Physics 842 – Fall 2012
Classical Electrodynamics II

Problem Set #3 – due Tuesday October 2

1. A cylindrical capacitor consisting of two long, coaxial, thin cylindrical conductors of radii *a* and *b*, is lowered vertically into a dielectric liquid. A potential difference V is applied between the plates and the liquid level rises by a height *h* inside the capacitor. Show that the dielectric susceptibility of the liquid is equal to:
   $\chi_e = \dfrac{\left(b^2 - a^2\right)\rho g h \ln\left(b/a\right)}{V^2}$, where ρ is the density of the liquid.

2. When you do problem 2 at the end of Section 8 in Landau & Lifshitz (see list of problems for Quiz #3 below), calculate the potential everywhere in space (not just inside the cavity). When you are finished, take the limit $b \to 0$, which corresponds to a solid sphere, and check that both the field inside the sphere and the total dipole moment of the sphere agree with the results we derived in class.

3. Problem 3 at the end of Section 8 in L&L is similar to problem 2. Do the same things you did for problem 2.

4. In class I derived the potential everywhere in space for the situation of a dielectric sphere placed in a uniform electric field. I also showed that the effective surface bound charge density can be obtained from $\sigma_{bound} = \mathbf{P}\cdot\mathbf{n}$, where **P** is the polarization and **n** is unit vector pointing normal to the surface. Calculate the discontinuity in the perpendicular component of the electric field, $\mathbf{E}\cdot\mathbf{n}$, at the surface, and show that is equal to $4\pi\sigma_{bound}$.

Quiz #3

The quiz on Thursday, October 4, will consist of one of the following problems:

- Problems 1 to 4 on Problem Set #3
- Problems 1, 2, 3, and 5 at the end of Section 7
- Problems 2 and 3 at the end of Section 8

(I realize that this list is partially redundant.)