AIM:- To find e/m of an electron by helical or bush method.

Apparatus required:- A cathode ray tube, a solenoid, a power supply, commutator, volt-meter (0-1.5 KV), an ammeter (0 - 1A) etc.



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4 "Experiment - 9"

AIM → To find e/m of an electron by Helical or Bush method.

Apparatus required → A cathode ray tube, a solenoid, a power supply, commutator, voltmeter (0 - 1.5 KV), an ammeter (0-1A) etc.

Theory :- The emission current density. When filament of a cathode ray tube is heated, it eject electrons. When some accelerating potential say V (volts) is applied to the electrons emitted from cathode then velocity (v) acquired by the electron is given by:-

$$\frac{1}{2} m v^2 = eV$$

$$v = \sqrt{2eV/m} \quad -(1)$$

If screen of CRO is at a distance l from filament of cathode then time taken by the electron to reach to screen.

By using ---- (1)

$$t = \frac{l}{v} = \frac{l}{\sqrt{2eV/m}} \text{ second} - (2)$$

If an alternating electric field is applied across the electron beam then electron will

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Calculation :-

(A) Using X plates

$$\left(\frac{e}{m}\right)_x = \frac{8\pi^2 V}{u_0^2 n^2 I^2 \cos^2\theta \cdot i_{cx}^2} \text{ columb/kg}$$

mean $\underset{(e/m)}{(i)}$ = ____ " ____ columb/kg

(B) Using x plates

$$\left(\frac{e}{m}\right)_x = \frac{8\pi^2 V}{u_0^2 n^2 I^2 \cos^2 i^2 c} \text{ columb/kg}$$

$\underset{e/m}{(i)}$ = ____ " ____ columb/kg

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experience a transverse alternating force & a line is formed on the screen, whose length depends upon magnitude of transverse electric field. If we apply a ~~loo~~ longitudinal magnetic field across the beam of electron which is pre-pendicular to both transverse motion of electron and applied longitudinal magnetic field, due to which electron describe a circular path with velocity 'v' in a circle of radius 'r'

i.e $Bev' = \frac{mv^2}{r'}$

$$\frac{Be}{m} = \frac{v'}{r'}$$

The angular speed $\omega = \frac{2\pi}{T} = \frac{v'}{r'} = \frac{Be}{m}$

The period of motion of electron in circular path is given by $T = \frac{2\pi}{\omega} = \frac{2\pi}{Be/m} = \frac{2\pi m}{Be}$

Adjust value of B so that periodic time T becomes equal to 't' given in eq^n (2) so that line will reduce to a point. Further increase B so that time period reduces to T/2, T/3 etc. such that we get number foci

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Observation:-

Distance b/w the edge of x plate and the screen e/A

Distance b/w the edge of y plate and the screen l/b

Diameter of solenoid

Length of solenoid

No. of turns of solenoid

$$\cos\theta = \frac{L}{\sqrt{D^2+L^2}}$$

S.No.	x plate I(A)	x plate Voltage	y plate I(A)	y plate Voltage
1	0.6A	600V	0.6A	600V
2	0.7A	700V	0.65A	700V
3	0.7A	800V	0.7A	800V
4	0.75A	900V	0.75A	900V

with variation of B

If Be is the field when t = T, then

$$T = \frac{2m\pi}{eB_c} \quad \text{—— (5)}$$

From eq^n (2) & (5)

$$\Rightarrow \frac{1}{\sqrt{2eV/m}} = \frac{2\pi m}{eB_c}$$

$$\Rightarrow \frac{I^2 m}{2eV} = \left(\frac{2\pi m}{eB_c}\right)^2$$

$$\Rightarrow \frac{I^2 m}{2eV} = \frac{4\pi^2 m^2}{e^2 B^2 e}$$

$$\Rightarrow \frac{e}{m} = \frac{8\pi^2 V}{I^2 B^2 e} \text{ columb/kg}$$

where $Be = \mu_0 n i c \cos\theta$. wb/m^2

ic = current produced by field B_c

$$\cos\theta = \frac{L/2}{\sqrt{\left\{\left(\frac{D^2}{4}\right) + \left(\frac{L^2}{4}\right)\right\}}} = \frac{L}{\sqrt{D^2+L^2}}$$

L = Length of solenoid.

