Activity: Electromagnetism (Cup Speakers)

Materials

- 1 round magnet (½ to ¾ inch diameter)
- 15ft., 20-24 gauge coil wire (enamel-coated)
- 1 cup
- 1 D-cell battery

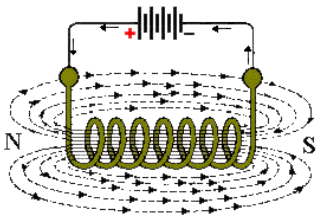
- Sandpaper
- Electrical tape
- Radio w/ detachable speakers (minimum 20W output)

Introduction

Magnets are incredibly important and are used in many devices, from the complex to the commonplace. Car doors, computers, vacuum cleaners, TVs and even radio speakers work because of magnets.

As a bioengineer, you might work with machines that use magnets, such as an MRI (Magnetic Resonance Imaging) machine. MRIs allow doctors to see inside the body without having to perform surgery. MRIs use a special kind of magnet called an **electromagnet**.

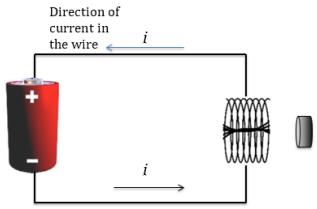
Did you know? When electricity flows through a wire, it creates a very small magnetic field. By turning the wire into a coil, the effect can be magnified to produce an electromagnet.



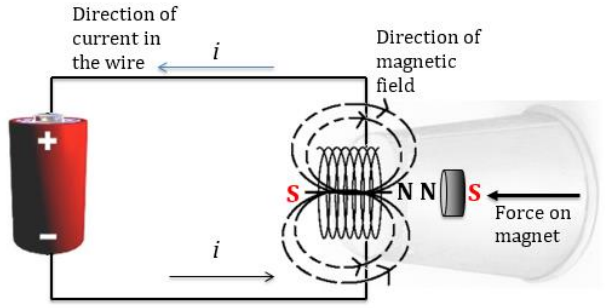
In this activity, you will make a radio speaker using an electromagnet.

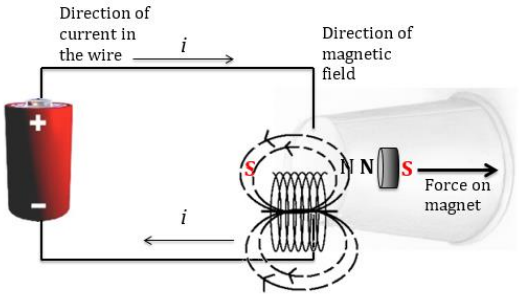
Building your Speaker

1	Wind 80 turns of wire around the D-cell battery. **Leave about two inches of wire hanging off each end.**	
2	Rub sandpaper on the free wire at each end of the coil to remove **about 1 inch** of enamel insulation. Show your activity leader when you think you have removed enough.	
3	While keeping the wire in the shape of a coil, carefully remove it from the D-cell battery. Then tape the coil, so it does not unravel.	

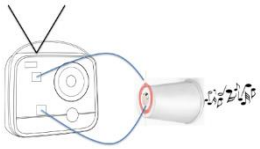
4	Hold the ends of the wire to the battery—one wire to the top of the battery, one wire to the bottom of the battery. Move the coil close to the magnet and observe its motion. Switch the wires to touch the battery at opposite ends, and see what happens to the magnet. *(When the coil is connected to the battery in one way, one side of the coil is the north pole, and the other side is the south pole of the electromagnet. The north pole of the electromagnet will be attracted to the south pole of the permanent, round magnet. When the battery is turned around, the poles of the electromagnet are reversed.)*	
5	Attach the permanent, round magnet to the bottom (inside) of the cup with tape. Try to center it as best you can.	
6	Attach the coil to the bottom (outside) of the cup with tape. Make sure the magnet and the coil are centered and secured with tape.	
7	With the help of an activity leader, connect the ends of the cup speaker wire to the radio speaker output connector. Choose the plugs for one speaker (the left, for example) and insert one end of the wire from the cup speaker into one hole, and the other end of the wire into the other hole.	

Turn the radio on and adjust the volume. When more current flows through the wire coil, the electromagnetic force increases.





As the radio output current changes direction very fast, the changing electromagnetic force causes the round magnet to vibrate. The vibration creates sound waves in the air, which is what you hear as sound!



CAUTION: The speaker wires may get hot. When electric current flows through the wire, some of the electrical energy is converted to heat energy due to the resistance inside the wire.

There are a few ways to make your electromagnet stronger. Put an "X" in two of the four boxes below, next to the two ideas that you think will increase the strength of your electromagnet:

Increase current (electricity) through wire.	☐	Add more coils.	☐
Cover the open end of the cup.	☐	Cover the coils in plastic.	☐

Below are four MRI scans. These machines use strong magnetic fields to make water molecules vibrate, like the magnet in the speaker activity. These vibrations create very small radio waves that can be measured by the machine. The human body is comprised of approximately 70 percent water. Since each biological tissue contains different amounts of liquid, it is possible to read images from each part of your body, based on the vibration of the water within the body part being scanned, and with much more detail than a traditional X-ray. Which body parts below have been scanned by a Magnetic Resonance Imaging machine? Fill in the boxes with the names of the body part.

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