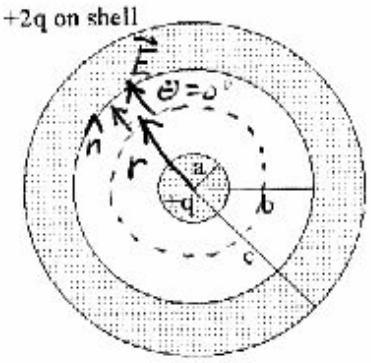
Name: KEY

PHYSICS 2220 - QUIZ #2 - SPRING 2009

1. A sphere, of radius a and charge +q uniformly distributed throughout its volume, is concentric with a spherical conducting shell of inner radius b and outer radius c. This shell has a net charge of +2q.



a. Find an expression for the electric field, as a function of the radius r, between the sphere and the shell (a < r < b).

$$\oint E\,dA\cos\theta = \frac{q_{enc}}{\varepsilon_0} \quad \text{where } q_{enc} = +q$$

$$\oint E\,dA = \frac{q}{\varepsilon_0} \quad \text{since } \cos 0^\circ = 1$$

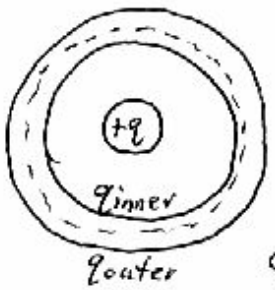
$$E\oint dA = \frac{q}{\varepsilon_0} \quad \text{since } E = \text{constant over the gaussian sphere}$$

$$E\,4\pi r^2 = \frac{q}{\varepsilon_0}$$

$$\boxed{E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}}$$

b. What are the charges on the inner and outer surfaces of the shell?

Draw a gaussian sphere between r = b and r = c, where E = 0



$$\oint E\,dA\cos\theta = \frac{q_{enc}}{\varepsilon_0}$$

Since E = 0, $q_{enc} = 0$

So $q_{enc} = +q + q_{inner} = 0 \Rightarrow \boxed{q_{inner} = -q}$

Since $q_{inner} + q_{outer} = +2q$, $-q + q_{outer} = 2q$

$$\Rightarrow \boxed{q_{outer} = +3q}$$