

# Hearing Magnetism

**Overview** Want to *hear* your magnets? We're going to use electromagnetism to learn how you can listen to your physics lesson, and you'll be surprised at how common this principle is in your everyday life.

**What to Learn** When a magnet moves next to a coil, it creates an electrical current in the coil. In a microphone, a magnet moves at the frequency of your voice next to a coil, which transmits your sound vibrations to an electrical signal.

## Materials

- Magnet wire
- Sandpaper
- 3 nails
- 4 different magnets
- Audio amplifier (RS #277-1008)
- Audio plug (RS #42-2420)

## Lab Time

1. Wind the magnet wire around the nail to make the electromagnet. Use a drill if you want to speed this up.
2. Use sandpaper to strip off the enamel coating of both ends of the magnet wire.
3. Take the audio plug apart by untwisting the casing from the metal pin.
4. Thread the metal wires from the electromagnet through the metal casing, narrow end first.
5. Thread one of the wires through the bottom hole of the metal plug and fold it back over into itself, twisting to secure it into place. Make sure you've sanded well to make a good metal connection.
6. Put the second electromagnet wire through two of the side tab holes, twist to secure.
7. Wrap each connection with a piece of tape to insulate them from each other. Since these wires are exposed in a tight space, it's easy for them to touch each other and short circuit.
8. Twist the casing back onto the metal plug.
9. Plug this into your audio amplifier. You should have an electromagnet plugged into the amplifier.
10. Make sure you have a 9V battery in your amplifier!
11. Turn on the amplifier. Turn the volume all the way up!
12. Bring a magnet close to the electromagnet, rubbing it along its length. What happened? Write it here:

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[illegible]

## Reading

We're going to invert the ideas used in an experiment (*Homemade Speakers*) into a basic microphone. Although you won't be able to record with this microphone, it will show you how the basics of a microphone and amplifier work, and how to turn sound waves back into electrical signals.

An amplifier's job is to take small electrical voltages (AKA the 'input') and make them bigger (*amplify* them). Then, we usually plug a speaker or headphones into the amplifier and those turn the bigger electrical signal (AKA the 'output') into sound. So any small voltage that we plug into the amplifier's input will get larger and then turn into sound through the built-in speaker.

One way to show this is to use a coil of wire and a magnet. If you take a coil of wire and move a magnet past, around, or through it, you will create a small electrical voltage (and current) in the wire. In fact, if you have enough wire and a big enough magnet, and move the magnet fast enough, the electricity coming out of the coil of wire can light up a light bulb (this is how an electric generator works).

So back to the amplifier: If we take the voltage from our little coil/magnet generator, and we put it into the amplifier, we'll hear the sound from the speaker each time it makes a voltage. If we move the magnet back and forth really fast, we'll hear a fast clicking sound. And if we were to move it super-incredibly-fast (faster than you could with your hands), then those clicks would blend together into a tone. Tones like this are what all sounds are made of.

In fact, this is exactly what a microphone does. Many microphones have a magnet and a coil of wire attached to a very thin piece of plastic or metal that vibrates when sound waves hit it. The plastic (or metal) in turn moves the coil of wire next to the magnet super-fast. Then this causes the electric voltage to come out of the coil, and if you plug it into an amplifier it will make the same sound that the microphone heard, only louder.

## Exercises

1. Why does the electromagnet make sound when you bring the permanent magnet close to it?
2. How is this like a microphone?
3. What did the aluminum do to the electromagnet?

**Answers to Exercises: Hearing Magnetism**

1. Why does the electromagnet make sound when you bring the permanent magnet close to it? (When the magnet comes close to the electromagnet, it gets magnetized in increments, which is what the sounds are in the amp as the atoms are lining up.)
2. How is this like a microphone? (The magnet moves in and out at the frequency of your voice next to a coil, which transmits your sound vibrations to an electrical signal. In our experiment, we are physically moving the magnet next to a coil of wire, which is transforming that signal to an electrical signal.)
3. What did the aluminum do to the electromagnet? (The aluminum sheet worked against the moving magnet by creating eddy currents that canceled out the magnet's effect on the electromagnet, so you don't hear very much.)