

- Discord for homework help??
 - Include Sonnenfeld?
 - Identify host?
- Chapter 4
- Force and torque on dipole
 - Problem RS 7-05
 - RS 7-07 Breakout rooms
- Electric fields in matter
 - Polarization
 - Bound Charges
 - RS 7-09

Force and Torque on a dipole

$$\vec{N} = \vec{p} \times \vec{E}$$

$$\vec{F} = (\vec{p} \cdot \nabla) \vec{E}$$

Problem RS 7-05 Torque induced by dipoles on each other

Problem RS 7-07 Force between charge and induced dipole.

Electric Fields in Matter

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

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”

Units Check

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

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

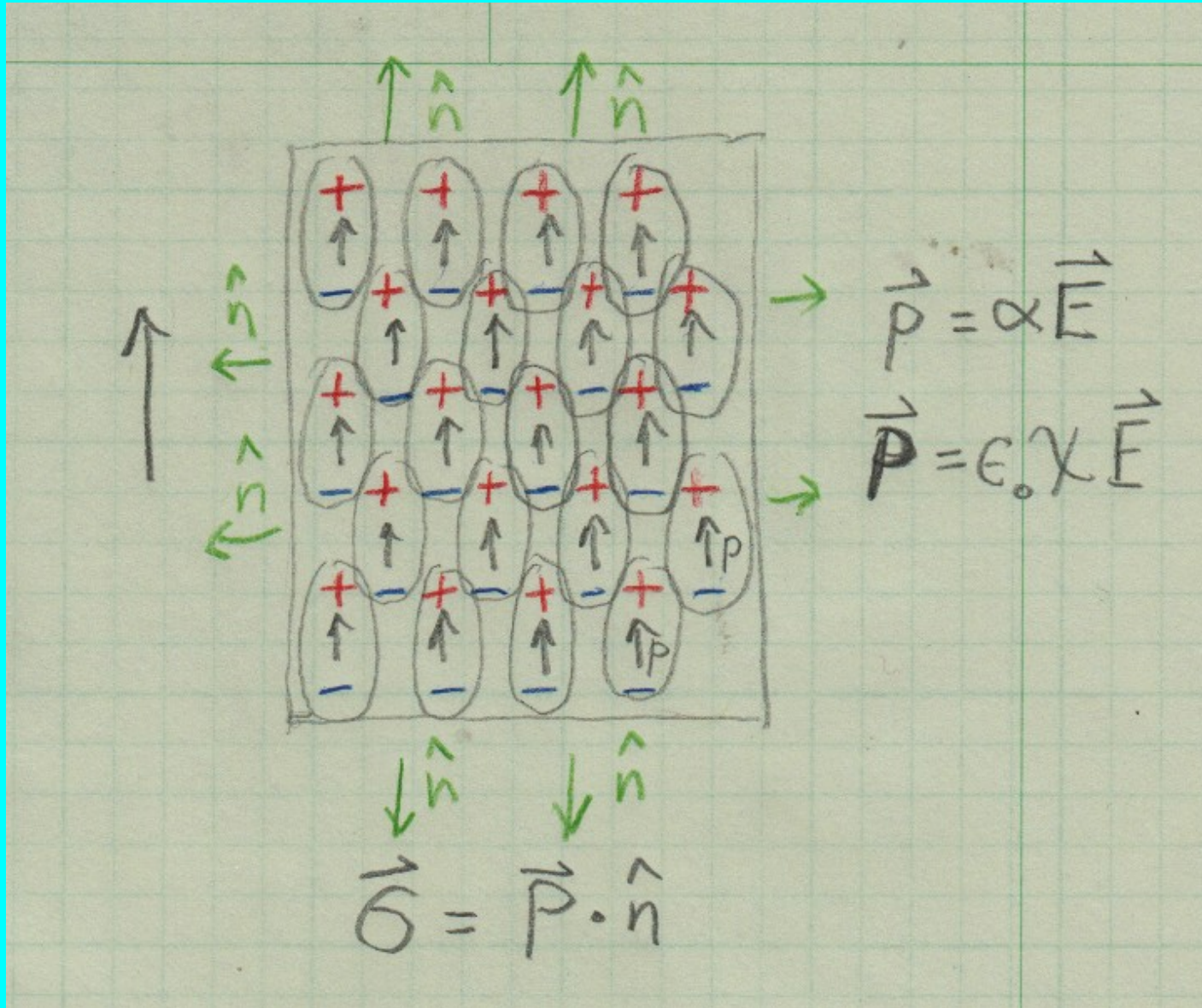
$$\vec{P} \stackrel{\text{def}}{=} \epsilon_0 \chi_E \vec{E}$$

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

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

Polarization = Dipole moment per Volume

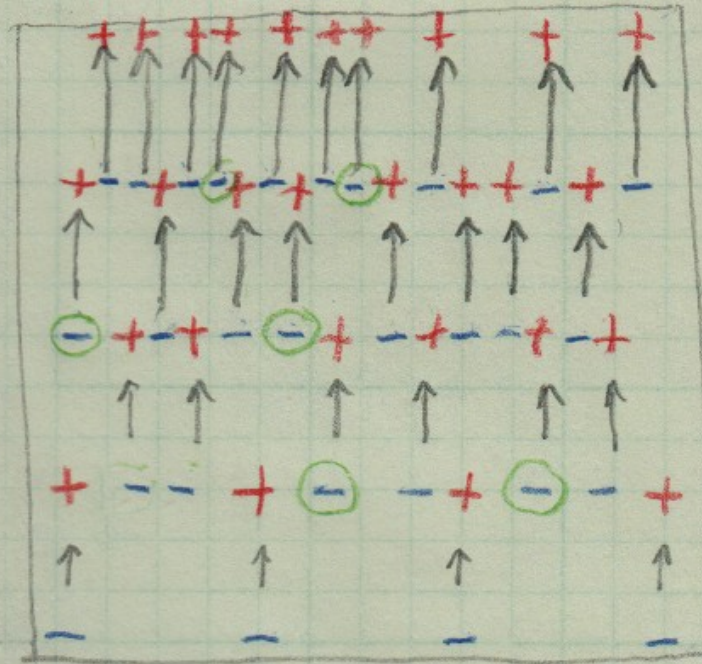
$$\sigma_B = \vec{P} \cdot \hat{n}$$



Polarization = Dipole moment per Volume

$$\rho_B = -\nabla \cdot \vec{P}$$

$$\vec{P} = (z_0 + 2z) \cdot -\nabla \cdot \vec{P} = -2$$



$$\rho_b = -\nabla \cdot \vec{P}$$

Real similar to RS 7-09

Imagine a cube centered at origin with polarization $\vec{P} = P_0 y \hat{x}$

The cube has side “a”

What is the bound surface and volume charge on the cube?

$$\rho_B = -\nabla \cdot \vec{P}$$

$$\sigma_B = \vec{P} \cdot \hat{n}$$

Gauss with Free and Bound Charge

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

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

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

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

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

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

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

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

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

