

Homemade Speakers

The Big Idea

- 1) An object produces sound when it vibrates in air.
- 2) Running electrical current through a coiled wire creates a magnetic field around the coil.
- 3) An alternating current through the coiled wire causes a constantly switching magnetic field which in turn interacts with a permanent magnet. Placing an object between the two magnets, causes the object to vibrate with the switching magnetic field and thus produce sound.

Background

This activity will demonstrate in the simplest sense how sound is created and how a speaker works. When an object vibrates in the air, sound is created. Speakers use two types of magnets to produce the vibration. One is a permanent magnet and the other is controlled by an electrical current. This is called an electromagnet. When current flows through a coiled wire, a magnetic field is created. These two types of magnets will interact with each other like most other magnets with opposite poles attracting and like poles repelling. When an alternating current flows through the electromagnet, the magnetic field of the electromagnet switches – the poles flip. Thus, the two types of magnets now alternately attract and repel each other with the alternating current. When an object is attached to the one of the magnets, the object will move back and forth with the constant attraction and repulsion of the two magnets, in other words, it will vibrate causing sound.

When this simple arrangement of two magnets with an object between them is attached to a stereo receiver, the arrangement will act like a speaker.

Materials

Demonstration - Wine glass

3 wine glasses with water

Demonstration - Headphones

Inexpensive headphones to take apart and observe electromagnet

Demonstration - electromagnet

Large nail with electromagnet wire coiled around it and attached to a battery

Speaker (per group)

120 cm of magnet wire
small piece of sandpaper
AA battery to wrap the wire around
2 disk shaped permanent magnets
Scotch tape
An assortment of plates, cups and materials to test

Procedure

To prepare before the session:

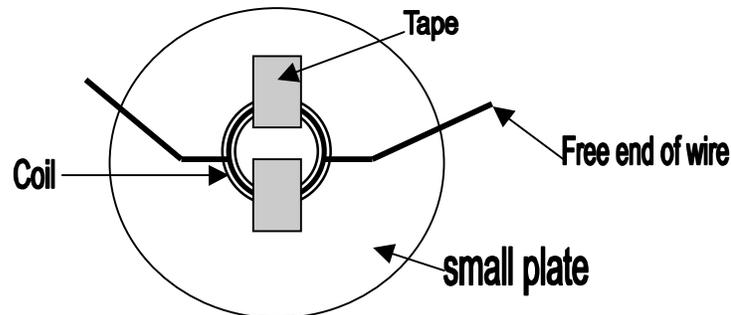
1. Fill the wine glasses with various levels of water. Perhaps to even play a song!
2. Prepare electromagnet to demonstrate that a current through a coiled wire produces a magnetic field which then causes the (iron) nail to become temporarily magnetic. Pick up paper clips to prove it.
3. Prepare headphones by revealing electromagnet.

During session

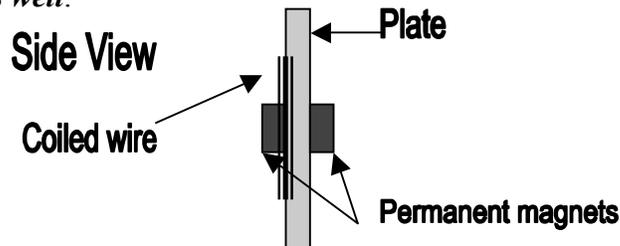
1. Ask participants to describe **Sound**. Accept and acknowledge all relevant answers.
2. Introduce the first concept, which is that a object produces sound when it vibrates in air. Clap or tap the wine glass to demonstrate the vibration and point out that there needs to be a medium through which the vibration travels – air, water, solids. Could they hear you speak without air in the room? Ask the audience if they have “played” wine glasses (by circling their fingers on the rim of the wine glass). You can ask for a volunteer who has had experience or demonstrate it yourself. Challenge them to explain how the sound is produced. Though the finger is wet when it circles the rim of the glass, it does through friction cause vibrations through the glass – that’s why you should hold the wine glass by the stem when doing this experiment. The different pitch is caused by the different levels of water in the glasses.
3. Pass out the slightly deconstructed headphones. Ask families to find out how the headphones produce sound. What is vibrating within the headphones? They will eventually point out the electromagnet piece.
4. Demonstrate the electromagnet by showing how with a current the coil/nail arrangement can pick up paper clips. The key point here is that current controls the magnet field complete with a north and south pole. Ask the audience what might happen if the current were to run in the opposite direction? ***The poles would flip***. If held by a permanent magnet, the electromagnet with it’s switching magnetic poles could alternately attract the permanent magnet and repel the permanent magnet – therefore causing motion! NOTE: ***The coil itself with current will produce a magnetic field, the iron nail is present to enhance the magnetism by temporarily becoming magnetic as the domains within the nail align to the magnetic field. This allows us to produce a magnet strong enough to pick up paperclips.***
5. Tell the families that they will use an electromagnet/permanent magnet arrangement to make a small object move. This movement will produce sound.

a. Pass out AA battery, sand paper and 120 cm magnet wire. Have the families sand off the coating of the wire (2 cm of each end) revealing the copper underneath. Leaving 10 cm of each end of the wire free and straight, coil the rest (middle) of the wire around the battery. Encourage neat coiling – it looks better.

b. Pass out small plates. Have the families place the coiled wire in the middle of one side of the plate and tape the coil to the plate. Secure the coil without taping through the center of the coil. Coils that are held tightly to the plate, produce better vibrations.



4. Pass out two disk permanent magnets. Have the families place one magnet in the center of the coil and the other magnet in the same spot but on the other side of the plate. *Now if one permanent magnet moves so will the other and the plate will be forced to move as well.*



5. Walk through the simple elements of the design and make sure the audience understands where the current will flow and why the plate will vibrate.

6. Have the families come up with their plates to try their speakers when hooked to a power source- the boombox! *Note: Play something with a fast lively beat.*

7. The **best** part of this activity is to now ask the families to explore different materials and shapes to create the best “speaker”. Give them 5 minutes to create and explore then have a competition. Clear a straight path from the boombox and have a judge walk away from each competing speaker until he/she no longer hears the sound being emitted from the speaker. The speaker that is able to amplify the sound the greatest distance, wins the competition.

Resources

<http://electronics.howstuffworks.com/speaker.htm> Excellent description and diagrams to how a simple speaker works