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University Physics 2

Course Overview

Acknowledgments

This presentation is based on and includes content derived from the following OER resource:

University Physics, Volume 2

The OpenStax books used for this course may be downloaded for free at:

https://openstax.org/details/books/university-physics-volume-2

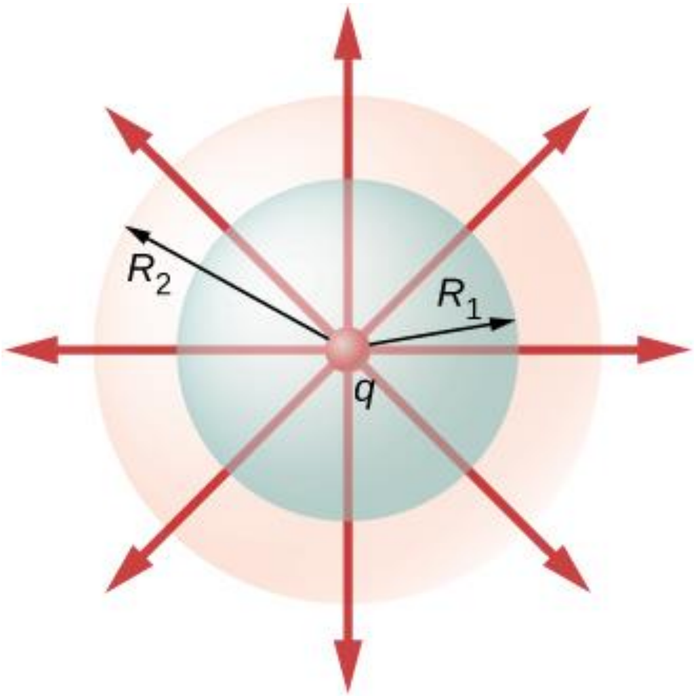
Electric Charges and Fields

Electric charge is a property of particles, like mass. Unlike mass, charge can be positive or negative. The electric force acts on all charged particles, causing particles with the same charge to repel one another, and particles with opposite charge to attract. The electric force holds atoms together and plays a central role in chemical and biological processes.

(University Physics Volume 2. OpenStax. Fig. 5.1.)

Gauss's Law

Gauss's law is a mathematical expression that describes the relationship between a charge distribution and the electric field that it produces. It describes how the field lines emanating from a charge distribution through a surface, called the electric flux, can be "counted" to determine how much charge is contained within the surface.



(University Physics Volume 2. OpenStax. Fig. 6.14.)

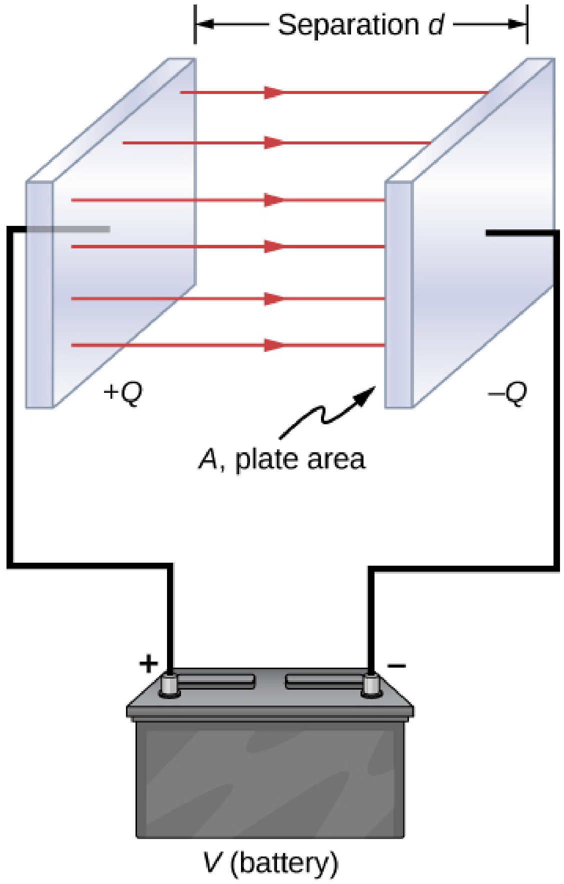
Electric Potential

Like the gravitational force, the electric force has an associated potential energy. The voltage, or electric potential, of an electric system is its potential energy per unit charge. The potential can also be used to calculate the electric field. Charged particles move towards areas of lower potential when they are free to move, which is the basic idea underlying the operation of a battery.

(University Physics Volume 2. OpenStax. Fig. 7.1.)