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D = diameter of solenoid.

$$\frac{e}{m} = \frac{8\pi^2 V}{\mu_0^2 n^2 i^2 c \cos^2\theta \, l^2} \text{ Columb/kg.}$$

Procedure:-

1. Place a solenoid in ~~tas~~ east-west direction and mouth cathode ray tube carefully inside the solenoid.
2. Make a connection as shown in figure & switch on the power supply unit.
3. Apply ac deflecting potential to one set at plates say X-X plates.
4. Switch on the solenoid current & adjust its value so that lines reduces to a point.
5. Repeat the step 3 & 4 for y-y set of ~~p~~ find ie.
6. Repeat whole procedure from Step 2 to Step 5 for diff. values of accelerating voltage.

Precaution:-

1. CRO tube should be placed symmetrically within the solenoid!

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2. Factor $\cos\theta$ should be applied for finding B.C if solenoid is of finite size.
3. Accelerating voltage should be applied carefully.
4. Length of line formed on screen should be 2-3 cm.
5. If potential applied is very high then relativistic correction for mass of electron should be applied.

Result:-

e/m from experiment

Standard value of e/m

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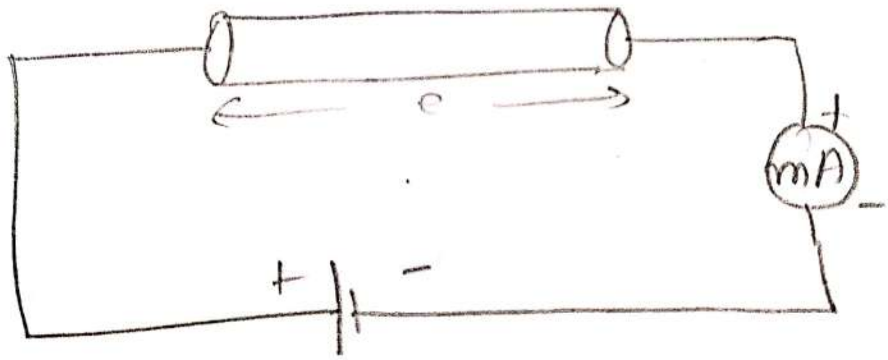
AIM:- To determine resistivity of a semi-conductor by four probe method.

Apparatus:- A four probe arrangement, various samples of semi-conductors, oven, a conductor current generation oven, a constant current generator, thermometer digital volt-meter, ammeter, etc.

Diagram:-



$$Slope \Rightarrow \frac{\Delta y}{\Delta x} = \frac{1.25-1.23}{3.09-3} = \frac{0.02}{0.09} = \frac{2}{9}$$

$$E_g = 0.396 \times \frac{\Delta y}{\Delta x}, eV$$

$$= 0.396 \times \frac{2}{9} = 0.088 \text{ eV}$$

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Experiment - 5

AIM:- To determine the resistivity of a semi-conductor by four probe method.

Theory:- The resistance of a conductor of length 'l' and uniform area cross section 'a' is given as $R \propto \frac{l}{a}$

$$R = \rho \frac{l}{a} \qquad \rho = \frac{Ra}{l}$$

where ρ is constant of proportionality & known as specific resistance or resistivity of the material. It has units - ohm - cm or ohm - m

If dia- meter of specimen are large compared to spacing b/w the probes then potential b/w two two points is given as

$$V = \frac{\rho l}{2\pi d}$$

$$\rho_0 = \frac{V}{I} 2\pi d.$$

where S is spacing b/w the probes. It slice is thin some connection divisor is to be applied.

