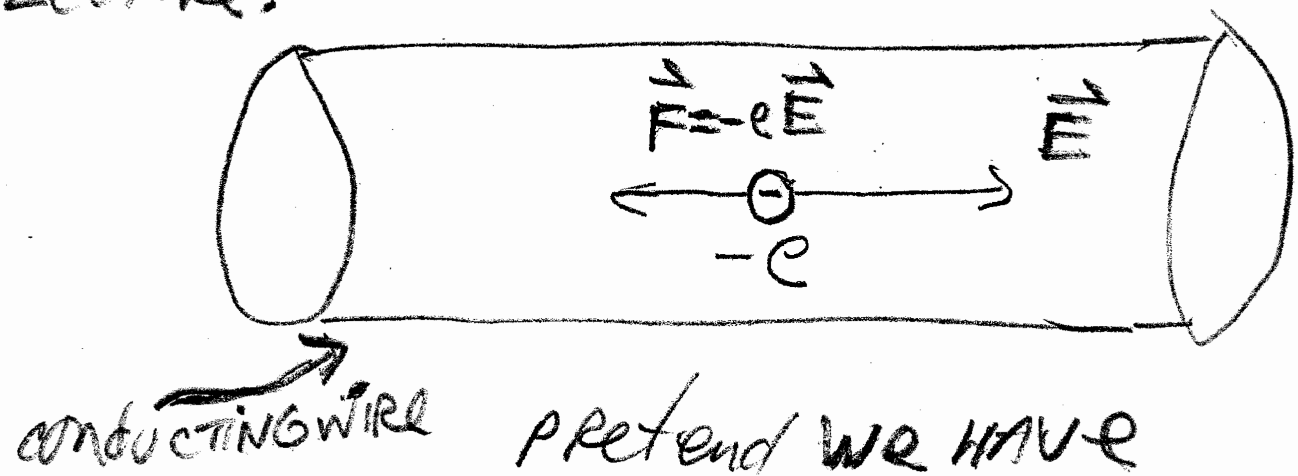
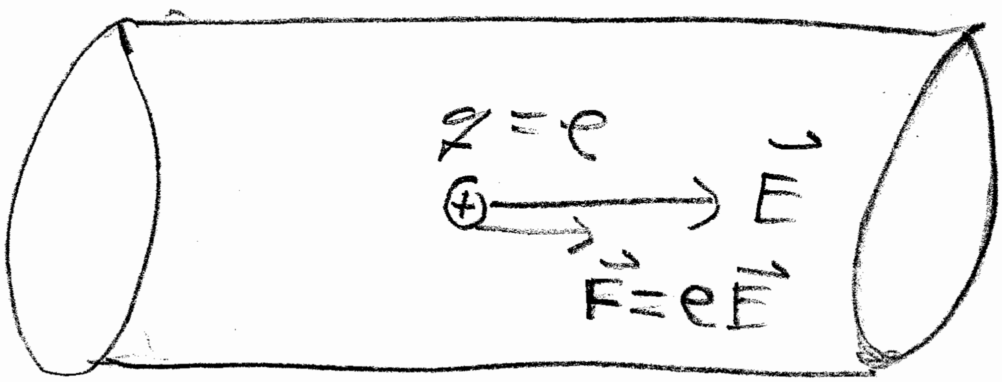
See sec 25.6

Pre-LAB lecture: Resistance and ohm's LAW



Pretend we have +ve conducting charges.

$\Downarrow$



$q = +e$

$\oplus \longrightarrow v_x$

$\longrightarrow$ X-AXIS

$$v_x = v_{0x} + a_x \cdot \Delta t$$

$\uparrow$

initial velocity JUST AFTER a collision.

$$a_x = \frac{eE_x}{m}, \quad m = \text{electron mass}$$

TAKE AVERAGE OVER MANY collisions.

