Magnetic Force and Magnetic Field Inquiry Lab

NGSS: MS-PS2 Motion and Stability: Forces and Interactions

Overview:

Students will be given the opportunity to investigate the invisible properties of magnets and electricity using a simple kit provided by the instructor. Students will be expected to answer some guiding questions using the appropriate vocabulary. This lesson is intended to check for understanding of the vocabulary and evoke an interest in electricity, electrical charges and the transfer of energy that will be built upon over the next several days.

Note: This lesson is meant to be completed prior to **Electromagnets, Generators, and Motors** but also works indepednent of that lesson.

NGSS:

MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces
MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Lesson Objectives:

- Students will demonstrate an understanding of magnetic field, and magnetic force by labeling a diagram.
- After interacting with magnets and iron fillings, students will hypothesize on how the magnetic field surrounding a lightly charged electrical wire is generated.
- Students will extend this information about magnets to the construction of a simple circuit (optional).

Assessment and Evaluation

Students will be expected to produce several short, written explanations or well-labeled diagrams describing the interactions they observed in the inquiry lab. The explanations and diagrams will lead to a Summary of Their Discoveries in which they demonstrate their understanding of magnetic fields, and magnetic force and compare them to the electric field surrounding the wire lead of the simple circuit.

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Materials:

1 - 1.5v, “D” Cell Battery,
1 - Battery Holder
1 - Switch
3 - leads with alligator clips
1 - Compass
1 - Bar Magnet
6 - Disc Magnets
Small container of iron fillings
Wooden dowel

Activating Strategy:

How do magnets attract each other? Are they the only objects that exhibit this characteristic?

Procedures:

1. The teacher will introduce the concept of field and force by first demonstrating the gravitational force of gravity on some object in the room that will get the students attention. This could be a book, a ball, etc.

2. The teacher should draw a cartoon/illustration/diagram on the board to represent the forces acting on the object.

3. The whole class or partners can discuss the definition of gravitational force and the field within which it is felt. The teacher should correct any misconceptions and complete a definition for both gravitational force and field.
4. The discussion can then shift the concept of force and field to the magnets. Using a K-W-L-Q chart or similar chart. The teacher can lead this exercise on the board, leaving the L and Q columns blank for now.

5. The teacher will then hand out the student activity kits and the student response sheets that include the guiding questions, space for diagrams, and an area for their constructed response (see worksheets at the end of this lesson). This can also be done with guidance in an Interactive Science Notebook (ISN).

6. Students should be divided into groups of 3 or less. The student response sheet should guide the students through the activity.

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7. The first activity is meant to help the students better visualize the invisible forces they will be investigating today. It requires the students to lightly dust or sprinkle iron filings onto their paper which is covering the bar magnet. This may require some close observation to make sure they do not use too much and the desired results are being produced. The students are to sketch their observations in the box provided on the handout or in their ISN.

8. The second activity asks the students to investigate and illustrate the attractive forces of magnets. They should play with the magnets and try to get a feel for how the natural forces of the magnets get stronger as the magnets get closer together. They need to find some way to illustrate and/or describe this either on the student handout or in their ISN.

9. The goal of activity number three is just the opposite of activity number two. Here, the students are to investigate the repulsive properties of the magnets by building a levitating stack of ring magnets on the wooden dowel provided in the kit. This can be done on a pencil if they do not have wooden dowels available. Once again, the students should be able to recognize that the force of the magnets gets stronger as the magnets get closer together. They will need to illustrate and/or describe this natural occurrence on their activity sheet or in the ISN

10. **Optional:** The final activity attempts to relate the invisible forces present around the magnets to the invisible forces that surround a lightly charged electrical conductor. The students will need to build a simple circuit using the D cell battery, a switch, and 3 leads. An illustration is provided on the student handout, but they might require some specific instruction on how to complete the required wiring. The idea here is to have the students realize there is a electrical field surrounding the wire lead when a current is moving through the wire and that field can act on or control a magnetically charged item that is in close proximity to the charged wire. This concept will be vital to them understanding the processes that allow electrical energy to be transformed into mechanical energy in an electric motor and the transformation of mechanical energy into electrical energy in an electrical generator.

