Fifth Grade Instructional Segment on Electricity and Magnetism

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<tr><th colspan="2">Student Science Performance</th></tr>
<tr><td>Grade Level - 5th</td><td rowspan="2">Title:
It's Shocking!</td></tr>
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Performance Expectations (Standard):

S5P2. Obtain, evaluate, and communicate information to investigate electricity.

a. Obtain and combine information from multiple sources to explain the difference between naturally occurring electricity (static) and human-harnessed electricity.
b. Design a complete, simple electric circuit, and explain all necessary components.
c. Plan and carry out investigations on common materials to determine if they are insulators or conductors of electricity.

S5P3. Obtain, evaluate, and communicate information about magnetism and its relationship to electricity.

a. Construct an argument based on experimental evidence to communicate the differences in function and purpose of an electromagnet and a magnet.
   (Clarification statement: Function is limited to understanding temporary and permanent magnetism.)
b. Plan and carry out an investigation to observe the interaction between a magnetic field and a magnetic object.
   (Clarification statement: The interaction should include placing materials of various types (wood, paper, glass, metal, and rocks) and thickness between the magnet and the magnetic object.)

Lesson Performance Expectations:

- Develop a model to describe phenomena like static electricity.
- Investigate collaboratively to produce data to serve as the basis for evidence using fair tests controlling variables and conducting numerous trials.
- Make observations and measurements to produce data for evidence to explain a phenomenon.
- Understand the need for caution and safety measures around current electricity.
- Design circuits using batteries, bulbs, wires and switches.
- Investigate conductors and insulators of electricity using various materials and a simple circuit.
- Make electromagnets and investigate how they are similar and different from permanent magnets.
- Use magnets to determine strength by using different materials that are attracted to magnets (magnetic objects).
- Use magnets to show attraction through various materials of different thicknesses such as wood, paper, glass, metal, and rocks.

Additional notes for student supports

Lesson Materials:

Static:

- Balloons (1 per student or 1 per pair)
- Two to four empty soda cans. (Tape over the sharp opening.)
- Stream of water from a water fountain or faucet.
- Tissue paper cut into small squares - preferably different colors
- It's Shocking! Lab Recording Sheet

Current:

- Regular 1.5-volt batteries (AA, C, D) (not rechargeable batteries)
- Copper wire (insulated and regular)
- Flashlight 1.5-volt bulbs (Higher volt bulbs will require more batteries.)
- Switches (Students can make one using a brass fastener and paper clip.)
- Electrical or masking tape
- Large scissors for cutting wire and stripping insulation
- Materials to use for testing conductivity such as coins, paper clips, plastic, paper, foil, string, keys, etc.
- Optional-- battery holders and bulb sockets
- Optional-- wire cutters
- Optional-- Battery tester
- Optional-- Buzzers and other battery-operated components such as energy balls

Magnetism:

- Permanent magnets such as horseshoe, bar, ceramic, etc.
- Materials for making an electromagnet: battery, iron or steel core such as a large nail or bolt, copper wire
- Materials to use for testing to see if the object is attracted to a magnet such as coins, paper clips, plastic, paper, foil, string, keys, etc.

Optional STEM Extension: Simple Homemade Robot Car

- A firm block of foam (we used a 6″ x 3″ x 2″ piece for $1.
- 4 bottle lids for wheels
- 2 straws
- 2 skewers
- a rubber band (it needs to be longer than the smallest dimension of your foam when pinched flat — 2″ in my case — so that when you stick it through the foam, it will protrude on both ends).
- 2 AAA battery holder
- 2 AAA batteries
- 1.5-3 V DC Motor
- Switch
- Insulated wire (22 gauge is suggested, about 4″ piece is needed.)
- 2 googly eyes (optional)
- a pipe cleaner for a mouth (optional)

Supplies & Tools:

- Scissors
- Wire strippers
- Needle nose pliers
- Hot glue gun
- Ruler
- Pencil
- Knife (for cutting eraser)
- Butter knife for cutting foam

