PHYS 3033/3053 Assignment 5

Due: 23 Oct 2015 at begin of lecture at 3:00 pm

Problem 1

When a neutral dielectric material is being polarized, charges move a bit, but the *total charge* in the material remains zero. This fact should be reflected in the bound charges σ_b and ρ_b. Given that $\sigma_b = \mathbf{P}\cdot\hat{\mathbf{n}}$ and $\rho_b = -\nabla\cdot\mathbf{P}$, prove that the total bound charge vanishes.

Problem 2

A thick spherical shell (inner radius *a*, outer radius *b*, see Figure 1) is made of the dielectric material with a "frozen-in" polarization

$$\mathbf{P}(\mathbf{r}) = \frac{k}{r^2}\hat{\mathbf{r}}$$

where *k* is a constant and *r* is the distance from the center (figure below). (There is no *free* charge in the problem.) Find the electric field in all three regions by two different methods:

(a) Locate the bound charge, and use Gauss's law to calculate the field it produces

(b) Find **D**, and then get **E** from **D**. [Notice that the second method is much faster, and avoids any explicit reference to the bound charges.]

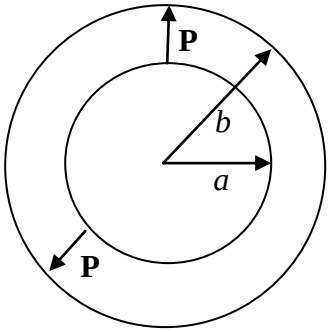

Figure 1

Problem 3

Consider a very large slab with thickness *t*, located in the region $0 < z < t$, as shown in Figure 2. The slab is uniformly polarized with polarization **P** making an angle of 45° with the positive *z* axis, as shown in the figure. Find the electric field inside the slab at a point (x, y, z), where $0 < z < t$.

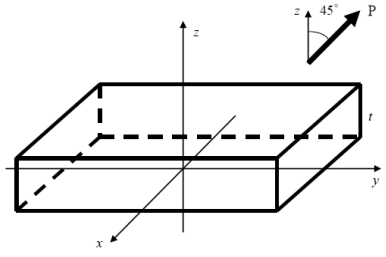

Figure 2