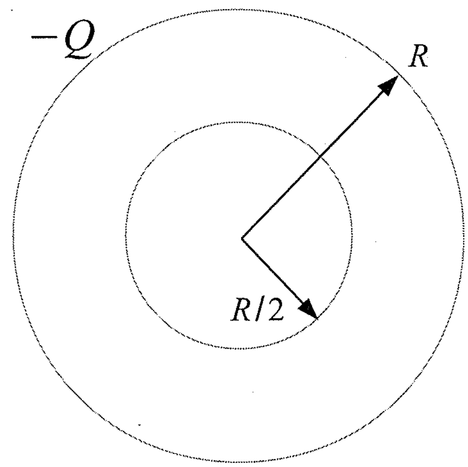
Physics 2212 Spring 2015 Lab Quiz #2

Name: Key Section: ____________

Show all work clearly and in order, and box your final answers.

A plastic sphere of radius R has hollow center of radius $R/2$. This thick spherical shell has a charge $-Q$ distributed uniformly throughout the plastic. For the following three regions, determine the magnitude and direction of the electric field at an observation location a distance r from the center of the sphere. Be sure to provide a briefly explanation to earn full credit.



1. (*20 points*) $r < R/2$ (inside the hollow center)

$r < \frac{R}{2}$, $\bar{E}_{net} = 0$

$\bar{E}_{net}$ cancels everywhere inside the hollow center.

2. (*20 points*) $r > R$ (outside the plastic shell)

$r > R$

For $r > R$, the field will resemble the field of a point charge with charge $-Q$.

$$\bar{E}_{net} = -\frac{Q_{TOT}}{4\pi\epsilon_0 r^2}\hat{r}$$ (radially inward)

3. (*40 points*) $R/2 < r < R$ (in the plastic)

$$E = \frac{-\Delta Q}{4\pi\epsilon_0 r^2}\hat{r}$$

from $\frac{R}{2} \to r$

$$\Delta Q = Q_{TOT}\frac{(\text{Volume of charge})}{(\text{Volume of total charge})}$$

$$= Q_{TOT}\frac{\left(\frac{4}{3}\pi r^3 - \frac{4}{3}\pi \frac{R^3}{8}\right)}{\left(\frac{4}{3}\pi R^3 - \frac{4}{3}\pi\frac{R^3}{8}\right)}$$

$$= Q_{TOT}\frac{(8r^3 - R^3)\rho\pi/6}{\frac{7}{6}\rho\pi R^3}$$

$$\Rightarrow \Delta Q = Q_{TOT}\frac{(8r^3 - R^3)}{7R^3}$$

$$E = \frac{-\Delta Q}{4\pi\epsilon_0 r^2}\hat{r}$$

$$= \frac{-Q_{TOT}}{4\pi\epsilon_0 r^2}\left(\frac{8r^3 - R^3}{7R^3}\right)\hat{r}$$

$$= -\frac{Q_{TOT}}{28\pi\epsilon_0 r^2}\left(\frac{8r^3 - R^3}{R^3}\right)\hat{r}$$

(radially inward)

4. (*20 points*) Replace the plastic shell with an identical metal shell also with charge $-Q$. Briefly describe how your answer for the electric field outside of the plastic shell $r > R$ would change.

The answer will not change. the electric field for the metal solid shell will also be

$$\bar{E}_{net} = -\frac{Q_{TOT}}{4\pi\epsilon_0 r^2}\hat{r} \quad \text{for } r > R$$