MOVING CHARGES, MAKING MAGNETS

(MODIFIED FOR ADEED)

INSTRUCTIONS

Science Teacher Education Program

Science Concept:

Electricity and magnetism are related aspects of the same phenomenon.

Objectives:

The student will:

- make an electromagnet.
- investigate the factors affecting the strength of an electromagnet by controlling variables, collecting data, and inferring; and
- write a lab report, communicating experimental results.

GLEs Addressed:

Science

[11] SB4.2 The student demonstrates an understanding of motions, forces, their characteristics, relationships, and effects by conducting an experiment to explore the relationships between magnetic forces and electric forces to show that they can be thought of as different aspects of a single electromagnetic force (e.g., generators and motors).

[10-11] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.

Writing

[10] W4.2.4 The student writes for a variety of purposes and audiences by using research-based information and/or analysis in research projects or extended report.

Vocabulary:

electric field – the space surrounding an electric charge, which exerts a force on other charged objects

electromagnetic induction – the production of voltage across a conductor situated in a changing magnetic field, or a conductor moving through a stationary magnetic field

electromagnetism - magnetism developed by a current of electricity

magnetic field – the part of the electromagnetic field that exerts a force on a moving charge

Materials:

- Compasses (1 per pair)
- 1.5v C-cell batteries (1 per pair)
- 22-gauge bell wire
- Iron nails of varying sizes
- Bar magnet (1 per pair)
- Masking tape
- Paper clips (20-30 per pair)
- Wire stripper

Activity Preparation:

Cut wire into lengths and strip the insulation off the last inch of each end.

Activity Procedure:

Gear Up

Process Skills: observing, inferring, and communicating

1. Divide students into pairs. Distribute a compass, a C-cell battery, a bar magnet, and some wire to each pair. Ask students to move the magnet around the compass and observe. Discuss what happens. Ask students why compasses point north. If necessary, explain that a compass is a magnetized object that aligns itself with the magnetic north of the planet. The proximity of the magnet with another magnetic object, causes the compass to try and align itself with the magnet instead.
2. Instruct groups to attach the ends of the wire to the poles of the battery, bring the compass near the wire, and observe what happens. Ask students to name reasons for the behavior of the compass. If needed, explain that a wire carrying an electric current produces a magnetic field.

Explore

Process Skills: observing, inferring, hypothesizing, and investigating

3. Direct groups to wrap their wire tightly around a nail ten times, leaving several inches free on each end. Ask students to connect each end of the wire to opposite ends of the battery and tape in place. Distribute 20 to 30 paper clips to each group. Instruct groups to move the wrapped nail assembly so that the nail is close to the paper clips and observe the result, then carefully slide the nail out of the coils and see if the coils will pick up the paper clips.
4. Explain that when a coiled wire produces a magnetic field, the magnetic field is concentrated inside the coil. The magnetic field inside the coil causes all the magnetic fields in the nail to align in one direction, just like a compass, enabling the nail to pick up some objects.

Generalize

Process Skills: observing, inferring, hypothesizing, and investigating

5. Ask students what a good name would be for this type of magnet.
6. Ask students how they might be able to alter the strength of their electromagnet. List student ideas on the board.

Experiment

Process Skills: investigating, observing, collecting data, inferring, and controlling variables

7. Explain that students will work in groups to design and conduct their own experiment to determine what factors affect the strength of electromagnets. Groups must select one independent variable. The dependent variable should be the number of paper clips picked up by the magnet.
8. Arrange students into groups and instruct them to identify the factors they will use as independent variables, form a hypothesis and write them down. Groups should then write a detailed procedure, including materials, to test their independent variable.
9. Approve student hypotheses and procedures before distributing materials and allowing students to proceed.
10. Instruct groups to perform their experiment, recording data. When done, groups should draw diagrams of their electromagnet, and present a summary of their experiment to the class, including a summary of their procedure, an explanation of their data, using both qualitative and quantitative terms, and their conclusion.

Interpret

Process Skills: communicating and interpreting data

11. As a class, discuss what varied about each experiment. Which changes had the greatest effect on magnet strength? Did magnet strength vary in a predictable way with each trial?

12. Assign students to write a lab report that summarizes their experiment and explains their findings.
13. Ask each group to contribute one result or idea for a possible further experiment.

Apply/Assess

Process Skill: communicating

14. As a class, brainstorm a list of devices that use electromagnets. Create a second list of ideas for new devices that could use electromagnets.
15. Alternately, ask students to compare different motors with generators in a two to three paragraph report or research how magnetic levitation trains work and give an oral or written report.

Extension Ideas:

Process Skills: communicating

1. Build a miniature motor.
2. Research machines that use a solenoid switch, and create a list of them.

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Objective	GLE	Emergent	Developing	Proficient	Advanced
The student will make a working electromagnet and use it in an experiment.	[11] SB4.2	The student's magnet does not work, that is, it does pick up any paper clips.	The student builds at least one version of a working magnet.	Student builds magnets of at least two different strengths by varying one feature.	Student builds magnets of three or more strengths by varying one feature.
The student will investigate the factors affecting the strength of an electromagnet by controlling variables, collecting data, and inferring.	[[10-11] SA1.1	The student does not participate in lab group.	The student collects data.	The student collects data and controls variables, changing only one factor at a time.	The student collects data, controls variables, and makes inferences about the results.
The student writes a lab report, communicating their experimental results.	[10] W 4.2.4	The student does not write report.	The student communicates experimental results in an incomplete and/or incoherent style.	The student communicates complete experimental results in a coherent style.	The student communicates complete results in a coherent style, and demonstrates an understanding of how electromagnets work.