Formative Assessment Exemplar - 7.1.4

Introduction:

The following formative assessment exemplar was created by a team of Utah educators to be used as a resource in the classroom. It was reviewed for appropriateness by a Bias and Sensitivity/Special Education team and by state science leaders. While no assessment is perfect, it is intended to be used as a formative tool that enables teachers to obtain evidence of student learning, identify gaps in that learning, and adjust instruction for all three dimensions (i.e., Science and Engineering Practices, Crosscutting Concepts, Disciplinary Core Ideas) included in a specific Science and Engineering Education (SEEd) Standard.

In order to fully assess students' understanding of all three dimensions of a SEEd standard, the assessment is written in a format called a cluster. Each cluster starts with a phenomenon, provides a task statement, necessary supporting information, and a sequenced list of questions using the gather, reason, and communicate model (Moulding et al., 2021) as a way to scaffold student sensemaking. The phenomenon used in an assessment exemplar is an analogous phenomenon (one that should not have been taught during instruction) to assess how well students can transfer and apply their learning in a novel situation. The cluster provides an example of the expected rigor of student learning for all three dimensions of a specific standard. In order to serve this purpose, this assessment is NOT INTENDED TO BE USED AS A LESSON FOR STUDENTS.

Because this assessment exemplar is a resource, teachers can choose to use it however they want for formative assessment purposes. It can be adjusted and formatted to fit a teacher's instructional needs. For example, teachers can choose to delete questions, add questions, edit questions, or break the tasks into smaller segments to be given to students over multiple days.

General Format:

Each formative assessment exemplar contains the following components:

1. Teacher Facing Information: This provides teachers with the full cluster as well as additional information including the question types, alignment to three dimensions, and answer key. Additionally, an example of a proficient student answer and a proficiency scale for all three dimensions are included to support the evaluation of the last item of the assessment.
2. Students Facing Assessment: This is what the student may see. It is in a form that can be printed or uploaded to a learning platform. (Exception: Questions including simulations will need technology to utilize during assessment.)

Accommodation Considerations:

Teachers should consider possible common ways to provide accommodations for students with disabilities, English language learners, students with diverse needs or students from different cultural backgrounds. For example, these accommodations may include: Providing academic language supports, presenting sentence stems, or reading aloud to students. All students should be allowed access to a dictionary.

References:

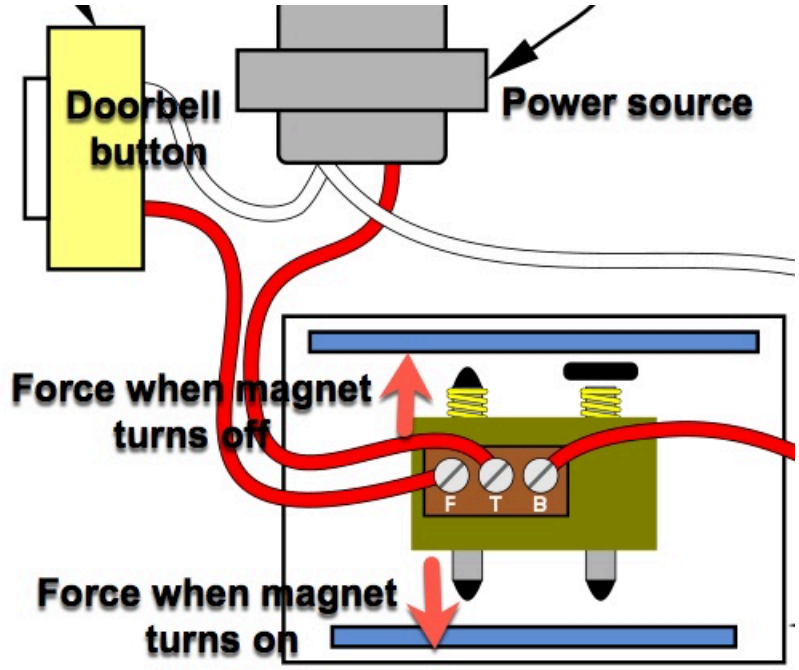
Moulding, B., Huff, K., & Van der Veen, W. (2021). *Engaging Students in Science Investigation Using GRC*. Ogden, UT: ELM Tree Publishing.

