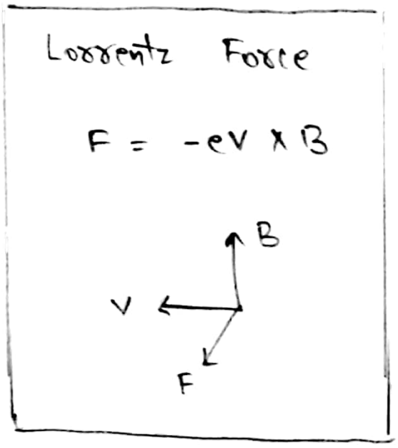
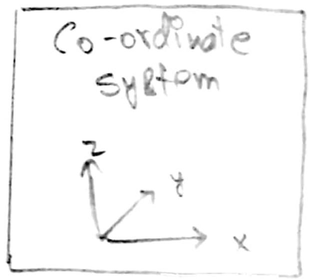
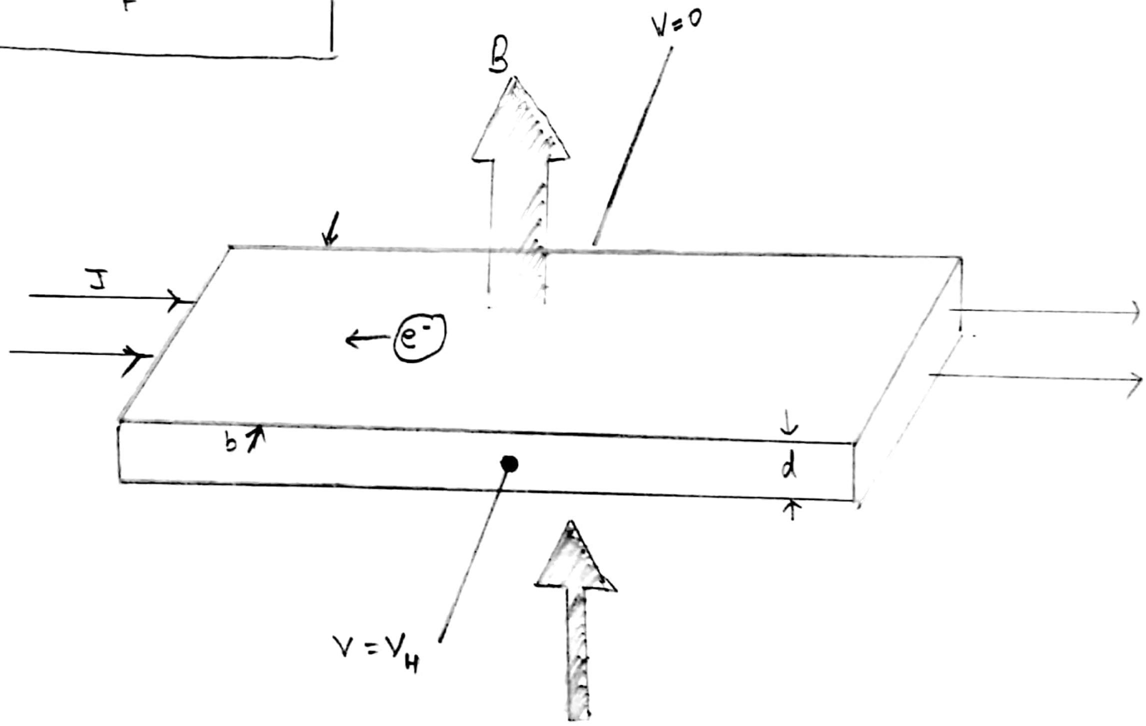

Lorrentz Force
F = -eV x B
B
V
F


Co-ordinate system
z
y
x


B
V=0
J
e⁻
b
d
V = V_H

DETERMINATION OF HALL-COEFFICIENT OF SEMICONDUCTOR

THEORY : The Lorrentz force acting on a current-carrying conductor placed in a magnetic field B applied along the +ve z direction is Bev where, v is the drift vel of the electrons. If E_H be the Hall field developed in the -ve y direction, then in eqn.

$$eE_H = Bev \quad \text{—(i)}$$

If n is the carrier concentration, the current density in the x direction is

$$J = nev$$

from (i) we get

$$E_H = \frac{JB}{ne} \quad \text{—(ii)}$$

The hall coefficient is defined as the Hall field / current density per unit magnetic field.

$$R_H = \frac{E_H}{JB} = \frac{1}{ne} \quad \text{—(iii)}$$

If a current carrying specimen of width b and thickness d is placed in a transverse magnetic field the Hall voltage (H_v) generated can be measured with the help of two probes placed at the centre of the top and bottom surface of the sample. Then

$$V_H = E_H d.$$

Teacher's Signature :

so,

$$V_H = R_H J B d$$

so,

$$V_H = R_H \frac{I}{b \cdot d} B \cdot d$$

or,

$$R_H = \frac{V_H\, b}{I \cdot B} \quad \text{—(iv)}$$

If V_H, ~~mased~~ b, I, B are measured in SI then R_H is m^3/C.

For n-type R_H is -ve and +ve for p-type.

$$\sigma = \frac{J}{E_H} = \frac{I}{b \cdot V_H} \quad \text{—(v)}$$

Mobility (μ) $= \frac{\sigma}{ne} = R_H \sigma$

APPARATUS : n-type semiconductor Ge crystal, electromagnet, digital gauss meter, ammeter, voltmeter power supply.

