Make an Electromagnet

Overview:

Students work together to make an electromagnet by creating a circuit using 6-volt batteries. Students pick up paper clips as a result of the magnetic field created around the wires carrying an electric current.

Objectives:

The student will:

- create an electric current that produces an invisible magnetic field;
- observe the invisible magnetic field generated around an electric current can behave like a magnet and attract objects, such as paper clips;
- determine that increasing the voltage supply increases the strength of an electromagnet; and
- conclude that increasing coils of wire around a nail increases the strength of an electromagnet.

Materials:

- Magnet wire
- Paper clips
- Nails
- Sandpaper (200 grit)
- Two 6-volt batteries per group of students
- Three battery hookups per group of students
- STUDENT WORKSHEET: "Make an Electromagnet"

Activity Procedure:

1. Distribute the STUDENT WORKSHEET: "Make an Electromagnet."
2. Instruct students to conduct two experiments to learn more about electromagnets.
3. Divide students into groups. Provide each group with the items on the materials list and ask students to collect the Control Data requested on the worksheet.
4. Ask students to check off the hypothesis they think will be most accurate, then proceed with Problem #1. Remind students to record their data in the data tables. After completing Problem #1, students should move on to Problem #2.

Teacher Note: During this activity, the current passing through the nail may cause it to get warm. If the nail gets hot, students should disconnect it from its power source immediately.

Answers to Student Worksheet:

Problem #1: ***Data:*** *answers will vary* ***Analysis of Data:*** *B. 80 wraps of wire + 6-volt battery*

Conclusion: *Changing the number of coils of wire around a nail will change the strength of the electromagnet. Other answers will vary.*

Further Questions: *1. electricity* *2. B. Temporary* *3. A. Increase*

Problem #2: ***Data:*** *answers will vary* ***Analysis of Data:*** *B. the 12- volt electromagnet*

Conclusion: *Changing the voltage supply will change the strength of the electromagnet. Other answers will vary.*

Further Questions: *1.A. Increase* *2. increase the voltage, increase the number of times wire is wrapped around the nail or magnet*

Name:_____ **Student Worksheet (1 of 5)**

Make an Electromagnet

Control Data:

How many paper clips does my nail pick up without additional wires or batteries attached to the nail? _____

How many paper clips does my 6-volt battery pick up without any additional wires or nails attached to the battery? _____

Problem #1: Coils

Testable Question:

Does changing the number of coils of wire around a nail change the strength of an electromagnet?

Background Information:

The concepts of electricity and magnetism have been known for a very long time. There is evidence that as early as 2000 B.C., the Chinese were aware of magnetism and that around 700 B.C. the ancient Greeks observed both electricity and magnetic phenomena. In particular, the Greeks discovered that when you rubbed a piece of amber it became electrified and would attract things like feathers and straw. There are naturally occurring magnets in the world; most common is the mineral magnetite, which is attracted to iron.

Scientists began to be aware of the connection between electricity and magnetism in the early part of the 19th century. In 1831, two scientists, Michael Faraday and Joseph Henry, working separately, demonstrated that when a wire is moved near a magnet, it creates an electric current. An electromagnet is defined as a magnet in which the magnetic field is created by a flow of electric current.

Hypothesis:

Use the background information provided by your teacher or on this worksheet to make a hypothesis (Check one):

_____ Changing the number of coils of wire around a nail will not change the strength of the electromagnet.

_____ Changing the number of coils of wire around a nail will change the strength of the electromagnet.

Name:_____ **Student Worksheet (2 of 5)**

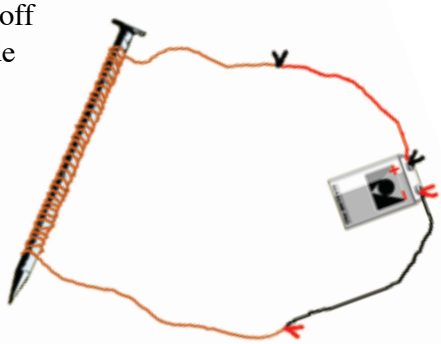
Make an Electromagnet

Experiment:

Materials:

- 6-volt battery
- 2 battery hookups
- Sandpaper
- Magnet wire
- Paper clips
- Nails

Procedure:



1. Make 40 wraps around a nail with magnet wire, leaving 2 inches on both ends. Using sandpaper, scrape 1/2 inch of enamel off each end of the wire so that a good connection can be made with the battery hookups.
2. Secure one end of the red battery hookup wire to one pole of a 6-volt battery. Clip the other end of the red hookup wire to one of the exposed ends of the magnet wire wrapped around the nail.
3. Clip the black hookup wire to the other battery pole and connect the black wire clip to the other exposed end of magnet wire.
4. Hold the connection for a few seconds. The wire-wrapped nail may get warm. **If it gets hot, disconnect immediately!**
5. Touch the nail to a small pile of paper clips and lift them. Count how many paper clips your electromagnet picked up and record the number on the data table.
6. Disconnect the electromagnet. Put the paper clips back in a pile and do the experiment again. Record results in the data table.
7. Unwind the wire from the nail in preparation for the next step.
8. Repeat steps 1-6, however, this time make 80 wraps around the nail with magnet wire.

