Unit 8.3 Forces at a Distance

Content Area: **Science**
Course(s): **Science 8**
Time Period: **MP3-4**
Length: **MP3-4**
Status: **Published**

Essential Questions

Unit Question How can a magnet move another object without touching it?

Lesson 1 What causes a speaker to vibrate?

Lesson 2 What can a magnet pull or push without touching?

Lesson 3 How does energy transfer between things that are not touching?

Lesson 4 What can we figure out about the invisible space around a magnet?

Lesson 5 How does the magnetic field change when we add another magnet to the system?

Lesson 6 How can we use magnetic fields to explain interactions at a a distance between the magnet and the coil?

Lesson 7 How does changing the distance between two magnets affect the amount of energy transferred out of the field?

Lesson 8 How does the energy transferred from a b attery to a wire coil compare to the energy transferred from a computer to a speaker?

Lesson 9 How do the magnet and electromagnet work together to move the speaker?

Big Ideas

Unit Summary and Storyline

Students dissect speakers to explore the inner workings, and engineer homemade cup speakers to manipulate the parts of the speaker. They identify that most speakers have the same parts–a magnet, a coil of wire, and a membrane. Students investigate each of these parts to figure out how they work together in the speaker system. Along the way, students manipulate the components (e.g. changing the strength of the magnet, number of coils, direction of current) to see how this technology can be modified and applied to a variety of contexts, like MagLev trains, junkyard magnets, and electric motors.

Anchoring Phenomenon

The speaker anchoring phenomenon was chosen from a group of phenomena aligned with the target performance expectations based on consultation with external advisory panels that include teachers, subject

matter experts, and state science administrators. The speaker was chosen for the following reasons:

- Teachers and administrators saw high relevance to students' everyday experiences with headphones, music players, and PA systems
- Explaining how a speaker works addresses all the DCIs in the bundle at a middle school level
- Students have the opportunity to engage in hands-on dissection on day 1
- The speaker shares constituent components with many other everyday devices that students may not have noticed
- Students are motivated to test the components of the speaker system

Enduring Understandings

NGSS Performance Expectations

- MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
- MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
- MS-PS3-2: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
- MS-PS2-2*: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- MS-PS3-1*: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- MS-PS3-5*: Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object (p. 61).

Disciplinary Core Ideas

The unit expands students' understanding of forces and energy transfer, which include these grades 6-8 DCI elements:

PS2.B: Types of Interactions

- Electrical and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3)
- Forces that act at a distance (electrical, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, a magnet, or a ball, respectively). (MS-PS2-5)

PS3.A: Definitions of Energy

- A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)
- When two objects interact, each one exerts a force on the other that can cause energy to be transferred

to or from the object. (MS-PS3-2)

The parts of the DCI elements that are not developed in this unit are crossed out. In the OpenSciEd Scope and Sequence, students will develop an understanding of gravity in OpenSciEd Unit 8.4. Electricity is treated as an extension opportunity within this unit. The placement of this OpenSciEd Unit 8.3 and associated units within the OpenSciEd Middle School Scope and Sequence.

Crosscutting Concepts

- Cause and Effect: This unit intentionally develops this crosscutting concept through the application of cause-effect sentence frames. Students routinely identify, test, and use relationships to explain change throughout.
- Systems and System Models: This crosscutting concept is key to the sensemaking in this unit.Students spend the unit breaking down and modeling the speaker system, describing and explaining the system in terms of its components and interactions
- Energy and Matter: This crosscutting concept is key to the sensemaking in this unit. Students figure out and apply the idea that energy can be transferred in various ways and between objects in order to explain how the speaker system works.
- The following crosscutting concepts are also key to the sensemaking in this unit:
    - Patterns
    - Scale, Proportion, and Quantity

CRLLKS- Career Education

9.2.8.B.3 Evaluate communication, collaboration, and leadership skills that can be developed through school, home, work, and extracurricular activities for use in a career.

9.2.8.B.4 Evaluate how traditional and nontraditional careers have evolved regionally, nationally, and globally.

9.2.8.B.5 Analyze labor market trends using state and federal labor market information and other resources available online.

9.2.8.B.6 Demonstrate understanding of the necessary preparation and legal requirements to enter the workforce.

Connection:

Instruct students to include a section about career options that go along with their research project topic. Example, if the research topic is high cholesterol and its harmful effects, students should connect careers in food science and/or in the medical field.

Cross-Curricular Integration

Integration Area: Language Arts

W.IW.8.2. Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

A. Introduce a topic clearly, previewing what is to follow; and organize ideas, concepts, and information, using text structures (e.g., definition, classification, comparison/contrast, cause/effect, etc.) and text features (e.g., headings, graphics, and multimedia) when useful to aid in comprehension.

B. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.

C. Use appropriate transitions to create cohesion and clarify the relationships among ideas and concepts.

D. Use precise language and domain/grade-level- specific vocabulary to inform about or explain the topic.

E. Establish and maintain a formal style/academic style, approach, and form.

F. Provide a concluding statement or section (e.g., sentence, part of a paragraph, paragraph, or multiple paragraphs) that synthesizes the information or explanation presented.

Activity:

Students will use CERs (Claim, Evidence & Reason) to explore Climate Change to show if students are able to convey their thinking and decision making in written form.

- Students will be answering the question, “What are causes of cancer and mutations?”
- Students provide evidence that supports their claim.
- Students will then write a reasoning that explains what their claim is, state knowledge they have on the topic, evidence to prove their topic, and close their reasoning with their claim again.

Integration Area: Math

8.EE.C.7.a Give linear equations in one variable.

Activity:

Students will take notes on a lesson about Punnett Squares which relates to probability, fractions, and percentages. Once Punnett Squares is taught, the students will work in groups to complete a worksheet on different scenarios relating to the possible outcomes of the offspring of varied traits of sexual reproductive parents: homozygous recessive and dominant as well as heterozygous.

Language Arts Companion Standards:

W.IW.8.2. Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

A. Introduce a topic clearly, previewing what is to follow; and organize ideas, concepts, and information, using text structures (e.g., definition, classification, comparison/contrast, cause/effect, etc.) and text features (e.g., headings, graphics, and multimedia) when useful to aid in comprehension.

B. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.

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D. Use precise language and domain/grade-level- specific vocabulary to inform about or explain the topic.

E. Establish and maintain a formal style/academic style, approach, and form.

F. Provide a concluding statement or section (e.g., sentence, part of a paragraph, paragraph, or multiple paragraphs) that synthesizes the information or explanation presented.

RL.CI.8.2. Determine a theme of a literary text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

RI.CI.8.2. Determine a central idea of an informational text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

Activity:

Water on Earth: One way in which NJ residents could help control the mosquito population is to eliminate or decrease the amount of standing water around their homes. Using evidence from one or more credible sources, explain why this procedure might be effective to reduce the mosquito population? Be sure to explain how this evidence supports your claim.

Diversity

Race and Ethnicity

Objective:

- Students should be able to identify the genetic diversity within the classroom.
- Students should be able to explain how genetic diversity relates to biodiversity.
- Students should be able to gather the information from their survey to find the population of students

who carry specific traits.
- Students should be able to graph this information in a pie chart.

Activity:

Students will obtain a list of traits they need to look for within their class. They are to mingle and record the data on the phenotypes of the students.

They must determine if the traits they are recording are acquired or genetic.

They will use a tool to create polls and/or pie chart on their findings.

Science and Engineering Practices

- Asking Questions and Defining Problems: This unit intentionally develops students' engagement in this practice through the use of sentence frames to help them ask investigable questions about specific cause and effect relationships, and to construct scientific hypotheses from these questions that include a mechanistic account of an observable relationship between variables.
- Planning and Carrying Out Investigation: This unit intentionally develops students' engagement in this practice. Students use hypothesis-building cause-effect sentence frames to identify variables they need to test to evaluate their hypothesis. In Lessons 10-11, students plan and conduct an investigation collaboratively as a class and in small groups to produce data to serve as the basis for evidence for describing cause and effect relationships between factors in a speaker system.
- Developing and Using Models: This practice is key to the sensemaking in this unit. Students develop and use models throughout the unit to try to explain how some parts of the speaker are moving without being in contact with the rest of the system, beginning in Lesson 1. They use their models to test cause and effect relationships to describe how the speaker works.
- Analyzing and Interpreting Data, and Using Mathematics and Computational Thinking are also key to the sensemaking in this unit. In Lessons 10-11, students analyze data from their investigations in order to identify and describe the nonlinear relationships between various factors and magnetic force.
- The following practice is also key to the sensemaking in this unit:
    - Constructing Explanations and Designing Solutions.

Science and Society

Robert Hooke

The cell was first discovered and named by Robert Hooke in 1665. He remarked that it looked strangely similar to 'cellula' or small rooms which monks inhabited, thus deriving the name.

Theodor Schwann

Schwann demonstrated that animal tissues contained cells, and in 1839 concluded that all tissues are made up of cells: this laid the foundations for the cell theory. Combined with Schleiden's findings of plant tissue containing cells, they concluded that all living things are made up of cells and that cells are the basic units of life.

