

## 20. What Is an Electromagnet?

Can electricity create a magnet?

### MATERIALS

- |   |   |
|---|---|
| <input type="checkbox"/> Data collection system | <input type="checkbox"/> Scissors                                 |
| <input type="checkbox"/> Voltage sensor         | <input type="checkbox"/> Masking tape, ~20 cm                     |
| <input type="checkbox"/> AA-cell battery (2)    | <input type="checkbox"/> Large iron nail, 3 to 4 inches long      |
| <input type="checkbox"/> Paper clip (10 to 15)  | <input type="checkbox"/> Insulated bell wire, 22 to 26 gauge, 1 m |

### Safety

Always follow your teacher's directions when doing any activity.

### Investigation

After you complete a step or answer a question, place a check mark in the box (☐) next to that step.

When you see the symbol "◆" with a superscripted number following a step, refer to the numbered Tech Tips listed in the Tech Tips appendix that corresponds to your PASCO data collection system. There you will find detailed technical instructions for performing that step.

#### Get Started

- What are some different uses for magnets? What are some examples of toys or devices that use magnets?

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- What are the parts of an electric circuit?

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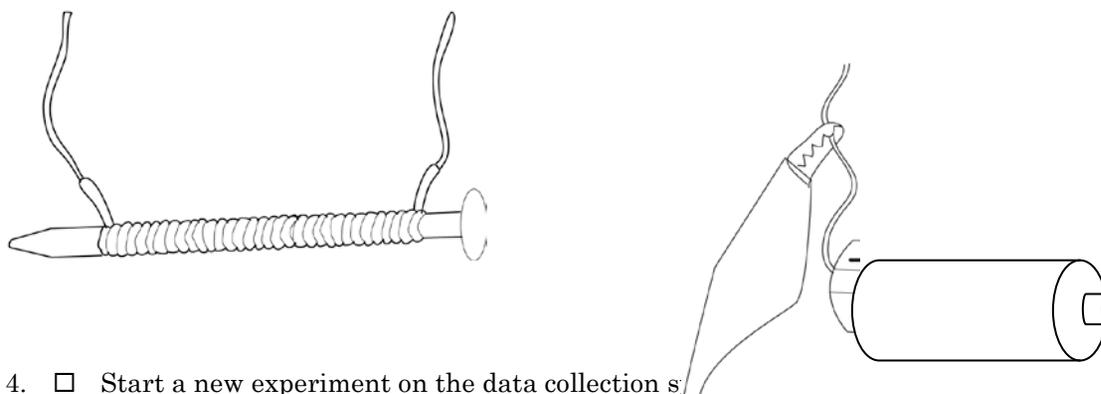
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## What Is an Electromagnet?

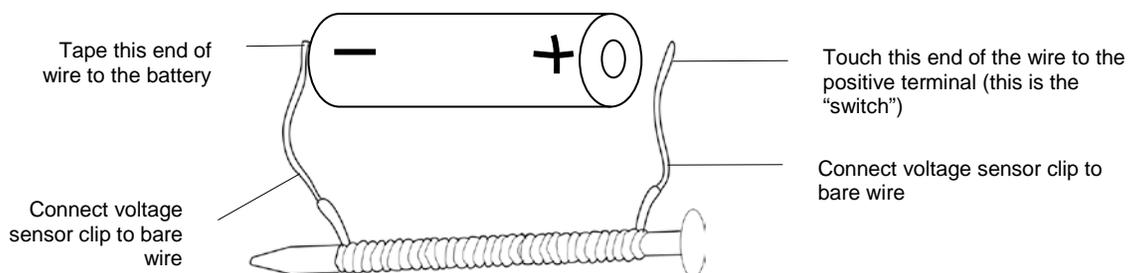
### Let's Explore

In this part of the activity you will construct an electromagnet using a nail, a long piece of wire, and one AA battery.

- While keeping about 10 cm of wire free on the starting end, begin winding your long wire neatly in a coil around the nail. Leave about 40 cm of wire free on the other end. Try to make the turns of wire in your coil as close together as possible, and as neat as possible, as shown in the illustration below.



