hall effect

Aim: To study hall effect in semiconductor sample and determine the hall coefficient and density of charge carriers. This experiment demonstrates the effect of lorentz force.

Apparatus Required:

(a) Two Solenoids, constant source of power to maintain magnetic field; hall probe with semiconductor sample, constant current supply with Ammeter and Voltmeter, gauss meter

Formula Used:

$$R_H = \frac{E_y}{JB} = \frac{V_H d}{IB} \quad -(1)$$

$$V_H = \frac{R_H B I}{d} \quad -(2)$$

$$m = \frac{R_H B}{d}$$

$$R_H = \frac{md}{B} \quad -(3)$$

Table 1

S.No.	Hall Current, I (mA)	Hall Voltage, V_H (mV)	Hall Coefficient, R_H ($\frac{-cm}{T}$ or $\frac{m^3}{C}$)	Density of charge carriers, n ($\frac{1}{m^3}$)
1	1.0	28.756		
2	1.5	43.133	194.035	3.215×10^{16}
3	2.0	57.511		
4	2.5	71.889		
5	3.0	86.267		
6	3.5	100.645		
7	4.0	115.023		

~~Table 2~~

Parameters in Table 1:

Current through Solenoid = 1A
Resultant magnetic field (B) = 0.1482G = $0.1482 \times 10^{-[illegible]}$T
Thickness of material (d) = 0.0001m
Charge of the carrier $|q| = 1.602 \times 10^{-19}$ C

Table2

S.NO.	Hall current, I(mA)	Hall Voltage, VH(mV)	Hall coefficient, R_H ($\frac{\Omega m}{T}$ or $\frac{m^3}{C}$)	Density of charge carrier, n ($\frac{1}{m^3}$)
1	1.0	23.963	~~[illegible]~~	~~[illegible]~~
2	1.5	35.945		
3	2.0	47.926	~~[illegible]~~	~~[illegible]~~
4	2.5	59.908		
5	3.0	71.889	193.98	3.217
6	3.5	83.871		
7	4.0	95.852		

parameters used in Table2:

Current through the Solenoid = 2.5A

Resultant Magnetic field (B) = 0.3706×10^{-4} T

Thickness of material (d) = 0.0003m

Charge of the carrier(|q|) = 1.602×10^{-19} C

$$R_H = \frac{1}{qn} \quad -④$$

where $|q| = 1.602 \times 10^{-19}\ C$

E_y = transverse electric field

J = current density

R_H = Hall coefficient.

V_H = Hall voltage

m = slope

Calculations:

from table 1 (graph)

$$\text{Slope } (m) = \frac{\Delta y}{\Delta x} = \frac{43.134}{1.5} = \boxed{28.756\ \Omega}$$

$$R_H = \frac{md}{B} = \frac{28.756 \times \cancel{0.0001}}{0.1482 \times \cancel{10}^{-4}}$$

$$= 194.035\ \Omega m/T \text{ or } m^3/C$$

now, $R_H = \frac{1}{qn}$

$= \frac{1}{1.602 \times 10^{-19} \times 0.0194}$

$n = 3.215 \times 10^{16} /m^3$

from table 2 (graph),

Slope $m = \frac{\Delta y}{\Delta x} = \frac{35.945}{1.5} = 23.963\,\Omega$

$R_H = \frac{md}{B} = \frac{23.964 \times 0.0003}{0.3706 \times 10^{-4}}$

$= 193.98\ \Omega\,m/T$ or m^3/C

now, $R_H = \frac{1}{qn}$

$n = \frac{1}{0.0194 \times 1.602 \times 10^{-19}}$

$n = 3.217 \times 10^{16} /m^3$

Result :

mean $R_H = 194.0075 \ \Omega m / T$ or m^3/C

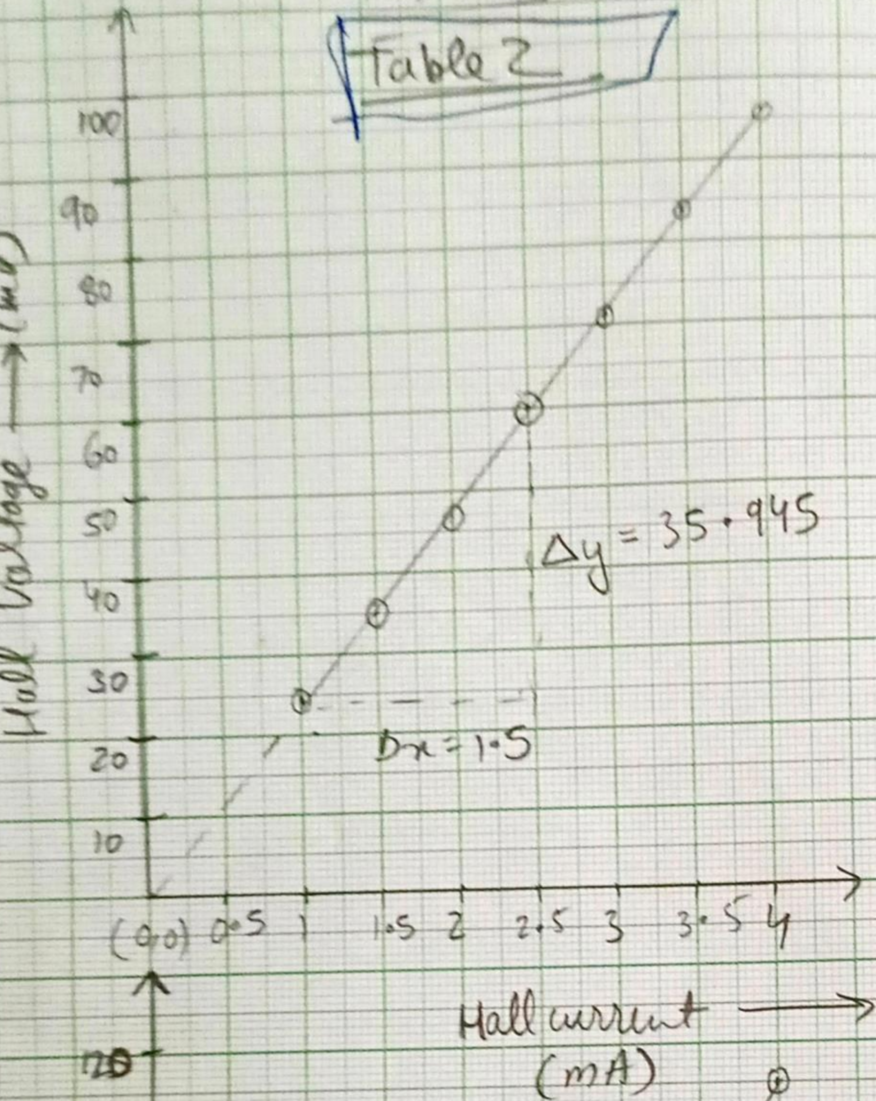
mean $n = 3.216 \times 10^{16} / m^3$

Table 2

Scale

X axis, 1 unit = 0.5 mA

Y axis, 1 unit = 10 mV



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