Lecture 30 outline: 10/28/2020

- HW06 … last call …
- HW07 change to Friday (10/30)

- Electric fields in matter
  - Gauss's law with free and bound charge
  - Electric displacement
    - Relative permittivity
    - Application – Parallel plate capacitor
    - Application – Insulated wire

Electric Fields in Dielectrics

$\vec{p} = \alpha \vec{E}$

Alpha is called "polarizability"

$\vec{P} = N \vec{p} = N \alpha \vec{E}$

Polarization is dipole moment/volume

$\vec{P} \stackrel{\text{def}}{=} \epsilon_0 \chi_E \vec{E}$

Chi is called "electric susceptibility"

$\epsilon \stackrel{\text{def}}{=} \epsilon_0 (1 + \chi_E)$

Epsilon is called "permittivity"

$\epsilon_r \stackrel{\text{def}}{=} (1 + \chi_E)$

Epsilon_r is called "relative permittivity" or "dielectric constant"

$\vec{D} = \epsilon \vec{E}$

$\vec{D} = \epsilon_r \epsilon_0 \vec{E}$

D is "Electric displacement"

Gauss with Free and Bound Charge

$$\nabla \cdot \vec{E} = \frac{\rho}{\epsilon_0}$$

$$\rho = \rho_{Free} + \rho_{Bound}$$

$$\rho_{Bound} = -\nabla \cdot \vec{P}$$

$$\epsilon_0 \nabla \cdot \vec{E} = \rho_F - \nabla \cdot \vec{P}$$

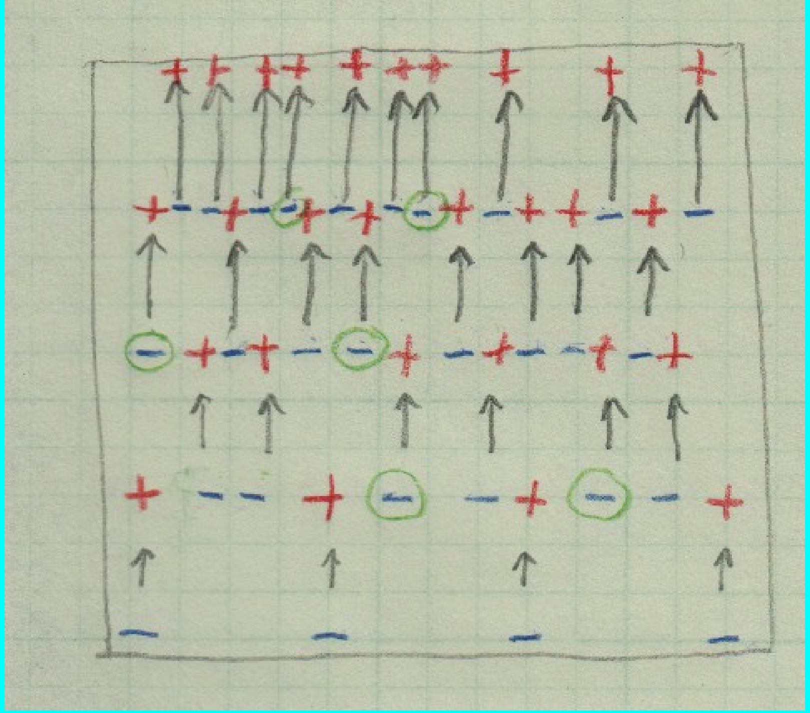
$$\nabla \cdot \epsilon_0 \vec{E} = \rho_F - \nabla \cdot \vec{P}$$

$$\nabla \cdot (\epsilon_0 \vec{E} + \vec{P}) = \rho_F$$

$$(\epsilon_0 \vec{E} + \vec{P}) \stackrel{\text{def}}{=} \vec{D}$$

$$\nabla \cdot \vec{D} = \rho_F$$

$$\int \vec{D} \cdot d\vec{A} = Q_{Free}$$



Application: Parallel plate capacitor with dielectric

Application: Charged wire with plastic insulator

“A Deceptive Parallel”