23. **M** A large, flat, horizontal sheet of charge has a charge per unit area of 9.00 μC/m². Find the electric field just above the middle of the sheet.

27. **M** Consider a thin, spherical shell of radius 14.0 cm with a total charge of 32.0 μC distributed uniformly on its surface. Find the electric field (a) 10.0 cm and (b) 20.0 cm from the center of the charge distribution.

29. **M** A uniformly charged, straight filament 7.00 m in length
has a total positive charge of 2.00 μC. An uncharged card-
board cylinder 2.00 cm in length and 10.0 cm in radius
surrounds the filament at its center, with the filament as
the axis of the cylinder. Using reasonable approximations,
find (a) the electric field at the surface of the cylinder and
(b) the total electric flux through the cylinder.

31. A solid sphere of radius 40.0 cm has a total positive charge of 26.0 μC uniformly distributed throughout its volume. Calculate the magnitude of the electric field (a) 0 cm, (b) 10.0 cm, (c) 40.0 cm, and (d) 60.0 cm from the center of the sphere.

33. **S** Consider a long, cylindrical charge distribution of radius R with a uniform charge density ρ. Find the electric field at distance r from the axis, where $r < R$.

41. Two identical conducting spheres each having a radius of 0.500 cm are connected by a light, 2.00-m-long conducting wire. A charge of 60.0 μC is placed on one of the conductors. Assume the surface distribution of charge on each sphere is uniform. Determine the tension in the wire.

51. A solid insulating sphere of radius $a = 5.00$ cm carries a net positive charge of $Q = 3.00\ \mu C$ uniformly distributed throughout its volume. Concentric with this sphere is a conducting spherical shell with inner radiu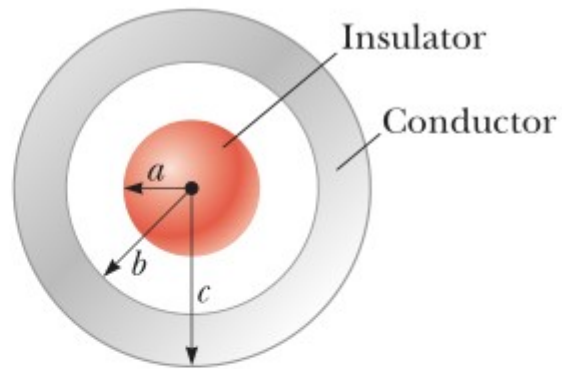s $b = 10.0$ cm and outer radius $c = 15.0$ cm as shown in Figure P24.51, having net charge $q = -1.00\ \mu C$. Prepare a graph of the magnitude of the electric field due to this configuration versus r for $0 < r < 25.0$ cm.

Figure P24.51
Problems 51, 52, and 55.

54. **S** Two infinite, nonconducting sheets of charge are parallel to each other as shown in Figure P24.54. The sheet on the left has a uniform surface charge density σ, and the one on the right has a uniform charge density $-\sigma$. Calculate the electric field at points (a) to the left of, (b) in between, and (c) to the right of the two sheets. (d) **What If?** Find the electric fields in all three regions if both sheets have *positive* uniform surface charge densities of value σ.
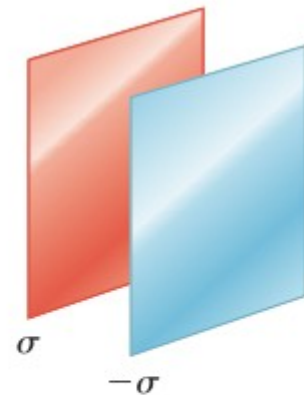

σ

$-\sigma$

Figure P24.54