Lecture 11

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1 Material Classification

If an external electric field $\vec{E}$ is applied to a material then the excess or mobile charges will be pushed along by the field through the electric force

$$\vec{F_E} = q\vec{E} = -e\vec{E}$$

Which leads to a current. Based on this, we can classify materials as *conductors*, *semiconductors*, and *dielectircs*.

2 Point form of Ohm's Law and Conductivity

$$I = \iint_S \vec{J} d\vec{S}$$

Where $\vec{J}$ is the current density.

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

Which relates to Ohm's Law

$$I = GV = \frac{V}{R}$$

Rearranging,

$$\sigma = \frac{N_e e^2 \tau}{m_e}$$

Where N_e is electron density and τ is mean free time (in seconds).
Generally, conductivity σ is inversely proportional to temperature T. Resistivity is just the inverse of conductivity,

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