PHENOMENON-BASED INSTRUCTIONAL TASK | **GRADE LEVEL:** 3rd Grade

MAGNETIC MAGIC

TARGETED DCI AND/OR ASSOCIATED PE

PE | 3-PS2-3

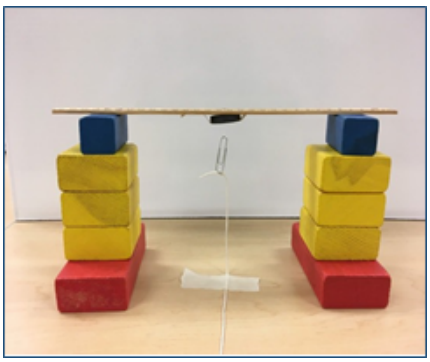
Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

DCI | TYPES OF INTERACTIONS

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, on their orientation relative to each other.

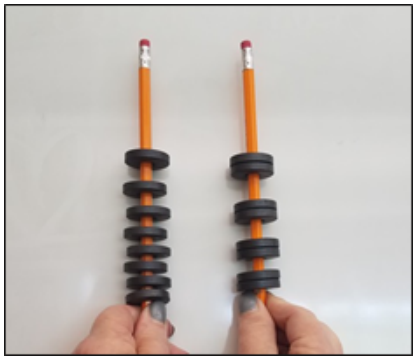
POSSIBLE DRIVING PHENOMENON

Student observation or initial interaction: Students observe a paper clip tied to an anchored string "floating" below a magnet attached to the bottom of a bridge-like structure.



Phenomenon explanation: The magnet attracts the paper clip. Gravity also pulls the paper clip downward, but the force of the magnet is larger than the force of gravity, so the paper clip is pulled toward the magnet. The pull on the string balances the forces between the magnet and the paper clip so it appears to "float" in the air. The magnet pulls on the paper clip even though they are not touching. As long as the force of the magnet is stronger than the force of gravity, the paper clip stays (floats) in

Student observation or initial interaction: Students observe donut magnets stacked on pencils. They notice different spacing between magnets depending on the arrangement and relative orientation of the stack of magnets.



Phenomenon Explanation: All magnets have a north and south pole. One side of a donut magnet is its north pole and the other side is its south pole. Opposite (north-south) poles of different magnets attract (pull) and like poles (north-north and south-south) repel (push). On the left side, the eight magnets are arranged with north and south poles adjacent so they repel one another. On the right side, the magnets are stacked with 4 sets of north-south attracting magnets arranged so that each set

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place. As the paper clip is pulled farther away from the magnet by pulling on the string taped loosely to the table, it reaches a distance where the force of the magnet cannot hold it any longer and it drops downward due to the force of gravity. The string is no longer needed to hold it in place from the force of the magnet because gravity takes over. This shows that the size of the force of a magnet decreases with distance from the magnet. The size of this force (and its associated distance) is a property of the magnet. It is known as magnetic field. The more powerful the magnet, the larger the magnetic field and the farther the paper clip can be pulled away from the magnet and remain suspended.

is adjacent to a like north or south pole. Each set of double magnets repels the other. Putting two magnets together effectively creates a single stronger magnet with a larger magnetic field. This explains why the spacing on the right stack is wider than on the left stack. Both stacks have a similar pattern of spacing showing an increase in the gap size from the lower to the upper magnets. This is because the upper magnets have less force from above than the lower magnets. The upper magnet has only gravity pulling downward on it while the lowest magnet has downward force from the magnets above it in addition to the pull of gravity on it.

THE PHENOMENON CONNECT TO HOW DOES THE PHENOMENON CONNECT TO THE DCI OR PE?

These phenomena provide students with opportunities to observe magnetic forces acting at a distance and collect data to provide evidence that some objects do not need to be in contact to exert force on another object. They observe that two magnets either attract or repel one another and can ask questions about patterns explaining the cause of the different directions in magnetic force. Students also ask questions leading to investigations that provide evidence to construct explanations showing the cause and effect relationship between the distance from a magnet to another object and the force exerted on the other object (attraction distance or magnetic field).