Teacher Facing Information

Standard: 7.1.4

Assessment Format: Online Only (Requires students to have online access)

Phenomenon	
A student notices that their doorbell is quieter than usual.	Proficient Student Explanation of Phenomenon: The turns of wire are weakening the strength of the electromagnet. This factor affects the strength of an electromagnet and is less than normal. The strength of electromagnetic forces depends on many factors. In this scenario the strength of the doorbell is being affected by the number of coils in the student's doorbell. With less coils, there is less electricity in contact with the temporary magnet. (The strength would be increased by increasing the number of coils on the electromagnet.)
Cluster Task Statement	
(Represents the ultimate way the phenomenon will be explained or the design problem will be addressed) In the questions that follow, you will investigate what affects the strength of the electric and magnetic forces and use data to justify your explanation.	
Supporting Information	
For decades, doorbells have used electromagnetism to work. However, electromagnetic doorbells are becoming less and less common and are being replaced with digital doorbells. You are going to look at how doorbells worked before the digital world (think 5-10 years ago, not 50-60 years ago). Here is an image of doorbell buttons that you have probably seen or may even have on your house right now.	



Screenshot from https://wonderopolis.org/wonder/how-does-a-doorbell-work

https://iwant2study.org/lookangejss/05electricitynmagnetism_21electromagnetism/ejss_model_EMStrengthpaperclips/EMStrengthpaperclips_Simulation.xhtml

https://www.fossweb.com/delegate/ssi-wdf-ucm-webContent/Contribution%20Folders/FOSS/multimedia_2E/MagElec_MM_2E/activities/electromagnet_html5/index.html

Cluster Questions	
Gather: Cluster Question #___1___ Question Type: Drop Down Addresses: __X__ DCI (PS2.B): Types Of Interactions ____ SEP __X__ CCC (cause & effect) Answer: on off	Question 1: Based on the information in Figure 1, complete the statements below by selecting the appropriate term. When the doorbell button is pressed, there is a direct connection between the power source and the electromagnet. When the doorbell button is released, that connection is broken. Therefore, when the doorbell button is pressed, the electromagnet is turned [on or off)]. And when the doorbell button is released, the electromagnet is turned [on or off]. 1. on off 2. On Off
Reason: Cluster Question #___2___ Question Type: Multiple Choice	Question 2: Each of the blue bars in Figure 1 is a chime. The bottom chime

<table>
<tr>
<td>Addresses:
__X__ DCI (PS2.B): Types Of Interactions
_____ SEP
__X__ CCC (cause & effect)

Answer:
Use iron for the bottom chime and copper for the top chime.</td>
<td>makes the "ding" sound and when the magnet turns off, a spring pushes the magnet back so it hits the top chime, making the "dong" sound. What is one way you could make sure the magnet is only attracted to the bottom chime?
a. Use iron for the bottom chime and copper for the top chime.
b. Use copper for the bottom chime and iron for the top chime.
c. Use a permanent magnet for the bottom chime and iron for the top chime.
d. Use iron for the bottom chime and a permanent magnet for the top chime.</td>
</tr>
<tr>
<td>Reasoning:
Cluster Question #___3___
Question Type: Multiple Select
Addresses:
__x__ DCI (PS2.B): Types Of Interactions
__x__ SEP (Analyzing & Interpreting Data)
__x__ CCC (Cause & Effect)

Answer:
b. The amount of wire wrapped around the core
c. The amount of electricity running through the wire
d. The material the core is made of</td>
<td>Question 3:

A student moves into a new house and notices that their doorbell is quieter than most. They decide to investigate. They know that the doorbell uses electromagnetism to work, but they want to know what factors affect the strength of an electromagnet. Select the three answers that would affect the strength of an electromagnet.
a. The amount that the electromagnet costs
b. The amount of wire wrapped around the core
c. The amount of electricity running through the wire
d. The material the core is made of
e. The length of the core</td>
</tr>
<tr>
<td>Reasoning:
Cluster Question #___4___
Question Type: Simulation
Addresses:
__X__ DCI (PS2.B): Types Of Interactions
__X__ SEP (Analyzing & Interpreting Data)
__X__ CCC (Cause & Effect)

Answer:
Data answers will vary but should match the statement
To create a stronger magnetic force I need to add [more] coils</td>
<td>Question 4:

The student uses the following simulator to test the different variables: Electromagnet Simulator

Feel free to play around with the simulator to see how it works. Please note that you must drag the rod into the paper clips. Then collect data about multiple variables to complete the statements that describe how each factor affects the strength of the magnetic force.

