Unit Overview	
Content Area: Physical Science	
Unit Title: Types of Interactions	**Unit: 2**
Target Course/Grade Level: 6th Grade	**Timeline: 25 days**

Unit Summary:

Is it possible to exert on an object without touching it?

Students use *cause and effect*; *system and system models*; and *stability and change* to understand ideas that explain why some materials are attracted to each other while others are not. Students apply ideas about gravitational, electrical, and magnetic forces to explain a variety of phenomena including beginning ideas about why some materials attract each other while others repel. In particular, students develop understandings that gravitational interactions are always attractive but that electrical and magnetic forces can be both attractive and negative. Students also develop ideas that objects can exert forces on each other even though the objects are not in contact, through fields. Students are expected to consider the influence of science, engineering, and technology on society and the natural world. Students are expected to demonstrate proficiency in *asking questions*, *planning and carrying out investigations*, *designing solutions*, and *engaging in argument*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on MS-PS2-3, MS-PS2-4, and MS-PS2-5.

Learning Targets

NJ Student Learning Standards- Science

MS-PS2-1	Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects.
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-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-PS2-3	**Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.**
MS-PS2-4	**Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.**

Disciplinary Core Ideas

PS2.B: Types of Interactions

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. (HS-PS2-4)

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. (HS-PS2-4)

PS2.A: Forces and Motion

If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-3)

ETS1.A: Defining and Delimiting an Engineering Problem

Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary) (HS-PS2-3)

ETS1.C: Optimizing the Design Solution

Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others

(trade-offs) may be needed. *(secondary HS-PS2-3)*

PS2.B: Types of Interactions

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. (HS-PS2-5)

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. (HS-PS2-5)

PS3.A: Definitions of Energy

"Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. *(secondary HS-PS2-5)*

Science and Engineering Practices

Using Mathematics and Computational Thinking

Use mathematical representations of phenomena to describe explanations. (HS-PS2-4)

Constructing Explanations and Designing Solutions

Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3)

Planning and Carrying Out Investigations

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-5)

NJSLS Connections

Primary Interdisciplinary

English Language Arts

- 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.(HS-PS2-5), (HS-PS2-3) **WHST.11-12.7**

- 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. (HS-PS2-5) **WHST.11-12.8**
- Cite specific textual evidence to support analysis of information about science and technical texts regarding *the factors that affect the strength of electric and magnetic forces,* attending to the precise details of explanations or descriptions.

- Write arguments focused on evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

- Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-5) **WHST.11-12.9**

Mathematics

- 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. (HS-PS2-5),(HS-PS2-4) **HSN.Q.A.1**

- Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-5),(HS-PS2-4) **HSN.Q.A.2**

- Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-5),(HS-PS2-4) **HSN.Q.A.3**

- Reason abstractly and quantitatively. (HS-PS2-4) **MP.2**

- Model with mathematics. (HS-PS2-4) **MP.4**

- Interpret expressions that represent a quantity in terms of its context. (HS-PS2-4) **HSA.SSE.A.1**

- Choose and produce an equivalent form of an expression to reveal and explain

properties of the quantity represented by the expression. (HS-PS2-4) **HSA.SSE.B.**

- Reason abstractly and quantitatively while using data to determine the factors that affect the strength of electric and magnetic forces.

Unit Essential Questions	**Unit Understandings**
• Can you apply a force on something without touching it? • How does a Maglev train work? • If I were able to eliminate air resistance and dropped a feather and a hammer at the same time, which would land first?	• Fields exist between objects that exert forces on each other even though the objects are not in contact. • The interactions of magnets, electrically charged strips of tape, and electrically charged pith balls are examples of fields that exist between objects exerting forces on each other, even though the objects are not in contact. • Forces that act at a distance (electric, 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 or a ball, respectively). • Cause-and-effect relationships may be used to predict phenomena in natural or designed systems. • Factors affect the strength of electric and magnetic forces. • Devices that use electric and magnetic forces could include electromagnets, electric motors, and generators. • Electric and magnetic (electromagnetic) forces can be attractive or repulsive. • The size of an electric or magnetic (electromagnetic) force depends on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. • Cause-and-effect relationships may be used to predict the factors that affect the strength of electrical and magnetic forces in natural or designed systems • Gravitational interactions are always attractive and depend on the masses of interacting objects. • There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass. • Evidence supporting the claim that gravitational interactions are attractive and depend on the masses of interacting objects could include data generated from simulations or digital tools and charts

