Problem Set #6

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These problems are due Friday, November 30.

1. A sphere of dielectric material with permitivity $\epsilon$ and radius $a$ is placed in an initially uniform electric field. Find the resulting electric field inside and outside the sphere. Note that this is similar to the problem done in class with a point charge. In this case the answer is much simpler.

Draw two sketches: one showing the lines of force corresponding to $E$, the other corresponding to $D$.

Calculate the polarization surface charge on the sphere.

2. The space $z > 0$ is filled with matter of dielectric constant $\epsilon_1$, and the space $z < 0$ with matter of dielectric constant $\epsilon_2$. A charge $q$ is at $z = d$ on the $z$-axis. Show that for $z > 0$ the field can be calculated as if it were due to a charge of magnitude $q/\epsilon_1$ at $z = d$ plus an image charge $q'$ at $z = -d$, and for $z < 0$ the field is as if it were due to a charge $q''$ at $z = d$. Find $q'$ and $q''$.

3. Two long straight parallel wires carry current $I$ in opposite directions. The wires are separated by a distance $a$. To make life easier for the grader (me) let’s all assume that the wires run in the $x$ direction and lie in the $x$-$y$ plane. Take the origin of your coordinate system to lie halfway between the two wires. Find $A$ in cartesian coordinates.