

Electromagnets

Objectives:

Grade Level: 4

- ❖ The students will make an electromagnet that will attract a metal object.
- ❖ The students will increase the strength of an electromagnet so that it will attract an increased number of metal objects.
- ❖ The students will compare the properties of magnets and electromagnets.

Kentucky Standards:

- SC-E-1.1.1 - Objects have many observable properties such as size, mass, shape, color, temperature, magnetism, and the ability to react with other substances. Some properties can be measured using tools such as metric rulers, balances, and thermometers
- SC-E-1.3.3 - Electricity in circuits can produce light, heat, sound, and magnetic effects. Electrical circuits require a complete conducting path through which an electrical current can pass.
- SC-E-1.3.4 - Magnets attract and repel each other, and magnets attract certain kinds of other materials (e.g., iron).

Materials Needed:

For 28 students.

- 14--20 inch strips of insulated copper wire, 1/2 exposed on each end
- 14--40 inch strips of insulated copper wire, 1/2 exposed on each end
- 20--size "D" batteries
- 14--battery holder for 2 "D" batteries
- 14--compasses
- 30--iron nails, 4" long
- 1--box of paper clips, approx. 300
- masking or transparent tape
- iron filings
- 5" x 7" index card or clear transparency

Strategies/Activities:

Activity #1:

- ❖ Give each pair of students one battery, iron nail, 40" copper wire, and about 30 paper clips. Have them, using only the nail, try to pick up as many paper clips as possible. Discuss methods and results.

- ❖ Then instruct them to wrap the copper wire around the nail ten times leaving 5-6 inches of wire free on each end of the nail. Attach one end of the wire to the negative pole of the battery. Tape securely and then touch the other end of the wire to the positive pole of the battery while their partner uses the nail to pick up paper clips. Then release the wire from the positive pole of the battery. Discuss methods and results. Record the number of paper clips picked up by the magnetized nail by each group.

Concept: Electric current flowing through a wire creates a magnetic field which caused the iron nail to become a temporary magnet. When the electric current is cut off, the nail loses its magnetic property and the paper clips fall off.

Activity #2:

- ❖ Elicit ideas and suggestions from students on how they can make the nail pick up more paper clips. *Possible ideas are to: 1) use more wire; 2) use more batteries; 3) use more nails.*
- ❖ Break students into groups of four and let one group test the idea of using more batteries; another group using 2-3 nails; a third group using more wire, wrapping the nail 15-20 times; and another group wrapping the nail 30-40 times. Reconnect the circuit and pick up as many nails as possible. Record the results of each group and discuss results.

Concepts: The strength of an electromagnet can be increased by using more batteries and/or more wires. Using more nails will increase the electromagnet's capacity to hold more paper clips, without necessarily increasing the magnetic force.

Activity #3:

- ❖ Have students work in pairs. Give each student a 20" length of wire and a compass in addition to their battery. Have them secure one end of the copper wire to the negative pole of the battery. Have their partner hold the looped center of the wire over the compass and they are to observe what happens to the compass needle when the other end of the wire makes contact with the positive pole of the battery.
- ❖ Repeat this process, but with a slight variation: attach the wire to the positive pole of the battery first, then, holding the looped end of the wire over the compass, complete the circuit touching the other end of the wire to the negative pole of the battery. Observe how the compass needle reacts. Discuss observations. Repeat if necessary.

Concept: Electromagnets have poles which can be reversed when the path of electricity is reversed. This is not a characteristic of regular magnets.

Activity #4:Teacher Demonstration

This is a teacher demonstration in which the students will observe what happens when iron filings are sprinkled over an electromagnet. Place two batteries in a battery holder and connect the end wires to the end

wires of an electromagnet(nail wrapped with copper wire). Place them on the overhead projector and place the clear transparency over the electromagnet. Slowly sprinkle iron filings over the transparency and observe what happens to the iron filings. Discuss observations.

Concept: Electromagnets have lines of force.

Assessments:

At the conclusion of the mini-teach, the students will be able to answer the following questions:

1. Name 3 ways in which magnets and electromagnets are alike.

(Have poles, attract metals, have lines of force)

2. Name 3 ways electromagnets differ from magnets.

(Electromagnets need electricity to work, the poles of electromagnets can be reversed, the strength of electromagnets can be increased)

3. List 2 ways to increase the strength of electromagnets.

(more batteries, more wire)