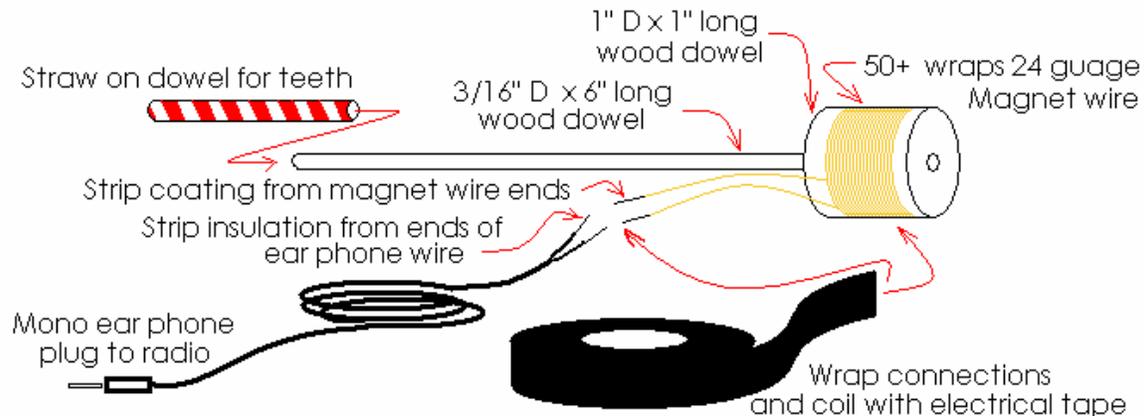


Ear Drum Speakers

Purpose: To make ear drums into speakers using opposing magnetic fields from a permanent magnet and an electromagnet.

Materials: 3/16" wood dowel, 1" wood dowel, flat toothpicks, wood glue, mono earphone with plug, straws, electrical tape and 24 gauge magnet wire, wire strippers.



Procedures:

Construction (skip this step if your device is already made):

- 1) Using wood glue, push the 3/16" dowel into the drilled hole of the 1" dowel. If it is not a snug fit, then use some small wood splinters or flat toothpicks to take up some space.
- 2) Use 24-gauge magnet wire to make the wire coil on the 1" dowel. Make sure that you use magnet wire because it has a thin plastic coating so that individual strands of wire cannot touch each other. Without the coating, there will not be a continuous coil. Wind the wire at least 50 times leaving several inches of free wire on each end. Make several wraps of electrical tape around the magnet wire to hold it in place on the dowel while leaving the ends exposed.
- 3) Using a fine piece of sandpaper or a utility blade scrape about 3/4" of insulation off each end of the magnet wire. You can see that the wire looks different without insulation. Make sure that it is striped all the way around.
- 4) Cut the earpiece off the mono earphone so that the length of wire is still left on the plug end. The earpiece is not needed.
- 5) Use wire strippers to strip about 3/4" of insulation from the ends of the earphone wire.
- 6) Wipe both striped ends of the magnet wire and ear phone wire with a clean cloth to remove any skin oils and wind one magnet wire with one ear phone wire so that you have two separate connections. These can be soldered, but is not necessary. Wrap the connections with a small amount of electrical tape so that no uninsulated parts are exposed. To take the strain off these connections, they may be taped to the 3/16" dowel next to the wire coil. This completes the construction of the apparatus.

Activity:

- 1) Cut a piece of drinking straw and slide it over the end of the 3/16" dowel. You will bite down on this with your teeth. Each user will use a fresh straw for good hygiene.
- 2) Find a boisterous radio station and plug in the earphone plug; turning the volume up high once plugged in.

- 3) Bite down on the end of the dowel with straw and bring two or three 1 1/8" donut shaped magnet (or the like) up close to the end of the coil, but not touching it. **Be sure that you are only holding the dowel with your teeth and not your lips or hand.** You should be able to feel vibration in your teeth and in the held magnets. You should be able to hear the music in your ears, and if someone puts their ear up next to yours' they can often hear the music as well. If you are not having success, then try one of the following:



- Make sure that you used insulated magnet wire and that you remembered to completely strip the ends all the way around.
 - Check to be sure that there are no striped magnet wire sections touching each other.
 - If you have unsoldered connections disconnect and re-clean them so they make better contact.
 - The radio volume should be turned up.
 - Make sure that you are biting down with significant force onto the dowel to adequately transfer vibration onto your jaw.
- 4) Turn the magnet around and see what happens. Record what you notice.
- 5) Move a compass around the coil while plugged into an operating radio. Sketch what the magnetic field lines on your paper. Make sure you include arrows for the direction of the field lines. Remember that arrows go in the direction of North and that the blue arrow on the compass is North Seeking.

Analysis:

- 1) Explain how what you were hearing with the dowel in your mouth was different than listening to the radio normally or even with head phones.
- 2) You were obviously experiencing sound in your head and believe it or not it was coming from your ears! From what you know about sound and how sound is produced and given that the radio was sending an electrical signal out to the coil, give a brief one or two sentence explanation of how the sound was produced in this case.
- 3) How should have the frequency of vibrations you felt in the coil and magnet compare to those of ear drum?
- 4) Why were you instructed not to put your hands or lips on the dowel, but rather only bit with some force with your teeth? If you had let your fingers or lips touch the dowel, then what would that have done.
- 5) In what direction was the induced magnetic field in the center of the coil? Show this direction on the sketch you made earlier. According to the Right Hand Rule (your curled fingers are the flow of current in the coil and your extended thumb is the direction of the field) if you were looking directly into the end of the coil from the end of the large dowel it is wrapped on, then is the current flow counter-clockwise or clockwise.
- 6) How would the current and the induced coil field be affected if you were to reverse the connections to the radio? Would this be any different than reversing the permanent magnets field by flipping it in the lab?
- 7) How do you think using a coil made of the same amount of superconducting material in place of the copper would have changed things if at all?