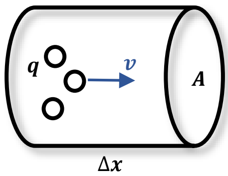
Current and Resistance

Electric Current



$\Delta Q = Nq = (nA\Delta x)q$

n is the number of mobile charge carriers per unit volume

$\Delta Q = nqAv\Delta t$

$$I_{avg} = \frac{\Delta Q}{\Delta t} = nqAv \Rightarrow \boxed{I = nqAv}$$

current density $J = \frac{I}{A} = nqv$

Conductivity

$\overline{v} = v_0 + a\overline{t} = v_0 + \frac{Eq}{m}\overline{t}$ $\overline{t}$ is average collision time

$\Rightarrow 0 + \frac{Eq}{m}\overline{t}$ when initially $v_0 = 0$

$$\Rightarrow \frac{Eq}{m}\tau \; (\tau = \overline{t})$$

$$J = nq\overline{v} = nq\frac{Eq}{m}\tau = \underbrace{\boxed{\frac{nq^2\tau}{m}}}_{\sigma}E = \sigma E$$

define conductivity $\sigma = \frac{nq^2\tau}{m}$

Ohm Law

$\boxed{\Delta V = IR}$

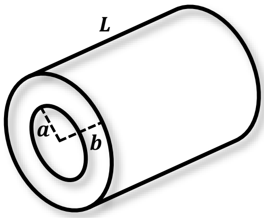
Resistance

$$I = JA = \sigma AE = \sigma A\frac{\Delta V}{L} = \frac{\Delta V}{R} \Rightarrow \boxed{R = \rho\frac{L}{A}}$$

define resistivity $\rho = \frac{1}{\sigma}$

generally, resistivity increases when the temperature increases

Resistance of a Cable



$$dR = \frac{\rho dr}{A} = \frac{\rho}{2\pi r L} dr$$

$$R = \int dR = \frac{\rho}{2\pi L} \int_a^b \frac{dr}{r} = \frac{\rho}{2\pi L} ln(\frac{b}{a})$$

Electric Power

$$\boxed{P = I\Delta V = I^2 R = \frac{(\Delta V)^2}{R}}$$