Engaging	**Student Science Performance** **Phenomenon:** Pie Pans on a Van de Graaff Generator **Obtaining:** Why do the aluminum pie plates fly off of the Van de Graaff machine? Have students research to find out. *Teacher Notes: The Van de Graaff machine works much like dragging your feet on carpet and then touching someone and shocking them. The goal is for students to research why the plates fly off of the machine and find the scientific reason this occurs. Students will learn about electrons building up on an object, how and why they discharge quickly and how negative and positive (unlike) charges attract and 2 negative charges (alike) or 2 positive charges (alike) repel. Since electrons and protons have different charges, they are attracted to each other. In their research, students will learn that protons are positive, and electrons are negative. Protons repel or push away from other protons because like charges repel, and electrons push away from other electrons for the same reason. (Like charges repel, opposite charges attract.) These forces (attractions and repulsions) make static electricity.* **Evaluating** Students should work in groups of two or three per computer. In their Science Journals, students explain why the aluminum pie plates fly off of the Van de Graaff machine. Students can respond in their journal, or use the lab recording sheet. (Their responses should include keywords such as, electrons, protons, positive and negative charges, and attracting and repelling.) *Teacher Notes: It is important for students to write in science and to explain their thoughts on paper. A major practice of science is the communication of ideas and the results of inquiry—orally, in writing, with the use of tables, diagrams, graphs, and equations, and by engaging in extended discussions with scientific peers.* **Communicating** When students are finished with their journal entry, have the class discuss their findings. Allow time for the students to talk to each other and have conversations that you are not leading. Let them question each other. Let them explain to each other. It is even ok to let them disagree and argue based on experience and evidence. Ask the students questions to get them thinking, “What if plastic pie plates were used instead? Paper plates? Would plastic or paper plates have the same effect? Why or why not? **Part B:** ***Connecting Static Electricity to Current Electricity*** *Teacher Notes: Current electricity is the form of electricity which makes all of our electronic gizmos possible. This form of electricity exists when charges are able to constantly flow. As opposed to static electricity where charges gather and remain at rest, current electricity is dynamic, charges are always on the move.*

	In order to flow, current electricity requires a <u>circuit</u>: a closed, never-ending loop of conductive material. A circuit could be as simple as a conductive wire connected end-to-end, but useful circuits usually contain a mix of wire and other components which control the flow of electricity. Phenomenon: Show students a picture of a light bulb and ask them why does a light come on when you flip the switch in our classroom or in your home? [Picture of a Light Bulb] Have students make a list of questions they have about static electricity compared to current electricity and how it works. Sample questions might include ● Why is electricity dangerous? ● What happens when there is a storm that causes the electricity to not work? ● How do you feel when the electricity is not available? Why are we so connected to current electricity? **Part C** ***Connecting Current Electricity to Electromagnets and how they are similar to and different from permanent magnets*** **Phenomenon:** Machines using electromagnets to pick up metal and drop it into a truck bed. [Picture of an Electromagnet at Work] *Teacher Notes: Students will not have magnets in the third-grade curriculum beginning in the 2017-18 school year. In first grade students had an introduction to magnets including how they are used in everyday life, how magnets attract and repel each other and attract some objects.* *Safety alert: Do not allow students to place magnets near any electronic equipment or cards with magnetic strips. Make the rule that if it has an on/off switch, no magnets are allowed. Strong magnets will damage computers, monitors, cell phones, credit cards, etc.* Ask students where they have seen magnets used. Provide small groups with permanent magnets to allow them to practice using them to attract and repel other magnets. After free exploration, have them design a test to check the strength of their magnets separately and together. One way is to see how many paper clips a magnet will pick up and then how many paper clips two magnets together will pick up. Have them design a worksheet to collect their data and write conclusions for their findings.

	Another way they can test the strength of a magnet is by how close the magnet gets to an object before it attracts the object. Have students use a ruler to measure the distance the magnet can attract or repel another magnet or attract magnetic objects. Then they can use the same materials you provided for the investigation on objects that conduct or insulate electricity to see which ones are attracted to a magnet (magnetic objects) such as paper clips, foil, coins, keys, paper, string, pencils, etc. Ask: Are the same objects that are conductors of electricity also magnetic objects? What are the differences?
Exploring	**Phenomenon:** Students will experience static electricity at work! **Obtaining** Students will perform several experiments to learn about static electricity and to observe how static electricity works and how positive and negative charges behave. (You can set up centers for students to rotate through or students can investigate as a class.) Teachers: Click on the title of each experiment for printable directions. **Hair Raising** Procedures: ● Rub the inflated balloon back and forth on your clothes or piece of wool really fast. This will give the balloon a charge. ● Then hold the balloon close to your hair without touching it. Slowly move the balloon away from your hair. (Clean hair without hair products works best.) ● The charged balloon should attract your hair and cause your hair to move toward the balloon. **Can Rolling** Procedures: ● Place two or more soda cans on their side on the floor or other flat surface. ● Rub the balloon back and forth on your hair or a piece of wool or felt really fast to charge the balloon. ● Hold the "charged" balloon close to the can without actually touching it and start walking backwards. ● The can will roll towards you. ● Keep moving back until the can no longer follows the balloon. ● Measure how far the balloon traveled with a yard or meter stick.

