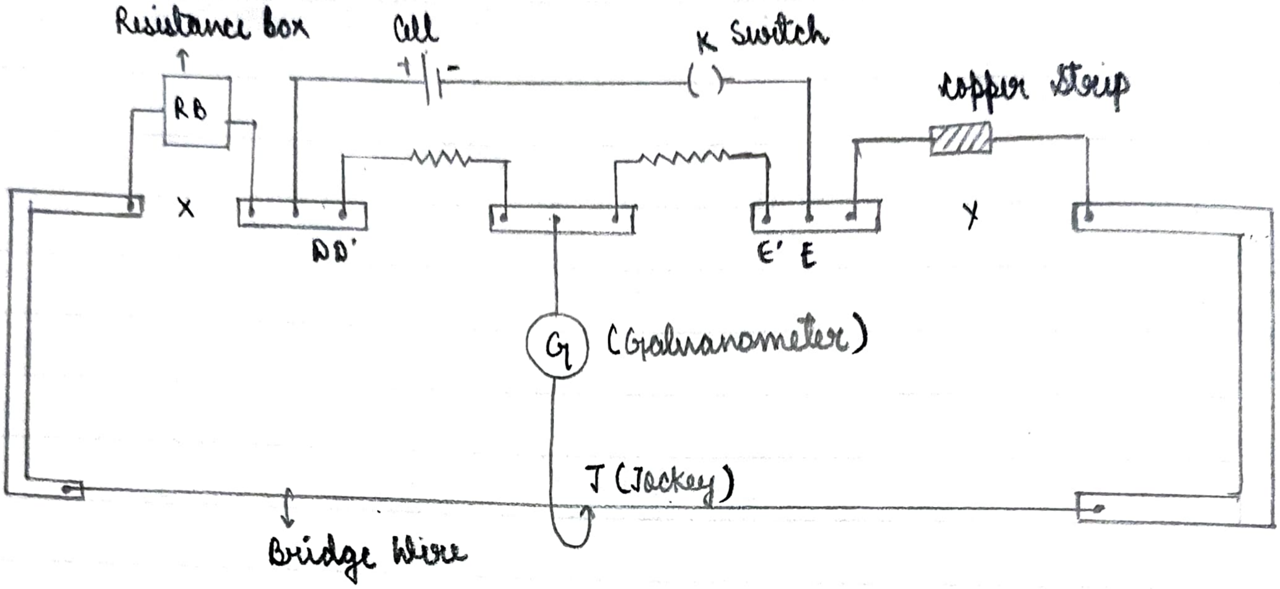

• Diagram of a Carey Foster's Bridge.

Experiment no:-01.

- **Object:-**

To determine the specific resistance of material of a given wire using Carey Foster's bridge.

- **Apparatus**

1. Carey Foster's bridge
2. Leclanche cell
3. A resistance box in decimal range
4. A sensitive galvanometer
5. Plug key
6. Thick copper strip
7. A sliding rheostat of nearly 10 Ω resistance.
8. Screw gauge
9. Meter scale
10. Jockey
11. Experimental wire
12. Connecting wires
13. A peice of sand paper

- **Theory and formula used**

The unknown resistance Y of the experimental wire whose specific resistance K is to be determined by formula

$$Y = X + \rho(L_2 - L_1) \text{ ohms}$$

The resistance per unit length (ρ) is determined by using known resistance R

$$\rho = \frac{R}{L_2' - L_1'} \text{ ohm/cm}$$

The specific resistance, K of of the material is calculated by using the formula:-

$K = \frac{\pi r^2 Y}{l}$ ohm-cm

where; X = unknown resistance

R = resistance introduced from resistance box.

l_1 = length of balance point on bridge wire when resistance box is in the left gap or unknown resistance is in the right gap.

l_2 = length of balance point on bridge wire when resistance box is in the right gap or unknown resistance is in the left gap.

ρ = resistance per unit length of bridge wire.

r = radius of experimental wire.

l = length of experimental wire.

• Observation table

(A) For the measurement of radius of wire.

S.No	Main scale division	Circular scale division	Diameter	Radius
01	0	52.8	0.528 mm	0.264 mm
02	0	52.9	0.529 mm	0.2645 mm
03	0	52.7	0.527 mm	0.2635 mm
04	0	52.6	0.526 mm	0.263 mm

Average radius of wire = 0.264 mm

= 0.264 mm = 0.264×10^{-1} cm

= 0.264×10^{-3} m.

