

Building Speakers

Overview: We'll be making different kinds of speakers using household materials (like plastic cups, foam plates, and business cards!), but before we begin, we need to make sure you really understand a few basic principles.

What to Learn: An electrical signal (like music) zings through the coil (which is also allowed to move and attached to your speaker cone), which is attracted or repulsed by the permanent magnet. The coil vibrates, taking the cone with it. The cone vibrates the air around it and sends sound waves to reach your ear.

Materials

- foam plate
- plastic cup
- copy paper (one sheet)
- business cards (3)
- magnet wire AWG 30 or 32 (RS#278-1345)
- neodymium magnets (2-4, use these from previous experiments)
- disc magnet (1" donut-shaped magnet) (RS#64-1888)
- index cards or stiff paper
- cup (plastic disposable)
- tape
- hot glue gun
- scissors
- audio plug (RS #42-2420) or other cable that fits into your stereo (iPods and other small devices are not recommended for this project – you need something with built-in amplifier like an old boombox)

Lab Time

1. Cut a business card in half lengthwise. Fold each strip in half, and then fold the lengths in half again so you have a W-shape.
2. Stack your magnets together and roll a small strip of copy paper around the magnets. Tape the paper into place. Do this one more time, so you now have two paper cylinder sleeves around your magnets.
3. Wrap the magnet wire 20-50 times around the paper tube (keep the magnets inside so this step is easier). Secure with tape.
4. Carefully remove only the *inside* paper sleeve and discard (you can take the magnets out when you do this).
5. Trim one side of the paper so one side of the coil is near the paper edge.
6. Hot glue the uncut side of the paper tube to the bottom of a foam plate.
7. Hot glue one side of the W-shape of the business card to the bottom of the foam plate. You want a W-shape on either side of the paper tube, an inch or two away.
8. Hot glue your magnets to the center of a stiff piece of cardboard.
9. Place your paper tube over the magnets and glue the W-shapes to the cardboard. These are your "springs."

10. Tap the plate lightly with your finger. Make sure the foam plate is free to bounce up and down.
11. Sand the ends of each magnet wire to strip away the insulation.
12. Unscrew the plastic insulation from the audio plug and wrap one wire around each terminal. Make sure the two contacts and wires don't touch each other, or your speaker won't work. You can secure each connection with tape.
13. Plug it into your boombox and play your music on the highest volume. You should hear the music coming from your speaker!

Reading

Let's talk about the telegraph. A telegraph is a small electromagnet that you can switch on and off. The electromagnet is a simple little thing made by wrapping insulated wire around a nail. An electromagnet is a magnet you can turn on and off with electricity, and it only works when you plug it into a battery.

Anytime you run electricity through a wire, you also get a magnetic field. You can amplify this effect by having lots of wire in a small space (hence wrapping the wire around a nail) to concentrate the magnetic effect. The opposite is true also – if you rub a permanent magnet along the length of the electromagnet, you'll get an electric current flowing through the wire. Magnetic fields cause electric fields, and electric fields cause magnetic fields. Got it?

A microphone has a small electromagnet next to a permanent magnet, separated by a thin space. The coil is allowed to move a bit (because it's lighter than the permanent magnet). When you speak into a microphone, your voice sends sound waves that vibrate the coil, and each time the coil moves, it causes an electrical signal to flow through the wires, which gets picked up by your recording system.

A loudspeaker works the opposite way. An electrical signal (like music) zings through the coil (which is also allowed to move and attached to your speaker cone), which is attracted or repulsed by the permanent magnet. The coil vibrates, taking the cone with it. The cone vibrates the air around it and sends sound waves to reach your ear.

If you placed your hand over the speaker as it was booming out sound, you felt something against your hand, right? That's the sound waves being generated by the speaker cone. Each time the speaker cone moves around, it creates a vibration in the air that you can detect with your ears. For deep notes, the cone moves the most, and a lot of air gets shoved at once, so you hear a low note. Which is why you can blow out your speakers if your bass is cranked up too much. Does that make sense?

Exercises Answer the questions below:

1. Does it matter how strong the magnets are?
2. What else can you use besides a foam plate?
3. Which works better: a larger or smaller magnet wire coil?
4. How can you detect magnetic fields?
5. How does an electromagnet work?
6. How does your speaker work?
7. Is a speaker the same as a microphone?
8. Does the shape and size of the plate matter? What if you use a plastic cup?

Answers to Exercises: Building Speakers

1. Does it matter how strong the magnets are? (Yes, the stronger they are, the better the signal you hear from the speaker.)
2. What else can you use besides a foam plate? (plastic cups, paper plates...)
3. Which works better: a larger or smaller magnet wire coil? (larger)
4. How can you detect magnetic fields? (with a compass)
5. How does an electromagnet work? (When you put electricity through the wire, it turns it into a magnet.)
6. How does your speaker work? (Refer to the Background Reading Section.)
7. Is a speaker the same as a microphone? (No – they are opposite. Refer to the Background Reading Section.)
8. Does the shape and size of the plate matter? What if you use a plastic cup? (Yes – shape and size do matter!)