

# Electromagnets in Audio Speakers Laboratory

## Materials

AM/FM radio with a headphone jack		Phillips screwdriver
Earphone plug	2 alligator clips	2 90-cm prepared piece of #22 hook-up wire
6 ring magnets	sandpaper square	6-m piece of #28 enameled wire
Pie pan		

## Procedure

1. Remove the housing of the earphone plug by turning it counterclockwise.

2. Insert one end of each of the hook-up wires through the housing, and connect the two bare ends to the two metal posts inside the plug. Place the wire through the hole and then twist it as tightly as you can against its terminal to make a good contact between each wire and its terminal post. To make sure that the bare wires do not touch each other, add a small piece of nonconductive material between the posts to keep the posts and their bare wires separated (e.g., a tiny scrap of paper, piece of electrical tape, or rubber band).

3. Slide the housing over both the wires and turn it clockwise to tighten.

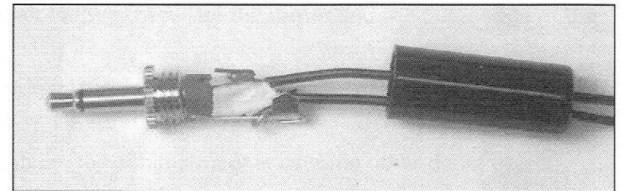
4. Loosen the screws on the two alligator clips, and attach the clips to the free ends of the hook-up wires. Pass the end of a wire through the cylinder of the clip and hook it around the screw. After hooking each wire around a screw, carefully tighten the screws to make a good contact.

5. You now have two wires with alligator clips at one end and an earphone plug at the other end. Make sure that your setup looks like the photo at right.

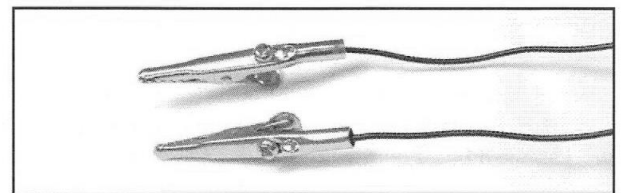
6. Find a smooth cylinder that is slightly larger than the diameter of the ring magnets (28 mm). A two-liter bottle cap is one possibility, with a diameter of 29-30 mm. Wrap the enameled wire around the cylinder in a very tight, narrow coil, leaving about 25 cm on each end to wrap around the left and right sides of the coil to keep the coil together. Leave around 12 – 15 cm free on each end, for attachment to the alligator clips of the earphone wires.

7. Sand the enamel finish off each end (3 – 5 cm) to allow good electrical contact.

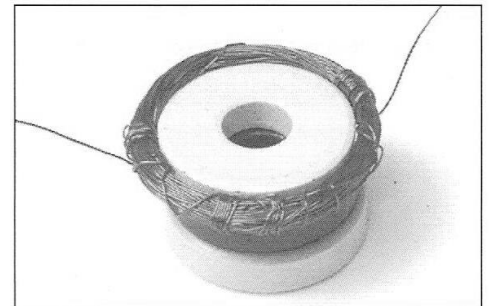
8. Stack three circular magnets on a level surface and slide the enamel wire coil down on the first magnet until the coil is even with the top of the magnet.



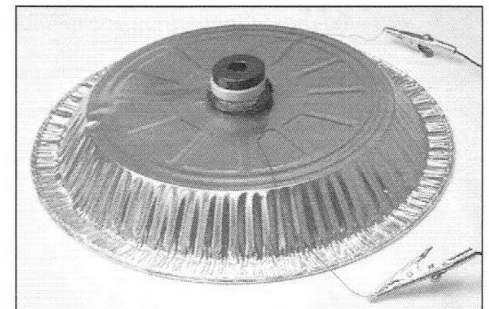
Earphone plug posts with connected wire



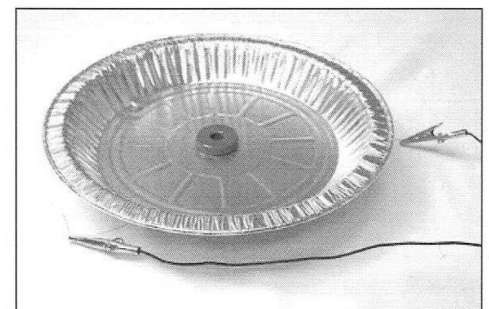
Alligator clips attached to other ends of the wires



Wire coil on magnets



Pan and magnet/wire assembly (bottom)



Pan and magnet/wire assembly (top)

9. Plug the earphone jack into the radio and connect each end of the coil wires to the alligator clips of the earphone wires.
10. Center an aluminum pie pan over the coil/ magnet assembly and place another magnet in the center of the pan on top to secure it.
11. Turn on the radio, select a station, and turn up the volume until you hear sound. If you hear no sound, make sure the alligator clips are not touching each other and are making contact with the sanded ends of the coil wire. If there is still no sound, check the wires in the earphone jack to make sure they are separated. The two wires must never touch.
12. With the radio still on, remove the pan and lift the wire coil from the top magnet. Slowly move it up and down over the permanent magnets. What do you feel and hear?
13. Add two more magnets to the bottom of the stack of magnets, replace the coil around the top magnet, place the aluminum pan on top, and secure it again, with a magnet on top. Place some crystals of sand or salt halfway between the center and the outer edge of the pan. Describe what you see.
14. Now experiment to see how the number of magnets (up to six) beneath the pan and the type of materials used for speakers will affect the sound quality.
15. Always place an object on top of the pan to stabilize it – either a magnet or some other dense object.
16. Try different types of materials (metal pans, cans, plastic deli trays, etc.) and see how sound is affected.
17. Devise an experiment using materials provided by your teacher to investigate whether speaker diameter creates different pitches (low, mid-range, or high).
18. Many cabinet speakers for stereos have a system of three types of speakers: woofers (for low bass sounds), mid-range (for sounds between bass and high pitches), and tweeters (for high pitches). Build a 3-in-1 speaker by stacking three pans, cans, deli trays, or the like to make a woofer, mid-range, and tweeter. How does the sound of this speaker compare with that of a single speaker?

## Questions

1. What happens to the coil of wire when you turn on the radio and electric current flows through the wire?
2. Why is there no sound until the coil of enameled wire is placed near the permanent magnets?
3. Why does the sound quality improve as you place a thin material like a plastic container or an aluminum pan on top of the wire coil and permanent magnet?
4. How does the speaker diameter affect the range of sound that is produced?
5. How does the number of permanent magnets affect the sound volume and quality?
6. List all of the energy transformations that take place from the radio station to the radio, to the earphone jack, and to the earphone or speaker.