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(B) Measurement of resistance per unit length of bridge

S.No.	Resistance	Balancing length with resistance		$(l_1'-l_2')$	$\rho = R/l_1'-l_2'$
		left gap (l_1')	right gap (l_2')		
01	0.4 Ω	52.7 cm	44 cm.	8.7 cm	0.0459 Ω/cm
02	0.5 Ω	53.7 cm	43.1 cm	10.6 cm	0.0472 Ω/cm
03	0.6 Ω	54.6 cm	42 cm	12.6 cm	0.0476 Ω/cm
04	0.7 Ω	55.9 cm	41 cm	14.9 cm	0.0469 Ω/cm
05	0.8 Ω	56.7 cm	39.1 cm	17.6 cm	0.0454 Ω/cm

Mean ρ = 0.0466 Ω/cm.

(C) Measurement of resistance (X) of given experimental wire

S.No.	Resistance	Balancing length with resistance		l_1-l_2	$X=R+(l_1-l_2)\rho$ Ω
		left gap (l_1)	Right gap (l_2)		
01	2	25 cm	79 cm	51 cm	4.516 Ω
02	3	33.7 cm	66.3 cm	32.6 cm	4.519 Ω
03	4	39.4 cm	60.6 cm	21.2 cm	4.988 Ω
04	5	45.1 cm	52.9 cm	7.8 cm	5.363 Ω
05	6	56.5 cm	44.3 cm	12.2 cm	5.432 Ω

Mean resistance = 5.082 Ω

• Calculations :-

a) The resistance per unit length of bridge wire is calculated by using the formula

$$\rho = \frac{R}{l_1'-l_2'}$$

and its mean value is obtained as 0.0466 Ω/cm.

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b) The resistance (x) of the experimental wire is calculated with the help of

$x = Y + \rho(l_1 - l_2)\ \Omega$

and its mean value is 5.028 Ω

c) The resistivity of wire is given as-

$$\rho = \frac{\pi r^2 x}{l}$$

$$R = 3.14 \times 0.264 \times 0.264 \times 5.028 \times 10^{-6}/1$$

$$= 1.112 \times 10^{-6}\ \Omega\text{-}m$$

d) The percentage error = ρ = standard value - obtained value

= 0.009 Ω-mm

or 0.009×10^{-6} m

Hence percentage error $= \frac{0.009 \times 10^{-6}}{1.112 \times 10^{-6}} \times 100 = 0.89\%$

• **Result :-**

The resistivity of wire is given as $1.112 \times 10^{-6}\ \Omega\text{-}m$ with percentage error of 0.89%.

• **Precautions :-**

1. All the connections must be tight.
2. The decimal-ohm box should be connected to the bridge gap by copper wire.
3. The plug key connected in circuit should be closed only when observation is taken
4. To avoid the excessive deflection in the sensitive galvanometer, the galvanometer should be shunted with a wire of low resistivity which should be removed as one reach near the balance point.

