Design a Speaker with a Drinking Cup

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Adapted from "Cheapie Speaker" by Al Guenther. Developed with funding from the American Council of Engineering Companies of Virginia and the MathScience Innovation Center.

Question

How can a drinking cup become a speaker for a pocket radio?

Grade/Subject

Physical Science, Life Science
Virginia Standards of Learning: (2010) 5.2, 6.2, PS.11

Background

A common speaker is like an electric motor. It uses a magnetic attraction and repulsion to a coil of wire to convert electrical energy into mechanical energy. Very simply, a speaker is a device that converts an electronic signal into sound. Most speakers have both a permanent magnet and an electromagnetic coil like most small motors. But unlike a motor which has a spinning armature, the wire coil of the speaker is designed to move back and forth in unison with the sound waves it receives. As the electric current passes through the coil of wire, the strength of its magnetic field varies with the vibrations of the sound waves which interacts with the permanent magnet in the same vibrating pattern. To the coil of wire is attached a flexile cone, often made of paper, which amplifies the vibrations of the wire coil increasing the intensity of the sound. The speaker is converting electrical pulses into mechanical vibrations which then produce sound waves in the air.

The speaker you will build (see figure 1) consists of a drinking cup, a coil of wire, a permanent magnet, and a signal source. The electronic signal goes through the coil and creates a varying electromagnet. The attraction and repulsion between the coil of wire and the permanent magnet cause the cup to vibrate and produce sound.

Safety

Remember to follow your regular classroom rules for labs and activities.

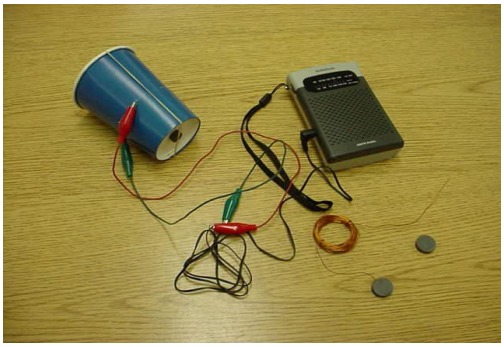
Materials

The following materials are needed for each student set-up:

- Round ceramic magnet
- Spool of enameled copper wire (magnet wire) – 22-30 gauge
- Pocket radio
- Ear phone adapter
- Sandpaper
- Drinking cup
- Film canister

Procedure

1. Wind a coil of about 50 turns of wire around a film canister. The two ends of the wire protruding from the coil should each be about 20 cm long.
2. Wind each end around the coil 2 or 3 times to keep the coil from unraveling.
3. Use sandpaper to completely remove the enamel coating from about 2 cm at each end of the wire.
4. Fasten the coil to a plastic cup using a rubber band or tape.



5. Place the magnet in the center of the coil of wire attaching it with tape.
6. Cut the earphone from its cord. Separate the two wires that make up the cord for a distance of a few centimeters.
7. Carefully remove about 2 cm of the insulation from the end of each wire.
8. Fasten alligator clips to each of these wires and connect them to the wires from the coil.
9. Turn on the radio.
10. Plug the speaker into the radio and turn up the volume.
11. Hold the magnet in the center of the coil.
12. Listen for the music.

Data Analysis/ Results

In a paragraph identify all the energy transformations in the drinking cup speaker. Explain how these transformations occur.

How does the drinking cup amplify sound?

Conclusion / Questions

1. Explain how a non-magnetic object can be made magnetic.
2. How are magnetic fields created?
3. How do the poles of one magnet affect the poles of a second magnet?
4. What affect does varying the size of the cup have on the speaker sound?
5. What affect does changing the volume on the radio have on the speaker sound?
6. Predict what would happen to the speaker sound if more magnets are added.
7. How many different forms of energy are there in the speaker circuit?
8. Is this circuit in series or parallel?
9. What was the conductor in the circuit?
10. What was the insulator in the circuit?
11. Explain how the speaker converts electrical energy into mechanical energy.
12. How can the strength of the speaker be increased?

References

Lesson activity adapted from “Cheapie Speaker,” by Al Guenter.

Other resources for modifications on this activitiy:
http://cse.ssl.berkeley.edu/lessons/indiv/regan/lessonplan.html
http://www.sfu.ca/phys/demos/demoindex/eandm/em5h/cupldspkr.html

"Drinking Cup Loudspeaker - A Surprise Demo" by Peter Heller, The Physics Teacher 35, 334 (Sept 1997).
http://csmt.msstate.edu/html/LearnToWork/projects/Speaker/index.html

MathScience Innovation Center
Information on educational programs available to students, teachers and school divisions and procedures for registering for programs.
http://mathsciencecenter.info