	displaying mass, strength of interaction, distance from the sun, and orbital periods of objects within the solar system.

Student Learning Targets (Outcomes)- Formative Assessment

Students who understand the concepts are able to:

- Students will conduct an investigation and evaluate an experimental design to produce data that can serve as the basis for evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
- Students will identify the cause-and-effect relationships between fields that exist between objects and the behavior of the objects.
- Students will ask questions about data to determine the effect of the strength of electric and magnetic forces that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.
- Students will perform investigations using devices that use electromagnetic forces.
- Students will collect and analyze data that could include the effect of the number of turns of wire on the strength of an electromagnet or the effect of increasing the number or strength of magnets on the speed of an electric motor.
- Students construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
- Students use models to represent the gravitational interactions between two masses

Cross Cutting Concepts

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS2-4)

Cause and Effect

- Systems can be designed to cause a desired effect. (HS-PS2-3)
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-5)
- Connections to Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- Theories and laws provide explanations in science. (HS-PS2-4)

- Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-4)

Integration of Technology:

Web-based textbook, interactive whiteboard, interactive texts, videos, digital board builder

Technology Resources:

Discovery Education website, Google

Opportunities for Differentiation:
Differentiation and support tips, which includes suggestions for ELL, struggling students, and accelerated students, are available below the instructional practice section of each model lesson.

Teacher Notes:

Primary interdisciplinary connections:

Career Ready Practices: *In this unit the following career ready practices are addressed*
CRP1: Act as a reasonable and contributing citizen and employee
CRP2: Apply appropriate academic and technical skills
CRP3: Attend to personal health and financial well-being
CRP4: Communicate clearly and effectively and with reason
CRP5: Consider the environmental, social and economic impacts of decisions
CRP6: Demonstrate creativity and innovation
CRP7: Employ valid and reliable research strategies
CRP8: Utilize critical thinking to make sense of problems and persevere in solving them
CRP9: Model integrity, ethical leadership and effective management
CRP10: Plan education and career paths aligned to personal goals
CRP11: Use technology to enhance productivity
CRP12: Work productively in teams while using cultural global competence

Evidence of Learning

Summative Assessment

Static Charges

1. Using Board Builder or poster board or other mode of presentation, students will complete the "Exploring Lightning" activity. Students will explain how

lightning rods absorb static charges produced by lightning and will also explain the cause of lightning and illustrate how lightning rods are used to protect building from static charge carried in lightning.

2. Hands-on activity option: Design-Your-Own Static Charge Investigation. In this activity, students explain how to create static charges using various materials and describe the interactions between these materials as a result of static charges and they test the cause and effect of charges by designing a procedure and carrying out an investigation.
3. Optional Project: Energy Transfer. In this investigation, students work in small groups to demonstrate charge transfer using two metal cans with a metal tack suspended between the cans. Students explain that a charge is created by rubbing wool on plastic wrap and also, how the interaction of static charges can move a tack between two metal cans.

**For all three of these options, students will be assessed on the Disciplinary Core Ideas: PS2.B and RST.6-8.1, WHST 6-8.1, RST.6-8.9, MP.2, Crosscutting: Cause and Effect , Science and Engineering Practices: Asking Questions and Defining Problems and Planning and Carrying out Investigations.