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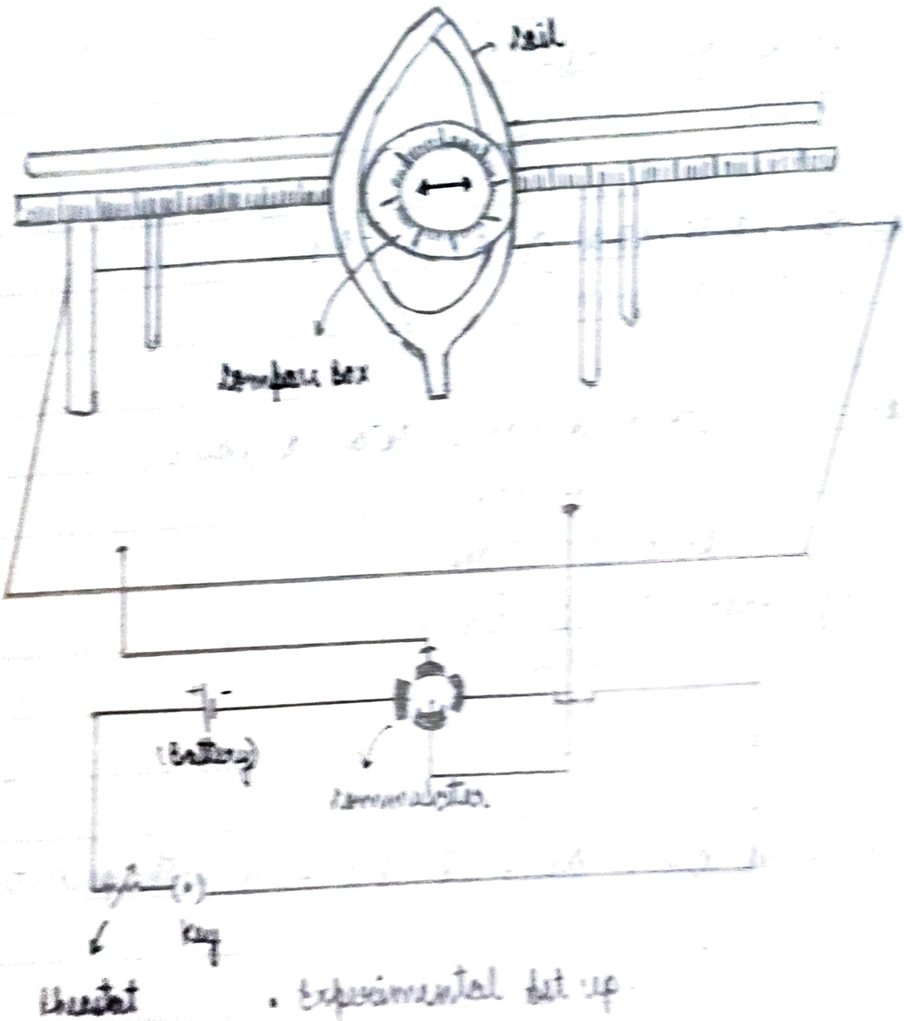


• Experimental set up

Experiment no:- 02.

- **Object:-**

To study the variation of magnetic field with distance along the axis of a circular coil carrying current and then to estimate the radius of the coil.

- **Apparatus:-**

1. circular coil
2. compass box
3. Ammeter
4. Rheostat
5. Commutator
6. cell
7. key
8. connection wires.