Capacitance

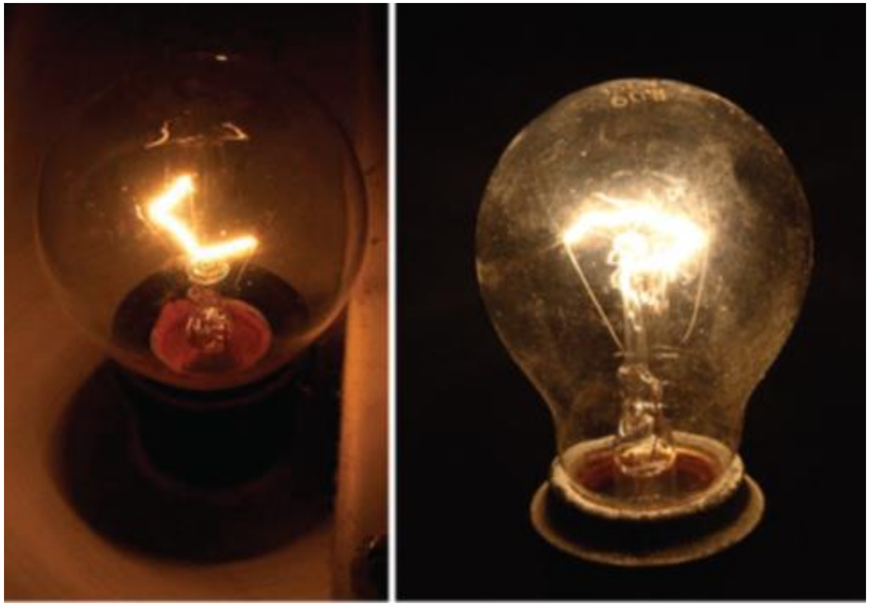
Capacitors are important components used in electrical circuits. When connected to a voltage source, like a battery, a capacitor stores charge and electrical energy to be used when needed. They are typically made of two or more metallic surfaces separated by air or an insulator called a dielectric. The ability of a capacitor to store charge at a given voltage is called its capacitance.



(University Physics Volume 2. OpenStax. Fig. 8.5.)

Current and Resistance

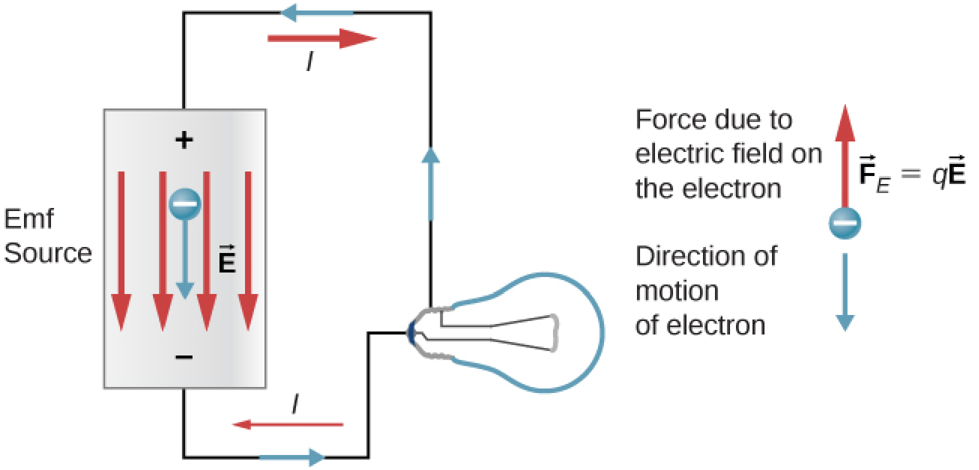
Current is the flow rate of charge, while resistance is a measure of how much a material impedes a current. The proportional relationship between current and resistance in most materials is described by Ohm's law. For circuit components, we sometimes want or need higher resistance to lower the current or to dissipate light or heat, like in a light bulb.



(University Physics Volume 2. OpenStax. Fig. 9.23.)

Direct-Current Circuits

Batteries and other sources of direct current provide a fixed, steady voltage to a circuit. Resistors, capacitors, and other circuit components may be connected in series or parallel to achieve a desired effect. Kirchoff's rules, based on conservation of energy and conservation of charge, are the foundation of circuit analysis and may be used to understand arbitrarily complex circuits.



(University Physics Volume 2. OpenStax. Fig. 10.3.)

Magnetic Forces and Fields

The motion of charged particles creates an additional force called the magnetic force. As with the electric force, the magnetic force can be visualized with magnetic field lines that travel from north to south magnetic poles. The magnetic force on a charged particle is perpendicular to its velocity and the magnetic field. Steady current results in static magnetic field.

