09 Electricity and Magnetism

Content Area: **Science**
Course(s): **AP Physics 1**
Time Period: **Semester 2**
Length: **6 periods**
Status: **Published**

Standards

	Patterns
	Cause and Effect
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.
PS2.B	Types of Interactions
PS3.A	Definitions of Energy
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.
PS3.C	Relationship Between Energy and Forces
	Scale, Proportion, and Quantity
	Using Mathematics and Computational Thinking
	Analyzing and Interpreting Data

Enduring Understandings

1. Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects.
2. Forces at a distance are explained by fields permeating space that can transfer energy through space.
3. Objects with an electric charge will create an electric field.
4. Objects with an electric charge will interact with each other by exerting forces on each other.
5. The total energy of a system composed of a collection of point charges can transfer from one form to another without changing the total amount of energy in the system.
6. Magnets or changing electric fields cause magnetic fields
7. Electric charges or changing magnetic fields cause electric fields.
8. Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. The strong and weak nuclear interactions are important inside atomic nuclei—for example, they determine the patterns of which nuclear isotopes are stable and what kind of decays occur for unstable ones.
9. "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents.

Essential Questions

1. What underlying forces explain the variety of interactions observed?
2. How is energy transferred and conserved?
3. How are forces related to energy?
4. Why does your hair stand up after brushing it with a plastic comb?
5. How does a charged rubber rod bend a stream of water?
6. Why is it sometimes necessary to shield against electric fields?
7. How are maps of voltage and topographical maps related?
8. Why can a bird land on a high voltage wire and not be electrocuted?

Knowledge and Skills

Knowledge:

1. Newton's Law of Universal Gravitation and Coulomb's Law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (DCI PS2.B Types of Interactions)
2. Particles and objects may contain electrostatic charges. The Law of Electrostatics states that like charges repel and unlike charges attract through electrostatic interactions.
3. The presence of an electric field will polarize a neutral object (conductor or insulator). This can create an "induced" charge on the surface of the object.
    a. As a consequence of this polarization, a charged object can interact with a neutral object, producing a net attraction between the charged object and the neutral object.
4. Point charge is defined as a charged object where the object is of negligible mass and size and takes up virtually no space.
5. The magnitude of electrostatic force between two point charges is given by Coulomb's Law.
6. Net force can be determined by superposition of all forces acting on a point charge due to the vector sum of other point charges.
7. Knowing the force acting on the charged object and the initial conditions of the charged object (such as initial velocity), the motion of the object (characteristics such as the acceleration, velocity and velocity changes, and trajectory of the object) can be determined.
8. Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (DCI PS2.B Types of Interactions)
9. Current is defined as the amount of charges that move through a cross section of wire per a unit of time.
10. Current is directly related to the quantity of the voltage and inversely related to the resistance.
11. "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents.

12. When two objects interacting through a field change relative position, the energy stored in the field is changed. (DCI PS3.C Relationship Between Energy and Forces)

Skills :

1. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
2. 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.
3. 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.

Transfer Goals

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

Energy and Matter: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

Structure and Function: The way an object is shaped or structured determines many of its properties and functions.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing

Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit?usp=shar

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