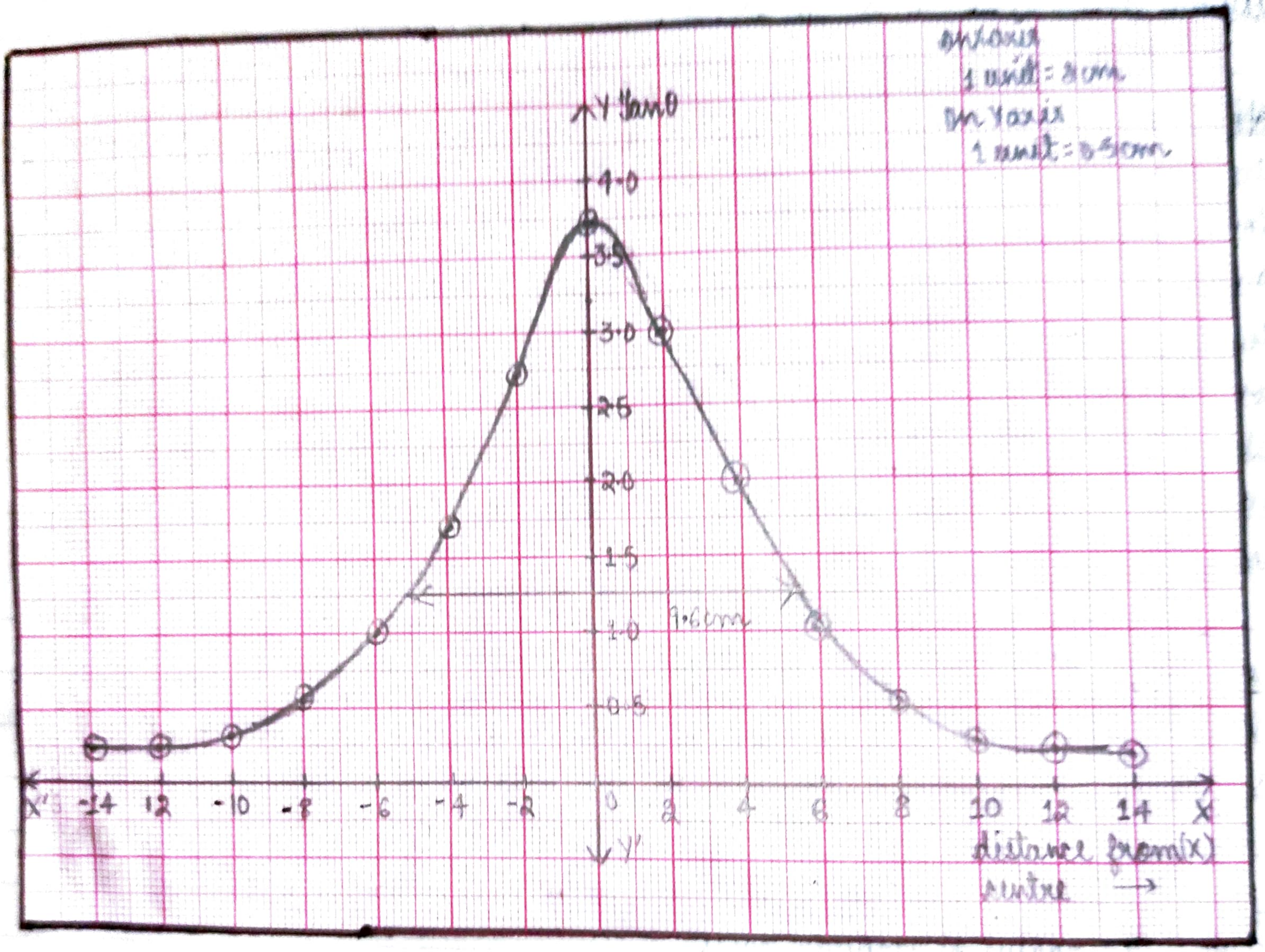
- **Theory and Formula used:-**

The magnetic field at any point distance x from the centre of coil along its axis is given by

$$F = \frac{2\pi n i r^2}{10(x^2+r^2)^{3/2}}$$

where r = radius of circular wire.
i = current flowing through the circular wire.
n = no of turns of the coil.

If the magnetometer is placed with the bench in East-West direction or coil parallel to magnetic meridian, then the field F will be at right angle to the horizontal component of the earth's magnetic field. In this



• A plot between tanθ and x (distance from centre) situation the tangent law hold good and the deflection θ of the magnetic needle from the magnetic meridian is given by

$$F = H \tan\theta$$

$$\therefore \frac{2\pi n i r^2}{10(x^2+r^2)^{3/2}} = H \tan\theta$$

$$\text{or } \frac{2\pi n i r^2}{10(x^2+r^2)^{3/2}} \propto \tan\theta$$

Hence the variation of magnetic field along the axis of a current carrying circular coil involves the plotting of the graph between x and $\tan\theta$.

- **Observation table :-**

Current (I) 1A

No of turns of coil :- 10

Radius of circular coil r :- 5cm.

S.No.	Distance of needle from centre of bench (x)	Deflection on left side of bench: Direct current θ_1	θ_2	Reverse current θ_3	θ_4	Mean $\theta = \frac{\theta_1+\theta_2+\theta_3+\theta_4}{4}$	$\tan\theta$	Deflection on right side of bench: Direct current θ_1	θ_2	Reverse current θ_3	θ_4	Mean $\theta' = \frac{\theta_1+\theta_2+\theta_3+\theta_4}{4}$	$\tan\theta'$
01	0cm	75	75	72	75	74.25	3.54	75	75	72	75	74.25	3.54
02	2cm	74	74	70	70	72	3.07	72	72	73	73	72.5	3.17
03	4cm	72	72	68	68	70	2.74	69	69	70	70	69.5	2.67
04	6cm	69	69	64	64	66.5	2.29	68	68	65	65	66.5	2.29
05	8cm	64	64	58	58	61	1.80	62	62	58	58	60	1.73
06	10cm	58	58	56	56	67	1.53	58	52	53	53	55.5	1.45
07	12cm	44	44	42	42	43	0.93	43	43	40	40	41.5	0.88
08	14cm	34	34	32	32	33	0.64	33	33	32	32	32.5	0.63

