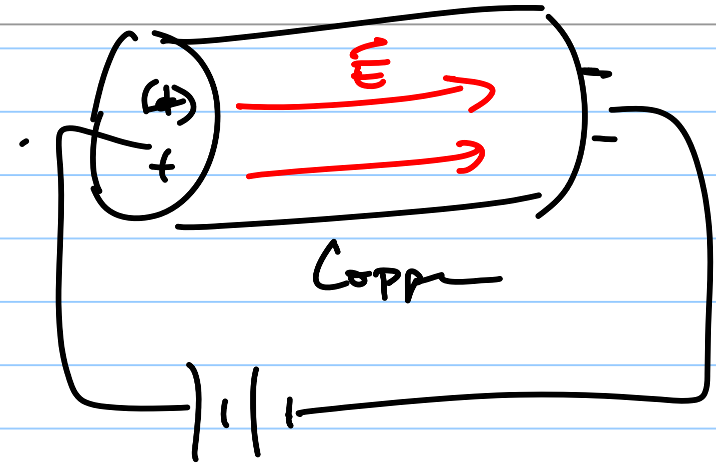
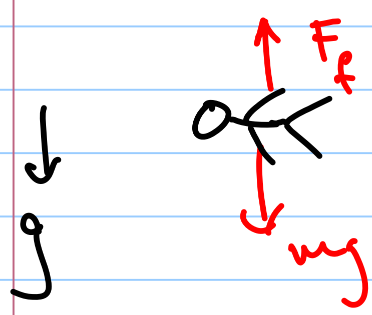
Note Title 3/26/2008




$\vec{F} = q\vec{E}$




$\sum \vec{F} = m\vec{a} = 0$

$mg - F_f = 0 \qquad F_f = mg$

$\alpha v = mg$

1D conductor

$qE \propto v$

$\vec{J} = \rho \vec{v}$ $\quad \frac{\text{Amps}}{m^2}$

$\rho$: $\frac{C}{m^3} \frac{m}{s}$

Ohm's Law

$$\vec{J} = \sigma \vec{E}$$

$+ + + + + \rightarrow \lambda v$ $\quad \frac{C}{m} \frac{m}{s}$

Model

1st model $\quad F = ma = qE \qquad a = \frac{qE}{m}$ const

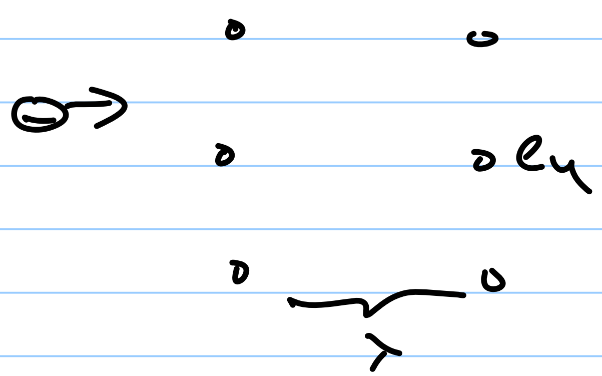
don't match Ohm's law

current should increase with distance (velocity)

$\rho$ const

$J = \rho v$

2nd model



electron hits lattice
& has to accel again

Inbetween freely accel

$v_0 = 0$

$\lambda = \frac{1}{2} a t^2 \qquad t = \sqrt{\frac{2\lambda}{a}}$

↗ time between collisions

$v_{ave} = \frac{v_i + v_f}{2} = \frac{at}{2} = \sqrt{\frac{\lambda a}{2}} = \sqrt{\frac{\lambda}{2} \frac{qE}{m}}$

(with $v_i = 0$)

$F = ma = qE \qquad a = \frac{qE}{m}$

model doesn't work because $v \propto \sqrt{E}$

Model 3 : $\frac{1}{2} m_e v_e^2 = kT$

$v_e = .01 \times \underbrace{3 \times 10^8 \, m/s}_{c}$

$t_{between\ collisions} = \frac{\lambda}{v_{therm}}$ ↗ $v_e$

$v_{ave} = \frac{v_i + v_f}{2} = \frac{0 + at}{2} = \frac{a\lambda}{2v_{therm}} = \frac{qE\lambda}{2m v_{therm}}$

Ohm's law

$\vec{J} = \rho \vec{v} = N f q v_{ave}$

N: # molecules / vol

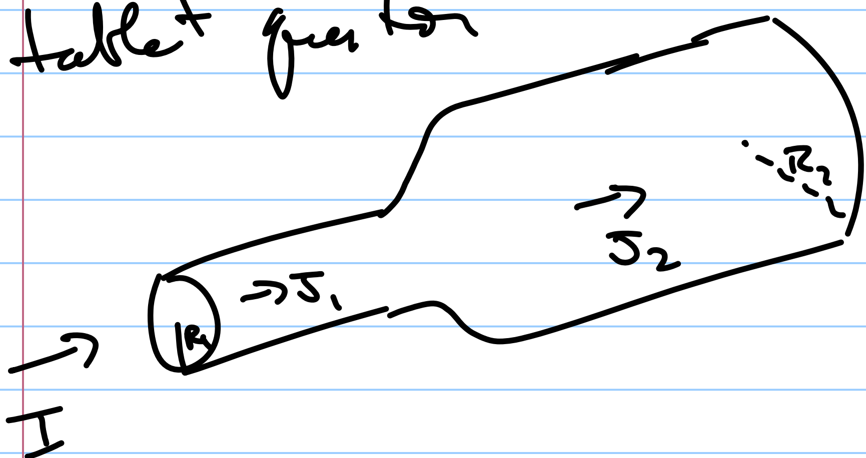
f: # free electrons / molecule

q: ↑ charge electron

where does ohm's law fail?

- temp → 0 model (II) applicable
- E very large then time between collision det. by E & thermal vel
- oscillate E so τ < collision time

tablet question




Fund. Principle : $I = \int J \cdot da = JA$

$J_1 = \rho_1 v_1 \qquad J_2 = \rho_2 v_2$

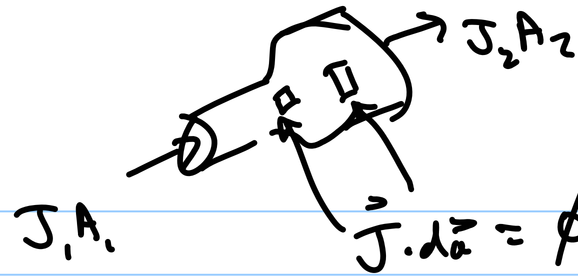
$\rho_1 = \rho_2$

Cons. charge

$\vec{\nabla} \cdot \vec{J} = -\frac{\partial \rho}{\partial t}$ no change with time $\frac{\partial \rho}{\partial t} = 0$

$\int \vec{\nabla} \cdot \vec{J} \, d\tau = \oint \vec{J} \cdot d\vec{a}$

$J_1 A_1 = J_2 A$ on two ends




$\vec{J} \cdot d\vec{a} = \phi$ because $\vec{J} \perp d\vec{a}$ on the side surfaces

free charge density is constant thru wire