Electricity and Magnetism
Using Gauss's Law

Lana Sheridan

De Anza College

Jan 19, 2018

Last time

- Electric flux
- Gauss's law

Warm Up Question

Imagine a Gaussian surface enclosing a dipole.

What is the net flux through the surface?

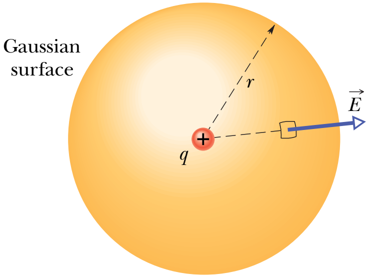
Overview

- Guass's law applied to various cases

Gauss's Law for a Point Charge

For a point charge, we can imagine a spherical Gaussian surface.

By considering spherical rotational symmetry about the charge, the field will be perpendicular to the surface and equal in magnitude at every point.



$$\Phi_E = \oint \mathbf{E} \cdot \mathbf{dA} = E \oint \mathrm{dA} = 4\pi r^2 E$$

Gauss's law:

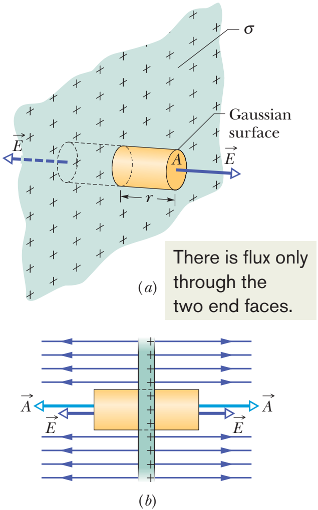
$$\epsilon_0 \Phi_E = 4\pi r^2 E = q$$

so,

$$E = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} = \frac{k_e q}{r^2}$$

Same as from Coulomb's law!

Nonconducting sheet of charge

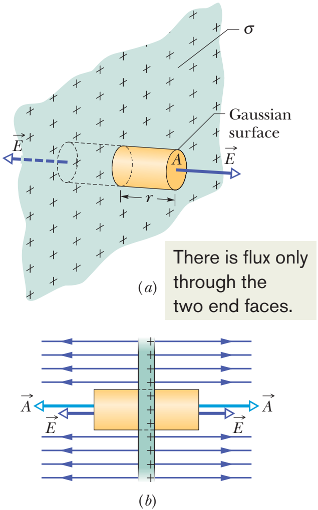


Again, the sides of the cylinder are $\parallel \mathbf{E}$ $\Rightarrow \ \Phi_E = 0$.

We only need to consider the ends. Translational and rotational symmetry of the charge sheet $\Rightarrow$ $\mathbf{E} \parallel \mathbf{A}$, and $\mathbf{E}$ is the same everywhere.

$$\begin{aligned} \Phi_E &= EA\cos(0) + EA\cos(0) \\ &= 2AE \end{aligned}$$

Nonconducting sheet of charge



Again, the sides of the cylinder are $\parallel$ **E** $\Rightarrow \; \Phi_E = 0$.

We only need to consider the ends. Translational and rotational symmetry of the charge sheet $\Rightarrow$ **E** $\parallel$ **A**, and **E** is the same everywhere.

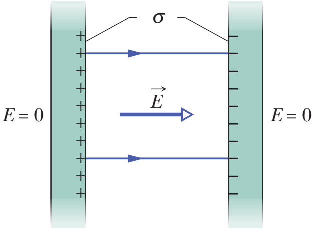
$$\begin{aligned} \Phi_E &= EA\cos(0) + EA\cos(0) \\ &= 2AE \end{aligned}$$

Then, using Gauss's law:

$$\begin{aligned} \epsilon_0(2AE) &= \sigma A \\ E &= \frac{\sigma}{2\epsilon_0} \end{aligned}$$

as claimed earlier.

Field between conducting plates



From Gauss's Law we can also find the field between conducting plates with an air (or vacuum) gap separating them:

$$E = \frac{\sigma}{\epsilon_0}$$

Summary

- using Gauss's law

First Test Friday, Jan 26.

Homework

- Collected homework 1, posted online, due on Monday, Jan 22.

Serway & Jewett:

- Ch 24, Section Qs: 25, 29, 31, 33, 39, 41, 43, 55, 61, 65