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Closure:

The students will be required to write a Summary of Their Discoveries on the page provided or in their ISN's. They will be told that they must use the following vocabulary in their summary:

magnetic field, magnetic force, electrical field, and simple circuit

They will also be given the following prompts:

- What you know about magnetic fields.
- What you know about magnetic forces.
- How you think magnetic fields and magnetic force may be similar to and/or different from the electric field you witnessed surrounding the wire lead in the simple circuit?

Name:_____

Magnetic Field Lab

A magnet is an object or material that attracts certain metals, such as iron, nickel and cobalt. It can also attract or repel another magnet. All magnets have North-seeking (N) and South-seeking (S) poles. The opposite poles attract and like poles repel each other when magnets are placed near each other, or within the range of the magnetic force. The strength of the attraction, or the magnetic force, will vary depending on the distance between the objects.

OBJECTIVES

FORM a hypothesis about where the magnetic fields are and what they look like.
FORM a hypothesis about the electrical field surrounding a lightly charged conductor.
COMPARE AND CONTRAST the magnetic field of the magnets with the electrical field of the conductor.

WHAT YOU'LL INVESTIGATE

In this activity, you will use disc magnets and a magnetic compass to investigate the interactions between like and opposite magnetic charges. You will also use a simple circuit and a magnetic compass to investigate the magnetic field surrounding a lightly charged conductor. You need to develop some method of illustrating the forces you experience and fields within which you feel or "see" them demonstrated. You will also need to describe and or illustrate the electrical field you "see" surrounding a lightly charged conductor.

MATERIALS

1 - 1.5v, "D" Cell Battery,
1 - Battery Holder
1 - Switch
3 - leads with alligator clips
1 - Compass
1 - Bar Magnet
6 - Disc Magnets
Small container of iron fillings
Wooden dowel

Name:_____

Magnetic Field Inquiry Lab

Procedure

1. Place the bar magnet under this piece of paper and **LIGHTLY** dust or sprinkle some of the iron filings on top of the paper. Observe the pattern that forms. Carefully poor the iron filings back into their container. Illustrate the pattern you observed.

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Magnetic Field Lab

2. Use the disc magnets to investigate the natural attraction between the magnets. Illustrate and/or describe what you believe to be happening. Make sure your illustration shows the forces at work within a certain field and the strength of the forces.

3. Stack the disc magnets on the wooden dowel with the like charges facing each other. The magnets should float, one above the other. Move the compass up and down close to the edge of the stacked magnets. Illustrate and/or describe what is happening, paying close attention to the magnetic fields and the strength of the forces at work.

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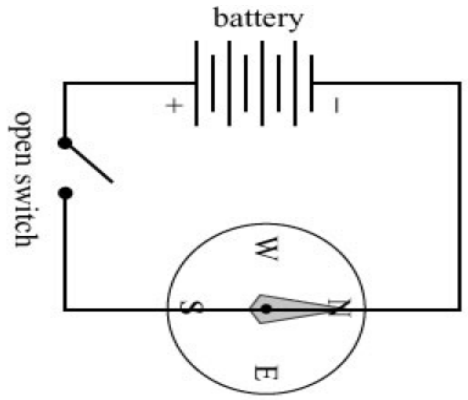
Magnetic Field Lab

4. **EXTENSION:** Build a simple circuit using the D-cell battery, the switch, and 2 wire leads. Leave the switch open and place the compass underneath one of the wire leads so the compass needle is perpendicular to the lead. Close the switch so electricity begins to flow through the lead. Observe what happens to the compass needle. Move the compass away from the lead and observe what happens. Illustrate and/or describe what is happening hypothesizing about what is causing the needle to move.



Name:_____

Summary of Your Discoveries

Write a short explanation of what you have discovered during your investigation. Refer back to your illustration when necessary. Be as specific as possible.

Your summary should include the following vocabulary words/phrases:
magnetic field, magnetic force, electrical field, and simple circuit (if circuit is made)

Your summary should also answer the following questions:

- What do you know about magnetic fields?
- What do you know about magnetic forces?
- How do you think magnetic fields and magnetic force of the magnets are similar to and/or different from the magnetic field you witnessed surrounding the wire lead in the simple circuit? (if circuit is made)

Name:_____

Summary of Your Discoveries