Phys 742 – Assignment 5 – Due 19 March 96

1.

As Jackson's 4.10, but for cylinders instead of spheres.

2. *(Related to Jackson's 4.13)*

In the previous problem, suppose that the dielectric is a liquid and that the axis of the cylinder is horizontal. Neglecting gravity and assuming the liquid to be incompressible, compare the configuration shown in the figure with configurations having cylindrical symmetry. Which configuration has the lowest energy for a given V?. Compute the energy when the liquid is distributed

(a) in a half shell as in the book's figure

(b) in a shell around the outer surface of the inner cylinder

(c) in a shell against the inner surface of the outer cylinder

3. *(Similar to Jackson's 4.9)*

A point charge q is located in free space a distance b from the center of a dielectric sphere of radius a ($a < b$) and dielectric constant ϵ.

(a) Find the potential at all points in space as an expansion in spherical harmonics (the method of images will not work). Show that for $a \to \infty$ the image-method formulas for a plane, Jackson's (4.43) and (4.44), are obtained correctly.

(b) Find the force between the charge and the sphere. Show that the limit of a conducting sphere, Jackson's eq. (2.6), is obtained correctly.

4. *(After problem 1 of in-class test)*

Two conducting spheres of radii a_1 and a_2 carry opposite charges and are immersed in a medium of dielectric constant ϵ.

(a) Find the capacitance C of this system when the centers of the spheres are separated by a distance $b >> a_1 + a_2$.

(b) What is the force between the spheres? Obtain the answer directly and check that it is also given by a general formula involving C, with the C of part (a)