

# Electromagnetic Induction Potpourri

**Objective:** We will explore various properties of electromagnetic induction through four activities.

**Procedure:** Complete the following steps and questions in your lab group.

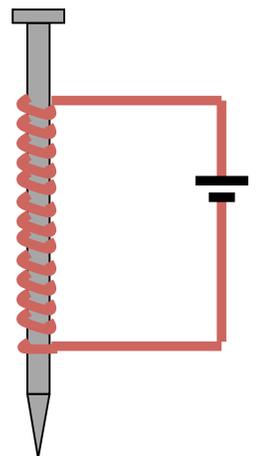
## Station 1: Coils, Batteries and Nails Oh My!

- Each group member should have one meter of magnetic wire, lead wires with alligator clips, two D-cell batteries with holders, one nail, and paper clips.
- Wrap the magnetic wire around the nail roughly 40 times.
- Connect the alligator clips leads from the end of the magnetic wire to the positive and negative terminals of one D-cell battery holder.
- Congratulations, you just made an electromagnet.
- Try and pick up loose paper clips. How many were you able to chain together and pick up? \_\_\_\_\_
- Reconnect your new electromagnet to two D-cell batteries.
- Try and pick up loose paper clips. How many were you able to chain together and pick up? \_\_\_\_\_
- Double the number of coils (80) on you electromagnet and reconnect to the two D-cell batteries.
- Try and pick up loose paper clips. How many were you able to chain together and pick up? \_\_\_\_\_

### Closure:

1. What relationship did you discover between number of coils and magnetic field strength?
2. What relationship did you discover between the number of batteries and magnetic field strength?
3. Why would a magnetic field that could be turned on and off be useful?

**Discussion:** The idea behind an electromagnet is simple. Electric current passing through a wire creates a magnetic field. Placing a wire around an iron nail will magnetize the nail while wire carries electricity. When the wire doesn't carry current the nail will no longer be magnetized. For the electromagnet to remain "on", a continuous supply of electrical energy is required to maintain the magnetic field. This is the ultimate type of temporary magnet. It can be turned on or off with a switch and the strength can be increased or decreased by changing the current passing through the wire. As current passes through the wire small magnetic regions within the iron nail, domains, align with the wire's magnetic field. This turns the electromagnet "on". When the current is turned off, the domains un-align and the electromagnet is turned "off". If the current is increased, all of the domains eventually become aligned and the strength of the electromagnetic increases. Motors, speakers, hard drives, and electric toothbrushes use this principle.



## Station 2: Speakers 🎧 🎧 🎧

- ❑ Each group member should have one meter of magnetic wire, connecting wires with alligator clips, two ring magnets, sandpaper, film canister, tape, stereo, and whatever material you plan to use to build the speaker.
- ❑ Connect the sample speaker and inspect its makeup before constructing your own.
- ❑ Wind the magnetic wire around a film canister leaving 3-5 cm of straight wire at each end. Remove the wire from the film canister and wrap the end length so they hold the loop in place as shown in the diagram below. Use sandpaper to remove the insulating coating on the end pieces of wire.



- ❑ Tape the coil to the speaker diaphragm (whatever material you brought to construct your speaker).
- ❑ Place two ring magnets in the center of the coil, one on either side of the diaphragm. The attractive forces of the magnet should pin them in place.
- ❑ Connect the sanded ends of the speaker coil to the stereo.
- ❑ Turn the music on and enjoy your new sound system.

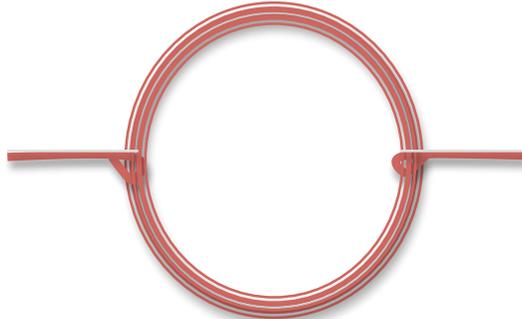
### Closure:

1. What purpose do the permanent magnets serve when placed in the current carrying coil of wire?
  
  
  
  
  
  
  
  
  
  
2. What are two things you could change about your speaker setup to increase its strength?

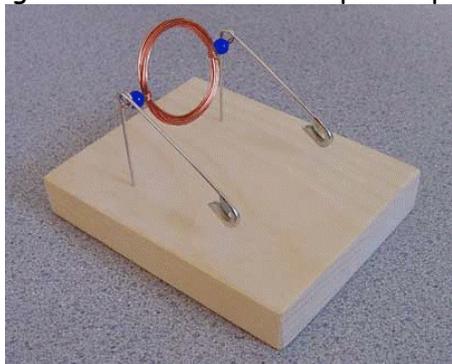
**Discussion:** A speaker generates sound by moving a diaphragm back and forth through the air. When surface moves toward you, it compresses the air in front of it and each time the surface moves away from you, it rarefies (spreads out) that air. By doing this repetitively, the speaker forms patterns of compressions and rarefactions in the air that move forward as sound. The magnet is part of the system that makes the surface move. Attached to the diaphragm is a coil of wire that fits around the speaker's permanent magnet. When an electric current passes through the coil of wire, the moving electric charges create a magnetic field that interacts with the permanent magnet. The forces of attraction and repulsion between the coil and permanent magnet moves the diaphragm, which in turn produces sound.

### Station 3: Motors

- ❑ Each group member should have one meter of magnetic wire, connecting wires with alligator clips, two ring magnets, sandpaper, film canister, tape, two D-Cell batteries and holders, two large safety pins, and block of wood.
- ❑ View (but, don't touch) the spinning sample motor before constructing your own.
- ❑ Wind the magnetic wire around a film canister leaving 3-5 cm of straight wire at each end. Remove the wire from the film canister and wrap the end length so they hold the loop in place as shown in the diagram below. Use sandpaper to remove the insulating coating on the top-side (only) of the straight ends of the wire.



- ❑ Put the safety pins in the block of wood and place the straight ends of the coil in the safety pin hole as shown below. Adjust the straight ends so that the loop will spin without wobbling.



- ❑ Use tape to hold the magnets below the coil on the wood block. The magnets should be close to the coil, but the coil needs to be able to spin without hitting the magnets.
- ❑ Use the connecting wires to attach the two D-Cells to the safety pins. Right before the pin goes into the wood is a good place to attach the alligator clips.
- ❑ Give the coil a gentle push to start it turning. Make fine adjustments on the loop, paper clips, and so on, to reduce friction until the motor works easily and spins on its own.

#### Closure:

1. How could you make the motor turn in the opposite direction?
2. What are three ways that the experiment could be modified to give the motor a greater speed?
3. What causes the coil to spin?

