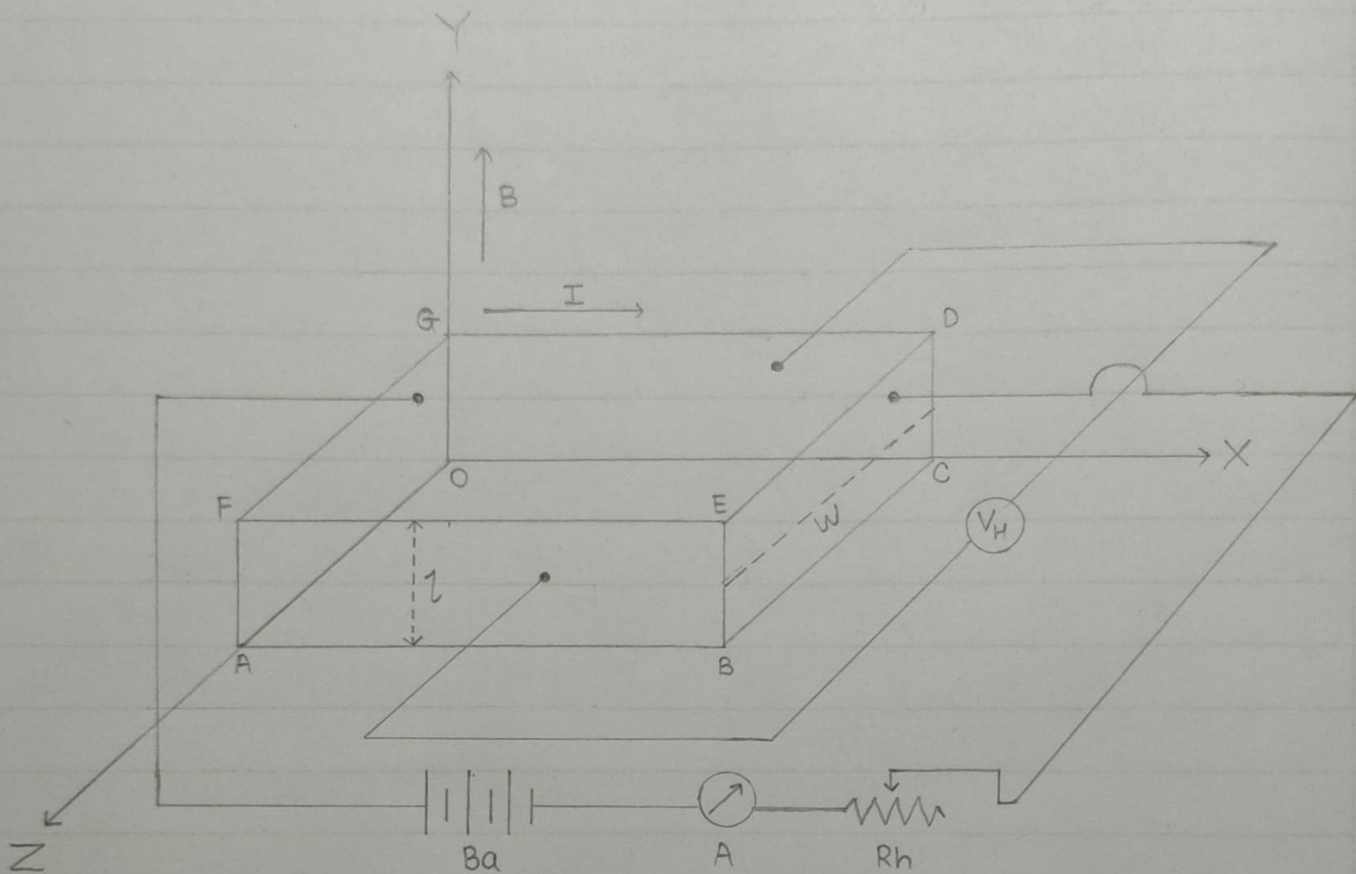
DIAGRAM ⟹



MEASUREMENT OF HALL COEFFICIENT ⟹

Current in the Hall effect setup = 2 mA.

Current in the constant current power supply (A)	Magnetic field (H) (gauss)	Hall Voltage (V_H) (volts)	Hall Coefficient (R_H) ($cm^3\ C^{-1}$)
1.0	1320	12.5	2.367×10^4
1.5	1940	18.1	2.322×10^4
2.0	2620	23.2	2.213×10^4
2.5	3040	27.4	2.253×10^4

DETERMINATION OF HALL - COEFFICIENT AND CARRIER TYPE FOR A SEMI - CONDUCTING MATERIAL.

AIM ⟹

To determine the hall coefficient of the given n-type or p-type semiconductor.

APPARATUS REQUIRED ⟹

Hall probe (n-type or p-type), Hall-effect setup, electromagnet, constant current power supply, gauss meter, etc.

