PHYS 401 Homework #4 , Due on 10/29

1) A rectangular pipe, running parallel to the z-axis (from $-\infty$ to $+\infty$), has three grounded metal sides, at $y = 0$, $y = a$, and $x = 0$. The fourth side, at $x = b$, is maintained at a specified potential $V_0(y)$.

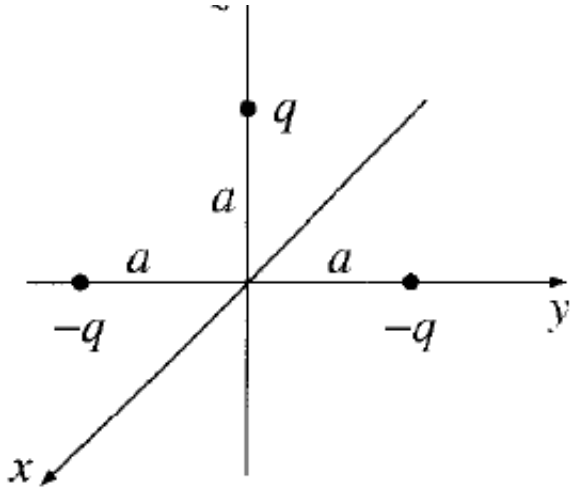
(a) Develop a general formula for the potential within the pipe.

(b) Find the potential explicitly, for the case $V_0(y) = V_0$ (a constant).

2) The potential at the surface of a sphere (radius R) is given by

$$V_0 = k \cos 3\theta,$$

where k is a constant. Find the potential inside and outside the sphere, as well as the surface charge density $\sigma(\theta)$ on the sphere. (Assume there's no charge inside or outside the sphere.)



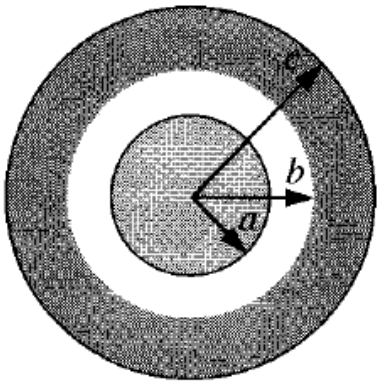
3) Three point charges are located as shown above. , each a distance a from the origin. Find the approximate electric field at points far from the origin. Express your answer in spherical coordinates, and include the two lowest orders in the multipole expansion.

4) A sphere of radius R, centered at the origin, carries charge density

$$\rho(r, \theta) = k \frac{R}{r^2} (R - 2r) \sin\theta,$$

where k is a constant, and r, θ are the usual spherical coordinates. Find the approximate potential for points on the z axis, far from the sphere.

5) A certain coaxial cable consists of a copper wire, radius a, surrounded by a concentric copper tube of inner radius c (Fig. 4.26). The space between is partially filled (from b out to c) with material of dielectric constant ϵ_r, as shown. Find the capacitance per unit length of this cable.



6. Griffith Problem 4.15 (page 184)