Data:

Number of wire wraps	First Try	Second Try	Average
40			
80			

Make an Electromagnet

Analysis of Data:

1. Which electromagnet picked up the most paper clips?

   A. 40 wraps of wire + 6-volt battery B. 80 wraps of wire + 6-volt battery

Conclusion:

Place a check next to your conclusion.

_____ Changing the number of coils of wire around a nail did not change the strength of the electromagnet.

_____ Changing the number of coils of wire around a nail did change the strength of the electromagnet.

Was your hypothesis for Problem #1 proved or disproved? Use a complete sentence.

_____

Explain what evidence supports your conclusion. Use complete sentences.

_____

_____

_____

Further Questions:

1. A magnetic field is created when _____ passes through a wire.

2. When an electric current creates a magnet, is the magnet permanent or temporary? Circle the correct answer.

   A. Permanent B. Temporary

3. Does increasing the number of turns around the nail increase or decrease the magnetic strength? Circle the correct answer.

   A. Increase B. Decrease

Name:_____ **Student Worksheet (4 of 5)**

Make an Electromagnet

Problem #2: *Voltage*

Testable Question:

Does changing the voltage supply change the strength of an electromagnet?

Hypothesis:

Use the background information provided by your teacher or on this worksheet to make a hypothesis (Check one):

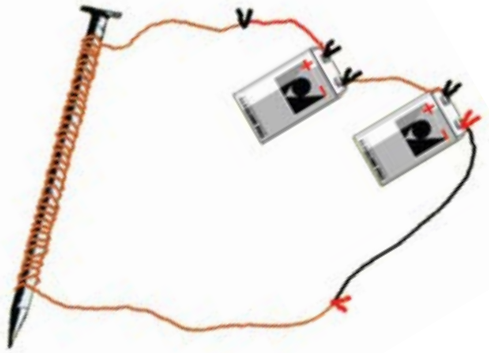
_____ Changing the voltage supply will not change the strength of the electromagnet.

_____ Changing the voltage supply will change the strength of the electromagnet.

Experiment:

Materials:

- 2 6-volt batteries
- 3 battery hookups
- Sandpaper
- Magnet wire
- Paper clips
- Nails



Procedure:

1. The first row of the data table for this activity can be completed by copying your data from the first row of your Problem #1 data table.
2. Make 40 wraps around a nail with magnet wire, leaving 2 inches on both ends.
3. Connect two 6-volt batteries in a series to make a 12-volt battery. Do this by connecting the positive pole of one battery to the negative pole of the next.
4. Connect the remaining positive pole to one end of the wire on the electromagnet and the remaining negative pole to the other.
5. Hold the connection for a few seconds. The wire-wrapped nail may get warm. **If it gets hot, disconnect immediately!**
6. Touch the nail to a small pile of paper clips and lift them. Count how many paper clips your electromagnet picked up and record the number on the data table.
7. Disconnect the electromagnet. Put the paper clips back in a pile and do the experiment again. Record results in the data table and calculate the average.

(Note: After current flows through the nail for a time, the nail will itself become magnetized. This can be reversed by periodically reversing the polarity of the leads to the battery.)

Name:_____ **Student Worksheet (5 of 5)**

Make an Electromagnet

Data:

Voltage	First Try	Second Try	Average
6 volts (1 battery)			
12 volts (2 batteries)			

Analysis of Data:

1. Which electromagnet picked up the most paper clips?

   A. the 6-volt electromagnet B. the 12-volt electromagnet

Conclusion:

Place a check next to your conclusion.

_____ Changing the voltage supply did not change the strength of the electromagnet.

_____ Changing the voltage supply did change the strength of the electromagnet.

Was your original hypothesis for Problem #2 proved or disproved? Use a complete sentence.

_____

_____

Explain what evidence supports your conclusion. Use complete sentences.

_____

_____

_____

Further Questions:

1. Does increasing the voltage increase or decrease the magnetic strength? Circle the correct answer.

   A. Increase B. Decrease

2. What two things can be done to make an electromagnet more powerful?

_____

