

06_Electrostatics and Circuits

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **3 weeks**
Status: **Published**

General Overview, Course Description or Course Philosophy

This course is about the nature of basic things such as motion, force, energy, matter, sound, light, electricity and the composition of atoms. Laboratory experiments, demonstrations, applications to daily life and current topics in physics provide students with an appreciation of this most basic science.

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Essential questions:

- How do electric charges interact with each other?

Students will understand:

- Electrical and magnetic forces are different aspects of a single electromagnetic force
- Energy takes many forms.
- Electricity is essential to modern living
- The motion of charges constitutes electricity and it carries energy

CONTENT AREA 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-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.

RELATED STANDARDS (Technology, 21st Century Life & Careers, ELA Companion Standards are Required)

SL.11-12.5: Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

MA.K-12.2	Reason abstractly and quantitatively.
MA.A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
PFL.9.1.K12.P.4	Demonstrate creativity and innovation.
MA.K-12.4	Model with mathematics.

MA.A-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
MA.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
MA.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
LA.WHST.11-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
LA.WHST.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
LA.WHST.11-12.9	Draw evidence from informational texts to support analysis, reflection, and research.
WRK.K-12.P.8	Use technology to enhance productivity increase collaboration and communicate effectively.
TECH.K-12.P.5	Utilize critical thinking to make sense of problems and persevere in solving them.

STUDENT LEARNING TARGETS

Declarative Knowledge

Students will know:

- Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.
- In a neutral atom, the positively charged nucleus is surrounded by the same number of negatively charged electrons. Atoms of an element whose nuclei have different numbers of neutrons are called isotopes.
- The flow of current in an electric circuit depends upon the components of the circuit and their arrangement, such as in series or parallel. Electricity flowing through an electrical circuit produces magnetic effects in the wires.
- Friction is required to give objects static charges.
- Coulomb's Law applies to charged objects of any size.
- Separated positive and negative charges exert forces of each other.
- Electric currents carry electrical energy that can be transformed into other energy forms.
- Differences between series and parallel circuits, including voltage, current, and equivalent resistance.

Procedural Knowledge

Students will be able to:

HS-PS2-4

- Students clearly define the system of the interacting objects that is mathematically represented.
- Using the given mathematical representations, students identify and describe the electrostatic force between two objects as the product of their individual charges divided by the separation distance squared ($F_e = (Kq_1q_2)/r^2$), where a negative force is understood to be attractive.
- Students correctly use the given mathematical formulas to predict the electrostatic force between charged objects.
- Based on the given mathematical models, students describe that the ratio between electric forces between objects with a given charge and mass is a pattern that is independent of distance.
- Students describe that the mathematical representation of the electric field ($F_e = (Kq_1q_2)/r^2$) predicts both attraction and repulsion because electric charge can be either positive or negative.
- Students use the given formulas for the forces as evidence to describe that the change in the energy of objects interacting through electric forces depends on the distance between the objects.

HS-PS3-5

- Students develop a model in which they identify and describe the relevant components to illustrate the forces and changes in energy involved when two objects interact, including:
 1. The two objects in the system, including their initial positions and velocities (limited to one dimension).
 2. The nature of the interaction (electric) between the two objects.
 3. The relative magnitude and the direction of the net force on each of the objects.
 4. Representation of a field as a quantity that has a magnitude and direction at all points in space and which contains energy.
- In the model, students describe the relationships between components, including the change in the energy of the objects, given the initial and final positions and velocities of the objects.
- Students use the model to determine whether the energy stored in the field increased, decreased, or remained the same when the objects interacted.
- Students use the model to support the claim that the change in the energy stored in the field (which is qualitatively determined to be either positive, negative, or zero) is consistent with the change in energy of the objects.
- Using the model, students describe the cause and effect relationships on a qualitative level between forces produced by electric fields and the change of energy of the objects in the system

EVIDENCE OF LEARNING

Formative Assessments

Strategic questioning

Class/small group discussions

Homework and classwork assignments

Conducting and analyzing labs

Summative Assessments

- Benchmarks – departmental benchmark given at the end of MP1, MP2, and MP3
- Alternative Assessments
 - Lab inquiries and investigations
 - Lab Practicals
 - Exploratory activities based on phenomenon
 - Gallery walks of student work
 - Creative Extension Projects
 - Build a model of a proposed solution
 - Let students design their own flashcards to test each other
 - Keynote presentations made by students on a topic
 - Portfolio

RESOURCES (Instructional, Supplemental, Intervention Materials)

The Physics Classroom - <http://www.physicsclassroom.com/>

PhET simulations - <https://phet.colorado.edu/>

Pivot - <https://www.pivotinteractives.com/>

Edpuzzle - <https://edpuzzle.com/>

Vernier labs - teacher lab manual available in classroom

INTERDISCIPLINARY CONNECTIONS

Calculations drive connections with mathematics courses

ACCOMMODATIONS & MODIFICATIONS FOR SUBGROUPS

See link to Accommodations & Modifications document in course folder.