Electricity and Magnetism Relationship

Students will be assessed on the Disciplinary Core Idea: PS2.B Types of Interactions and Crosscutting Concept: Cause and Effect, RST.6-8.1, MP.2, MP.4; Science and Engineering Practices: Asking Questions and Defining Problems

1. Hands-on activity: "Circuit Boxes". Students will investigate
2. Using Board Builder, students will answer one of the following Lesson Questions for the concept:
    a. How are electricity and magnetism related?
    b. How can wire, a magnet, and mechanical energy be used to generate electricity?
    c. What factors affect the amount of electricity that a generator produces?
3. Review Sheet: Students may review the information in this section using The Concept Review: How Electricity and Magnetism are Related.
4. Using the Performance Task, students will assessed on each dimension of NGSS, the Performance Expectation of NGSS.

Equipment needed:

Whiteboard, laptops, headphones, and hands-on materials for lessons

Modifications

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g**.** multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.
- Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Teacher Instructional Resources:

Electromagnetic Power! Students investigate the characteristics of electromagnetism and then use what they learn to plan and conduct an experiment on electromagnets.

Inspector Detector Challenge: Students use the engineering design process to design and build magnetic-field detectors, and use them to find hidden magnets. Parallels are drawn to real-world NASA missions and how NASA scientists use magnetic field data from planets and moons. The website has video clips, teaching suggestions, a student handout, and a link to the pdf of the Teacher's Guide for Mission: Solar System. The Inspector Detector challenge is a series of activities that form a unit in the Mission: Solar System collection. * NOTE: The Teacher's Guide does not contain the lesson plan. You will need to click on the Student Handout heading of the website to download the "Inspector Detector Challenge Leader's Notes". Or you can go to the Design Squad webpage

ACTIVITIES	**MATERIALS**

Grades 6-8 Physical Science Techbook Course: Interactions of Matter and Energy **Unit:** Electricity and Magnetism **Concept:**	
Session 1 (Approx. 1 day): Lesson Question: What is happening when you experience static electricity? Activate prior knowledge - Open the session by asking students if they have experienced static electricity. Allow students to describe their experiences, and encourage them to explain what they think is happening in these experiences. Start with these activities to get students thinking about static electricity. Teacher can divide class into small groups to complete these and then switch after they finish. "Don't Give Me Any Static" Activity and/or "Charge it Up" Activity.	**Scientific Notebooks, Scientific Explanation (SE) sheet, or other graphic organizer** **See below for activity materials**
"Static Electricity-Charge It Up" hands-on activity	**balloons; sm. soda bottles; combs; wool cloth**
"Don't Give Me Any Static" hands-on activity	**Salt; pepper; wool cloth; combs**
Session 2 (Approx 2 days): Lesson Questions: What causes static electricity?; How do statically charged objects interact? Students use the interactive glossary to define the following terms: **static electricity**, **electric field**, **negative charge**, **positive charge**, **friction** Students cite evidence as they read, watching videos, and add text to the Scientific Explanation (or two-column chart). Review with students the basics of atomic structure. Show students the next two videos: Static Electricity: Takes place at the Atomic Level (1:49), Charge (1:02). Ask students to add any new information to their charts. Quick Modeling hands-on activity (see below for materials and overview): "Build An Atom Activity" (Packet includes templates for many different elements but carbon might be an appropriate one to cover since carbon is present in all living things!)	**Scientific Notebooks, Scientific Explanation (SE) sheet, or other graphic organizer**
"Build An Atom" hands-on activity Use the 3 hole puncher to create colored circles and pick one color to be electrons, one to be protons, and one to be neutrons. Then tell your students which colors symbolize which subatomic particle and have them glue their circles to their Bohr atomic model.	**3 different color paper** (For carbon - you will need 6 circles of each color); **3 hole puncher;** **Glue sticks for each student**