	Bending Stream Procedures: ● Turn on the faucet and slowly turn down the water until you have a thin stream of water flowing. ● Rub the inflated balloon back and forth on your hair or a piece of wool or felt really fast to charge the balloon. ● Hold the "charged" balloon close to the stream of water without actually touching it and slowly pull away the balloon. The stream of water should bend towards the balloon. **Jumping Tissue** Procedures: ● Cut tissue paper into small (1 inch) pieces. ● Place tissue pieces on a flat surface. ● Rub the charged balloon back and forth on your hair or piece of felt or wool really fast to charge the balloon. ● Hold the "charged" balloon close to the tissue pieces without actually touching them. ● Observe what happens to the tissue. **Evaluating** Ask the students what they observed or observed in each experiment. Why is this happening? Instead of explaining, have them research to find out the scientific explanation of these observations/results. *Teacher Notes: Static electricity is the buildup of electrons (negative charges) or non-moving electricity. When you rub the balloon through your hair, electrons build up on the surface of the balloon. The electrons have the power to pull very light objects (with positive charge) toward them.* **Communicating** Students will have a class discussion to share their findings. **Part B:** Ask: What other objects besides a brass fastener and paper clip allow electricity to continue to flow. Provide several objects for students to test such as plastic tabs, keys, coins, string, foil, pencils, etc. Ask them how they could introduce these objects to their simple circuit design in place of where the switch was to see if it will continue to light the bulb. Challenge small groups of students to plan a step by step list of how they will set up the investigation and list what materials they would need to conduct this investigation. Have them sketch their investigation design. When they have completed their plan, give them components they included in their plan for making a simple circuit such as bulb, battery, copper wires and materials to test such as paper, string, pencils, tacks, coins, etc.

	Students can make a T chart to list objects that are conductors (conducts electricity) and objects that are insulators (blocks electricity). **Part C** Ask students if magnets can attract other objects through materials such as wood, paper, cardboard, glass, plastic, metal, rocks, etc. Students will put one magnet on top of their desk or table and the other magnet under to see if they can move one with the other. Ask them if there are materials that do not allow the magnet to pull or push through them. Have them measure the thickness of the material to see if there is a correlation to that and the magnet's attraction to another magnet or magnetic object. Students can use different thicknesses of pages in a textbook to measure strength of attraction of the magnet. Challenge them to find out the number of pages through which the magnet could attract. Have them record their results and conclude their findings.
Explaining	**Student Science Performance** **Evaluating:** Students will sketch or write about static electricity to explain how electrons behave. **Communicating** Students will use the information they used in the experiments, will give examples of static electricity, and will explain how electrons build up and then are discharged. Students will also explain how positive and negative charges behave with each other--like charges repel and unlike charges attract. They use the results of the experiments as examples to explain this phenomenon. **Plan and carry out an investigation** Have students make a list of questions they have after completing the experiments they experienced in the labs on static electricity. Have them share their questions in small groups and determine whether the questions are answered by research or by investigation. Post chart paper and have students write up the investigation questions. Have groups: 1. choose a question to investigate. 2. list the materials they will need. 3. steps to find out the answer to their chosen question. Have them 4. plan the data they will collect to show evidence that they answered the question. 5. plan how they will share that data. Provide the student groups time to complete their investigations and share their findings.

	Part B: Have students design a circuit that would turn on the light bulb in the classroom. Students should use relevant vocabulary to describe the design. Have the students explain the choice of materials and placement of materials. **Part C:** Have students discuss in pairs why magnets work to pick up certain objects but not others. Have students plan an investigation to use magnets on different objects to see what patters arise in the use of magnets. *Teacher note: provide the students with different materials to try magnets on within the classroom. It can be things like chairs- metal vs plastic, wooden popsicle sticks, pens, pencils, nails, office supplies. This will cut down on students running around the classroom and trying magnets on different objects. Be sure to put away all electronics to keep the magnets from getting to close to them.* Have students formulate an argument about why magnets work on some things and not others. Discuss as a class what the magnets worked on and what they did not work on.
Elaborating	**Obtaining** Let's dig deeper. The amount of humidity (or moisture) in the air can affect the results of the Static Electricity experiments. Ask the students: What if it was more humid outside? What if it were a less humid day? Would the same results have occurred? What would have been different? The students can test this by keeping track of the humidity and trying the experiments (Hair Raising and the Stream Bending) on different days. **Communicating**. Moisture makes the air more conductive, so charges pass more easily between objects. This means less buildup occurs, resulting in less static electricity on humid days. Ask the students if they notice that they get shocked more in the winter. They may recall being shocked by touching the handle of a car or a doorknob on cold/dry days. Build on this prior knowledge. **Evaluate** Have a class discussion with your students. What are their responses? Are they showing understanding of electrons and how static electricity occurs? **Part B:** Have students work with the phet circuit (PhET Interactive Simulations, University of Colorado Boulder; https://phet.colorado.edu) construction simulator to build a working circuit.

