**Eighth Grade Instructional Segment on Force Fields**

Forces at work all around us are the driving *force* in engaging students in understanding how force fields exist between objects, even when they are not in direct contact.

**Student Science Performance**

| **Grade 8** | **Title:** Seeing is Believing |
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| **Topic – Forces** | |

**GSE Performance Expectation**

**S8P5. Obtain, evaluate, and communicate information about gravity, electricity, and magnetism as major forces acting in nature.**

a. Construct an argument using evidence to support the claim that fields (i.e., magnetic fields, gravitational fields, and electric fields) exist between objects exerting forces on each other even when the objects are not in contact.

b. Plan and carry out investigations that demonstrate the distribution of charge in conductors and insulators.
(*Clarification statement*: Include conduction, induction, and friction.)

c. Plan and carry out investigations to identify the factors (e.g., distance between objects, magnet 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.)

Additional notes on student supports

**Lesson Performance Expectations:**

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| Engage | ***Obtaining***<br>**Phenomenon: Forces can act through fields without direct contact.**<br>Classroom demonstration: consider showing the following demonstrations to show students forces acting at a distance.<br>• Ball drop; different types/sizes at varying heights<br>• Magnetic forces acting on objects without contact (and non-magnetic objects to contrast)<br>• Compass and current-carrying wire; compass will move without contact with wire<br><br>Although they may have already seen these interactions, they may not have constructed arguments/claims about the respective fields. The purpose of the demonstration is to allow students to begin constructing arguments about field forces. Students can complete a claim-evidence-reasoning sheet as they begin this activity. |
| Explore | ***Obtaining*** Through exploratory stations students gather information about what various objects will do based on the presence of a force field. In addition, students explore charge distribution in conductors and insulators. Students describe observations for each station.<br><br>Suggestions for Magnetic Force Stations:<br>1. The Exploratorium: Magnetic Fruit<br>2. The Exploratorium: Eddy Currents<br><br>Suggestions for Electric Force Stations:<br>1. The Exploratorium: Soda Can Race |

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| | 2. Magical Mylar: with a piece of pvc pipe that is charged by rubbing on fur or hair, thin strips of mylar (like tinsel) will float above pipe; there are multiple online examples.<br><br>Suggestion for Electromagnetic Force Stations:<br>1. The Exploratorium: Stripped Down Motor<br>2. Other simple motor setups can be found online.<br><br>Suggestions for Gravitational Force Stations:<br>1. Balancing Clown: students balance object with coins; online templates can be found of activity<br>2. Balancing Nails Challenge: students must balance nails on a single nail that is in wood; multiple online sources and videos can be found of setup.<br><br>Suggestions for Charge Distribution Stations:<br>1. Van De Graaff generator showing charge build up; some possible investigations: floating aluminum pie pans, bubbles will show attraction/repulsion, crisp-rice cereal can move in electric field<br>2. Electrostatic investigation (with kits or other resources)<br>The intent of these stations is that students are determining what/how to investigate in order to show charge distribution in conductors and insulators.<br><br>*Teacher Notes: Allow students' ample opportunity to explore on their own. As students show a need for support/guidance, encourage discovery and risk taking. Some students will benefit from using this organizer to record their observations of force stations. From sample organizer students would only be working in Column 1: Initial Model for----. In addition, a separate organizer would need to be used for each force station. A sample organizer for the charge distribution station is provided.*<br><br>***Evaluating/Communicating*** Students provide initial explanations for each station.<br><br>*Teacher Notes: Remind students of purpose in learning: force fields. Encourage students to think about what they know about these forces as they describe/draw models of their initial explanations and construct arguments about the field forces. It is important to discuss with students that although they experienced "static electricity," it was not created during the investigation; students generated a charge-imbalance.* |
| Explain | ***Obtaining*** Students obtain information about each of the forces/force fields and charge distribution represented in the various stations.<br><br>*Teacher Notes: Students can obtain information as part of teacher facilitated lecture, self-directed research, or teacher facilitated research. Suggestions for teacher facilitated research are provided below. Information could be added to force station organizers.*<br><br>Suggestions for Magnetic Force Informational Text:<br>• CK-12 Magnetic Force |