$\langle W \rangle$ = AVERAGE W = LANGUAGE.

$$\langle v_x \rangle = \langle v_{0x} \rangle + \langle a_x \cdot \Delta t \rangle$$

⟨AVERAGE⟩ NOTATION

$\downarrow$

0 on AVERAGE

NOTE: $\langle \Delta t \rangle = \tau$

$$\langle v_x \rangle = v_d = \frac{eE_x}{m} \cdot \tau;$$

τ = AVERAGE time between collisions

τ = Average time between collisions

DRIFT speed = $v_d = \frac{eE_x}{m} \cdot \tau$

$\underbrace{e n \cdot v_d}_{\text{units} = \frac{C}{s \cdot m^2}} \equiv$ current density $= J \left(\frac{C}{s \cdot m^2}\right)$

n = conducting charge density in conductor.

units = $\frac{\#\text{electrons}}{m^3}$.

$\boxed{\text{TYPICAL: } n \sim 10^{28} m^{-3} \text{ FOR METALS.}}$

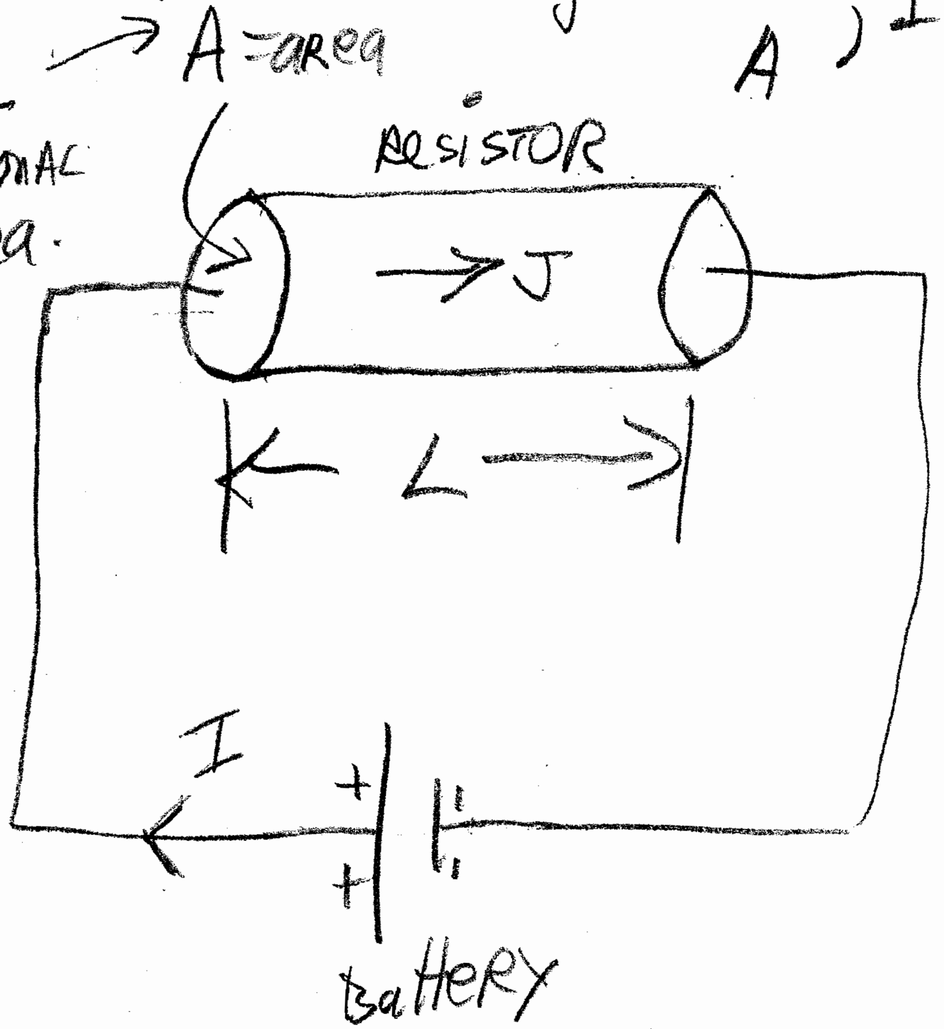
$e = 1.6 \times 10^{-19} (C)$

note: v_d units $= \frac{m}{s}$

e units = C = coulomb

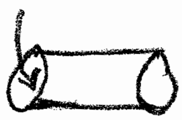
FOR J, check unit conversion: $(C) \cdot (m^{-3}) \cdot \frac{m}{s} = \frac{C}{s \cdot m^2}$

