HW 2: **Electrostatics**

**Example 2.1** Find the electric field a distance *z* above the midpoint of a straight-line segment of length 2*L*, which carries a uniform line charge λ (Fig. 2.6).

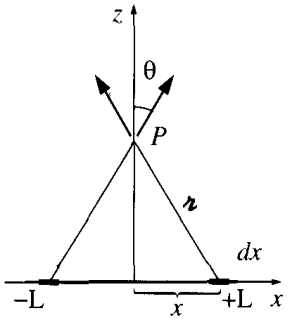


Figure 2.6

**Problem 2.4** Find the electric field a distance *z* above the center of a square loop (side *a)* carrying uniform line charge λ (Fig. 2.8). *[Hint:* Use the result of Ex. 2.1.]

**Problem 2.5** Find the electric field a distance *z* above the center of a circular loop of radius *r* (Fig. 2.9), which carries a uniform line charge λ.

**Problem 2.6** Find the electric field a distance *z* above the center of a flat circular disk of radius *R* (Fig. 2.10), which carries a uniform surface charge $\sigma$. What does your formula give in the limit $R \to \infty$? Also check the case $z \gg R$.

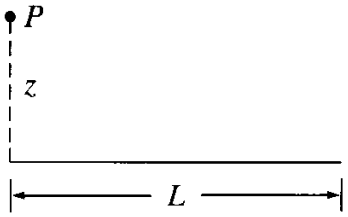


Figure 2.7

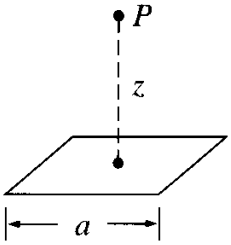


Figure 2.8

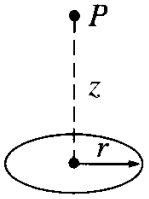


Figure 2.9

**Problem 2.6** Find the electric field a distance $z$ above the center of a flat circular disk of radius $R$ (Fig. 2.10), which carries a uniform surface charge $\sigma$. What does your formula give in the limit $R \to \infty$? Also check the case $z \gg R$.

**Problem 2.7** Find the electric field a distance $z$ from the center of a spherical surface of radius $R$ (Fig. 2.11), which carries a uniform charge density $\sigma$. 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 law of cosines to write $r$ in terms of $R$ and $\theta$. Be sure to take the *positive* square root: $\sqrt{R^2 + z^2 - 2Rz} = (R - z)$ if $R > z$, but it's $(z - R)$ if $R < z$.]

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

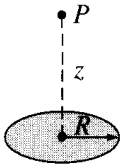


Figure 2.10

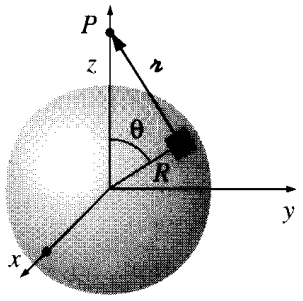


Figure 2.11

**Problem 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 a sphere of radius $R$, centered at the origin. (Do it two different ways.)

**Problem 2.15** A hollow spherical shell carries charge density

$$\rho = \frac{k}{r^2}$$

in the region $a \leq r \leq b$ (Fig. 2.25). Find the electric field in the three regions: (i) $r < a$, (ii) $a < r < b$, (iii) $r > b$. Plot $|\mathbf{E}|$ as a function of $r$.