(University Physics Volume 2. OpenStax. Fig. 11.1.)

Sources of Magnetic Fields

Magnetic fields can be created by an arbitrary distribution of electric current, described by the Biot-Savart law. Ampère’s law describes how the current through a surface is related to the magnetic field around the surface’s boundary. A magnetic field can create a torque on a loop of current due to the magnetic force experienced by the moving charges in the loop.

(University Physics Volume 2. OpenStax. Fig. 12.7.)

Electromagnetic Induction

When the electric and magnetic fields are allowed to vary in time, the change in one field induces a change in the other. Faraday’s law describes how changing the magnetic flux through a loop of wire causes it to experience a current due to a change in magnetic flux. This result, called electromagnetic induction, is the underlying principle of all motors and generators.

(University Physics Volume 2. OpenStax. Fig. 13.1.)

Inductance

A changing current flowing in a circuit can be used to produce a magnetic field. The inductance of a device describes how effectively it induces an emf in another device. Inductors are circuit devices that store energy in a magnetic field using electromagnetic induction. Together with resistors and capacitors, they can be used to create circuits with characteristic frequencies of alternating current.

(University Physics Volume 1. OpenStax. Fig. 14.1.)

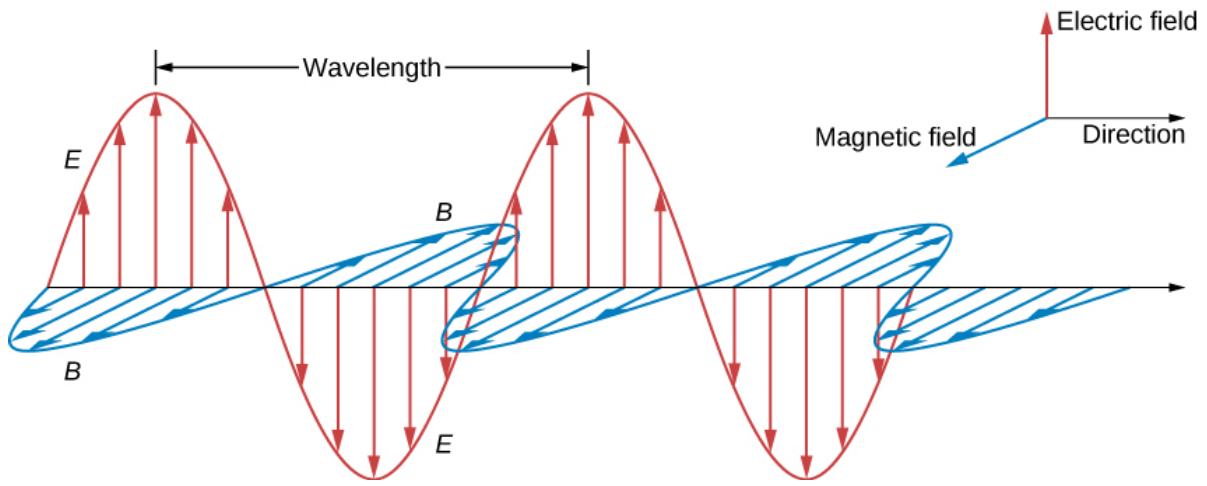
Alternating-Current Circuits

Alternating current (ac), as opposed to direct current (dc), is a current that periodically reverses. The electrical grid provides ac to power our homes. When exposed to an ac source, capacitors and inductors exhibit resistive behaviors similar to a resistor in a dc circuit. This gives rise to resonance behavior, similar to that of a driven damped harmonic oscillator, and a great number of applications.

(University Physics Volume 2. OpenStax. Fig. 15.1.)

Electromagnetic Waves

Maxwell's equations describe the relationship between electric and magnetic fields and matter. In free space with no charges, they show that an oscillating electric field will induce a changing magnetic field, which in turn induces an electric field. This phenomenon results in electromagnetic waves, which are what we commonly refer to as light.



(University Physics Volume 2. OpenStax. Fig. 16.8.)

Study Tips

- Read the syllabus or schedule of assignments regularly.
- Understand key terms; look up and define all unfamiliar words and terms.
- Take notes on your readings, assigned media, and lectures.
- As appropriate, work all questions and/or problems assigned and as many additional questions and/or problems as possible.
- Discuss topics with classmates.
- Frequently review your notes. Make flow charts and outlines from your notes to help you study for assessments.
- Complete all course assessments.

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