1. [G 2.6] Find the electric field a distance $z$ above the center of a flat circular disk of radius $R$ (see figure), which carries a uniform surface charge $\sigma$. What does your formula give in the limit $R \to \infty$? Also check the case $z \gg R$.

2. A spherical surface of radius $R$ and center at origin carries a surface charge $\sigma(\theta, \phi) = \sigma_0 \cos\theta$. Find the electric field at $z$ on $z$-axis. Treat the case $z < R$ (inside) as well as $z > R$ (outside). [Hint: Be sure to take the positive square root: $\sqrt{R^2 + z^2 - 2Rz} = (R - z)$ if $R > z$, but its $(z - R)$ if $R < z$.]

3. [G 2.9] Suppose the electric field in some region is found to be $\mathbf{E} = kr^3\hat{\mathbf{r}}$, in spherical coordinates ($k$ is some constant).

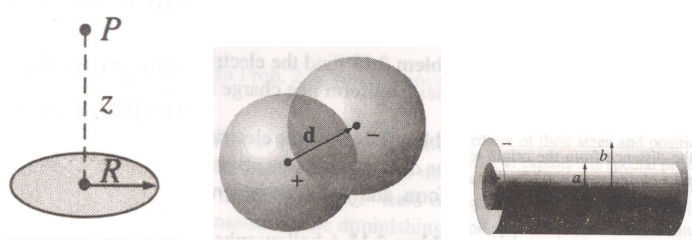
   (a) Find the charge density $\rho$.

   (b) Find the total charge contained in the sphere of radius $R$, centered at the origin. (Do it two different ways.)

4. [G 2.12] Use Gauss's law to find the electric field inside a uniformly charged sphere (charge density $\rho$). [G 2.18] Two spheres each of radius $R$ and carrying uniform charge densities $+\rho$ and $-\rho$, respectively, are placed so that they partially overlap (See Figure). Call the vector from the positive center to the negative center $\mathbf{d}$. Show that the field in the region of overlap is constant, and find its value.

5. [G 2.16] A long coaxial cable (see figure) carries a uniform *volume* charge density $\rho$ on the inner cylinder (radius $a$), and a uniform *surface* charge density on the outer cylindrical shell (radius $b$). This surface charge is negative and of just the right magnitude so that the cable as a whole is electrically neutral. Find the electric field in each of the three regions: (a) inside the inner cylinder ($s < a$), (b) between the cylinders ($a < s < b$), (c) outside the cable ($s > b$). Plot $|\mathbf{E}|$ as a function of $s$.

6. [G 2.20] One of these is an impossible electrostatic field. Which one?




(a) Problem 1 (b) Problem 4 (c) Problem 5

Figure 1

(a) $\mathbf{E} = k\,[xy\hat{\mathbf{x}} + 2yz\hat{\mathbf{y}} + 3xz\hat{\mathbf{z}}]$

(b) $\mathbf{E} = k\,[y^2\hat{\mathbf{x}} + (2xy + z^2)\hat{\mathbf{y}} + 2yz\hat{\mathbf{z}}]$.
Here $k$ is a constant with the appropriate units. For the *possible* one, find the potential, using the *origin* as your reference point. Check your answers by computing $\nabla V$. [Hint: You must select a specific path to integrate along. It does not matter *what* path you choose, since the answer is path-independent, but you simply cannot integrate unless you have a particular path in mind.]

7. [G 2.21] Find the potential inside and outside a uniformly charged solid sphere whose radius is $R$ and whose total charge is $q$. Use infinity as your reference point. Compute the gradient of $V$ in each region, and check that it yields the correct field. Sketch $V(r)$.

8. [G 2.22] Find the potential a distance $s$ from an infinitely long straight wire that carries a uniform line charge $\lambda$. Compute the gradient of your potential, and check that it yields the correct field.

9. [G 2.26] A conical surface (an empty ice-cream cone) carries a uniform surface charge $\sigma$. The height of the cone is $h$, as is the radius of the top. Find the potential difference between points **a** (the vertex) and **b** (the center of the top).

10. [G2.27] Find the potential on the axis of a uniformly charged solid cylinder, a distance $z$ from the center. The length of the cylinder is $L$ and its radius is $R$, and the charge density is $\rho$. Use your result to calculate the electric field at this point. (Assume that $z > L/2$.)