59. (a) Consider a uniformly charged cylindrical shell having total charge Q, radius R, and height h. Determine the electrostatic potential at a point a distance d from the right side of the cylinder, as shown in Figure P25.59. (*Hint:* Use the result of Example 25.5 by treating the cylinder as a collection of ring charges.) (b) Use the result of Example 25.6 to solve the same problem for a solid cylinder.

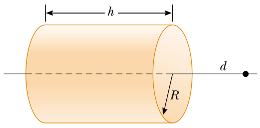

Figure P25.59

68. The thin, uniformly charged rod shown in Figure P25.68 has a linear charge density λ. Find an expression for the electric potential at P.

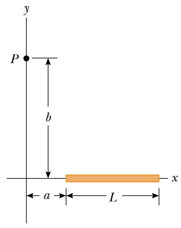

Figure P25.68

71. A disk of radius R has a nonuniform surface charge density $\sigma = Cr$, where C is a constant and r is measured from the center of the disk (Fig. P25.71). Find (by direct integration) the potential at P.

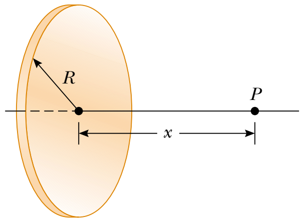

Figure P25.71

and (c) r = 11.0 cm from the center.

50. Two concentric spherical conducting shells of radii a = 0.400 m and b = 0.500 m are connected by a thin wire, as shown in Figure P25.50. If a total charge Q = 10.0 μC is placed on the system, how much charge settles on each sphere?

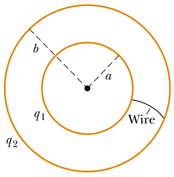

Figure P25.50

61. A Geiger tube is a radiation detector that essentially consists of a closed, hollow metal cylinder (the cathode) of inner radius r_a and a coaxial cylindrical wire (the anode) of radius r_b (Fig. P25.61). The charge per unit length on the anode is λ, while the charge per unit length on the cathode is $-\lambda$. A gas fills the space between the electrodes. When a high-energy elementary particle passes through this space, it can ionize an atom of the gas. The strong electric field makes the resulting ion and electron accelerate in opposite directions. They strike other molecules of the gas to ionize them, producing an avalanche of electrical discharge. The pulse of electric current between the wire and the cylinder is counted by an external circuit. (a) Show that the magnitude of the potential difference between the wire and the cylinder is

$$\Delta V = 2k_e\lambda \ln\left(\frac{r_a}{r_b}\right)$$

(b) Show that the magnitude of the electric field in the space between cathode and anode is given by

$$E = \frac{\Delta V}{\ln(r_a/r_b)}\left(\frac{1}{r}\right)$$

where r is the distance from the axis of the anode to the point where the field is to be calculated.

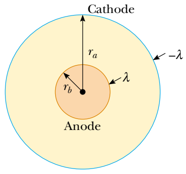

Figure P25.61 Problems 61 and 62.

69. An electric dipole is located along the y axis as shown in Figure P25.69. The magnitude of its electric dipole moment is defined as $p = 2qa$. (a) At a point P, which is far from the dipole ($r >> a$), show that the electric potential is

$$V = \frac{k_e p \cos\theta}{r^2}$$

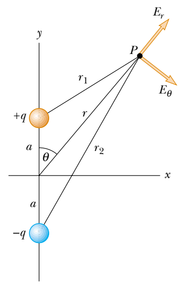

Figure P25.69

(b) Calculate the radial component E_r and the perpendicular component E_θ of the associated electric field. Note that $E_\theta = -(1/r)(\partial V/\partial\theta)$. Do these results seem reasonable for $\theta = 90°$ and $0°$? for $r = 0$? (c) For the dipole arrangement shown, express V in terms of Cartesian coordinates using $r = (x^2 + y^2)^{1/2}$ and

$$\cos\theta = \frac{y}{(x^2 + y^2)^{1/2}}$$

Using these results and again taking $r >> a$, calculate the field components E_x and E_y.

circle and (b) at point P, which is on the central axis of the circle at distance D = 6.71 cm from the center?

•24 In Fig. 24-38, a plastic rod having a uniformly distributed charge $Q = -25.6$ pC has been bent into a circular arc of radius R = 3.71 cm and central angle ϕ = 120°. With V = 0 at infinity, what is the electric potential at P, the center of curvature of the rod?

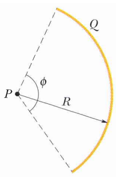

FIG. 24-38 Problem 24.

•25 (a) Figure 24-39a shows a nonconducting rod of length L = 6.00 cm and

46. Calculate the electric potential at point P on the axis of the annulus shown in Figure P25.46, which has a uniform charge density σ.

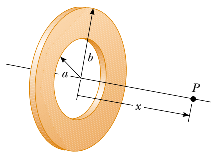

Figure P25.46

Distribution

•23 A plastic rod has been bent into a circle of radius R = 8.20 cm. It has a charge Q_1 = +4.20 pC uniformly distributed along one-quarter of its circumference and a charge $Q_2 = -6Q_1$ uniformly distributed along the rest of the circumference (Fig. 24-37). With V = 0 at infinity, what is the electric potential (a) at the center C of the circle and (b) at point P, which is on the central axis of the circle at distance D = 6.71 cm from the center?

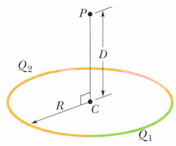

FIG. 24-37 Problem 23.