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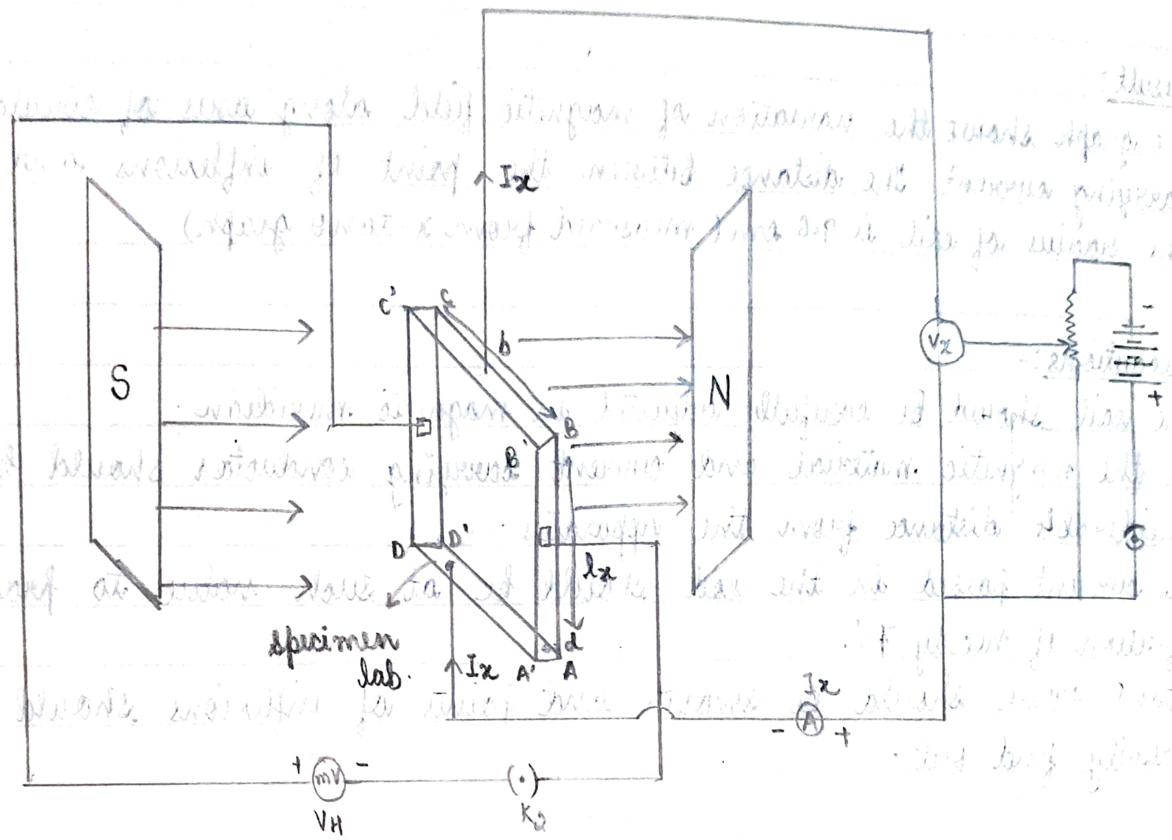
Result:-

The graph shows the variation of magnetic field along axis of circular coil carrying current. The distance between the point of inflexions and hence the radius of coil is 9.6 cm (measured from x-$\tan\theta$ graph)

Precautions:-

1. The coil should be carefully adjusted in magnetic meridian.
2. All the magnetic material and current carrying conductor should be at a considerable distance from the apparatus.
3. The current passed in the coil should be at such value to produce a deflection of nearly 75°.
4. x-$\tan\theta$ curve should be smooth and points of inflexions should be carefully find out.



• Experimental set up for Hall Effect.

Experiment no:- 03

- **Object:-**
To study the Hall Effect and to determine Hall coefficient, carrier density and mobility of a given semiconductor (n type) material using hall effect set up.

- **Apparatus:-**
1. A rectangular slab specimen crystal to about 7mm x 2mm x 0.2 mm.
2. Electromagnetic cable of producing magnetic field.
3. A battery
4. Two plug keys
5. Milli-ammeter
6. Milli-Voltmeter
7. A voltmeter for measuring potential difference.
8. Rheostat
9. Search coil
10. A calibrated fluxmeter
11. Connection wires.
12. Ballistic Galvanometer.

