a WOW Lab BLUEPRINT

Styrofoam Plate Speaker

Lesson Logistics

Learning Outcomes

Grades 10-12
Waves
Fields

Class Organization

Divide the students into groups of two.

Ensure that each group has a Styrofoam plate, 6 m of enamelled copper wire, two business cards, a cardboard tube and a 4 in. x 6 in. piece of strong cardboard.

Notes

One neodymium magnet can be shared amongst groups.

It is recommended that the teacher construct a pair of Styrofoam speakers and tests them a day before the activity. These speakers can serve as a model for the students. Since all audio equipment is different, the connection instructions in the *Activity Instructions* are intended as examples and general guidelines. Technical issues should be discovered and handled prior to the activity.

Instruct the students how to safely use the hot glue gun, lighter and the audio equipment. Amplifier systems will often have exposed electrical contacts and high output voltage. Remember to handle electrical equipment with one hand to avoid creating a path of low resistance through the heart.

This activity requires the use of rare-earth magnets. These are very strong magnets and care should be taken when handling them as they can pinch fingers and erase computer hard drives. Do not bring two magnets in proximity of each other and keep all computers and electronics out of the immediate vicinity of the magnets.

The hot glue and lighter should both be used with caution.

An amplifier is needed to increase the voltage across the coil. The time-varying voltage signal directly across the audio output port of the computer or MP3 player is not large enough to provide mechanical energy to drive the speakers. Without an amplifier, the plate will not vibrate enough to produce audible sound; even commercially made speakers face this problem.

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Further Exploration

Constructive and Destructive Interference

Each speaker can function as a "point" source of vibration. This means sound waves radiate from the speaker similar to water rippling when a pebble is dropped. When two speakers are placed within audible distance of each other, the sound waves that the speakers generate will interfere. The interference between the two waves can either superimpose to increase, decrease or even cancel out the sound. Have two speakers play the same note continuously. This can be done with a wave generation program (see *Resources*). Select a sinusoidal, triangular, saw tooth or square wave form. Set the generator to maximum amplitude and choose a frequency such as 440Hz, which is the note A above middle C. Play this at maximum volume through both speakers. Place the speakers at audible distance from each other and have the students walk around slowly between the two speakers. The volume of the sound will differ depending on the location of the listener. Most introductory physics text books will describe how to graphically predict the location of the points of maximum interference due to two point sources. Have the students draw a diagram showing the nodes (points of maximum constructive interference) and antinodes (points of maximum destructive interference). They can then use this diagram to help them locate these points in the classroom while the two speakers are playing.

Sound Waves

The vibrations that cause sound waves can be visualized by sprinkling sand on the surface of the plate.