$J = \frac{I}{A}$, I = current



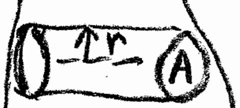
NOTE:

A



CYLINDER

A = end cap area



$A = \pi \cdot r^2$
r = RADIUS

$$I = \frac{\Delta Q}{\Delta t} = \frac{dQ}{dt} = \text{rate of}$$

charge passing through area A.

$$I \text{ units} = \frac{C}{s} = \text{Amperes} = (A)$$

$$J \text{ units} = \frac{(A)}{m^2} = \text{current density} = \frac{I}{A}$$

Review: τ = Average time between collisions.

$$J = nev_d = ne \cdot \left(\frac{eE_x}{m}\right) \cdot \tau$$

$$J = \frac{ne^2\tau}{m} \cdot E_x$$

$$J = \sigma \cdot E_x$$

σ = conductivity

$J = \dfrac{E_x}{\rho}$, ρ = Resistivity $= \dfrac{1}{\sigma}$.

$\sigma = \dfrac{ne^2\tau}{m}$; $\sigma \to \infty$ as $\tau \to \infty$

Superconductor (no collisions)

$$\rho = \frac{1}{\sigma} = \frac{m}{ne^2\tau}$$

$\rho \to 0$ as $\tau \to \infty$

$\rho \to \infty$ as $\tau \to 0$

ohm's LAW:

$$\frac{I}{A} = \frac{E_x}{\rho}$$

$$I = \frac{E_x \cdot A}{\rho}$$

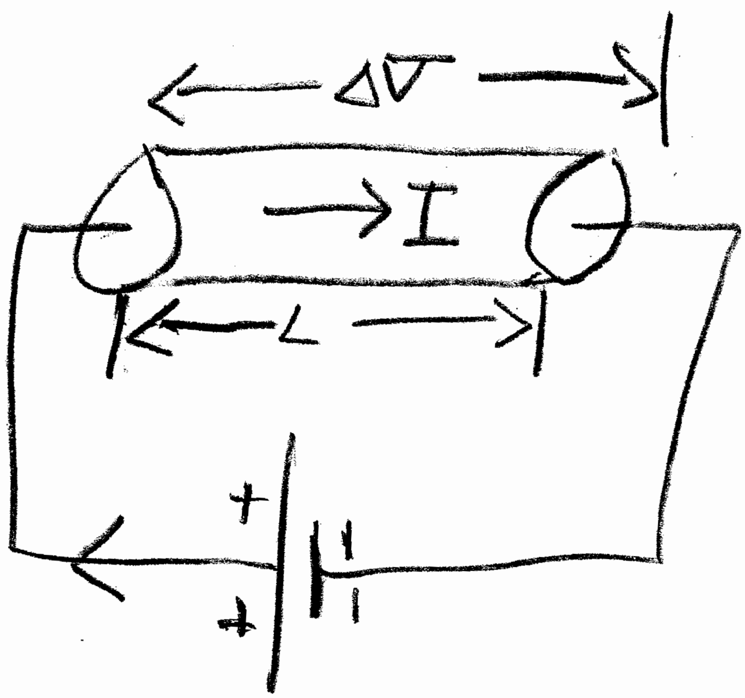
$$I = \frac{E_x \cdot A \cdot L}{\rho \cdot L} = \frac{E_x \cdot L \cdot A}{\rho \cdot L}$$

