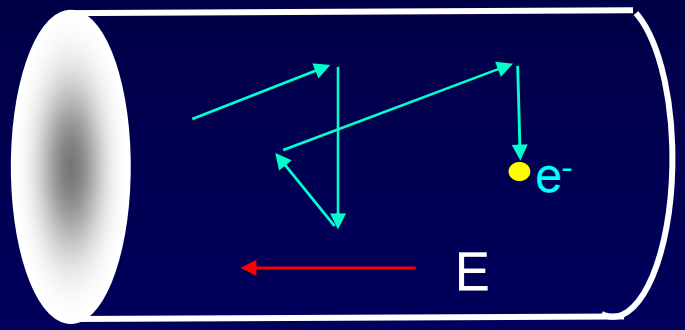
Semi-classical Picture of Conduction

Wire with cross section A



n = # free electrons/volume
τ = time between scattering events
J = current density = I/A
F = force = -eE
a = acceleration = F/m

$$J = nev_{drift}$$

$$v_{drift} = a\tau = \frac{F}{m}\tau = \frac{eE}{m}\tau$$

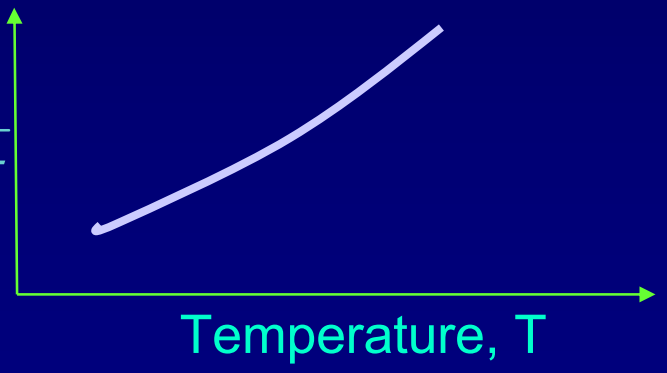
$$J = \frac{ne^2\tau}{m}E = \sigma E, \text{ where}$$

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

Metal: scattering time gets shorter with increasing T

Resistivity

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



A more accurate description requires that we treat the electron as a quantum mechanical object.