GAUSS' LAW

1. The *closed* Gaussian surface shown at right consists of a hemispherical surface and a flat plane. A point charge $+q$ is outside the surface, and no charge is enclosed by the surface.

a. What is the flux through the *entire* closed surface? Explain.

Let $\Phi_L$ represent the flux through the flat left-hand portion of the surface. Write an expression in terms of $\Phi_L$ for the flux through the curved portion of the surface, $\Phi_C$.

b. Suppose that the curved portion of the Gaussian surface in part a is replaced by the larger curved surface as shown. The flat left-hand portion of the surface is unchanged.

i. Does the value of $\Phi_L$ change? Explain.

ii. How does the flux through the new curved portion of the surface compare to the flux through the original curved portion of the surface? Explain.

c. Suppose that the curved portion of the Gaussian surface is replaced by the larger curved surface that encloses the charge as shown. The flat left-hand portion of the surface is still unchanged.

i. Does the value of $\Phi_L$ change? Explain.

ii. How does the flux through the new curved portion of the surface compare to the flux through the original curved portion of the surface? Explain.

iii. Use Gauss' law to write an expression for the flux through the curved portion of the surface in terms of $\Phi_L$ and $q$. 

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d. A second point charge \(+q\) is placed to the right of the Gaussian surface as shown.

i. Is the value of \(\Phi_L\) greater than, less than, or equal to the value of \(\Phi_L\) in part c? Explain.

ii. Is the value of the flux through the entire Gaussian surface greater than, less than, or equal to the value of the flux through the entire Gaussian surface in part c? Explain.

2. Consider three sheets of charge with the charge densities shown below. The sheets are very large and extend beyond the top and bottom of the side-view diagram at right.

a. Sketch a vector at each of the points \(A-D\) to represent the electric field at that point due to sheet 1. Draw your vectors to scale and state how they compare in magnitude.

\[
\begin{array}{cccc}
A & B & C & D \\
\bullet & \bullet & \bullet & \bullet \\
+\sigma_o & -\sigma_o & +\sigma_o & \\
1 & 2 & 3 & \\
\end{array}
\]

b. Sketch a vector at each of the points \(A-D\) to represent the electric field at that point due to sheet 2. Draw your vectors to scale and state how they compare in magnitude.

\[
\begin{array}{cccc}
A & B & C & D \\
\bullet & \bullet & \bullet & \bullet \\
+\sigma_o & -\sigma_o & +\sigma_o & \\
1 & 2 & 3 & \\
\end{array}
\]

c. Sketch a vector at each of the points \(A-D\) to represent the electric field at that point due to sheet 3. Draw your vectors to scale and state how they compare in magnitude.

\[
\begin{array}{cccc}
A & B & C & D \\
\bullet & \bullet & \bullet & \bullet \\
+\sigma_o & -\sigma_o & +\sigma_o & \\
1 & 2 & 3 & \\
\end{array}
\]

d. Sketch the net electric field at each of points \(A-D\).

e. Calculate the magnitude of the electric field at each point \(A-D\). Use superposition to answer this question.