Robert Virchow

Concluded that all cells come from pre-existing cells

Antonie Van Leeuwenhoek

The first to observe living bacteria and protista.

Gregor Mendel

Discovered the basic principles of genetics concerning dominant and recessive traits within pea plants. He also proved that traits undergo independent assortment; traits are able to separate from each other.

Rosalind Franklin

Rosalind Franklin was a chemical physicist (1920–1958), who used x-ray diffraction to determine the structure of DNA.

Francis Crick and James Watson

Crick and Watson, together with Maurice Wilkins, won the 1962 Nobel Prize in Medicine for their discovery of the structure of DNA. Watson and Crick created the first accurate 3D model of DNA.

Charles Darwin

English naturalist whose scientific theory of evolution by natural selection became the foundation of modern evolutionary studies. Darwin stated that animals and humans shared a common ancestor.

CSDT Technology Integration

8.2.8.NT.4: Explain how a product designed for a specific demand was modified to meet a new demand and led to a new product

Action: Students will identify, compare, and contrast the evolution of the microscope. Students will work with the compound light microscope, identify the parts, and explain how it works.
OpenSciEd:

Lesson 1 (Speaker Vibration): Use slow-motion video recording on tablets to observe the high-frequency vibrations of a speaker cone that are too fast for the naked eye.

Lesson 5 (Magnetic Fields): Use computer interactives to simulate the complex field shapes that occur when adding a second magnet, helping students visualize attractive versus repulsive field lines.

Lesson 8 (Energy Transfer): Use a free online sound generator (tone generator) to vary the frequency and volume of sound, observing the direct effect on the speaker system's movement.

Lab

Exploring Forces at a Distance with Magnets and Waves of Energy

Objective:
Students will investigate the concept of forces acting at a distance, focusing on magnetic forces and waves of energy.

Reflection Questions

1. How do magnets demonstrate forces acting at a distance?
2. What patterns did you observe in the iron filings, and what do they indicate about magnetic fields?
3. How is the motion of the pendulum similar to waves of energy?

Assessment

- Have students complete a worksheet where they draw the magnetic field lines observed and answer reflection questions.
- Collect student worksheets to assess understanding.

Standards Addressed

- MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
- MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
- MS-PS3-2: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

https://docs.google.com/document/d/108xRpyvp8xALxwRPRhChdH1KaY4rHAvH-EtLWxtg_J4/edit?usp=drive_link

Service Learning

Community Issue: Students will choose between one of these issues to research, create a presentation on how they can help with this issue in Milltown, and then make a pamphlet to be posted.

Focus Areas:

- **Mosquito Pathogens:** Investigate the diseases and viruses mosquitoes carry. Determine the most prevalent pathogens as well as their effects on humans and other organisms. Using the internet, library, and other resources, students can create a PowerPoint or brochure to share with the community.
- **Mosquito Population Control:** Learn about the breeding grounds of mosquitoes and how to reduce their population. Using the internet, library, and other resources, students can create a PowerPoint or brochure to share with the community.
- **Natural Predators:** Use the internet and other resources to gather information about mosquito preditors and the predator's ideal environments. Students will research the cost, the materials needed, and the placement of these objects in the environment. The information can be shared with the public.
- **Natural Pest Control:** Learn alternative methods of pest control and the different impacts that these methods have on the environment. Create a brochure to demonstrate how everyone in town can do this and not use harmful pesticides.

Activity:

- **Pre-Reflection:**
  - Students in their groups, will look over the list of types of projects they can do their project on.
  - They will talk about what they already know about mosquitos, their breeding seasons, and what they can do to share their information with the community in the most effective way. Using their previous knowledge, they will choose the best project for their group.
- **Research:**
  - Students will research their topic. They will brainstorm and come up with a concept map of how they want to create their presentation Google Slides and their pamphlet in Google Docs.
- **Presentation & Pamphlet:**
  - Students will take all of their research on their chosen topic and create a presentation in Google Slides. This presentation will be presented to the class.
  - Students will also come up with a pamphlet summarizing their presentations that can be shared on Parent Square to help bring awareness to the Milltown Community.
- **Reflection:**

- Students will then reflect (in a Google Doc) on how they think their project went, and how they will use the suggestions they provided to help the environment.

Resources

Scientific Inquiry

MS-LS1-1	Plant, Animal, Bacteria Lab
MS-LS1-2	Cell Organelle Project - Inner Life of a Cell Multiple Project Choice, 2D Cell Project, 3D Cell Project
MS-LS3-1	Strawberry DNA Lab
MS-LS4-5	Technologies that Influence Inheritance of Traits
MS-LS4-1	Investigating Natural Selection
MS-LS4-3	Comparative Embryology