Assignment-5.

2) A copper strip 3 cm wide & 2 mm thick placed in a magnetic field of 1.75 T. If a current of 150 A is set up in the strip, Calculate (i) hall voltage (ii) hall mobility, if the no. of electron per unit volume is 8.4×10^{28} electron/m^3 & resistivity 1.72×10^{-8} Ωm

⇒ Soln.

width (d) = 3 cm = 0.03

thickness (t) = 2 mm = 2×10^{-3} m

Magnetic field (B) = 1.75 T

Current (I) = 150 A

no. of electron per vol. (n) = $8.4\times10^{28}/m^3$

resistivity (ρ) = 1.72×10^{-8} Ωm

i) hall voltage (V_H) = $\frac{BI}{net}$

$$= \frac{1.75\times150}{8.4\times10^{28}\times1.6\times10^{-19}\times\cancel{1.72\times10^{-8}}\,2\times10^{-3}}$$

$$= 9.76\times10^{-6}\ V$$

ii) hall mobility (μ) = $\frac{\sigma}{ne} = \frac{1}{\rho ne}$

$$= \frac{1}{1.72\times10^{-8}\times8.4\times10^{28}\times1.6\times10^{-19}}$$

$$= 4.32\times10^{-3}\ \Omega^{-1}m^2C$$

1) Deuterons in cyclotron describe a circle of radius 0.32 m just before emerging from Dees. The frequency of the applied emf. is 10 MHz. find the flux density of the magnetic field & energy of deuterons emerging out of the cyclotron.

⇒ soln,

(a) ~~Frequency~~ ~~of~~

radius, (r) = 0.32m

frequency (f) = 10 MHz = 10×10^6 Hz

flux density (B) = ?

Energy (E) = ?

we have

$$f = \frac{qB}{2\pi m}$$

a) $$B = \frac{2\pi m f}{q}$$

$$= \frac{2\pi \times 3.32 \times 10^{-27} \times 10 \times 10^6}{1.6 \times 10^{-19}}$$

$$B = 1.303 T$$

we have

$$r = \frac{mv}{Bq} = \frac{1.303 \times 1.6 \times 10^{-19} \times 0.32}{3.32 \times 10^{-27}}$$

$$v = \frac{Bqr}{m} \Rightarrow V = 2.01 \times 10^7 \text{ m/s}.$$

b) Energy $= \frac{1}{2} mv^2$

$$= \frac{1}{2} \times 3.32 \times 10^{-27} \times (2.01 \times 10^7)^2$$

$$E = 6.71 \times 10^{-13} J$$ //

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4) In a Hall experiment a current of 25A is passed through a long foil of silver, which is 0.1 mm thick & 3m long. Calculate the Hall voltage produce across the width by a flux of 1.4 wb/m². If the conduction of silver is 6.8×10^{7} mho/m, estimate the mobility of electron in silver.

=> Sol^n,

$I = 25A$

$L = 3m$

$B = 1.4\ wb/m^2$

$t = 0.1\ mm = 0.1 \times 10^{-3} m$

$\sigma = 6.8 \times 10^{7}$ mho/m

$\frac{v_d}{E_H} = \frac{1}{B} \Rightarrow \mu = \frac{1}{B} = \frac{1}{1.4} = 0.714$

we have,

$\mu = \frac{\sigma}{ne}$

$n = \frac{\sigma}{\mu e} = \frac{6.8 \times 10^{7}}{0.71 \times 1.6 \times 10^{-19}}$

$= 5.95 \times 10^{26}$

finally

$V_H = \frac{BI}{net}$

i) Hall voltage $(V_H) = \frac{BI}{net}$

$= \frac{1.4 \times 25}{5.95 \times 10^{26} \times 1.6 \times 10^{-19} \times 0.1 \times 10^{-3}}$

$= 3.67 \times 10^{-3} V$

$V_H = 3.67 \times 10^{-3} V$ #

~~3) In a Hall Effect expⁿ, a current of 25 A is passed through a long foil of silver which is 0.1 mm thick & 3m long~~

3) In a Hall effect expⁿ, a current 3.2 A lengthwise in a conductor 1.2 cm wide, 4.0 cm long & 9.5 μm thick produce a transverse hall voltage of 40 μV. when a megnetic field of 1.4T is passed perpendicularly through thin conductor. From these data, find (a) The drift velocity of the charge carries (b) The no. of density of charge carries.

⇒ Solⁿ,

$I = 3.2 A$

$d = 1.2 cm = 0.012 m$

$L = 40 cm = 0.4 m$

$t = 9.5 \mu m = 9.5 \times 10^{-6} m$

$V_H = 40 \mu V = 40 \times 10^{-6} V$

$B = 1.4 T$

i) drift velocity (V_d)

$$eE_H = Be V_d$$

$$V_d = \frac{E_H}{B} = \frac{V_H}{d.B} = \cancel{\frac{9.5 \times 10^{-6}}{0.012 \times 1.4}}$$

$$\cancel{V_d = 5.65 \times 10^{-4} m/s.}$$

$$= \frac{V_H}{d.B}$$

$$= \frac{40 \times 10^{-6}}{0.012 \times 1.4}$$

$$= 2.38 \times 10^{-3} m/s$$

ii) hall voltage $(V_H) = \frac{BI}{net}$

$$n = \frac{B \cdot I}{V_H e t}$$

$$= \frac{\cancel{1.5 \times 3}}{\cancel{10 \times 10^{-6} \times 1.6 \times 10^{-19} \times 10 \times 10^{-6}}}$$

$$= \frac{1.4 \times 3.2}{40 \times 10^{-6} \times 1.6 \times 10^{-19} \times 9.5 \times 10^{-6}}$$

$$= 7.368 \times 10^{28} \text{ eletron}/m^3$$

5) A copper strip 150 μm thick is placed in a magnetic field of strength 0.65 T perpendicular to the plane of the strip & current of 23 A is set up in the strip. Calculate i) the Hall voltage coefficient & ii) Hall coefficient & iii) Hall mobility, if the no. of electron per unit volume is 8.4×10^{28} electron/m3 & resistivity 1.72×10^{-8} Ωm

⇒ Soln,

$t = 150$ μm $= 150 \times 10^{-6}$ m

$B = 0.65$ T

$I = 23A$

No. of electron per unit vol. $(n) = 8.4 \times 10^{28}$ el/m³

resistivity $(\rho) = 1.73 \times 10^{-8} \Omega m$

we know,

$$\text{hall voltage} = \frac{BI}{net}$$

$$= \frac{0.65 \times 23}{8.4 \times 10^{28} \times 1.6 \times 10^{-19} \times 150 \times 10^{-6}}$$

$$= 7.41 \times 10^{-6} V$$

$$\text{hall coefficient } (R_H) = \frac{E_H}{JB} = \frac{1}{ne}$$

$$= \frac{1}{8.4 \times 10^{28} \times 1.6 \times 10^{-19}}$$

$$= 7.44 \times 10^{-11} \ m^3/C$$

$$\text{hall mobility } (\mu) = \frac{\sigma}{ne} = \frac{1}{\rho ne}$$

$$= \frac{1}{1.72 \times 10^{-8} \times 8.4 \times 10^{28} \times 1.6 \times 10^{-19}}$$

$$= 4.32 \times 10^{-3} \ \Omega^{-1} m^2 C$$