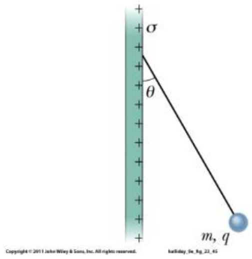
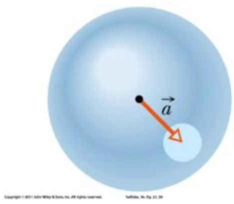
Home Work 2



23-39 In Fig. 23-45, a small, nonconducting ball of mass m **=** 1.0 *mg* and charge q **=** 2.0 $\times 10^{-8}$ C (distributed uniformly through its volume) hangs from an insulating thread that makes an angle **=** 30° with a vertical, uniformly charged nonconducting sheet (shown in cross section). Considering the gravitational force on the ball and assuming the sheet extends far vertically and into and out of the page, calculate the surface charge density $\boldsymbol{\sigma}$ of the sheet.

23-53 A solid nonconducting sphere of radius R = 5.60 cm has a nonuniform charge distribution of volume charge density ρ = (14.1 pC/m^3)r/R, where r is radial distance from the sphere's center. (a) What is the sphere's total charge? What is the magnitude E of the electric field at (b) r = 0, (c) r = R/2.00, and (d) r = R? (e) Sketch a graph of E versus r.



23-73 A nonconducting solid sphere has a uniform volume charge density ρ. Let $\vec{r}$ be the vector from the center of the sphere to a general point P within the sphere. (a) Show that the electric field $\vec{E} = \rho\vec{r}/3\varepsilon_0$ at P is given by (Note that the result is independent of the radius of the sphere.) (b) A spherical cavity is hollowed out of the sphere, as shown in Fig. 23-57. Using superposition concepts, show that the electric field at all points within the cavity is uniform and equal to where $\vec{a}$ is the position vector $\vec{E} = \rho\vec{a}/3\varepsilon_0$ from the center of the sphere to the center of the cavity. (Note that this result is independent of the radius of the sphere and the radius of the cavity.)

22.42 • A very long, solid cylinder with radius R has positive charge uniformly distributed throughout it, with charge per unit volume ρ. (a) Derive the expression for the electric field inside the volume at a distance r from the axis of the cylinder in terms of the charge density ρ. (b) What is the electric field at a point outside the volume in terms of the charge per unit length λ in the cylinder? (c) Compare the answers to parts (a) and (b) for $r = R$. (d) Graph the electric-field magnitude as a function of r from $r = 0$ to $r = 3R$.

22.58 • **CALC** A nonuniform, but spherically symmetric, distribution of charge has a charge density $\rho(r)$ given as follows:

$$\rho(r) = \rho_0(1 - 4r/3R) \qquad \text{for } r \leq R$$
$$\rho(r) = 0 \qquad \text{for } r \geq R$$

where ρ_0 is a positive constant. (a) Find the total charge contained in the charge distribution. (b) Obtain an expression for the electric field in the region $r \geq R$. (c) Obtain an expression for the electric field in the region $r \leq R$. (d) Graph the electric-field magnitude E as a function of r. (e) Find the value of r at which the electric field is maximum, and find the value of that maximum field.

22.62 • A very long, solid insulating cylinder with radius R has a cylindrical hole with radius a bored along its entire length. The axis of the hole is a distance b from the axis of the cylinder, where $a < b < R$ (Fig. P22.62). The solid material of the cylinder has a uniform volume charge density ρ. Find the magnitude and direction of the electric field $\vec{E}$ inside the hole, and show that $\vec{E}$ is uniform over the entire hole. (*Hint:* See Problem 22.61.)

Figure **P22.62**