- Start a new experiment on the data collection system.
- Connect a voltage sensor to the data collection system. ♦(2.1)
- Display voltage in a meter display. ♦(7.4.1)
- Use a piece of tape to connect one end of the wire coil to the negative end of the battery.
- Use an alligator clip adapter to connect the black lead from the voltage sensor to the bare part of the coiled wire where it connects to the battery.



- Use an alligator clip adapter to connect the red lead clip of the voltage sensor to the other end of the coiled wire.

**Note:** You will touch this wire to the positive end of the battery to close the circuit. This is your circuit's switch.

- Monitor live voltage data. ♦(6.1)
- Touch the wire to the positive end of the battery and place the pointed tip of the nail near some paper clips.

12.  Are the paper clips attracted to the nail? Can you pick up a paper clip from the table?

Explain It

13.  Open and close the switch in your electromagnet circuit. As you do, observe the change in voltage across the circuit.

14.  How does the voltage change when the switch is open and closed?

15.  How does the electromagnet's ability to attract paper clips change when the switch is opened and closed?

16.  In your investigation of electricity and magnetism you learned some new scientific ideas and terms. It is important to be able to discuss your results using these words and terms correctly.

Write the meaning of the following terms in your own words using what you have learned from the lab.

➤ Vocabulary and definitions

Circuit	
Electromagnet	
Switch	
Magnetic	
Coil	

## What Is an Electromagnet?

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Tell Me More

17.  What would happen to the strength of your electromagnet if you connected it to two batteries? How would the voltage of your circuit change if you used two batteries instead of one? Write your prediction in the space below.

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18.  Connect a second battery to your circuit. Use tape to hold the negative end of the second battery to the positive end of the first battery.
19.  Try your electromagnet by closing the switch. See how many paper clips your electromagnet can pick up. How does this compare to your electromagnet when there was only one battery in the circuit?

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20.  Monitor live voltage data. <sup>◆(6.1)</sup>
21.  Open and close the switch in your electromagnet circuit. As you do, observe the change in voltage across the circuit.
22.  How does the voltage change when the switch is open and when it is closed?

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23.  Besides using additional batteries, can you think of any other way to increase the strength of your electromagnet? Write your idea below.

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24.  Try your idea for increasing the strength of your electromagnet. What was the result?

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Sum It Up

25.  How did the number of batteries used affect the strength of your electromagnet?

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26.  Can electricity make a magnet?

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27.  If you needed to build an electromagnet that could pick up a heavy, metal object such as a car, would it be better to design it with fewer or with more turns of wire in its coil?

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28.  An electromagnet is part of an electric circuit. What evidence did you have from the voltage sensor that the electromagnet works only when the circuit is closed?

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29.  Can you turn off the magnetism of an electromagnet? If so, how can this be done?

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## What Is an Electromagnet?

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### Assessment

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#### Multiple Choice

**Darken the circle of the best answer to each of the questions below. Be prepared to give the reasons for your choices.**

1. A magnet made of a coil of wire with electricity flowing through the coil is called a/an
  - Ⓐ Permanent magnet
  - Ⓑ Electromagnet
  - Ⓒ Refrigerator magnet
2. When the voltage is zero there is
  - Ⓐ An open switch in the circuit with the electromagnet
  - Ⓑ A closed switch in the circuit with the electromagnet
  - Ⓒ Two closed switches in the circuit

#### True or False

**Enter a "T" if the statement is true or an "F" if it is false.**

- \_\_\_\_\_ 1. A circuit contains a source of electricity, connecting wires, a load, and a switch.
- \_\_\_\_\_ 2. A coil of wire always makes magnetism, even when no electricity flows in the coil.

#### Key Term Challenge

**Fill in the blanks from the list of randomly ordered words.**

switch	wires	load	coil
source	flow	conductor	insulator

1. A \_\_\_\_\_ is a material through which electricity can easily flow.
2. When electricity flows through a \_\_\_\_\_ of wire, an electromagnet is formed.
3. The \_\_\_\_\_ of an electric circuit must be closed in order for electricity to flow.