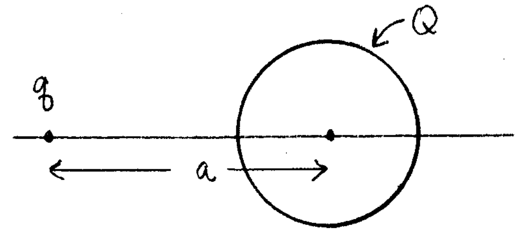
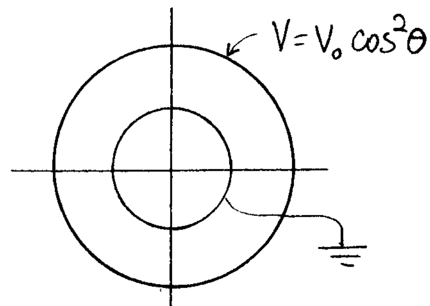
Physics 322 **EXAM 1** **March 2, 2005**

Each problem is worth 20 points

1) A point charge q is located a distance a from the center of a conducting sphere of radius R. The sphere carries a net charge Q and is NOT grounded. Find the force between the sphere and the point charge.



2) A grounded conducting sphere of radius R is surrounded by a second sphere of radius $2R$. The outer sphere (which is not a conductor) is held at a fixed potential $V = V_0 \cos^2\theta$. Find the potential V in the region between the two spheres.

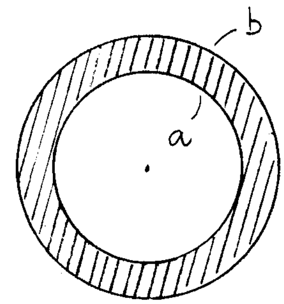


3) The diagram below shows a sphere with inner radius a and outer radius b. The sphere is made of dielectric, and has a uniform (frozen in) polarization P_0 which is directed radially outward.

(a) Find the bound surface charge densities on the inner and outer surfaces.

(b) Find the density of bound charge within the volume of the dielectric.

(c) Determine the potential, V, at the center of the sphere (relative to $V = 0$ at infinity).



POSSIBLY USEFUL INFORMATION:

$P_0 = 1 \qquad P_1 = \cos\theta \qquad P_2 = \frac{3}{2}\cos^2\theta - \frac{1}{2} \qquad P_3 = \frac{5}{2}\cos^3\theta - \frac{3}{2}\cos\theta$

$$\int_0^\pi P_n(\cos\theta)\, P_m(\cos\theta)\, \sin\theta\, d\theta = \frac{2}{2n+1}\delta_{nm}$$

$$\int \cos^n\theta \sin\theta\, d\theta = -\frac{\cos^{n+1}\theta}{n+1}$$

$$\vec{\nabla}\cdot\vec{A} = \frac{1}{r^2}\frac{\partial}{\partial r}r^2 A_r + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}\sin\theta A_\theta + \frac{1}{r\sin\theta}\frac{\partial}{\partial\phi}A_\phi$$