

Speaker Design Activity – Cuicchi

Objectives for Student Activities:

- Review physics concepts relating to the following principles
 - Magnetic fields associated with permanent magnets and AC and DC circuits
 - Sound Production
 - Inertia and its effect on frequency response
 - The Motor Effect
 - Interference
 - Impedance Matching
- Develop a method for constructing a speaker and analyzing the principles of its operations.
- Analyze factors, which effect the sound output of the speaker in terms of intensity and frequency response and impedance matching.

Teacher Resources

References

Heller, PC (1997). Drinking cup loudspeaker-A surprise demo. The Physics Teacher, 35, 334.

Williams, Trinklein and Metcalfe, "Modern Physics 1984 Chapter 11, Sound Waves, Chapter 18, Heating and Chemical Effects, Chapter 19, Magnetic Effects, Chapter 20, Electromagnetic Induction, and Chapter 21, Alternating Current sources.

Tillery, Bill W. "Physical Science" 1991m Chapter 9, Electricity and Magnetism,

Giancoli, Douglas, "Physics" 5th edition, 1995, Chapter 20, Magnetism

Murphy, Hollow, Zitsewitz, and Smott, Physics, Principles and Problems 1986, Chapter 25, Magnetic fields, Chapter 27, Electric and Magnetic Fields

Materials:

- Six-foot lengths of No. 28 – 30 magnet wire
- Six-inch lengths of 1/2 inch PVC pipe
- Hot glue gun/glue sticks
- 9 oz or larger paper cup
- Masking tape
- Sand paper or emery cloth
- Light bulb (6.3 volts or lower)
- Alligator clips

- Tape recorder on CD player with external speaker jack
- 1/8" Jack plug with leads to connect to speaker
- 1/2" bolt
- 1/2" neodymium magnet (available from arbor scientific company ant 20,000 per pair. The catalog number for the magnets is P8-1123. The phone number for Arbor Scientific is 1-800-367-6695.

Procedure

Construction of speaker coil

- Cut a 1/2-inch diameter hole in the center of the paper cup as shown.
- Wrap a piece of 1/2 to 3/4" masking tape (sticky side out) so that it can be easily removed from the piece of PVC pipe.
- Wrap the wire around the pipe/tape combination a neat coil with at least 8 inches of wire free at both ends to use as leads.
- Wrap the masking tape around the wire to keep it from unraveling and slide the coil off the PVC pipe.
- Carefully glue the coil around the opening in the bottom of the cup as shown.
- Scrape the lacquer coating for the ends of the wire using the emery cloth.

Students Analysis of speaker operation

- Have the students connect the 1/8" Jack plug with lead to the external speaker jack of the sound source, i.e. tape player, CD player or radio.
- As part of the "What do you think?" and "How do you know?" inquiry process, have students complete the following exercise involving speaker operation:
- If you were to connect the paper cup/coil to the output leads of a radio or tape player, what do you think would happen? Why do you think so?
- Try it. What happened? Why do you think that happened?
- With the coil connected to the source leads, obtain a magnet from your instructor and place it near the coil. Does the speaker operate?
- Move the magnet to several locations and determine the position where the speaker operates best. Where is that position?
- Place a small light bulb in series with the speaker leads and connect to the source. Does the light bulb turn on when the speaker operates? Is its brightness constant? Note: You will need a relatively high output source of 10 watts or more to conduct this part of the activity. You must be careful when using an amplifier to ensure that there is a sufficient load or impedance in the speaker and/or bulb so as not to damage the amplifier. When using a high output source always use a light bulb in series with the speaker to increase the impedance of the load.
- What does this tell you about the kind of signal going through the wire to the speaker? What kind of signal is it?

- i. As the sound coming from the speaker gets louder, what happens to the brightness of the bulb? What does that tell you about the relationship between the strength of the signal coming from the source and the loudness of the speaker?
- j. Why does the speaker vibrate when the magnet is placed near the speaker and the wires are connected to a radio or tape player?
- k. Why is a tweeter (high frequency speaker) smaller in size than a woofer (bass-low frequency speaker)?
- l. What changes in speaker design could you implement to improve the output of the speaker with an input signal of constant strength?
- m. What did you learn from this activity?
- n. What could be done to improve this activity so that it would help you better understand the concepts involved in speaker construction and operation?

Follow up Activities:

This exercise could be followed by challenging the students to prepare a speaker employing their own design features. A competition can be held with students competing for best output as measured by decibel meter at a given distance. The decibel meter is available from Radio Shack for about \$35.00 You can also have categories such as most creative design or "ugliest" design that works.

Students should be encouraged to consider the effect of playing a baffle around the base of the speaker and noting the effect on the loudness. They should also investigate the importance of impedance matching in delivering power to the speaker.

Students should also be encouraged to vary the shape of the cone from a cup's shape to one of their own design.

Integration of the speaker design activity with other departments within the school:

- a. Students from music, art and computer science could participate in the speaker design activity by having music/band students comment on the quality of the sound as a function of speaker design. Art or computer science students could design a WebPages to market the student speaker in a simulated activity. They could also create a logo and product packaging design.
- b. Advertising layouts can be designed which are appropriate for target consumers.