	Have the students record the steps and draw what they did in the simulation **Part C** How are static electricity and magnetic fields alike? How are they different? *Both attract and repel, but static electricity has positive and negative charges and magnets have north and south poles.* We can use electricity to make a temporary magnet. Provide students with a battery, large nail or bolt, and a length of copper wire. Tell them that the number of coils neatly wrapped around the metal core can determine the strength of the electromagnet. A video: How to Make an Electromagnet Challenge small groups of students to make an electromagnet and record the number of coils around the metal core. Give them paper clips to use to test the strength of the electromagnet. Have them investigate how the difference in the number of coils affects the strength of the magnet and share their data with other groups. Ask: What happens when the wire is not touching one of the battery ends? *The nail/bolt is no longer magnetized.* Lead students to understand that the difference between an electromagnet and a permanent magnet is the ability to turn the magnet on and off. Refer back to the phenomenon picture of the crane picking up metal objects: Electromagnet at Work
Evaluating	**Evaluate and Communicate:** *Teacher Notes: By the end of the lesson, students should have a thorough understanding of charges. Since electrons and protons have different charges, they are attracted to each other. However, protons repel, or push away from other protons, and electrons push away from other electrons. (Like charges repel, opposite charges attract.) These forces or attractions and repulsions make static electricity. Students might also say that static electricity is created when two objects are rubbed together, causing an object to give up or gain electrons. This can happen by putting on a sweater, walking on a carpet, or getting out of a car. The imbalance of charges on objects results in a sudden discharge of electrons which is called static electricity. Their journal entries and lab sheet should reflect this knowledge.* Students will answer a question in their Science Journal and will be assessed on the thoroughness of their answer. Their answer should show understanding of static electricity, the buildup of electrons, the sudden discharge of electrons, and negative and positive charges attracting.

	Assess students' understanding by evaluating their responses to the questions on the It's Shocking! Lab Recording Sheet. Though answers will vary, students should explain that static electricity is the buildup of electrons and the sudden discharge of those electrons. Students: Explain why a charged balloon sticks to a wall or why a stream of water will bend towards a charged balloon. Use the information you learned in the lesson and use science language to show understanding. **Part B:** Have students sketch a diagram, label the parts of a simple circuit and write step by step instructions on how to make a simple circuit. Ask them to write a rule for how to know if an object could conduct electricity. Have students evaluate and revise their previous model. **Part C** Ask students to construct an argument about the function and differences between permanent and temporary magnets. Students write a claim about when a permanent magnet is better and when a temporary magnet is better. (function) Have them include their reasoning and use the evidence they gained from working with both permanent and temporary magnets. Have students make a T chart with the heading Permanent Magnet on one side and Temporary Magnet (Electromagnet) on the other. Have them list ways they are alike and ways they are different. Instruct them to conclude when permanent magnets work better and when temporary magnets work better.
SEP, CCC, DCI	**Science Essentials**
Science and Engineering Practices	• Planning and carrying out investigations • Constructing explanations and designing solutions • Engaging in argument from evidence • Obtaining, evaluating, and communicating information
Crosscutting Concepts	• Cause and effect • Energy and Matter • Stability and Change
Disciplinary Core Ideas	From A Framework for K-12 Science Education: • PS2.B: TYPES OF INTERACTIONS • PS3.B: CONSERVATION OF ENERGY AND ENERGY TRANSFER • PS3.C: RELATIONSHIP BETWEEN ENERGY AND FORCES

