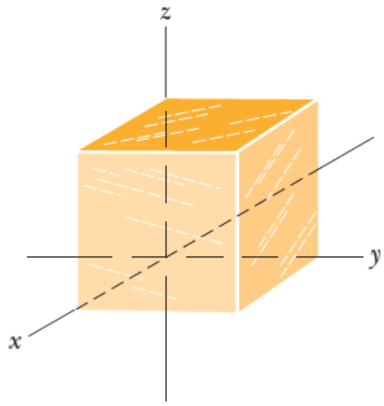
CHAPTER 23 | Gauss' Law

1 | The figure ahead shows a Gaussian surface in the shape of a cube with edge length $1.40\,m$. If $\vec{E} = [-4.00\hat{\imath} + (6.00 + 3.00y)\hat{\jmath}]\,N/C$, with y in meters, what are

a) the net flux Φ through the surface $(Ans: \Phi = 8.23\ \mathrm{N}.m^2/C)$ and

b) the net charge q_{enc} enclosed by the surface? $(Ans: q_{enc} = 7.29 \times 10^{-11}\ C)$

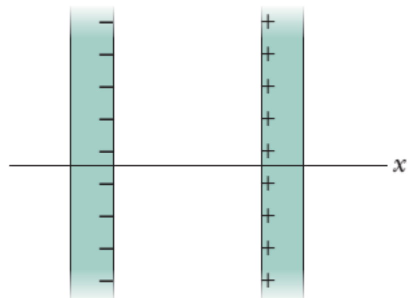


2 | In the figure, two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have excess surface charge densities of opposite signs and magnitude $7.00 \times 10^{-22}\ C/m^2$. In unit-vector notation, what is the electric field at points

a) to the left of the plates, $(Ans: \vec{E} = 0)$

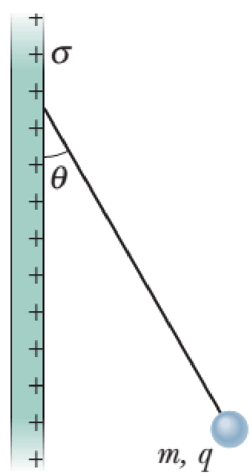
b) to the right of them, $(Ans: \vec{E} = 0)$ and

c) between them? $(Ans: \vec{E} = -7.91 \times 10^{-11}\ (\hat{\imath})\ N/C)$



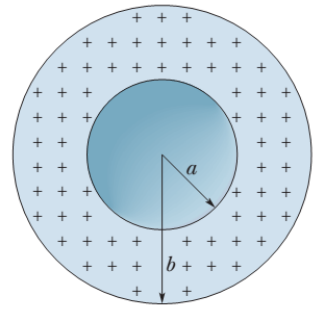
3 | In the figure below, a small, non-conducting ball of mass $m = 1.0\,mg$ and charge $q = 2.0 \times 10^{-8}\ C$ (distributed uniformly through its volume) hangs from an insulating thread that makes an angle $\theta = 30°$ with a vertical, uniformly charged nonconducting sheet (shown in cross section). 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 sof the sheet.

$(Ans: \sigma = 5.0\ \times 10^{-9}\ C/m^2)$



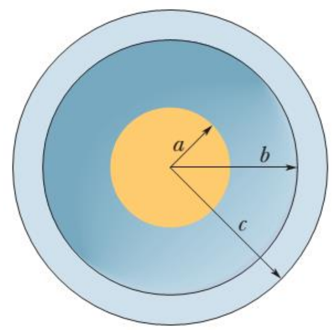
$k = 8.99 \times 10^9 \cong 9 \times 10^9$

4 | The following figure shows a spherical shell with uniform volume charge density $\rho = 1.84\ nC/m^3$, inner radius $a = 10.0\ cm$, and outer radius $b = 2.00a$. What is the magnitude of the electric field at radial distances



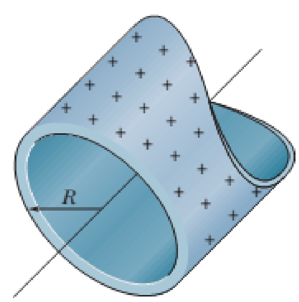
a) $r = 0$, $(Ans: E = 0)$
b) $r = a/2.00$, $(Ans: E = 0)$
c) $r = a$, $(Ans: E = 0)$
d) $r = 1.50a$, $(Ans: E = 7.32\ N/C)$
e) $r = b$, $(Ans: E = 12.1\ N/C)$ and
f) $r = 3.00b$? $(Ans: E = 1.35\ N/C)$

5 | In figure, a solid sphere of radius $a = 2.00\ cm$ is concentric with a spherical conducting shell of inner radius $b = 2.00a$ and outer radius $c = 2.40a$. The sphere has a net uniform charge $q_1 = +5.00\ fC$; the shell has a net charge $q_2 = -q_1$.What is the magnitude of the electric field at radial distances



a) $r = 0$, $(Ans: E = 0)$
b) $r = a/2.00$, $(Ans: E = 5.6 \times 10^{-2}\ N/C)$
c) $r = a$, $(Ans: E = 11.2 \times 10^{-2}\ N/C)$
d) $r = 1.50a$, $(Ans: E = 4.99 \times 10^{-2}\ N/C)$
e) $r = 2.30a$, $(Ans: E = 0)$ and
f) $r = 3.50a$? $(Ans: E = 0)$
What is the net charge on the
g) inner $(Ans: q_{inner} = -5.00\ fC)$ and
h) outer surface of the shell? $(Ans: q_{outer} = 0)$

6 | The presented figure shows a section of a long, thin-walled metal tube of radius $R = 3.00\ cm$, with a charge per unit length of $\lambda = 2.00 \times 10^{-8}\ C/m$. What is the magnitude E of the electric field at radial distance



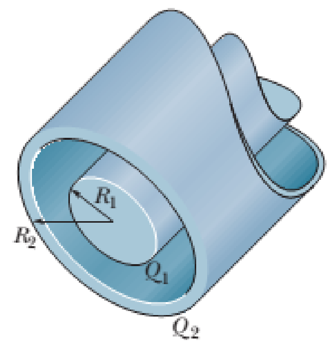
a) $r = R/2.00$ $(Ans: E = 0)$ and
b) $R = 2.00R$? $(Ans: E = 5.99 \times 10^3\ N/C)$
c) Graph E versus r for the range $r = 0$ to $2.00R$.

$k = 8.99 \times 10^9 \cong 9 \times 10^9$

7 | The following figure is a section of a conducting rod of radius $R_1 = 1.30\ mm$ and length $L = 11.00\ m$ inside a thin-walled coaxial conducting cylindrical shell of radius $R_2 = 10.0R_1$ and the (same) length L. The net charge on the rod is $Q_1 = +3.40 \times 10^{-12}\ C$; that on the shell is $Q_2 = -2.00Q_1$. What are the

a) magnitude E $(Ans: |E| = 0.214\ \ N/C)$ and

b) direction (radially inward or outward) of the electric field at radial distance $r = 2.00R_2$? $(Ans: inward)$



What are

c) E $(Ans: E = 0.855\ \ N/C)$ and

d) the direction at $r = 5.00R_1$? $(Ans: outward)$

What is the charge on the

e) interior $(Ans: Q_{in} = -3.40 \times 10^{-12}\ C)$ and

f)exterior surface of the shell? $(Ans: Q_{out} = -3.40 \times 10^{-12}\ C)$

$k = 8.99 \times 10^9 \cong 9 \times 10^9$