- **Theory and Formula Used.**
When a specimen rectangular slab of semiconductor l x (AB) along X-axis, breadth 'b' (BC) along Y axis and thickness d (AA') along Z-axis is placed in the magnetic field B (applied along the Z axis) and if I_x current is made to flow along the X-axis in the slab then a voltage called Hall voltage (VH) is developed across the faces which are normal to Y axis. This Hall-Voltage is measured with the help of millimeter connected in the circuit. The allied parameter such as hall coefficient 'RH' number of charge carrier per unit volume 'n'. Hall angle (Ø) and

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mobility of charge carriers are determined by using following relations :-

1. Hall coefficient :-

$$R_H = \frac{V_H}{I_x} \cdot \frac{d}{B_z} \quad \Omega\text{-}m^2/\text{weber}$$

If μ is the permeability of the medium of the slab, then actual magnetic field with in rectangular slab is

$$B_z = \mu B.$$

2. No of charge carrier per unit volume 'n' in the semiconductor is calculated as:-

$$n = \frac{1}{eR_H}$$

where; e = charge on electron or hole. and it is equal to 1.6×10^{-19} C.

3. Hall Angle :-

$$\phi = \frac{V_H}{I_x} \cdot \frac{I_x}{b} \text{ radian}$$

where V_x is potential difference applied across the specimen length.

4. Mobility of charge carriers:-

$$\mu_H = \frac{\phi}{B_z} \text{ rad-}m^3/\text{weber}$$

B_z is determined by galvanometer or fluxometer or ballistic galvanometer.

5. The electrical conductivity of specimen slab 'σ' is calculated as:-

$$\sigma = \frac{\mu_H}{R_H} \text{ mho } m^{-1}$$

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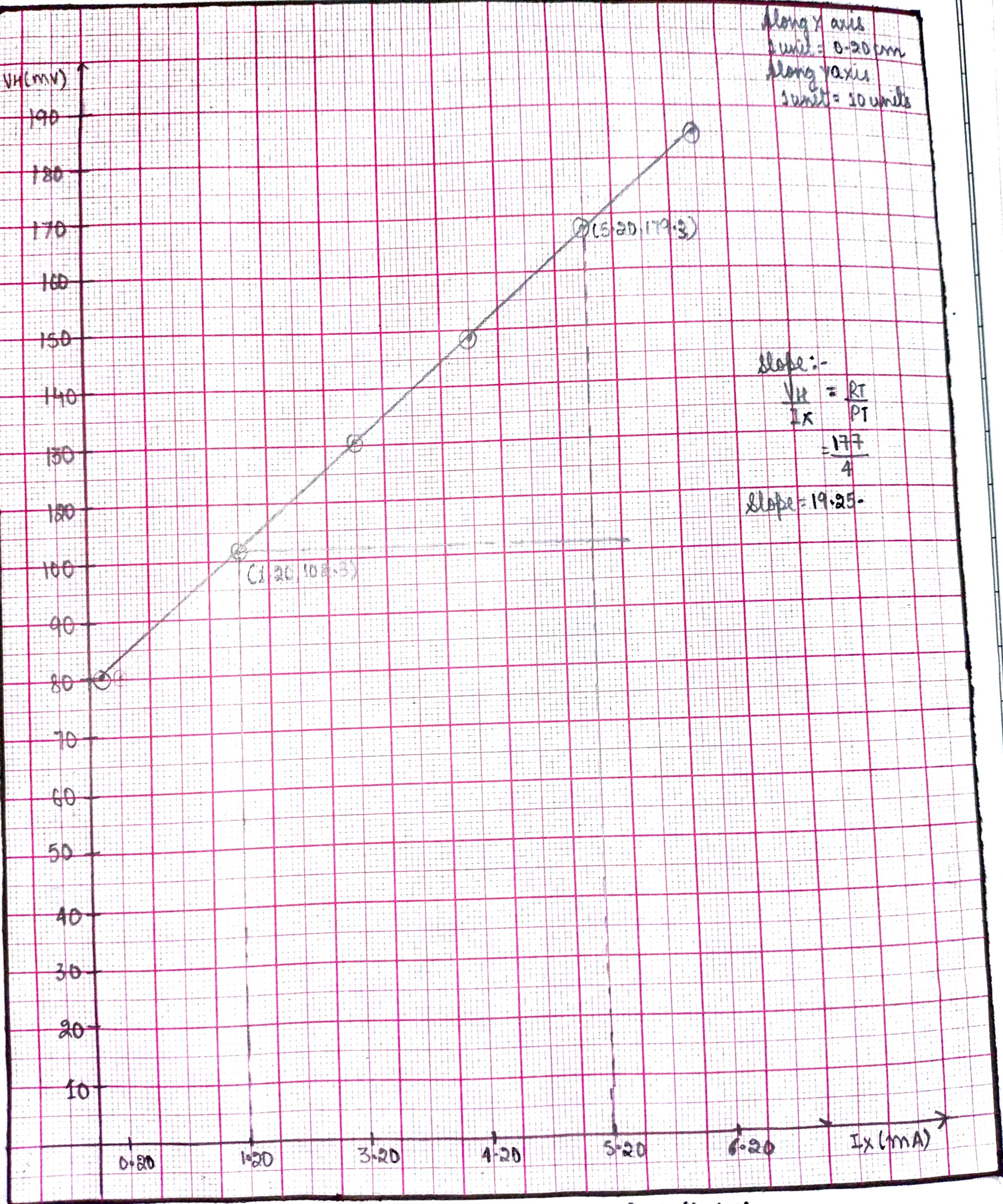