To create a stronger magnetic force I need to add [more/less/the same amount of] coils as shown in trial [1,2,3] because it holds [more/less/the same number of] paper clips.
<table>
<tr><td>Trial #</td><td>No. of paper</td><td>No. of batteri</td><td>Batter y level</td><td>No. of coils</td><td>Materi al type</td><td>Size of rod</td></tr>
</table>
</td>
</tr>
</table>

as shown in trial(s)[the one with the most coils] because it holds [more] paper clips.

To create a stronger magnetic force I need to make the core out of [iron] that is [large] as shown in trial(s) [trials with iron and large]because it holds [more] paper clips.

To create a stronger magnetic force I need to add [more] batteries that are [full] as shown in trial [the one with most batteries and full] because it holds [more] paper clips.

	clips attracted	es				
1						
2						
3						

To create a stronger magnetic force I need to make the core out of [iron/plastic/either] that is [large/small/either] as shown in trial because it holds [more/less/the same number of] paper clips.

Trial #	No. of paper clips attracted	No. of batteries	Battery level	No. of coils	Material type	Size of rod
1						
2						
3						
4						

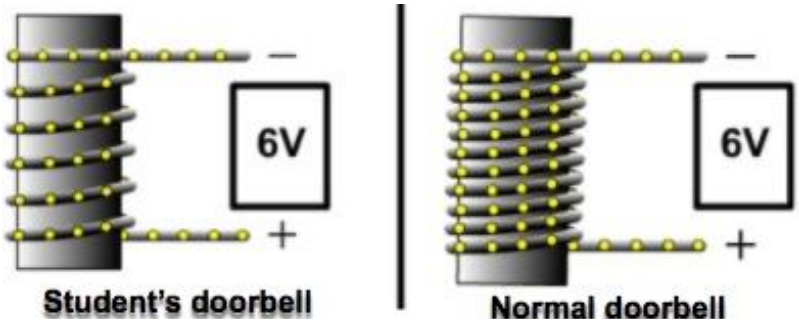
To create a stronger magnetic force I need to add [more/less/the same amount of] batteries that are [full/low] as shown in trial(s)[1,2,3,4] because it holds [more/less/the same number of] paper clips.

Trial #	No. of paper clips attracted	No. of batteries	Battery level	No. of coils	Material type	Size of rod
1						
2						
3						
4						

Reasoning:
Cluster Question #___5___
Question Type: Multiple Choice

Question 5:

Based on the data collected from the previous, which of the

Addresses: __X__ DCI (PS2.B): Types Of Interactions __X__ SEP (Analyzing & Interpreting Data) __X__ CCC (Cause & Effect) Answer: Using a plastic core instead of an iron core	following changes made the weakest electromagnet? a. Using a plastic core instead of an iron core b. Using 1 battery instead of 5 c. Using a small core instead of a large core d. Using batteries with low charge instead of full charge
Reasoning: Cluster Question #___6___ Question Type: Addresses: Short Answer __X__ DCI (PS2.B): Types Of Interactions __X__ SEP (Analyzing & Interpreting Data) __X__ CCC (Cause & Effect) Answer: The strongest electromagnet in the simulation could pick up [3] [iron] paper clips. This electromagnet had [9] coils was made of [large iron] and had [5] batteries that were [full].	Question 6: Complete the statement below to describe the strongest possible electromagnet. The strongest electromagnet in the simulation could pick up [1,2,3,4,5,6] [cooper/iron] paper clips. This electromagnet had [3,5,9] coils was made of [large iron, small iron, large plastic, small plastic] and had [1,2,3,4,5] batteries that were [full/low].
Communicate: Cluster Question #__9____ Question Type: Long Answer Addresses: __X__ DCI (PS2.B): Types Of Interactions __X__ SEP (Analyzing & Interpreting Data) __X__ CCC (Cause & Effect) Answer: Students should talk about number of coils and how it affects the strength of the electromagnet and provide evidence from the simulation.	Question 7: Once the student understands electromagnetism, they decide to take apart their doorbell to see if they can figure out what's wrong. The diagram below shows their doorbell electromagnet on the left and an image of a normal doorbell electromagnet on the right.  Construct an explanation with evidence from the simulation

	explaining the cause of why the student's doorbell is weaker than a normal doorbell.

