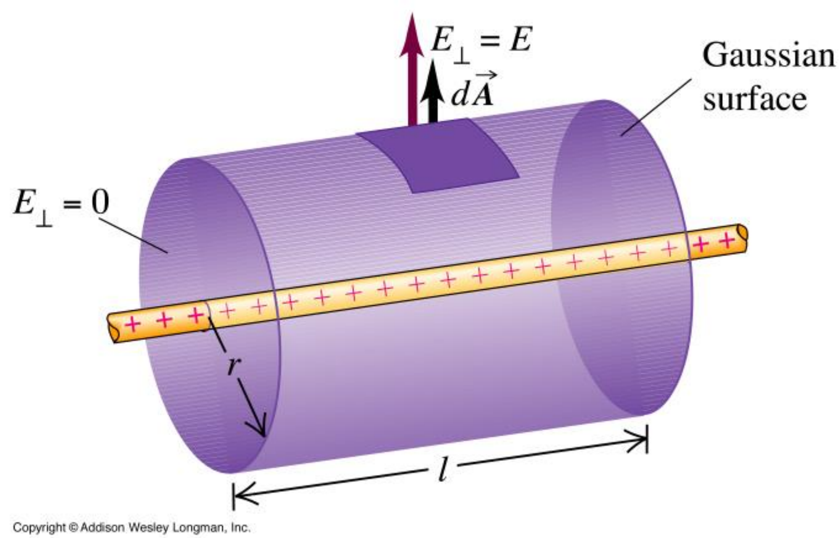
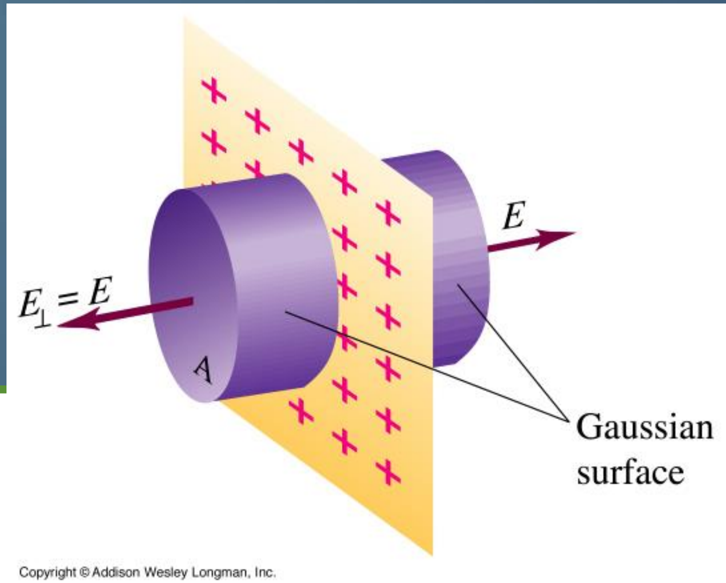
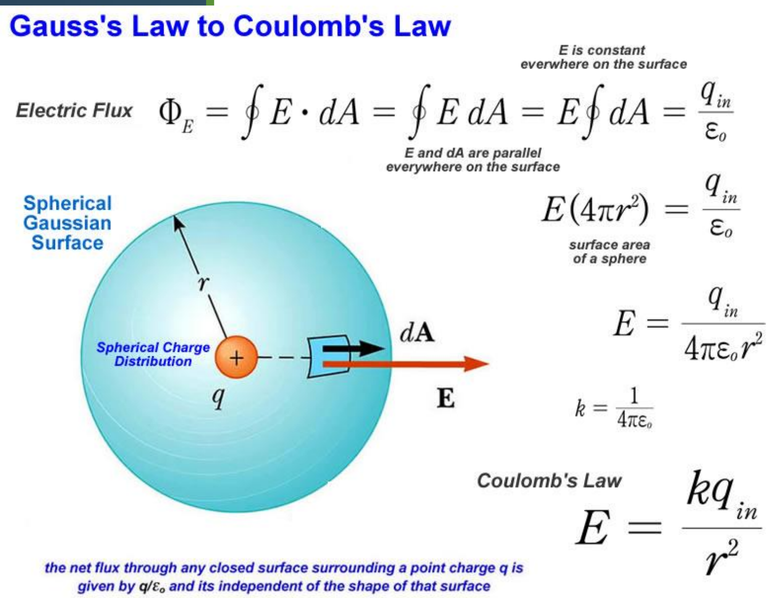




Chapter 23

Gauss' Law



23-2 Electric Flux

Learning Objectives

23.01 Identify that Gauss' law relates the electric field at points on a closed surface (real or imaginary, said to be a Gaussian surface) to the net charge enclosed by that surface.

