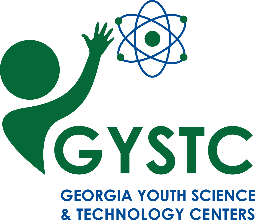
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**In-Class Field Trip:**

**Electromagnets**

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| **Estimated Time: 45 minutes** | |
| **GSE Standard and Element(s):**  **S8P5. Obtain, evaluate, and communicate information about gravity, electricity, and magnetism as major forces acting in nature.**  c. Plan and carry out investigations to identify the factors (e.g., distance between objects, magnetic force produced by an electromagnet with varying number of wire turns, varying number or size of dry cells, and varying size of iron core) that affect the strength of electric and magnetic forces. (Clarification statement: Including, but not limited to, generators or motors.) | |
| **Science and Engineering Practices:**  Asking Questions and Defining Problems  Ask questions 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. | **Disciplinary Core Idea:**  PS2.B: Types of Interactions  Electric 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. |
| **Crosscutting Concepts:**  Cause and Effect  Cause and effect relationships may be used to predict phenomena in natural or designed systems. |
| **Authentic Scenario (Phenomena):**  Show students a video of a junkyard using an electromagnetic:  <https://www.youtube.com/watch?v=2nY2i_L68jA> | **Vocabulary:**   * electromagnet * poles * repel * attract * magnetic field * permanent magnet * induced/temporary magnet |
| **Guiding Questions:**  How do the changes in the construction of the electromagnet affect the resulting electromagnetic force? |
| **Materials Needed:**   * Electromagnet Data Sheet * 1.5 V batteries, 2 per group * 30-gauge enameled copper wire * 4-inch bolt (¼ inch diameter), one per group * large plastic straw (¼ inch diameter), one per group * wooden dowel (¼ inch diameter), one per group * large paperclips * tape | **Safety Considerations:**   * Students need to be cautious of the wires around the core – they get hot from the electric current. |
| **Technology Integration:**   * Device with Internet access for JavaLab: <https://javalab.org/en/category/electricity_en/electromagnetism_en/> |
| **Literacy Connections:**   * *The Spinning Magnet: The Electromagnetic Force that Created the Modern World – and Could Destroy It* by Alanna Mitchell | |

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| **5E Stage** | **Student Activities**  How will students engage actively in the three dimensions throughout the lesson?  **Teacher Activities**  How will the teacher facilitate and monitor student learning? |
| **Engage** | Begin by showing the students a video of a junkyard using an electromagnetic:  <https://www.youtube.com/watch?v=2nY2i_L68jA>  Ask, “What did you see happening? How do you think that works?”  Show students a small bar magnet and the Hovering Globe suspended by electromagnets. Ask, “What is the difference between these two magnetic objects?”  Explain that magnetism can be found in natural materials as well as a tool caused by an electric current. Students will recognize that natural magnets are not as strong as electromagnets and the use of natural magnets is not as adaptable as electromagnets. |
| **Explore** | Before the students begin constructing their electromagnets, ask them to hypothesize how changing components of their electromagnetic will affect the strength of the electromagnetic (i.e., the core material, the number of coils, and the number of batteries). Using the far right column on the Electromagnet Data Sheet, students should predict how the changes are going to affect the resulting strength of the electromagnet (the number of large paperclips picked up).  Directions:   1. Place the students in groups of 3-4 and hand out the materials for the investigation. 2. For the first trial, students should construct an electromagnet with one 1.5-volt battery and 5 coils of wire wrapped tightly around a bolt core. Record the strength of the electromagnet by writing down the number of large paper clips picked up on the Electromagnet Data Sheet. 3. Students should repeat the investigation with the air core (straw) and wood core (dowel). Record the results. 4. For the second and third trials, the students will increase the number of coils by 10 each time. Record the results. 5. In the next section, the students will repeat the investigation with an additional battery and record the results. |
| **Explain** | Ask, “Was your hypothesis supported by your observations during your investigation?”  Lead a discussion on the properties of electromagnets and how the number of coils of tightly wrapped wire about various cores changed the induced magnetic field. Also, discuss how the current caused by the different numbers of batteries also affected the induced magnetic field. |
| **Elaborate** | Students can explore more simulations with electromagnets at JavaLab: <https://javalab.org/en/category/electricity_en/electromagnetism_en/> |
| **Evaluate** | * Using the C-E-R Model (Claim, Evidence, Reasoning), ask students to answer the following question using evidence from their investigation: *Three students build electromagnets using three 1.5-volt batteries and 25 coils of wire wrapped tightly around a core. Student A uses an air core, Student B uses a bolt core, and Student C uses a wood core. Which electromagnet will be the strongest and why?* * Post-Test |

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