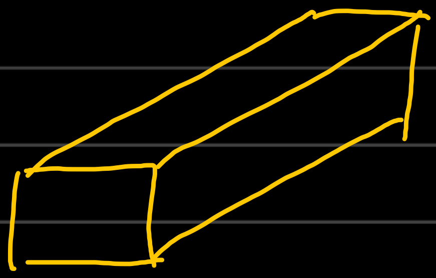
Lecture 2



$R = \frac{\rho L}{A}$ $\quad \rho = \frac{1}{\sigma}$

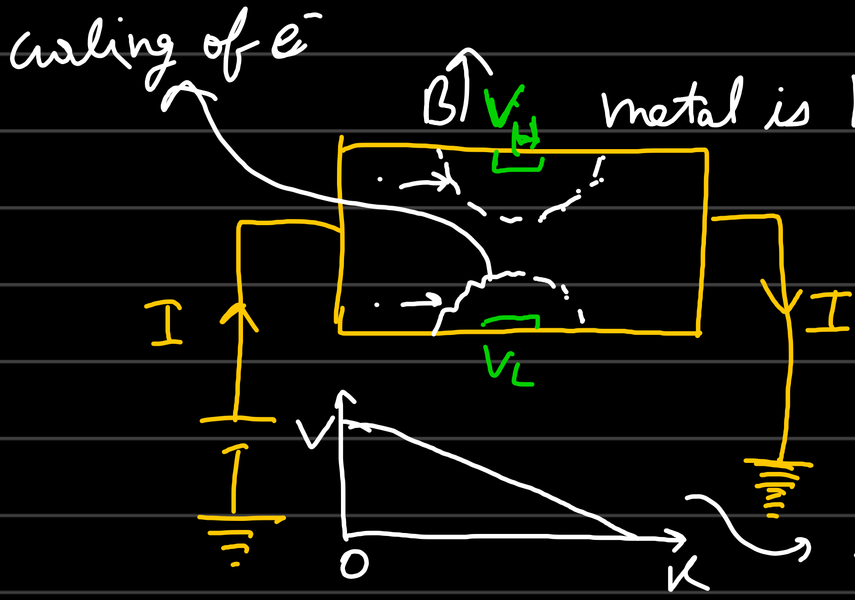
$$\sigma = \frac{ne^2 \tau}{m}$$

$$\boxed{\rho = \frac{m}{ne^2 \tau}}$$

τ = Varies with conditions
$\Downarrow$
mean time to scatter
(probability to scatter)

τ longer : mean velocity is higher
↳ higher current
↳ higher conductivity.

{All above derivations are for DC conditions}



metal is homogenous

$V_H - V_L = 0$

linear decay of V across length of conductor.

↳ On application of a transverse field $\vec{B}$

↳ electrons are curled and accumulation can take place.

$$V_H - V_L = V(B) \neq 0$$

Hall's Experiment

Derivation of Hall's Voltage:

$$\boxed{\frac{dv_d}{dt} = \frac{F}{m} - \frac{v_d}{\tau}}$$

$$\vec{F} = -eE - e(\vec{v}_d \times \vec{B})$$

$$v_d = \begin{pmatrix} v_{dx} \\ v_{dy} \end{pmatrix}$$

$$\frac{dV_{dx}}{dt} = \frac{-eE_x}{m} - \frac{e}{m}Bv_y - \frac{v_x}{\tau}$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ v_x & v_y & 0 \\ 0 & 0 & B \end{vmatrix}$$

$$\frac{dv_{dy}}{dt} = \frac{-eE_y}{m} + \frac{e}{m}Bv_x - \frac{v_y}{\tau}$$

$$(Bv_y\hat{i} - v_xB\hat{j})$$

Stedy State DC soln $\frac{d\vec{v}}{dt} = 0$

$$\frac{eE_y}{m} = \frac{eBv_x}{m} - \frac{v_y}{\tau}$$

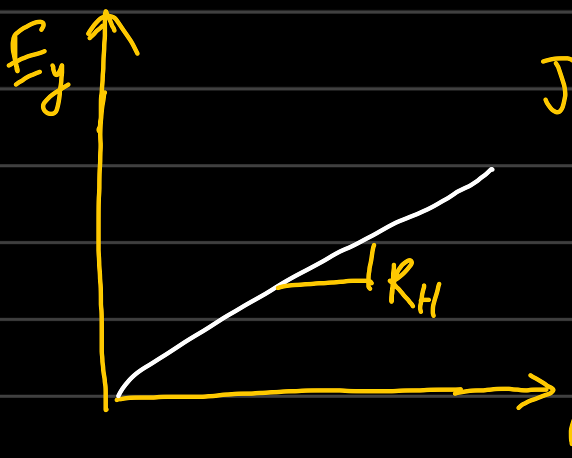
$$\boxed{E_y = Bv_x} \qquad v_y = 0$$

$J_x = neV_x$ $\qquad E_y = B \cdot \frac{J}{ne}$

$$E_y = \left(\frac{1}{ne}\right) \cdot B J_x = R_H J_x B$$

Hall's Field

Hall's Coefficient



$J_x =$ const.

$$R_H = \frac{1}{(N_e)e}$$

from RH, we can extract Ne.

→ Experiment done in 1900's

Li : 0.8 , Na : 1.2 ; Au : 1.5

Be : $-0.2N_f$, Mg : $-0.4N_f$; Al : $-0.3N_f$

$$\left\{\text{Valence} \times \frac{\text{Vol}}{\text{molarV}} \times N_A\right\} \longleftrightarrow \text{Valence}$$

↳ Be, Mg, Al ⇒ some charge carriers behave as having -ve mass.

→ Concave & Convex energy bands and their curvature dictate if charge carriers behave like electrons or holes.

* Charge carrier can be of two types
  : electrons & holes.

AC conditions:

$E_x = E(\omega)e^{-i\omega t}$ oscillating electric field