Proficiency Scale

Proficient Student Explanation:

The turns of wire are weakening the strength of the electromagnet. This factor affects the strength of an electromagnet and is less than normal.

The strength of electromagnetic forces depends on many factors. In this scenario the strength of the doorbell is being affected by the number of coils in the student's doorbell. With less coils, there is less electricity in contact with the temporary magnet. (The strength would be increased by increasing the number of coils on the electromagnet.)

Level 1 - Emerging	Level 2 - Partially Proficient	Level 3 - Proficient	Level 4 - Extending
SEP: Does not meet the minimum standard to receive a 2.	**SEP:** Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships. Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation	**SEP:** Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. Use graphical displays (e.g., graphs, and/or tables) of large data sets to identify temporal and spatial relationships. Analyze and interpret data to provide evidence for phenomena. Consider limitations of data analysis (e.g. measurement error) and/or seek to improve precision and	**SEP:** Extends beyond proficient in any way.

		accuracy of data with better technological tools and methods (e.g., multiple trials)	
CCC: Does not meet the minimum standard to receive a 2.	**CCC:** Cause and effect relationships are routinely identified, tested, and used to explain change.	**CCC:** Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.	**CCC:** Extends beyond proficient in any way.
DCI: Does not meet the minimum standard to receive a 2.	**DCI:** Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets.	**DCI:** 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. Forces that act at a distance (electric, and magnetic) can be explained by fields that extend through space and can be mapped by their effect on a test object (a ball, a charged object, or a magnet, respectively).	**DCI:** Extends beyond proficient in any way.

(Student Facing Format on following page)

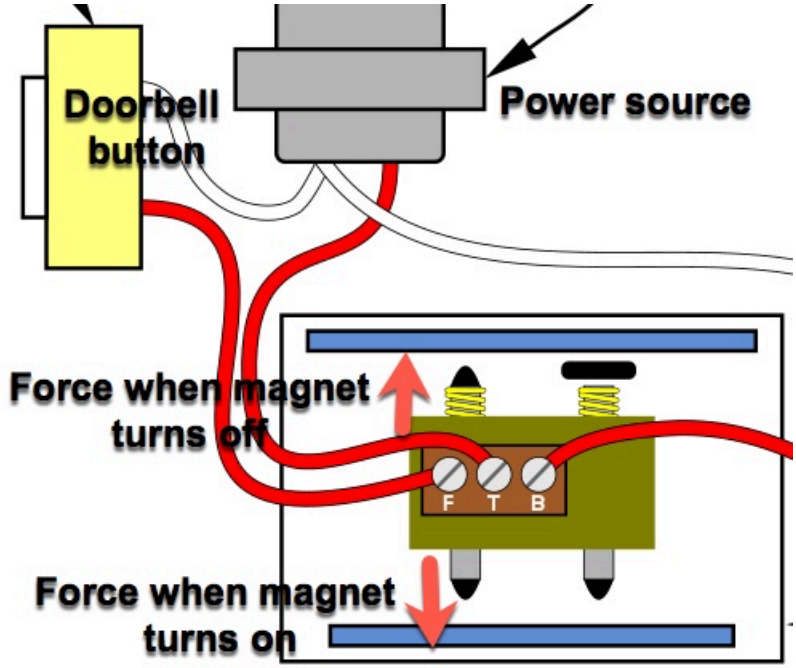
Name: _____ Date: _____

Stimulus

A student notices that their doorbell is quieter than usual.

For decades, doorbells have used electromagnetism to work. However, electromagnetic doorbells are becoming less and less common and are being replaced with digital doorbells. You are going to look at how doorbells worked before the digital world (think 5-10 years ago, not 50-60 years ago).

Figure 1 - Image of Doorbell System



An image of a doorbell button that you have probably seen or may even have on your house right now.

Your Task

In the questions that follow, you will investigate what affects the strength of the electric and magnetic forces and use data to justify your explanation.

Question 1

Based on the information in Figure 1, complete the statements below by selecting the appropriate term.

