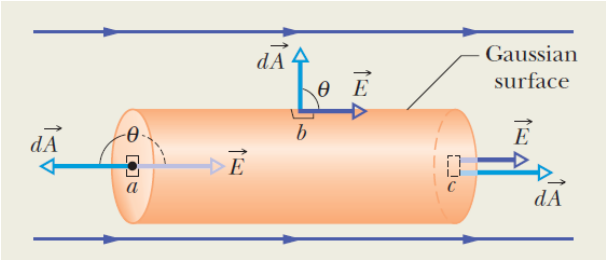
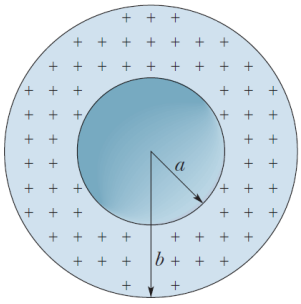
Gauss's Law Problems

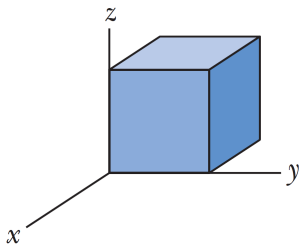
1. The figure below shows a Gaussian surface in the form of a closed cylinder (a Gaussian cylinder or G-cylinder) of radius R. It lies in a uniform electric field with the cylinder's central axis (along the length of the cylinder) parallel to the field. What is the net flux of the electric field through the cylinder?



2. The figure below shows a spherical shell with a uniform volume charge density $\rho = 1.84nC/m^3$, inner radius $a = 10.0cm$, and outer radius $b = 2.00a$. What is the magnitude of the electric field at radial distances (a) $r = 0$; (b) $r = a/2.00$, (c) $r = a$, (d) $r = 1.50a$, (e) $r = b$,and (f) $r = 3.00b$?



3. The figure below shows a Gaussian surface in the shape of a cube with edge length $1.40m$. What are (a) the net flux ϕ through the surface and (b) the net charge q_{enc} enclosed by the surface if $\vec{E} = (3y\hat{j})N/C$, with y in meters? What are (c) ϕ and (d) q_{enc} if $\vec{E} = [-4\hat{i} + (6 + 3y)\hat{j}]N/C$?



4. A solid non-conducting sphere of radius $R = 0.3\,\mathrm{m}$ has a uniform charge density $\rho = 2\,\mu\mathrm{C/m^3}$. Find the electric field at a distance $r = 0.2\,\mathrm{m}$ inside the sphere.

5. In the figure below, a small, nonconducting ball of mass $m = 1.0mg$ and charge $q = 2.0 \times 10^{-8}C$ (distributed uniformly through its volume) hangs from an insulating thread that makes an angle $\theta = 30°$ 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 s of the sheet.