OBSERVATIONS :

$b = 0.05$ cm =

Current through sample I = 3.05 mA

off set voltage = -21.3 mV

SL No.	Current through the electromagnet (A)	Magnetic field strength (H) Gauss	Hall voltage develded V_H (mV)	Corrected Hall Voltage V_H (mV)
1.	0.99	1000	−7.8	13.5
2.	1.09	1100	−6.5	14.8
3.	1.19	1200	−5.0	16.3
4	1.29	1300	−3.7	17.6
5.	1.38	1400	−2.5	18.8
6.	1.48	1500	−1.9	20.2
7	1.57	1600	0.0	21.3
8	1.67	1700	1.2	22.5
9	1.75	1800	1.8	23.1
10	1.85	1900	3.3	24.6
11	1.95	2000	4.3	25.6
12	2.04	2100	5.7	27.0
13	2.13	2200	6.7	28.0
14	2.25	2300	8.1	29.4
15	2.35	2400	9.1	30.4
16	2.44	2500	10.2	31.5

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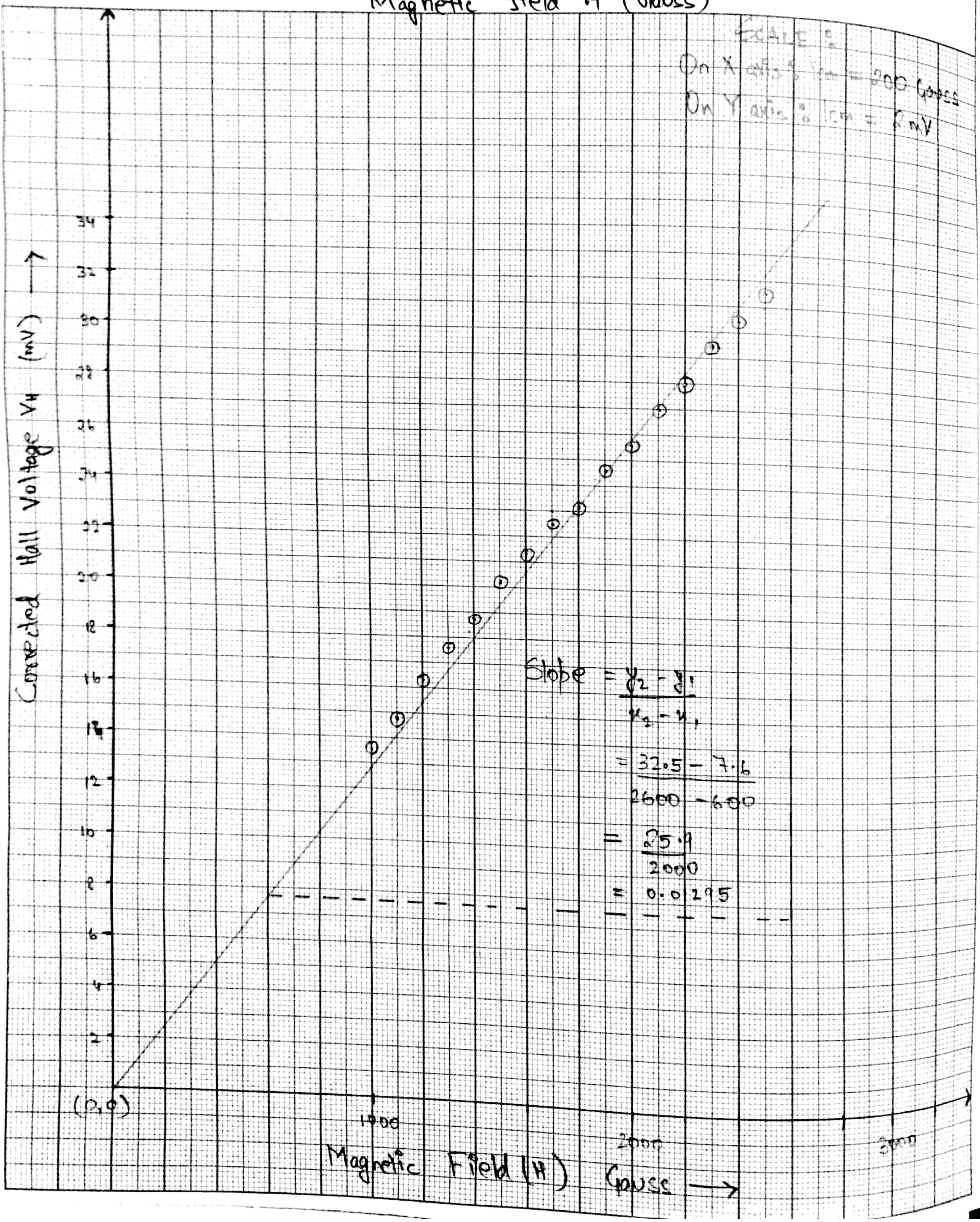
Corrected Hall Voltage H_v (mV)
Vs
Magnetic field H (Gauss)



CALCULATIONS :

From the graph, slope $m = \cancel{0.011577}$ 0.01295 mV/H

$$R_H = \frac{V_H \cdot b}{I \cdot B} = \frac{m \cdot b}{I \cdot B} = \frac{\cancel{0.01157} \; 0.01295 \times 0.5 \times 10^{-4} \times 10^{4}}{3.05}$$

$$= \cancel{0.01896955} \; 0.021229$$

$$= \cancel{0.0190} \; m^3/C$$

$$= 0.021 \; m^3/C$$

DISCUSSIONS :

1. Care is taken to limit the current through the probe to a value less than that mentioned by the manufacturer.
2. The probe is properly centered and oriented in the magnetic field such that max Hall voltage is generated.
3. The potential of the electromagnet power supply is kept at its min position while switching on or off the power supply.
4. In this case since R_H is +ve the majority carriers are holes.
5. Magnetic field is gradually varied in steps to avoid damage to the electromagnet.
6. The potential control of the current is brought to its min before switching on or off the current source.

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