

## Electromagnets

**Lesson Concept** Electric current makes an electric field. An electromagnet is a piece of iron that becomes a temporary magnet when electricity flows through an insulated wire wrapped around it. More coils of wire wrapped around the iron nail results in a stronger electromagnet.

**Link** In the previous lesson students learned that a parallel circuit has multiple pathways for electricity to follow. If one light bulb goes out in a parallel circuit, the remaining light bulbs will stay lit because there are multiple paths for the electricity to follow.

**Time** 75 minutes

### Materials

#### Whole class

1 Wire cutter

One poster sized class graph

1 D-Cell

1 Battery holder or masking tape

30 Inches of insulated copper wire

1 Large iron nail or large bolt

1 Compass

#### Per Group (groups of 2)

1 D-Cell

1 Battery holder or masking tape

30 Inches of insulated copper wire

1 Large iron nail or large bolt

1 Compass

Small box of paper clips

10 Staples

#### Individual

### Advance Preparation

1. Prepare one electromagnet as a model.
2. Remove one inch of the plastic insulation from the ends of the wires.

## **Procedure:**

### **Engage** (15 minutes). *Electricity and magnetism are related effects*

1. Ask students to remember when they have seen a compass needle move before. Why does a compass needle move? [Expected Student Response (ESR): A compass needle detects a magnetic field.]
2. Display the prepared electromagnet. Tell students to closely observe what happens when a compass is placed near the electromagnet. The compass needle moves in the direction of the electromagnet. Disconnect the wiring on the preassembled electromagnet, move the compass close by it. Have students observe again. [Expected Student Response (ESR): The compass needle does not move.]
3. Ask students to explain why the compass needle moves. (ESR): The compass needle detects a magnetic field.

### **Explore** (20 minutes) *Electric current makes an electric field.*

4. Ask students to observe as you disassemble then reassemble the electromagnet.
5. Without speaking, methodically disconnect the wires, and unravel the coils.
6. Next, rebuild the simple electromagnet. Exaggerate your careful coiling and leaving approximately 3 inches of wire loose on each end of the bolt. Also demonstrate the reconnecting of the wires to the battery terminals. Last, use the magnetic field to attract small paperclips.
7. Have student partners tell each other how to build an electromagnet.
8. Distribute the wire, battery, bolt or nail, and the battery holder. Allow students time to build and test a simple electromagnet in pairs.
9. Have students use their electromagnet to pick up paperclips or staples.
10. Have students place a compass near the bolt or nail. Ask students, "What do you notice?" (ESR): The compass moved. Ask, "What does that mean?" (ESR): There is a magnetic field around the bolt or nail.
11. Explain to students that they have made a temporary magnet. Most magnets cannot be turned off but this one can so it is considered a temporary magnet.

### **Explore** (10 minutes) *The strength of an electromagnet is determined by the number of coils of wire.*

12. Ask student to think about the strength of their electromagnet. How many paper clip or staples did your electromagnet pick up?
13. Explain to students that in order to change the strength of an electromagnet, they must change the number of coils of wire around the bolt or nail.

14. Have students investigate how the number of coils around the bolt or nail affects the strength of their electromagnet. Have students record their observations on a “T-Chart” in their science notebooks. (See **R1 T-Chart**). Have students label the T-Chart columns with “Number of Coils” and “Number of Paper Clips.”
15. Ask pairs of students to make a single hypothesis about the relationship between the number of coils and the number of paperclips attracted to the electromagnet on their recording sheet. If the number of coils in an electromagnet increases, then the number of paperclips attracted \_\_\_\_\_ (will decrease, increase, remain the same). Have each student write his/her hypothesis in his/her science notebook.
16. Instruct students to make 5 different electromagnets by coiling the wire 20, 30, 40, 50, and 60 times around the bolt or nail. Have students record the number of paperclips each different number of coils will attract.
17. Notice that each electromagnet uses multiples of ten coils. They must stop between each to test how many paperclips attach to the electromagnet and record it on the sheet

**Explain**                      ***(15 minutes) The strength of an electromagnet is determined by the number of coils of wire.***

18. Ask students to review their data. Have students explain in their science notebooks what happens to the strength of the electromagnet as the number of coils increases. (ESR): The strength of the electromagnet increases as the number of coils increases.
19. Have student revisit their hypothesis. Have student write the following statement: My hypothesis was (correct or incorrect) because as the number of coils increased so did the strength of the electromagnet.
20. Have students answer the following question: Does the number of times you coil the wire around the nail affect the strength of the electromagnet? (ESR): Yes!

**Extend/Evaluate**    ***(10 minutes extend; 5 minutes evaluate) The strength of an electromagnet is determined by the number of coils of wire.***

21. Extend. Have students graph their data. See **R1** for a sample graph.
22. Evaluate. Ask students to fold one sheet of their science notebook in half. Have student write label one side with “Properties of an Electromagnet” and the other side with “Properties of a Permanent Magnet.” Have students compare how electromagnets are similar to a permanent magnets. (ESR): Both types of magnets are attracted to some metals. Have students describe how electromagnets are different from permanent magnets. (ESR): An electromagnet is a temporary magnet.

# T-Chart

Number of Coils	Number of Paper Clips
20	
30	
40	
50	
60	

Graph Title:  
 Number of coils of wire vs. strength of an electromagnet

