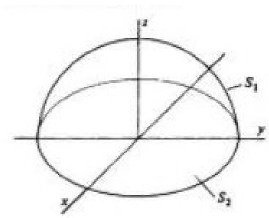
Name ____________________
Physics 51M Section ___ Box # _____
Problem Set 3
23 September 2019

Collaborators:

Schey II-8 An electrostatic force field is given by $\vec{E} = \lambda(\vec{\mathbf{i}}yz + \vec{\mathbf{j}}xz + \vec{\mathbf{k}}xy)$, where λ is a constant. Use Gauss' law to find the total charge enclosed by the surface shown in the figure consisting of S_1, the hemisphere $z = (R^2 - x^2 - y^2)^{\frac{1}{2}}$, and S_2, its circular base in the xy-plane.



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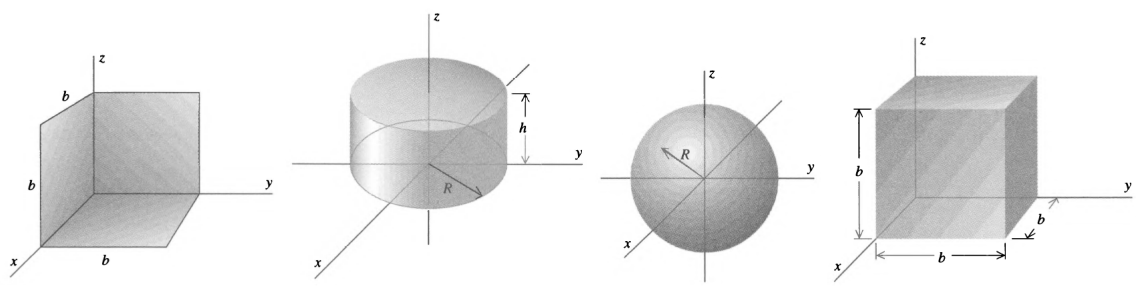
Schey II-10 It sometimes happens that surface integrals can be evaluated without using the long-winded procedures outlined in the text. Try evaluating $\iint_S \vec{\mathbf{F}} \cdot \hat{\mathbf{n}}\, dA$ for each of the following; think a bit and avoid a lot of work!

(a) $\vec{\mathbf{F}} = \vec{\mathbf{i}}x + \vec{\mathbf{j}}y + \vec{\mathbf{k}}z$.
A, the three squares each of side b as shown in the figure.

(b) $\vec{\mathbf{F}} = (\vec{\mathbf{i}}x + \vec{\mathbf{j}}y)\ln(x^2 + y^2)$.
A, the cylinder (including the top and bottom) of radius R and height h shown in the figure.

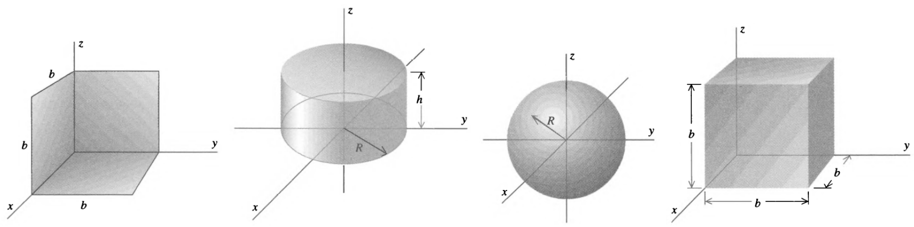
(c) $\vec{\mathbf{F}} = (\vec{\mathbf{i}}x + \vec{\mathbf{j}}y + \vec{\mathbf{k}}z)e^{-(x^2+y^2+z^2)}$.
A, the surface of the sphere of radius R centered at the origin as shown in the figure.

(d) $\vec{\mathbf{F}} = \vec{\mathbf{i}}E(x)$, where $E(x)$ is an arbitrary scalar function of x.
A, the surface of the cube of side b shown in the figure.



Figures (a), (b), (c), and (d)

HRK E27.11 A point charge q is placed at one corner of a cube of edge a. What is the flux through each of the cube faces? (Hint: Use Gauss' law and symmetry arguments.)



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HRK E26.40 Figure 26-36 shows a Thomson atom model of helium $(Z = 2)$. Two electrons, at rest, are embedded inside a uniform sphere of positive charge $2e$. Find the distance d between the electrons so that the configuration is in static equilibrium.

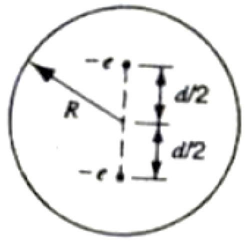

FIGURE 26-36. Exercise 40.

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HRK P27.17 A solid nonconducting sphere of radius R carries a nonuniform charge distribution, with charge density $\rho = \rho_s r/R$, where ρ_s is a constant and r is the distance from the center of the sphere. Show that

(a) the total charge on the sphere is $Q = \pi \rho_s R^3$

(b) the electric field inside the sphere is given by $E = \frac{1}{4\pi\epsilon_0}\frac{Q}{R^4}r^2$

(c) Write down the electric field outside the sphere, $r > R$. You do not need to derive your result, just explain how you know what it is.

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HRK E27.25
Charge is distributed uniformly throughout an infinitely long cylinder of radius R.

(a) Show that E at a distance r from the cylinder axis ($r < R$) is given by $E = \frac{\rho r}{2\epsilon_0}$, where ρ is the volume charge density.

(b) What result do you obtain for $r > R$?

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