When the doorbell button is pressed, there is a direct connection between the power source and the electromagnet. When the doorbell button is released, that connection is broken. Therefore, when the doorbell button is pressed, the electromagnet is __(on, off)__. When the doorbell button is released, the electromagnet is__(on, off)__.

Question 2

Each of the blue bars in Figure 1 is a chime. The bottom chime makes the "ding" sound and when the magnet turns off, a spring pushes the magnet back so it hits the top chime, making the "dong" sound. What is one way you could make sure the magnet is only attracted to the bottom chime?

a. Use iron for the bottom chime and copper for the top chime.
b. Use copper for the bottom chime and iron for the top chime.
c. Use a permanent magnet for the bottom chime and iron for the top chime.
d. Use iron for the bottom chime and a permanent magnet for the top chime.

Question 3

A student moves into a new house and notices that their doorbell is quieter than most. They decide to investigate. They know that the doorbell uses electromagnetism to work, but they want to know what factors affect the strength of an electromagnet. Select the three answers that would affect the strength of an electromagnet.

a. The amount that the electromagnet costs
b. The amount of wire wrapped around the core
c. The amount of electricity running through the wire
d. The material the core is made of
e. The length of the core

Question 4

The student uses the following simulator to test the different variables: Electromagnet Simulator

Try the simulator to see how it works, note you must drag the rod into the paper clips. Collect data about multiple variables to complete the statements that describe how each factor affects the strength of the magnetic force.

To create a stronger magnetic force I need to add [more/less/the same amount of] coils as shown in trial [1,2,3] because it holds [more/less/the same number of] paper clips.

Trial #	No. of paper clips	No. of batteries	Battery level	No. of coils	Material type	Size of rod
1						
2						
3						

To create a stronger magnetic force I need to make the core out of [iron/plastic/either] that is [large/small/either] as shown in trial [1,2,3,4] because it holds [more/less/the same number of] paper clips.

Trial #	No. of paper clips	No. of batteries	Battery level	No. of coils	Material type	Size of rod
1						
2						
3						
4						

To create a stronger magnetic force I need to add [more/less/the same amount of] batteries that are [full/low] as shown in trial [1,2,3,4] because it holds [more/less/the same number of] paper clips.

Trial #	No. of paper clips	No. of batteries	Battery level	No. of coils	Material type	Size of rod
1						
2						
3						
4						

Question 5

Based on the data collected from the previous, which of the following changes made the weakest electromagnet?

a. Using a plastic core instead of an iron core
b. Using 1 battery instead of 5
c. Using a small core instead of a large core
d. Using batteries with low charge instead of full charge

Question 6

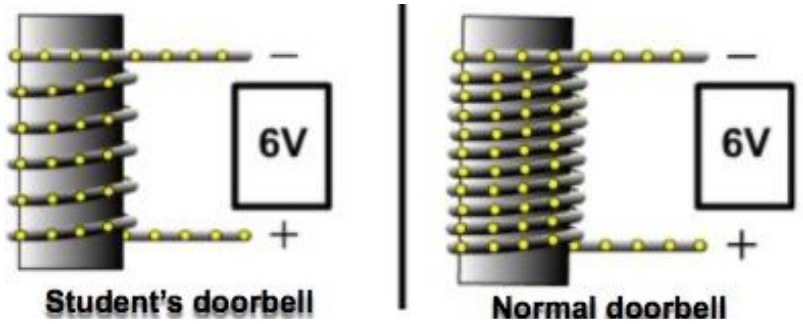
Complete the statement below to describe the strongest possible electromagnet.

The strongest electromagnet in the simulation could pick up __(1,2,3,4,5,6)__ __(cooper,iron)__ paper clips. The strongest electromagnet had __(3,5,9)__ coils was made of __(large iron, small iron, large plastic, small plastic)__ and had __(1,2,3,4,5)__ batteries that were __(full/low)__.

Question 7

Once the student understands electromagnetism, they decide to take apart their doorbell to see if they can figure out what's wrong. Figure 2 below shows their doorbell electromagnet on the left and an image of a normal doorbell electromagnet on the right.

Figure 2 - Comparing Doorbells



Construct an explanation with evidence from the simulation explaining the cause of why the student's doorbell is weaker than a normal doorbell.

_____

_____

_____

_____

_____

_____