



LAB 60: ELECTROMAGNETS

Lab 60: Electromagnets

Remind students not to keep the electromagnet connected too long or the battery wire can get hot. Even the bell wire that appears to be copper colored has enamel on it, and the ends must be stripped to connect to the battery. The wire should be at least 1 m long in order to increase the resistance and decrease the current running through the wire. Be sure that students do not hook the paper clips onto the nail; they should only stick them magnetically to it. Some of the answers may vary depending on the wire, battery, and number of coils used.

Students will construct electromagnets and test to see which variables make them stronger. Although elementary and middle school teachers are expected to have done this activity with their classes, teachers of younger students often do not have access to the equipment. Therefore every student should complete the activity to understand transformers, electric motors, speakers, and generators.

Post-Lab Answers

1. a-e: Stronger
f: Weaker
2. An iron core drastically increases the strength of the electromagnet.
3. The battery voltage increases the strength of the magnet as long as the battery is capable of providing enough current.

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QUESTION

What affects the strength of an electromagnet?

SAFETY

Do not keep an electromagnet hooked up for more than 15 seconds or the wire and the battery will get very hot and the battery will die. Do not plug any of these items into a wall socket or connect them to a car battery or other large battery.

MATERIALS

2 D-cell batteries, enameled bell wire, iron nail, small compass, multimeter, sandpaper

PROCEDURE

In this lab, you will make an electromagnet and study how different things affect its strength. First, you will see how an iron core affects your magnet. Build your electromagnet by stripping an inch of the enamel (the colored paint) off each end of your wire with sandpaper. Then wrap the wire around an iron nail. Test your D battery to see that it is not dead. It needs to be more than 1.25 V to be considered good. Be sure to use a long piece of wire or you will short out the battery, and both the battery and wire will get hot while the battery quickly dies.

Part 1

1. Connect the electromagnet to the battery. It doesn't matter which way you connect the wires to the battery. Put one wire on top and one wire on bottom. Don't leave the electromagnet hooked up for more than 15 seconds at a time or it will get hot and your battery will die.

Lab 60: Electromagnets

- Determine how many small paper clips you can pick up with this electromagnet. Open one paper clip and form a hook out of it. Stick it to the electromagnet and then hang more paper clips from the hook. Don't connect the paper clip to the nail. It should be sticking to it, not hanging on it.
- Now slide the nail out from the coil of wire and see how many paper clips you can pick up with just the coil.

Electromagnet with iron core _____ paper clips

Electromagnet without iron core _____ paper clips

Part 2

Now you will see if voltage makes a difference in the power of a magnet. Test both of your batteries to make sure that they are not dead.

- Connect the electromagnet to the batteries connected in series (stacked on top of each other). Don't leave it hooked up for more than 15 seconds.
- Determine how many small paper clips you can pick up with the electromagnet.
- Slide the nail out and see how many paper clips you can pick up.

Electromagnet with iron core _____ paper clips

Electromagnet without iron core _____ paper clips

Part 3

Now you will determine how the direction of the battery affects the poles of the electromagnet. You will do this by bringing the tip of the electromagnet near a small compass. Whether the tip of the compass is attracted or repelled by the magnet will tell you its polarity. Remember that the Earth's north pole is actually a magnetic south pole. So, the tip of the electromagnet that attracts the tip of the compass is also a magnetic south pole. If it is repelled, then it is a magnetic north pole.

- Attach your electromagnet with the iron core to the battery in such a way that the wire from the flat end of the nail is connected to the positive side of the battery and the wire from the pointed end of the nail is connected to the negative terminal.
- Use the compass to determine if the pointed end of the nail is north or south.
- Now switch the terminals of the power supply and repeat the test. Is the pointed end now north or south?

BE SURE TO SAVE YOUR WIRE WHEN YOU'RE DONE. YOU MAY USE IT AGAIN.

Section 4

Post-Lab Questions

1. Give your best guess of how each of the following things would affect the strength of the electromagnet by putting "stronger" or "weaker." If you don't know the first four, design an activity to figure them out.
 - a. more coils of wire
 - b. using a wire with a lower resistance
 - c. a thicker nail
 - d. using a thicker wire
 - e. using a car battery
 - f. using AC instead of DC
2. How did an iron core affect the strength of the magnet?
3. How did the voltage of the battery affect the strength of the magnet?

Extension

Find out if electromagnets are really used to pick up cars in junkyards or if that is only in the movies. If they are used, find out more about them, such as how strong they are and how much current flows through them.