FORMULAE ⟹

1) Hall coefficient $(R_H) = \frac{V_H \cdot t}{IH} \times 10^8 \ cm^3 \ C^{-1}$

where, V_H = Hall voltage (volt)
t = Thickness of sample (cm)
I = Current (ampere)
H = Magnetic field (gauss)

2) Current Density $(n) = \frac{1}{R_H \cdot q} \ cm^{-3}$

where, R_H = Hall coefficient $(cm^3 \ C^{-1})$
q = Charge of electron or hole (c)

3) Carrier Mobility $(\mu) = R_H \cdot \sigma \ cm^2 \ V^{-1} \ s^{-1}$

where, R_H = Hall coefficient $(cm^3 \ C^{-1})$
σ = Conductivity $(C \ V^{-1} \ s^{-1} \ cm^{-1})$

3.0	3600	31.2	2.166×10^4
3.5	4390	35.6	2.027×10^4
			MEAN $\Rightarrow 2.226 \times 10^4$

OBSERVATIONS $\Longrightarrow$

1) Thickness of the sample (t) = 0.05 cms.

2) Resistivity of the sample (ρ) = $10\ V\ C^{-1}\ S\ cm$.

3) Conductivity of the sample (σ) = $0.1\ C\ V^{-1}\ S^{-1}\ cm^{-1}$.

4) Charge of electron or hole (q) = 1.6×10^{-19} C.

CALCULATION $\Longrightarrow$

1) $$R_H = \frac{V_H \cdot t}{IH} \times 10^8$$

$$= \frac{12.5 \times \cancel{10^{-3}} \times 0.05}{2 \times \cancel{10^{-3}} \times 1320} \times 10^8$$

$$= \frac{0.625}{2640} \times 10^8 = \frac{625}{2640} \times 10^5 = 0.2367 \times 10^5$$

$$\approx 2.367 \times 10^4\ cm^3\ C^{-1}$$

2) $$R_H = \frac{V_H \cdot t}{IH} \times 10^8$$

$$= \frac{18.1 \times \cancel{10^{-3}} \times 0.05}{2 \times \cancel{10^{-3}} \times 1940} \times 10^8$$

$$= \frac{0.905}{3880} \times 10^8 = \frac{905}{3880} \times 10^5 = 0.2213 \times 10^5$$

$$\approx 2.322 \times 10^4\ cm^3\ C^{-1}$$

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When a current carrying conductor is placed in a transverse magnetic field, a potential difference is developed across the conductor in a direction perpendicular to both the current and the magnetic field.

RESULT ⟹

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3)
$$R_H = \frac{V_H \cdot t}{IH} \times 10^8$$

$$= \frac{\overset{23.2}{\cancel{27.4}} \times \cancel{10^{-3}} \times 0.05}{2 \times \cancel{10^{-3}} \times 2620} \times 10^8$$

$$= \frac{1.16}{5240} \times 10^8 = \frac{1160}{5240} \times 10^{\cancel{8}5} = 0.2213 \times 10^5$$

$$\approx 2.213 \times 10^4 \ cm^3 \ C^{-1}$$

4)
$$R_H = \frac{V_H \cdot t}{IH} \times 10^8$$

$$= \frac{27.4 \times \cancel{10^{-3}} \times 0.05}{2 \times \cancel{10^{-3}} \times 3040} \times 10^8$$

$$= \frac{1.37}{6080} \times 10^8 = \frac{1370}{6080} \times 10^5 = 0.2253 \times 10^5$$

$$\approx 2.253 \times 10^4 \ cm^3 \ C^{-1}$$

5)
$$R_H = \frac{V_H \cdot t}{IH} \times 10^8$$

$$= \frac{31.2 \times \cancel{10^{-3}} \times 0.05}{2 \times \cancel{10^{-3}} \times 3600} \times 10^8$$

$$= \frac{1.56}{7200} \times 10^8 = \frac{1560}{7200} \times 10^5 = 0.2166 \times 10^5$$

$$\approx 2.166 \times 10^4 \ cm^3 \ C^{-1}$$

6)
$$R_H = \frac{V_H \cdot t}{IH} \times 10^8$$

$$= \frac{35.6 \times \cancel{10^{-3}} \times 0.05}{2 \times \cancel{10^{-3}} \times 4390} \times 10^8$$

$$= \frac{1.78}{8780} \times 10^8 = \frac{1780}{8780} \times 10^5 = 0.2027 \times 10^5$$

$$\approx 2.027 \times 10^4 \ cm^3 \ C^{-1}$$

Carrier Density (n) $= \dfrac{1}{R_H \cdot q}$ cm^{-3}

$$\therefore \; n = \frac{1}{2.226 \times 10^{4} \times 1.6 \times 10^{-19}} = \frac{10^{19} \times 10^{-4}}{2.226 \times 1.9}$$

$$= \frac{1}{3.5616} \times 10^{15} \approx 0.2807 \times 10^{15}$$

so, $n \approx 2.807 \times 10^{14}$ cm^{-3}

Carrier Mobility (μ) $= R_H \cdot \sigma$

$$\therefore \; \mu = 2.226 \times 10^{4} \times 0.1$$

$$\approx 2.226 \times 10^{3} \; cm^{2} \, V^{-1} \, s^{-1}$$

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1) The Hall coefficient of the given semi-conducting material = 2.226×10^4 $cm^3\ C^{-1}$.

2) The carrier density = 2.807×10^{14} carriers/cm^3.

3) The carrier mobility = 2.226×10^3 cm^2/volt·sec

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