

Physics 842 – Fall 2011  
Classical Electrodynamics II

Problem Set #3 – due Tuesday October 4

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:

$$\chi_e = \frac{(b^2 - a^2)\rho gh \ln(b/a)}{V^2}, \text{ where } \rho \text{ is the density of the liquid.}$$

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  $b \rightarrow 0$ , 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.

Quiz #3

The quiz on Thursday, October 6, will consist of one of the following problems:

- Problems 1 to 3 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

(And yes, I realize that this list is partially redundant!)