Unit 11: Electric Charges and Flows

Content Area: **Template**
Course(s):
Time Period:
Length:
Status: **Published**

State Mandated Topics Addressed in this Unit

This unit aligns with the following NJ Student Learning Standards for Science (NJSLS-S) and supports exploration of electric and magnetic forces, fields, and their applications:

NJSLS-S Performance Expectations:

- **HS-PS2-4**: Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
- **HS-PS2-5**: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
- **HS-PS3-5**: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

Integrated Mathematics Standards (NJSLS-M):

- **A-CED.A.1**: Create equations and inequalities in one variable and use them to solve problems.
- **A-REI.D.10**: Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.

Science & Engineering Practices (SEPs):

- SEP 2: Developing and Using Models
- SEP 3: Planning and Carrying Out Investigations
- SEP 4: Analyzing and Interpreting Data
- SEP 5: Using Mathematics and Computational Thinking
- SEP 6: Constructing Explanations and Designing Solutions
- SEP 7: Engaging in Argument from Evidence

Crosscutting Concepts:

- Cause and Effect
- Systems and System Models
- Energy and Matter

These standards support instructional objectives including:

- Classifying and modeling electric charge interactions
- Investigating and applying Coulomb's Law
- Constructing and analyzing electrical circuits
- Explaining the relationship between electricity and magnetism
- Designing and testing electromagnetic devices

Unit Summary

This unit investigates the nature and behavior of electric charges and how they interact with matter and energy. Students will classify types of electric charge, explore electrostatic forces, and use Coulomb's Law to model electric interactions. They will also examine how electric currents are generated and transmitted, exploring the principles behind electrical circuits and the role of conductors, insulators, and resistance. Emphasis will be placed on the relationship between electricity and magnetism, including the design and operation of electromagnets and electric motors. Through experimentation, modeling, and technical communication, students will explore how electric and magnetic fields influence the flow of energy in technological systems and natural phenomena, in alignment with NJ State Science Standards.

Learning Objectives

- How do conductors and insulators affect the flow of electric current?
- How do different circuits perform electrical work?
- How do electric and magnetic forces power the technologies we use every day?
- How do electric currents interact with magnetic fields?
- How do electric fields influence the behavior of charges in space?
- How does moving an electric charge do work?
- How is electrical energy stored and transferred?
- What determines the strength of the electric force between two charges?
- What is the relationship between voltage, current, and resistance in a circuit?

Essential Skills

- Apply Ohm's Law to solve problems involving voltage, current, and resistance.
- Construct and analyze simple series and parallel circuits.
- Define and calculate electric potential difference.

- Demonstrate that charging is the separation, not the creation, of electrical charges.
- Describe the differences between conductors and insulators.
- Differentiate between static electricity and current electricity.
- Explain how electric power is calculated and how it relates to energy consumption.
- Identify safety practices when working with electric circuits.
- Investigate the interaction between electric currents and magnetic fields.
- Model electric fields and describe how field lines represent force direction and magnitude.
- Recognize that objects that are charged exert forces, both attractive and repulsive.
- Solve problems relating to charge, electric fields, and forces.
- Use Coulomb's Law to calculate electric force between charged particles.

Standards

SCI.HS-PS2-4	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
SCI.HS-PS2-5	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
SCI.HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
SCI.HS-PS3-5	Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

Instructional Tasks/Activities

- Common assessment chapter test
- Common assessment quiz
- Constructed response
- Do now's and/or exit slips
- Exit Cards (answer to daily objective questions)
- Graphic organizers or models
- Guided practice
- Homework
- Homework
- Individual, small, and large group work
- Laboratory investigations within small groups
- Review Activity
- Section Review Questions
- Study Guide Packets
- Vocabulary flash cards or map (word, picture, sentence, example)

Assessment Procedure

- Flashcards and/or drill and practice
- Inquiry based activities with reflective discussion
- Laboratory groups
- Lecture with note taking or guided notes
- Online models and simulators
- Power point presentations
- Whole and small group discussions

Recommended Technology Activities

- Appropriate Content Specific Online Resource
- Chromebook
- Copy/Paste Content Specific Link Here
- Copy/Paste Content Specific Link Here
- Copy/Paste Content Specific Link Here
- Gimkit
- GoGuardian
- Google Classroom
- Google Docs
- Google Forms
- Google Slides
- Kahoot
- MagicSchool AI
- Other- Specified in Lesson
- Quiziz
- Screencastify

Accommodations & Modifications & Differentiation

Accommodations and Modifications should be used to meet individual needs. Their IEP and 504 plans should be used in addition to the following suggestions.

Gifted and Talented

- Compare & Contrast

- Conferencing
- Debates
- Jigsaw
- Peer Partner Learning
- Problem Solving
- Structured Controversy
- Think, Pair, Share
- Tutorial Groups

Instruction/Materials

- alter format of materials (type/highlight, etc.)
- color code materials
- eliminate answers
- extended time
- extended time
- large print
- modified quiz
- modified test
- Modify Assignments as Needed
- Modify/Repeat/Model directions
- necessary assignments only
- Other (specify in plans)
- other- named in lesson
- provide assistance and cues for transitions
- provide daily assignment list
- read class materials orally
- reduce work load
- shorten assignments
- study guide/outline
- utilize multi-sensory modes to reinforce instruction

Environment

- alter physical room environment
- assign peer tutors/work buddies/note takers
- assign preferential seating
- individualized instruction/small group
- modify student schedule (Describe)

- other- please specify in plans
- provide desktop list/formula

Honors Modifications

Resources

- Resource 1
- Resource 2
- Resource 3
- Resource 4
- Resource 5