23.02 Identify that the amount of electric field piercing a surface (not skimming along parallel to the surface) is the electric flux Φ through the surface.

23.03 Identify that an area vector for a flat surface is a vector that is perpendicular to the surface and that has a magnitude equal to the area of the surface.

23.04 Identify that any surface can be divided into area elements (patch elements) that are each small enough and flat enough for an area vector $d\vec{A}$ to be assigned to it, with the vector perpendicular to the element and having a magnitude equal to the area of the element.

Learning Objectives (Contd.)

23.05 Calculate the flux Φ through a surface by integrating the dot product of the electric field vector ***E*** and the area vector *d**A*** (for patch elements) over the surface, in magnitude- angle notation and unit-vector notation.

23.06 For a closed surface, explain the algebraic signs associated with inward flux and outward flux.

23.07 Calculate the net flux ϕ through a closed surface, algebraic sign included, by integrating the dot product of the electric field vector ***E*** and the area vector *d**A*** (for patch elements) over the full surface.

23.08 Determine whether a closed surface can be broken up into parts (such as the sides of a cube) to simplify the integration that yields the net flux through the surface.

23-4 Gauss' Law

Learning Objectives

23.09 Apply Gauss' law to relate the net flux ϕ through a closed surface to the net enclosed charge q_{enc}.

23.10 Identify how the algebraic sign of the net enclosed charge corresponds to the direction (inward or outward) of the net flux through a Gaussian surface.

23.11 Identify that charge outside a Gaussian surface makes no contribution to the net flux through the closed surface.

23.12 Derive the expression for the magnitude of the electric field of a charged particle by using Gauss' law.

23.13 Identify that for a charged particle or uniformly charged sphere, Gauss' law is applied with a Gaussian surface that is a concentric sphere.

23-6 A Charged Isolated Conductor

Learning Objectives

23.14 Apply the relationship between surface charge density σ and the area over which the charge is uniformly spread.

23.15 Identify that if excess charge (positive or negative) is placed on an isolated conductor, that charge moves to the surface and none is in the interior.

23.16 Identify the value of the electric field inside an isolated conductor.

23.17 For a conductor with a cavity that contains a charged object, determine the charge on the cavity wall and on the external surface.

23.18 Explain how Gauss' law is used to find the electric field magnitude E near an isolated conducting surface with a uniform surface charge density σ.

23.19 For a uniformly charged conducting surface, apply the relationship between the charge density σ and the electric field magnitude E at points near the conductor, and identify the direction of the field vectors.

23-7 Applying Gauss' Law: Cylindrical Symmetry

Learning Objectives

23.20 Explain how Gauss' law is used to derive the electric field magnitude outside a line of charge or a cylindrical surface (such as a plastic rod) with a uniform linear charge density λ.

23.21 Apply the relationship between linear charge density λ on a cylindrical surface and the electric field magnitude E at radial distance r from the central axis.

23.22 Explain how Gauss' law can be used to find the electric field magnitude inside a cylindrical non-conducting surface (such as a plastic rod) with a uniform volume charge density ρ.

23-8 Applying Gauss' Law: Planar Symmetry

Learning Objectives

23.23 Apply Gauss' law to derive the electric field magnitude ***E*** near a large, flat, non-conducting surface with a uniform surface charge density σ.

23.24 For points near a large, flat non-conducting surface with a uniform charge density σ, apply the relationship between the charge density and the electric field magnitude ***E*** and also specify the direction of the field.

23.25 For points near two large, flat, parallel, conducting surfaces with a uniform charge density σ, apply the relationship between the charge density and the electric field magnitude ***E*** and also specify the direction of the field.

23-9 Applying Gauss' Law: Spherical Symmetry

Learning Objectives

23.26 Identify that a shell of uniform charge attracts or repels a charged particle that is outside the shell as if all the shell's charge is concentrated at the center of the shell.

23.27 Identify that if a charged particle is enclosed by a shell of uniform charge, there is no electrostatic force on the particle from the shell.

23.28 For a point outside a spherical shell with uniform charge, apply the relationship between the electric field magnitude E, the charge q on the shell, and the distance r from the shell's center.

23.29 Identify the magnitude of the electric field for points enclosed by a spherical shell with uniform charge.

23.30 For a uniform spherical charge distribution (a uniform ball of charge), determine the magnitude and direction of the electric field at interior and exterior points.