Homework #9 (10 points) - Show all work on the following problems:

Problem 1 (2 points): Consider a spherical conductor of radius a, with a total free charge Q, surrounded by linear dielectric material with susceptibility $\chi_{e,}$ extending from radius a to radius b (same as Example 4.5). Find the energy required to bring in the free charge Q from infinity (including the energy required to polarize the dielectric).

Problem 2 (3 points): Consider a dielectric sphere of radius R and susceptibility $\chi_{e,}$, with a free point charge q at the center.

2a (1 point): Find the electric field and the corresponding polarization.

2b (1 point): Find the surface and volume bound charge densities. *Beware, there's a delta function in the problem!*

2c (1 point): Find the total bound surface charge and the total bound volume charge inside the dielectric, and show that they cancel.

Problem 3 (2 points): Consider a current I flowing down a cylindrical wire with a circular cross-section of radius a.

3a (1 point): If the current flows entirely on the surface of the wire and uniformly distributed, what is the surface current density K?

3b (1 point): If the volume current density is inversely proportional to the distance s from the axis, what is $J(s)$?

Problem 4 (3 points): Consider two infinite straight line charges with linear charge density λ, aligned parallel to each other and separated by a distance d. How fast would these two line charges have to move in order for the magnetic attraction between the wires to balance the electrostatic repulsion? Is this possible?