E&M Problem Set 3
Due Friday, February 1 at 4PM

SPECIAL NOTE: I could not find a symbol that exactly matches the book's script r for the separation vector. Instead I am using the following notation: $\vec{\mathfrak{r}} = \vec{r} - \vec{r}'$, $\mathfrak{r} = |\vec{\mathfrak{r}}|$ and $\hat{\mathfrak{r}} = \vec{\mathfrak{r}}/\mathfrak{r}$.

GENERAL HINT FOR THIS PROBLEM SET: Other than the first two problems on this problem set (and really, mostly the first), if you are engaged in extensive calculus, you haven't set up the problem correctly. The last four problems are relatively straight-forward once you exploit relevant symmetries or suggestions.

1. **Griffiths Problem 2.7:** Find the electric field a distance z from the center of a spherical surface of radius R (see Figure 2.11), which carries a uniform charge density σ. Treat the case $z < R$ (inside) as well as $z > R$ (outside). Express your answers in terms of the total charge q on the sphere. [*Hint:* Use the large of cosines to write $\mathfrak{r}$ in terms of R and θ. Be sure to take the *positive* square root:

$$\sqrt{R^2 + z^2 - 2Rz} = \begin{Bmatrix} (R - z), & \text{if } R > z \\ (z - R), & \text{if } R < z \end{Bmatrix}$$

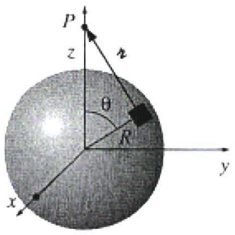

Figure 2.11

2. **Griffiths Problem 2.8:** Use your result in Problem 2.7 to find the field inside and outside a sphere of radius R, which carries a uniform volume charge density ρ. Express your answers in terms of the total charge of the sphere, q. Draw a graph of $|\vec{E}|$ as a function of the distance from the center.

3. **Griffiths Problem 2.10:** A charge q sits at the back corner of a cube, as shown in Figure 2.17. What is the flux of $\vec{E}$ through the shaded area?

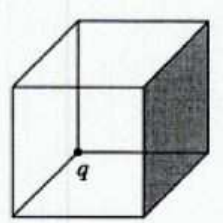

Figure 2.17

(**HINT:** For simplicity, treat the cube drawn in Figure 2.17 as one octant of a cube with a charge at the center. If you start doing complicated calculus, you are on the wrong path to E&M enlightenment.)

4. **Griffiths Problem 2.11:** Use Gauss's law to find the electric field inside and outside a spherical shell of radius R, which carries a uniform surface charge density of σ. Compare your answer to Problem 2.7.

5. **Griffiths Problem 2.12:** Use Gauss's law to find the electric field inside a uniformly charged sphere (charge density ρ). Compare your answer to Problem 2.8.

6. **Griffiths Problem 2.18:** Two spheres, each of radius R and carrying uniform charge densities $+\rho$ and $-\rho$, respectively, are placed so that they partially overlap (Fig. 2.28). Call the vector from the positive center to the negative center $\vec{d}$. Show that the field in the region of overlap is constant, and find its value. [*Hint:* Use the answer to Problem 2.12.]

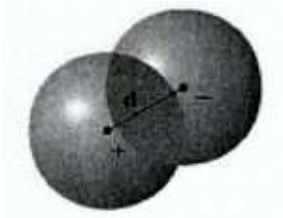

Figure 2.28