GATHERING AND REASONING IN ORDER TO CONSTRUCT AND REFINE EXPLANATIONS:

How could students gather evidence using SEPs and CCCs that will help them construct/refine a supported explanation of the phenomenon?

1. INITIAL ENGAGEMENT WITH THE PHENOMENON:

The phenomena can be presented as a demonstration or students can set it up themselves. Students should provide an initial explanation as a written entry and/or a model (drawing) that explains what forces are acting to cause the phenomenon.

Ask the students what they observe and what questions they have about the phenomenon. Ask them what they might do to find answers to their questions. For example, students might ask if a stronger magnet would change how far the paper clip can "float" from the magnet. Have them design investigations to test their questions.

2. CONTINUING EXPLORATION

Students can do some free exploration with magnets and magnetic materials. They should be

GUIDING QUESTIONS

- What questions do you have about this phenomenon?
- What data could you collect as evidence to answer your question(s) and how would you collect it?
- What forces are acting in this system? How do you know this?
- How do the forces change when you make changes to the system?

encouraged to come up with possible explanations for anything they discover during the exploration.

Example: Testing properties such as the ability of magnetic force to go through materials, magnetize other objects, or exert force on objects without touching them.

3. Students can explore different types and sizes of magnets to determine that the properties of the various magnets determine the distance the force extends from the magnet (attraction distance). An investigation can be designed by the teacher or the students to measure, record, and graph distances resulting from different strengths, locations, or types of magnets.

Example: Measure distances required to attract a paper clip by adding additional magnets one by one to a stack or grouping of magnets. Record data and graph the relationship.

4. Students can observe patterns and make predictions about what happens when magnets are placed in different north-south orientations.

Floating magnet phenomenon:

- What would happen to the system if you…(added magnets, changed the size of the paper clip, added paper clips, etc.)
- What properties of magnets did you observe in your explorations?
- How do magnets interact with metals? Do they act the same with all types of metals?
- How do magnets interact with one another?
- What determines the amount of attraction distance between a magnet and a magnetic object such as a paper clip?

Magnets on a pencil phenomenon:

- How does the direction the magnets are turned affect the force of the magnet?
- What differences are there between the patterns of separation of the magnets on the two pencils?
- What could account for these differences?
- Why do you think the spacing pattern is larger with two magnets together?

COMMUNICATE FINAL EXPLANATION OF THE PHENOMENON

How might students communicate their understanding of the targeted DCI or PE in an explanation supported by evidence?

Students construct a final explanation of the phenomenon by revising their initial explanation or drawing.

POSSIBLE FORMATS FOR CONSTRUCTING EXPLANATIONS OF THIS PHENOMENON.

- Students construct a final written explanation which reflects elements of the DCI related to force acting at a distance and magnetic properties associated with different strengths and types of magnets.
  - Use a sentence scaffold such as:
    - The paper clip stays in place without touching the magnet because…
    - The forces acting on the paper clip and magnet system are… This causes …
    - The magnets on the pencil are not touching each other because…
    - The double magnets have larger spaces between them because…
  - Ask students to write an explanation that contains specific terms related to this DCI such as: attract, repel, force, magnetic, property, cause, distance, pattern, gravity, etc.
- Students revise or re-draw their initial model and include labels and arrows showing how forces are acting and/or short explanations of interactions in the system.
- Students solve an engineering problem using magnets and explain in a presentation how magnetic force is utilized in the design.

Example detailed explanation: The paper clip looks like it is floating because the force from the magnet acts on the paper clip through the air without touching it. The string holds it in place so it can't move closer to the magnet. If the paper clip is too far away from the magnet, the magnetic force cannot act on it anymore and the paper clip falls to the ground because of gravity.

Example detailed explanation: The magnets do not touch each other on the pencil because they are turned so that the north poles face each other, and the south poles face each other. This causes the magnetic force to repel the magnets from each other. They will not stay together. When you put two magnets together with north and south poles facing each other, a stronger magnet is created. When these are stacked, they repel each other with a stronger force and leave bigger spaces between magnets.