MAGNETISM

Teacher Notes

FOURTH GRADE BACKGROUND

- Fourth graders studied magnetism in 3rd grade.
- They know that magnets have a north and south pole and that there are invisible magnetic fields.
- The students have dealt with simple magnets, but not electromagnets (they do know about electricity).
- They students have some experience using a compass.

PREVIOUS LESSON REVIEW

- What did you learn about electricity? What's the difference between a closed and open circuit?
- Did you use anything with electricity at home since we last met? How about with magnets?
- In this lesson we will be exploring the magnets. Their strength can be increased using electricity.

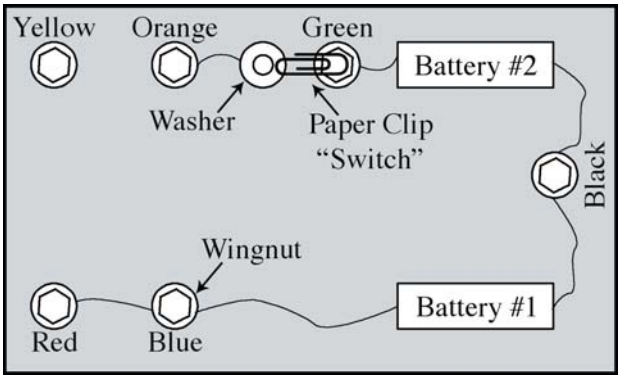
INTRODUCTION

All magnets have two ends, usually marked "north" (N) and "south" (S): opposites attract and likes repel. If you have two bar magnets with their ends marked "north" and "south", the north end of one magnet will attract the south end of the other. On the other hand, the north end of one magnet will repel the north end of the other (and similarly, south will repel south). Magnets attract objects made of steel or iron.

Electromagnets are the same, except that they are temporary; the magnetic field exists only when electric current is flowing. An electromagnet starts with a battery (or some other source of power) and a wire. If you look at a battery, you can see two ends: one marked plus (+) and the other marked minus (-). Electrons collect at the negative end of the battery, and, they will flow to the positive end through a wire. If you attach a wire directly between the positive and negative terminals of a battery, three things will happen:

- Electrons will flow from the negative side of the battery to the positive side as fast as they can.
- The battery drains quickly, and normally, you connect some load in the middle of the wire so the electrons can do useful work. The load could be a motor, light bulb, or radio.
- A small magnetic field is generated in the wire, which is the basis of an electromagnet.

For example, if you wrap your wire around a nail 10 times, connect the wire to the battery, and bring one end of a nail near the compass, you will find that it has a much larger effect on the compass. In fact, the nail behaves just like a bar magnet; however, the magnet exists only when the current is flowing from the battery! This electromagnet is able to pick up small steel objects like paper clips, staples and thumbtacks.



Show two demonstrations. The first shows that opposite poles of a magnet repel (in a set of round magnets placed onto a wooden dowel, the top one will hover if you put similar poles together). The second is a simple motor. If you place a circular coil of wire between two round magnets in a circuit with a battery, the wire coil will spin like a motor.

DISCUSSION THOUGHTS

Where are magnets found around you?

VOCABULARY

- **Magnetism**: a phenomenon by which materials exert an attractive or repulsive force on other materials
- **Electromagnets**: created when electrons flow through a magnetic field
- **Magnetic Pole**: the direction of a magnetic force (north or south)
- **Permanent Magnet**: a material that stays magnetic (unlike an electromagnet)
- **Magnetic Field**: an invisible magnetic force that surrounds a magnet or electrified wire
- **Magnetic Attraction**: the attraction between oppositely charged magnetic poles
- **Magnetic Repulsion**: the repulsion between similarly charged magnetic poles

ACTIVITIES

- **Worksheets**
  - Students complete the Magnetism Worksheet. You can use the overhead to work together.
  - Materials:
    - 25 Magnetism Worksheets

- **The Dancing Paperclip**
  - Hand out one circular magnet and one paperclip on a string to each student. Ask them the make their paperclip dance by holding it over the magnet and finding the distance at which the attraction starts to drop off (where it will dance).
  - Objective: To understand that magnetic fields are weaker as you move farther from the magnet
  - Materials:
    - 25 round magnets
    - 25 paperclips on strings

- **The Twist Tie Compass**
  - Hand out one twist tie and a small cup of water to each student. Tell the students to rub their magnets across the twist tie in one direction, which will magnetize it. The students should place their twist ties into the cup of water. As they float, they will act as a compass and point North.
  - Objective: To learn about magnetizing a metal and how a compass is related to magnetism
  - Materials:
    - 25 round magnets
    - 25 twist ties
    - 25 cups of water

- **Bar Magnet Fun!**
  - Group the students into teams of 4. Give each team two bar magnets and let them explore the attraction and repulsion of the magnets. Hand out the Magnetism Experiment worksheet, and ask the students to fill out whether the objects will be magnetic or non-magnetic. After they make hypotheses, hand them a bag of objects and let them determine their magnetic properties. Discuss which objects displayed magnetic properties and which objects they were surprised by.
  - Objective: Become familiar with bar magnets and the magnetic properties of ordinary objects
  - Materials:
    - 25 Magnetism Experiment worksheets
    - 25 bar magnets
    - 15 bags of objects (wood, penny, rubber, clear plastic, silver plastic, paper clip, hair pin, cardboard, aluminum foil, and wing nut)

- **Electromagnet Paperclip Demo**
  - Hand each volunteer a circuit board, a nail with wire coiled around it, and some paper clips. Using the circuit board, connect the leads from the wire-covered nail to the blue and orange dots on the circuit board. To turn the electromagnet "on," have volunteers close the switch (press the paper clip down). Make sure that the switch does turn off because the electromagnet drains the batteries quickly. Have volunteers compete to see who can pick up the greatest number of paper clips using the electromagnet. Which is stronger: the electromagnet or a bar magnet? ***CAREFUL: the nail gets very hot if left on too long!***
  - Objective: To learn about electromagnets and their relative strength compared to bar magnets
  - Materials:
    - 3 circuit boards
    - 3 metal nails covered with coiled wire
    - Paper clips

CONCLUDING THOUGHT

How does a compass work?