

P506

Problem Set 9

(Due: November 13, 2008)

1) Jackson, problem 4.8.

A very long, right, circular, cylindrical shell of dielectric constant ϵ/ϵ_0 and inner and outer radii a and b , respectively, is placed in a previously uniform electric field E_0 with its axis perpendicular to the field. The medium inside and outside the cylinder has a dielectric constant of unity.

- (a) Determine the potential and electric field in the three regions, neglecting end effects.
- (b) Sketch the lines of force for a typical case of $b \simeq 2a$.
- (c) Discuss the limiting forms of your solution appropriate for a solid dielectric cylinder in a uniform field, and a cylindrical cavity in a uniform dielectric.

2) A set of charge distributions is given by

$$\rho(\mathbf{x}') = \begin{cases} C_n r'^n \cos \theta', & r' < a \\ 0, & r' > a \end{cases}$$

where C_n are constants and n is a positive integer.

- (a) Calculate all the multipole moments q_{lm} of these charge distributions.
- (b) What is the potential in the region $r > a$ for all of these charge distributions?
- (b) What is the electric field in the region $r > a$ for all of these charge distributions?

3) Jackson, problem 4.10.

Two concentric conducting spheres of inner and outer radii a and b , respectively, carry charges $\pm Q$. The empty space between the spheres is half-filled by a hemispherical shell of dielectric (of dielectric constant ϵ/ϵ_0), as shown in the figure (in Jackson).

- (a) Find the electric field everywhere between the spheres.
- (b) Calculate the surface-charge distribution on the inner sphere.
- (c) Calculate the polarization-charge density induced on the surface of the dielectric at $r = a$.