Homework Assignment #2 (due in class Fri Sept 13)

Instructions:

- You may work with other students (in fact, I recommend that) but do not copy solutions. Write your own solutions in your own words.
- Solutions should be complete but concise, and legible.
- To aid in grading, draw a box around your final answers, using red pencil.

2-1. Consider a uniformly polarized sphere of radius a. The polarization **P(x)** is $P_0\ \hat{e}_z$ for r < a, and 0 for r > a.

(A) Determine **P(x), E(x)** and **D(x)** both inside and outside the sphere. The answers depend on P_o and a. (Do not assume **D** is linearly related to **E**! E.g., imagine that this is a spherical electret.)

(B) Sketch the E-field lines and sketch the D-field lines. For extra credit use a computer to make the figures.

2-2. In one paragraph, describe and explain an application of electrets.

2-3. Jackson Problem 4-8.

2-4. Jackson Problem 4-10.

2-5. Two dielectric materials (ϵ_1 for x > 0 and ϵ_2 for x < 0) are separated by a planar interface, which is the yz plane. (Draw a picture.) A point charge q is located at (x,y,z) = (d,0,0) in the region of ϵ_1. Use the method of images to determine **E(x)** in both regions.

(A) Calculate the surface charge density σ(0,y,z). Note: this is bound charge.

(B) Is the force on q attractive or repulsive with respect to the interface?

2-6. (Davidson, 6.6) Show that if a small piece of dielectric is placed adjacent to a charged sphere, then it is attracted to the sphere. (A sketch showing the bound charge is all that is needed.)

2-7. An air-filled parallel plate capacitor with rectangular plates (dimensions L x H) is fixed in a vertical position. The plates are at x = 0 and x = d where d is small. The plates are connected to a battery and the electric field
is $E_o\ \hat{e}_x$. Then the battery is disconnected. Now the plates are lowered into contact with a liquid dielectric material with mass density ρ and permittivity ϵ. A height h of liquid is pulled up into the space between the plates by an electrostatic force. (Ignore capillarity.) Draw a picture. Calculate h.
[HINTs. The energy of a capacitor is $Q^2/(2C)$. The capacitance of a parallel plate capacitor, partially filled with dielectric, is $C_1 + C_2 = \epsilon hL / d + \epsilon_0 (H - h)\ L / d$.]