Session 3-6 (approx. 2-3 day): Lesson Questions: What causes static electricity?; How do statically charged objects interact? Students cite evidence as they read, watch videos, and add text to the Scientific Explanation (or two-column chart). **Core Interactive Text: What Causes Static Electricity?, How do statically charged objects interact?** **Videos: Pith Ball Demonstration (1:50), Static Electricity(1:22)** (other videos available) Complete the Hands-On activity: "Positive or Negative?" (see below for materials and overview)	**Scientific Notebooks, Scientific Explanation (SE) sheet, or other graphic organizer**
"Positive or Negative?" activity Divide students into groups of three to five, depending on your materials supply and the number of students. Give each group a selection of materials of various types: fabrics, objects, plastic. Give each group a balloon. Explain to students that when they rub a balloon on their hair, the balloon always becomes negatively charged. Knowing this can help them determine if the charge on other objects is positive or negative. Students will first use friction to build up a charge on their objects. They will rub a balloon on their hair to create a negatively charged object. They will use the balloon to test the charge of the other objects. The balloon will attract positively charged objects, and repel negatively charged objects. Guide students in making a data table in which to record what they observe such as the one in the "Positive or Negative?" Teacher's Guide (can be found within Model Lesson Session 1-5 and scroll down to activity).	**Per class: Aluminum foil, packing peanuts, styrofoam, glass, Plastic wrap, fake fur, fleece, yarn, paper, nylon stockings, smooth rocks** **Per group: balloon**
Session 7-9 (Approx. 3 days): Lesson Question: How can objects release their electrostatic charges? Add the following vocabulary to student's vocab chart: cumulonimbus clouds and energy transfer Have students cite evidence as they read, watch videos, and add text to the Scientific Explanation (or two-column chart). ****Reading passages: Negative attitude (printable) and/or Atoms Family worksheet (printable)** ****Videos:Electric Transfer(2:58), Positive and Negative Charges: "Grounded" Electricity(1:25), Van De Graaf Generator(6:33)** Hands-On Activity choices (see below for materials and overviews): Design-Your-Own Static Charge Investigation, Energy Transfer Activity, Boardbuilder Activity- Exploring Lightning (Research the structure/function of lightning rods, video provided: "Exploring Lightning")	**Science Notebooks; "Negative Attitude" (printable); Atoms Family worksheet (printable)** **See below for activity materials**

Design-Your-Own Static Charge Investigation Students work in small groups to design their own static charges investigation using the given materials. Students write a testable question, form a hypothesis, design a procedure, carry out an investigation, and report the results to the class.	**Wool, plastic ruler, balloon, plastic grocery bag, salt, pepper, packing peanuts**
Energy Transfer Activity Students reproduce the activity outlined in Electric Transfer (2.58). Students record observations in the student worksheet and explain why the tack moves between two cans. (See Teacher's Guide on Discovery Education website)	**Student worksheet; 2 metal cans; metal tack; plastic wrap; wool**
Boardbuilder Activity- Exploring Lightning Students watch the video, Exploring Lightning (7:03) and then research the structure and function of lightning rods. (See Teacher's Guide on Discovery Education website) Students use Board Builder to illustrate the structure and function of lightning rods and present their finding to the class.	**Boardbuilder Tool; access to research tools**
Session 10 (Approx 1 day): Lesson Questions: What causes static electricity?; How do statically charged objects interact? Students complete the Brief Constructed Response or other assessment of your choosing.	**Brief Constructed Response worksheet; Science Notebook**
Concept: Electricity and Magnetism Relationship	
Session 1 (Approx. 1 day): Lesson Questions: What is a magnet? Explore magnetic field and when do magnets attract and repel each other? Activate prior knowledge - review what students have learned about magnetism by exploring the following questions in the activity "What Can Magnets Do?" Lesson 2 from the STC book, Magnets and Motors (see below for activity materials and overview)	**Science Notebook** **Cup; string; magnet**
Session 2-3 (Approx. 1-2 days): Lesson Questions: How are electricity and magnetism related?; How can wire, a magnet, and mechanical energy be used to generate electricity?; What factors affect the amount of electricity that a generator produces? Introduce vocabulary and define terms: magnet, magnetic field, repel, attract, north and south pole on a magnet, electromagnet.	**Science Notebook** **"A Shocking Discovery" printable** **See below for optional activity materials**