<u>**Additional Supports for struggling learners:**</u> **The following supports are suggestions for this lesson and are not the only options to support students in the classroom. These supports target students that struggle with science material, this lesson or a previous lesson. These are generalized supports and do not take the place of IEP accommodations as required by each student's Individualized Education Program.**		
General supports for the following categories:		
<u>Reading:</u> 1. Provide reading support by reading aloud or doing partner reads 2. Have the teacher model what they are thinking when reading the text 3. Annotate the text with students so that they may refer to it as they work through the lab	<u>Writing:</u> 1. The teacher can provide a sentence starter for the students. 2. The teacher can give students an audience to write to (i.e. Write a letter to your sibling explaining this topic). 3. The teacher can provide constructive feedback during the writing process to help students understand the expectations.	<u>Math:</u> 1. Provide calculators as needed.
Supports for this specific lesson if needed:		
Performance expectations for instruction: 1. The teacher should provide information to students in various formats to reach as many students as possible. 2. The students should be given adequate time to complete each part of the lesson. 3. The students should be allowed to express their knowledge in various formats. 4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material.		
Engaging: 1. The teacher should use intentional grouping to partner students. Best practice is using data to form groups. 2. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include drawing, writing or verbally explaining their knowledge. 3. The teacher should have clear guidelines laid out for discussion. This should help lessen anxiety for some students during the discussion. 4. The teacher should have clear rules for when students disagree, how students should interact and when to take a break from the disagreement. Disagreements happen in		

science but sometimes the students need to know exactly what will occur if/when they disagree.

5. The teacher may need to help students see the connections between the topics in this lesson. Remember that the teacher can skip around as they see fit within the lesson.
6. The teacher can show the image of a light bulb, but the teacher can, also, go flip the classroom lights to help students visualize what the teacher is talking about.
7. Recording the questions on the board while students are generating the questions will give some students something to refresh their memory.
8. The teacher should put away any electronics that they can prior to turning students loose with magnets. Then give the students clear guidelines of where the magnets can go and emphasizing that the magnets cannot go anywhere that was not mentioned.
9. The teacher should provide the students an organizer for the students to record their observations on as they use the magnets around the classroom.
10. The students can use the bottom of the organizer to draw conclusions about using magnets.

Exploring:

1. The teacher should provide students with an organizer to record data.
2. The teacher should have a set of resources to use to find scientific information about their observations.
3. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include drawing, writing or verbally explaining their knowledge.
4. The teacher should provide a format for the students to record observations and plans on.
5. The teacher should be prepared to repeat directions as needed.
6. The teacher should give the students a T-chart to record their insulators and conductors.

Explaining:

1. The teacher should provide students an organizer to use to plan their investigation, record data and draw conclusions.
2. Students may need additional time to complete all activities within the explain section.
3. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include drawing, writing or verbally explaining their knowledge.

Elaborating:

1. The teacher should provide an organizer for students to keep up with data over several days.
2. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include drawing, writing or verbally explaining their knowledge.
3. Students may need additional time to complete the activities.
4. The teacher should remind students to try having the wire not touch one end of the battery and record the results.

Evaluating:

1. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include drawing, writing or verbally explaining their knowledge.
2. Students may need additional time.

It's Shocking!

NAME: ______________________________ **DATE**: _________________

Experiment	Describe what you observed and explain why it happened.
Hair Raising	
Can Rolling	
Bending Stream	
Jumping Tissue	

Explaining what you have learned:

1. What happens when two positively charged objects come into contact?

____

____

2. What happens when one negative and one positive charged object come into contact?

____

____

3. When your hair is pulled up towards the balloon is your hair or the balloon positively charged? How do you know?

____

____

4. How can an object become charged?

____

____

5. When have you experienced static electricity? Explain when and how this happened.

____

____

6. Is Static Electricity usable electricity? Why or why not?

____

____

Return to Instructional Segment

HAIR RAISING

- Blow up your balloon.
- Rub the balloon back and forth on your hair or on wool really fast.
- Hold the charged balloon to your hair and slowly bring the balloon away from your hair.

Return to Instructional Segment

CAN ROLLING

- Place the can on a flat surface.
- Rub the balloon back and forth on your hair or wool really fast.
- Hold the balloon in front of the can without touching it and walk backwards slowly.
- Keep going to see how far you can pull the can with the charged balloon.
- Measure and record how far the can moved.
- What could you do to change that distance?

Return to Instructional Segment

Bending Stream

- Blow up your balloon.
- Turn on the faucet slowly until you have a thin stream of water flowing.
- Rub the balloon back and forth on your hair or wool really fast.
- Hold the “charged” balloon close to the stream of water without actually touching it and slowly pull the balloon away.

Return to Instructional Segment

Jumping Tissue

- Blow up your balloon (if it's not blown up already).
- Rub the balloon back and forth on your hair or wool really fast.
- Hold the "charged" balloon close to the tissue paper and watch what happens.
- See how far away you can place the balloon but still be able to pick up the tissue.
- Try "charging" the balloon less/more. Do you notice a difference?

Return to Instructional Segment