$$I = \frac{E_x \cdot L}{\left(\frac{\rho L}{A}\right)} = \frac{\Delta V}{R}$$

$\Delta V \equiv E_x \cdot L$

$R \equiv$ Resistance

$$R \equiv \frac{\rho L}{A}$$



$I = \frac{dQ}{dt}$

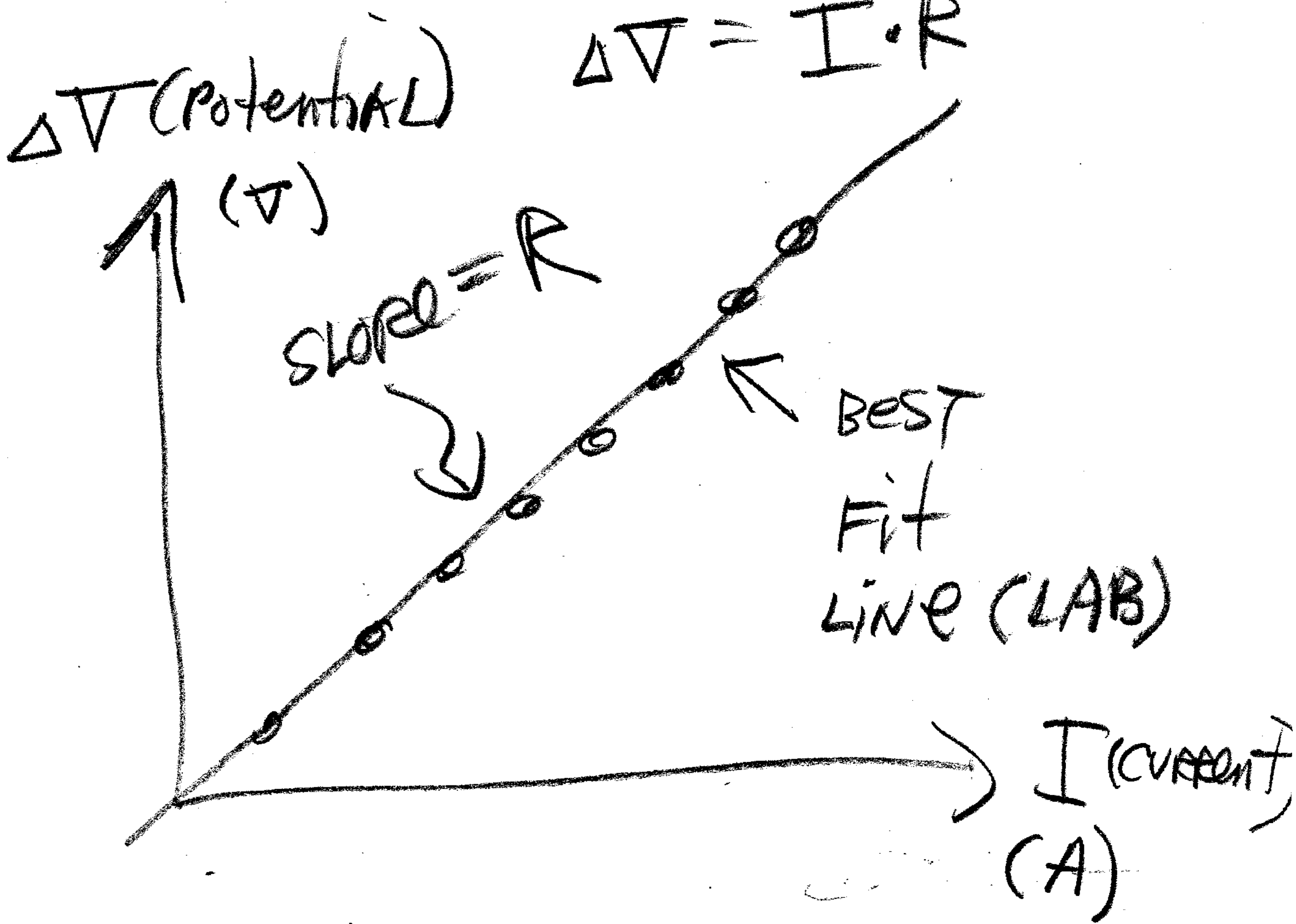
$\Delta V = V_+ - V_-$

V_+ = voltage at +ve terminal.

V_- = " " −ve terminal.

Battery voltage $= V_+ - V_-$

$\Delta V = I \cdot R$



<u>NOTE:</u>

$$I = \frac{\Delta V}{R} = \frac{E_x \cdot L}{R} = \frac{Q \cdot E_x \cdot L}{Q \cdot R}$$

$$= \frac{\text{Force} \cdot \text{Distance}}{Q \cdot R} = \frac{\text{Work}}{Q \cdot R}$$

$$= \frac{\text{Work per unit charge}}{\text{resistance}}$$

Work is performed by field over distance L.