Ask students to begin a concept map with "Electromagnetism" in the center and the words "Electricity" and "Magnetism" connected to "electromagnetism" but below it. Students watch the video segments, Maglev: Magnetic Levitation (2:01) and Electromagnetism (4:31), adding information to their chart as needed. Students should also revise, correct or delete any inaccuracies in their chart. Optional Reading assignment - Have students read the reading passage, "A Shocking Discovery" Students should read only the first page-and-a-half, through the end of Faraday's diary. Students should not yet read the instructions for the "Activity: Generating Excitement" on the second page of the reading passage. Discuss students' responses to the question, then have them compare their ideas to the step-by-step instructions listed under the "Activity: Generating Excitement." Optional Hands-On Activity - Follow instructions for "Measuring Magnets" from Lesson 4 in STC book, Magnets and Motors	
"Measuring Magnets" Optional Activity Students learn about "fair tests" and in teams, conduct an experiment to find out how strong different combinations of magnets are. The graph the results of the experiment.	**Per student:** **Science Notebook;** **Activity Sheet,** "The Strengths of Different Combinations of Magnets" **Per group:** **4 magnets; 2 plastic cups; 1 craft stick; 1 jumbo paper clip; 25 washers**
Session 4 (Approx. 1-2 days): Lesson Questions: How are electricity and magnetism related?; How can wire, a magnet, and mechanical energy be used to generate electricity? Hands-on activity: Follow instructions for "Making Magnets With Electricity (Electromagnet)" from Lesson 8 in the STC book, Magnets and Motors	**Science Notebook; Battery; battery holder; alligator clip; black wire; switch; bolt**
Session 5-7 (Approx. 2-3 days): Lesson Questions: How can wire, a magnet, and mechanical energy be used to generate electricity?; What factors affect the amount of electricity that a generator produces? Students cite evidence as they read, watch videos, and add text to the Scientific Explanation, two-column chart, or other graphic organizer.	**Science Notebook** **Spinning Coil materials:** **2 alligator clips; battery; battery holder; switch; bolt; two copper wires; plastic cup; two**

Watch video segments, Electricity from Magnetism (1:45), Generators (1:16), Generating Electricity at a Power Plant(8:58). As they watch, students should list each factor mentioned that affects the amount of electricity produced by a generator. Discuss these factors as a class. Guide students to conclude that increasing the strength of the magnet increases the amount of electricity produced by the generator and that decreasing the strength of the magnet decreases the amount of electricity – a direct relationship. Hands-on activity: Follow instructions for "Building a Spinning Coil Motor" from Lesson 13 in the STC book, Magnets and Motors Optional Integrated Science Simulation: Students work in pairs to complete the Integrated Science Simulation Electricity. Students should begin using the worksheet, Student Activities: Group 1. This worksheet will guide students through a test in which they change the variables "How to Wire a Light Bulb" and "Wattage of a Light Bulb."	**rubber bands; sandpaper** **Optional Simulation: Printable Worksheet, "Student Activities: Group 1"**
Session 8-10 (Approx. 1 week): Lesson Questions: How can wire, a magnet, and mechanical energy be used to generate electricity?; What factors affect the amount of electricity that a generator produces?; What factors affect the amount of electricity that a generator produces? Hands-on activity: "Hidden Circuit Boxes" - See procedures in handout. To use as an assessment, questions can be based on the entire unit on electricity and magnetism. Students complete the Brief Constructed Response: Electricity and Magnetism in a Generator	**Brief Constructed Response worksheet or Science Notebook** **Circuit Box materials:** **Shoebox; brass fasteners; copper wire; alligator clips; battery; battery holder; light bulb; switch**