. A plot between current (I_X) and Hall Voltage (V_H)

Thickness of the specimen slab along X axis is 5×10^{-2} cm.

• **Observation Table:-**

(A) **Caliberation of EMU-50 with gaussmeter**

S.No.	EMU-50 current	Magnetic field
01	0.25 A	0.685 KG
02	0.50 A	1.085 KG
03	1.00 A	2.050 KG
04	1.25 A	2.620 KG
05	1.75 A	3.530 KG
06	2.00 A	4.020 KG

(B) **Keeping Magnetic field constant and vary probe current**

Magnetic field $(B_z) = 2.050 \times 10^3$ Gauss.

S.No.	Current (I_x)	Hall Voltage (V_H)
01	0.05 mA	74.7 mV
02	0.20 mA	82.7 mV
03	1.20 mA	102.3 mV
04	2.20 mA	121.3 mV
05	3.20 mA	141.4 mV
06	4.20 mA	159.3 mV
07	5.20 mA	179.3 mV
08	6.20 mA	198.0 mV

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- **Calculations:-**

1. A graph is plotted by taking I_x along X-axis and the corresponding Hall Voltage along Y-axis which will be a straight line.

$B_Z = 2.050 \times 10^3$ Gauss or 0.2050 Weber/m^2.

- Slope of the curve:- $\frac{V_H}{I_x} = 19.25$.

- The Hall Coefficient :- $R_H = \frac{V_H}{I_x} \frac{d}{B_z} = \frac{19.25 \times 0.005}{0.2050}$

$R_H = 470 \times 10^{-3}\ \Omega m^3/Wb$ or $0.47\ \Omega m^3/Wb$.

- No. of charge carriers:- $\eta = \frac{1}{eR_H} = \frac{1}{1.6 \times 10^{-19} \times 4.7 \times 10^{-1}}$

$= \frac{10^{20}}{1.6 \times 10^{-1} \times 47} = 0.133 \times 10^{20}$ or 133×10^{17}.

- Hall Angle : $\phi = \frac{V_H}{V_x} \times \frac{I_x}{B_z}$ radian =

$\frac{77 \times 4}{0.2050 \times 82.7} = 18.16$ radian

- **Result:-**

The hall coefficient's observed value is given by $4.7 \times 10^{-1}\ \Omega m^3$/weber. and no. of charge carriers are 133×10^{17}.

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- Precautions and Sources of Error

1. Hall Voltage should be measured very carefully and accurately either by a milli-voltmeter or by a potentiometer.
2. The distance between the pole pieces of the the electromagnet should be changed during whole experiment.
3. Magnetic field should be kept constant for one set of observations.
4. current passing through the experimental wire of semiconductor should be strictly with in the permissible limit.