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| | Suggestions for Electric Force Informational Text:<br>• CK-12 Electric Force<br>• CK-12 Static Electricity: CK-12 Electric Force<br><br>Suggestion for Electric Force Simulations:<br>• PhET: Balloons and Static Electricity (Attribution: PhET Interactive Simulations, University of Colorado Boulder; https://phet.colorado.edu )<br><br>Suggestions for Gravitational Force Informational Text:<br>• CK-12 Gravity<br><br>Suggestions for strength of electric and magnetic forces investigations:<br>• For electromagnetic forces, have students revisit the simple motor lab station (or build their own). They are charged with investigating the factors that influence the force strength, this could also be done by using simple electromagnets as well. Their findings will be recorded in a summary organizer.<br>• For magnetic forces, students could use the PhET simulation Magnets and Electromagnets.<br>• For generators: PhET Generator.<br>(Attribution: PhET Interactive Simulations, University of Colorado Boulder; https://phet.colorado.edu)<br><br>*Teacher Notes: Some students may benefit from the use of an organizer to record obtained information. Have students record information from two different resources in the second column. Students draw revised models in the third column of the organizer.*<br><br>***Evaluating/Communicating***<br>Students revise their previous explanations for the force station outcomes. |
| Elaborate | ***Phenomenon – Aurora Borealis: science fiction or real?***<br>   <br><br>***Communicating*** Students share what they observe and their initial thoughts to what may cause the sky to look this way. Students prompted to conjecture whether this is real or science fiction. Students record their initial claims.<br>*Teacher Notes**:** Revisit the theme/title of the instructional segment "Seeing is Believing" through discussion. Guiding Questions: Have you ever seen a night sky like this? Based on the photos, where do you think this photograph was taken? Given that the theme of this* |

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| | *instructional segment is forces, is there a force you think could cause this night sky? Explain why you think this.*<br><br>*Teacher Notes: Provide a CER framework for students to record initial claims.*<br><br>***Obtaining*** Students obtain information by conducting research about aurora borealis. Students identify the criteria and constraints for aurora borealis to be observed, and record reasoning that will support their claims.<br><br>***Evaluating*** Students compare obtained information to their initial claim. Students revise claim if deemed inaccurate. Students use the models and informational text from the resources as evidence to construct an argument to defend their claim.<br><br>***Communicating*** Students write a final argument supported with evidence (to include models) and reasoning. |
| Evaluate | **Assessment of Student Learning**<br>Students summarize facts associated with scientific principles for: forces that act at a distance, charge distribution in conductors and insulators, and factors that influence field force strength. Students then provided new contexts for arguing their understandings of GSE.<br><br>Suggested Organizer for Summary<br><br>Riddle Me This – Students argue, and counter argue plausibility of at least two of the three given contexts. |
| *SEP, CCC, & DCI Featured in Lesson* | **Science Essentials** |
| **Science Practices** | • Planning and carrying out investigations<br>• Constructing arguments<br>• Obtain, evaluate, and communicate information |
| **Crosscutting Concepts** | • Matter and Energy<br>• Cause and Effect<br>• Structure and Function |
| **Disciplinary Core Ideas** | From *A Framework for K-12 Science Education*:<br>• **PS2.B: TYPES OF INTERACTIONS**<br>• **PS3.C: RELATIONSHIP BETWEEN ENERGY AND FORCES** |

**Additional Supports for struggling learners:**

**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:**

| Reading: | Writing: | Math: |
|---|---|---|
| 1. Provide reading support by reading aloud or doing partner reads<br>2. Have the teacher model what they are thinking when reading the text<br>3. Annotate the text with students so that they may refer to it as they work through the lab | 1. The teacher can provide a sentence starter for the students.<br>2. The teacher can give students an audience to write to (i.e. Write a letter to your sibling explaining this topic).<br>3. The teacher can provide constructive feedback during the writing process to help students understand the expectations. | 1. Provide calculators as needed.<br>2. Provide graph paper 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.

**Engage:**

1. The teacher may need to show the demo more than once to help struggling students identify the most important pieces.
2. Also, doing multiple demos will allow students to see the topic from different perspectives.

3. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This can be in writing, drawing or designing a play.
4. Students may need assistance formulating a claim. The teacher can provide an example from a different topic to model the steps of writing a scientific claim.

**Exploring:**

1. The teacher should provide an organizer for students to record their observations on as they move through the station activities.
2. Struggling students may need to have directions repeated to them multiple times.
3. This lesson is very self-guided for the students. Some students will benefit from a more structured exploration, though, and for those students the teacher can provide a set amount of time at each station and a set order of, to move through.
4. 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 designing a play.

**Explaining:**

1. Struggling readers may need assistance with reading the informational texts. This assistance could be provided by the teacher leading a read aloud, using a text to speech program or using videos instead of the informational texts.
2. The teacher should provide students an organizer to record their thoughts and observations as they read and move through the simulations.
3. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This can be in writing, drawing or designing a play.
4. Struggling students may need additional time to revise their explanations.

**Elaborating:**

1. The teacher can add some anonymity for the students sharing their ideas by giving them sticky notes and having the students add them to the board. Giving the students an opportunity to share without having to speak out in class may increase struggling students' participation.
2. The discussion questions should be provided to students in advance to give students the opportunity to formulate their responses in advance. This will help students feel more comfortable participating in a discussion.
3. The teacher should provide warning to struggling students that they may be called on to add to the discussion. The teacher could choose to give the student the topic that will be asked about, as well, if it will make the students more comfortable.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This can be in writing, drawing or designing a play.
5. Struggling students may not have formulated and defended a claim in the past. The teacher can model making a claim and defending it to the class to help students understand the requirements of this assignment.

**Evaluating:**

1. The students may need additional time to formulate the argument and counter argument.
2. Students should be allowed to express their knowledge in various ways. This could include writing their argument, drawing a cartoon, designing a play or making a power point.
3. Struggling students benefit from explicit explanations of what is expected. Graphic organizers, rubrics and other organizers to help students see the big picture of the requirements for this design project should be provided.

Return to Instructional Segment

**Claim-Evidence-Reasoning**

| Guiding Question: How can a force act on an object without touching it? | |
|---|---|
| Initial Claim | |
| Evidence | |
| Reasoning | |

Return to Instructional Segment

**Force Station Organizer**

| **Initial Model for_____ Force Station** | **Obtained Information** | **Revised Model** (*include labels*) |
|---|---|---|
| | From Resource 1: | |
| | From Resource 2: | |

Return to Instructional Segment

**Charge Distribution Organizer**

<table>
<tr><td colspan="3">For each experiment station, answer the following questions:</td></tr>
<tr><td rowspan="2">Experiment Diagram:</td><td rowspan="2">What happened in the investigation?</td><td>How were charged particles organized in the investigation?</td></tr>
<tr><td>Draw a model of the charge behavior:</td></tr>
<tr><td rowspan="2">Experiment Diagram:</td><td rowspan="2">What happened in the investigation?</td><td>How were charged particles organized in the investigation?</td></tr>
<tr><td>Draw a model of the charge behavior:</td></tr>
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Return to Instructional Segment

**Aurora Borealis Claim-Evidence-Reasoning**

| **Question:**<br>**Aurora Borealis: Real or Science Fiction?** | |
|---|---|
| **Initial Claim:** | |
| **Supporting Evidence** | **Connected Reasoning** |
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| | |
| **Revised Claim:** | |

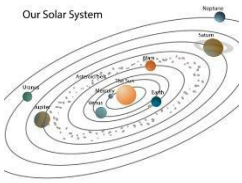
Return to Instructional Segment

**Summary Organizer**

| | Gravitational | Electric | Magnetic |
|---|---|---|---|
| Attract or Repel? | | | |
| Force Field Looks Like…. | | | |
| Factors that Affect Strength | | | |
| Related Terms | | | |
| Evidence of its Work | | | |

Return to Instructional Segment

**Riddle Me This**

| Scenario | Supporting Evidence | Counter Evidence | Your Claim |
|---|---|---|---|
|  An orbiting satellite falls back to Earth. | | | |
|   There is no gravity in outer space. | | | |
|  Two balloons can be stuck to the wall and repel each other. | | | |

Return to Instructional Segment