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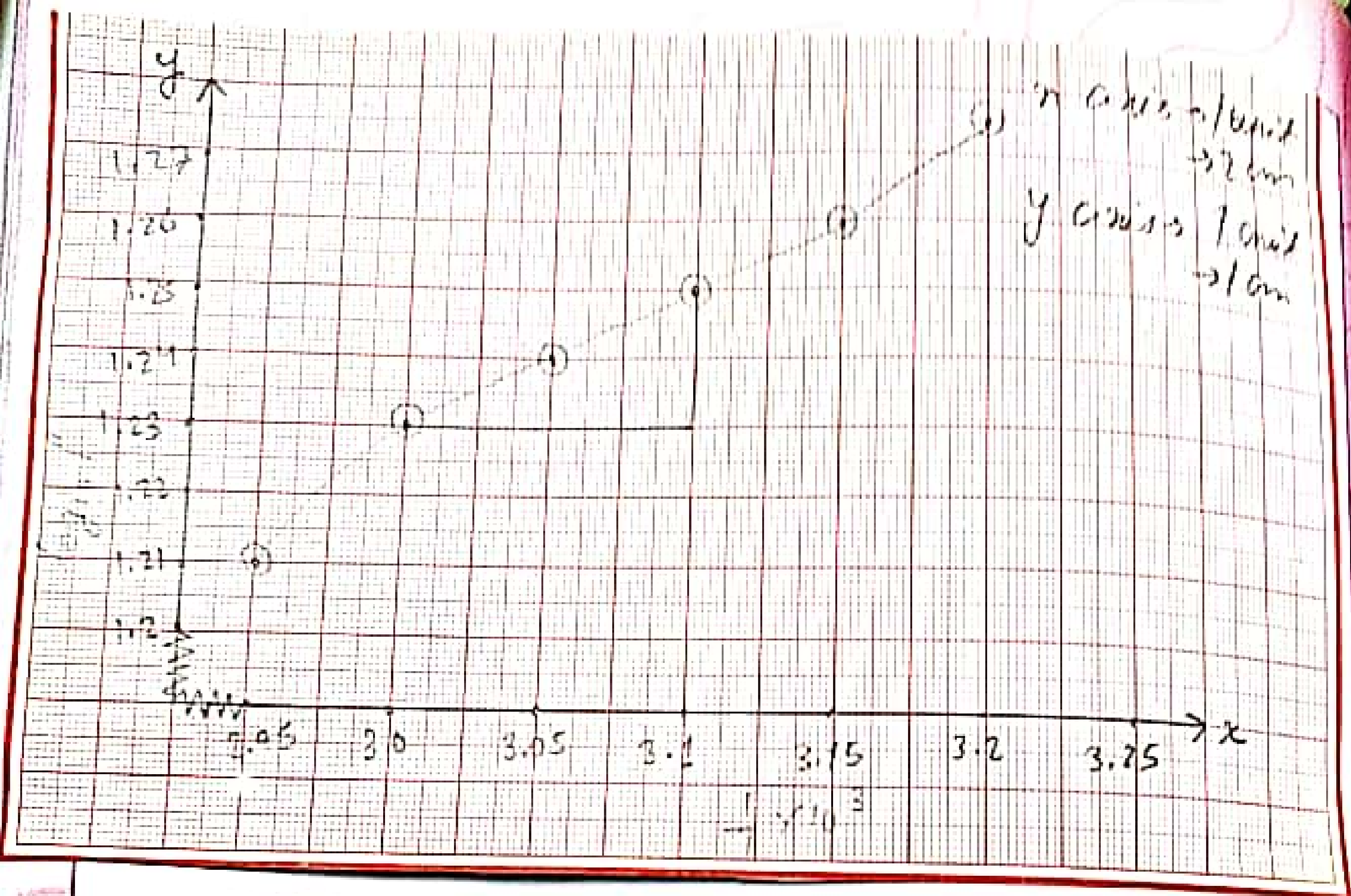

S No.	Temp in (K)	$\frac{1}{T} \times 1000$	P	$\log_{10} P$
1	293	3.413	18.71	1.27
2	298	3.36	18.74	1.273
3	303	3.30	18.78	1.27
4	308	3.25	18.84	1.275
5	313	3.2	18.68	1.274
6	318	3.14	18.40	1.274
7	323	3.09	17.9	1.26
8	328	3.04	17.59	1.25
9	333	3.003	17.08	1.24
10	338	2.95	16.49	1.23
				1.21

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for conducting bottom surface.

$$\rho = \rho_0 / F(\omega/d)$$

Procedure :-

i) The order pair of probes is connected to current source and inner pair of probes is connected to the voltmeter.

ii) Set a constant current in constant current supply and note down its value.

iii) Now increase the temperature of oven and note down corresponding value of voltage for every 5°C rise in temp.

Calculation :-

Plot a graph b/w $\log_{10} P$ and $\frac{10^3}{T}$

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

$$E_g = 0.396 \text{ slope eV}$$

$$E_g = 0.396 \times \frac{\Delta y}{\Delta x} \text{ eV}$$

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Observations:-

i) Distance b/w probes = 2mm

ii) Thickness of SC wafer = 0.5 mm

iii) Current, I = 1mA

S No.	Temp (C)	Voltage (V)
1	25	58.0
2	30	58.2
3	35	58.6
4	40	58.6
5	50	58.0
6	55.	57.0
7	60	56.1

Distance b/w probes = 0.3 cm

Thickness of semi-conductor water = ___ cm

Current I = <u>1</u> mA.

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Precautions:-

i) Resistivity of the material should be in uniform in the area of measurement.
ii) The surface on which probe rests should be flat.
iii) Current through the sample should be kept constant.
iv) Except minimum pressure to make electrical contact of probe with the water.
v) Temperature should be measured carefully.
vi) Current should not be large enough to cause heating.

Result:-

The Band Gap is given semi-conductor is = 0.7 eV

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