Science Unit: ***The Electron: Conductivity and Chemistry***

Lesson 5: ***Making a Speaker***

School Year:	2011/2012
Developed for:	Trafalgar Elementary School, Vancouver School District
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Grade level:	Presented to grade 6; appropriate for grades 5 – 7 with age appropriate modifications
Duration of lesson:	1 hour and 20 minutes
Notes:	This lesson is a modification of Lesson 5, Speakers, in the Electricity with Applications science unit, Scientist in Residence Program. http://scientistinresidence.ca/science-lesson-plans/electricity-with-applications/ This unit assumes that the class has had a lesson on circuits, as well as an understanding of elecromagnetism. It might help to show students, or have them access, the following simulations: <http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc> <http://phet.colorado.edu/en/simulation/faraday>

Objectives

1. To learn how electromagnetism can be used to create motion that can be then applied to converting electrical energy into sound.

2. To learn how to make a simple speaker using only a piece of paper, magnet wire, and a magnet.

Background Information

Sound waves are a sequence of pressure waves that propagates through a compressible medium, such as air. When these pressure waves hit our eardrums, we 'hear' the sound. During propagation, sound waves can be reflected (bounced back), refracted (bent), or attenuated (diminished in power) by the medium. Sound waves are created whenever something causes the air in our vicinity to move or vibrate. The vibration shakes the air back and forth, creating changes in air pressure, which then move out in all directions. The speed of sound is 340 meters per second (1224 kilometers per hour).

Vocabulary

Sound:	Vibrations that the ears can detect.
sound waves:	Pressure fluctuations that move through a medium (gas, liquid, or solid).
Speaker:	A device for converting electrical energy into sound.
Electromagnet:	A magnet that can be turned on and off with electrical current.
Magnet wire:	Wire that is coated with an insulating lamination. It is used so that adjacent wires can touch without shorting.
Force:	Something that changes the movement or shape of an object.

Materials

- 5cm x 5cm paper
- music player (e.g., iPod, cell phone, etc.)
- neodymium magnets (~ 1cm high, ~ 1cm diameter)
- 2 meters of 34-gauge magnet wire, coiled, lamination stripped at the ends
- Scotch tape
- patch cord with 3.5mm audio plugs at one end and bare ends at the other
- alligator clip terminated connecting wires

In the Classroom

Introductory Discussion

1. What is sound? How fast does sound travel? Does it travel faster or slower than light? During a thunderstorm, do you see the lightning first of hear the thunder? How do we hear sound? How do humans create sound with their voices? Activity: place hand on throat and speak. Do you feel vibrations? Can you make the sound of your voice more directional (cup hands around mouth to form a cone).

2. What is a speaker? How does it create vibrations? Are there any speakers in the room (PA system, CD player, computer speaker, television, cell phone). Show the commercial speaker. Review that electrical current creates magnet fields and that magnet fields create forces (north attracts south, repels north, etc.). Current flowing in a coil of wire creates a magnetic field. More coils give a stronger magnetic field.

3. Briefly describe science experiment/activity. Students will work in pairs to create a simple speaker that they can user to hear music from their music player.

4. Mention that students should focus on recording a schematic diagram of the speaker they put together. They should also be encouraged to write down ideas that would result in an improved speaker.

5. Briefly describe safety guidelines. In particular, student must handle the magnets with care as they are surprisingly strong. Allowing two or more magnets to come together violently can chip the magnets themselves, and magnets can cause pinches.

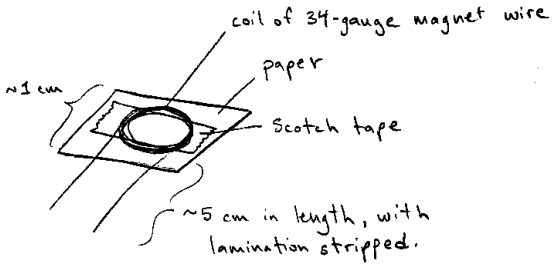
Science Activity

Activity Title: Build your own speaker.

Purpose of Activity: To strengthen conceptual understanding of how electromagnets work. To gain hands-on experience building a simple circuit.

Prediction or Hypothesis: Before making your prediction (or hypothesis), it helps to start with a question, or make observations and then ask a question. Record your prediction based on the following question: What do you think will happen when you change the size or shape of your speaker? What do you think will happen when you increase the number of magnets?

Methods and Instructions:
Set-up prior to experiment: Coils will be prepared by the scientist. Wrap the 34-gauge magnet wire around something roughly the size of a AAA battery, leaving about 5 cm at each. Strip the lamination from these 5 cm ends. Using Scotch tape, affix the coil to a small circle of paper, as shown schematically below.

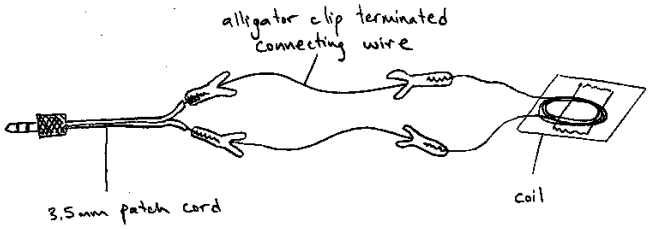


The scientist should also prepare the patch cords. Begin by purchasing 3.5mm-to-3.5mm cords. Cut these cords in half and strip the ends of the loose wires at the cut, as shown below. The cable should contain 3 wires: one red, one black, one bare. Twist the bare wire together with the black wire; twist the red wire alone.

Students will work in pairs or threes.

1. Each group will cut a 5 cm x 5 cm square of paper and tape a coil of magnet wire (already taped to small piece of paper). Also provide each group with a 3.5mm patch cord to bare wire and a set of alligator clip terminated connecting wires (shown below, in a bundle of 15).

2. Using the alligator clip terminated connecting wires, connect the ends of the coil to the end of the 3.5mm patch cord, as shown below. Plug in the 3.5-mm plug into the music source (iPod, etc.).



3. Play music or a sound program on the music device.

4. Hold the coil directly over (or place it directly under) the magnet and put your ear over the speaker. Students should be able to hear their music.

5. Have the students sketch the circuit of their speaker into their notebooks and label the various parts.

6. Students will be asked if there is anything they can do to make the sound louder (turn up volume on music device, add magnets, add more loops in the coil).

Closure Discussion

1. How could you make the speaker louder (more coils, larger electrical signal, bigger or more magnets)?

2. Can you think of a way to make your speaker more directional?

3. What did you learn? Did anything surprise you?

References (examples of the format to use for different types of references are below)

1. <http://scientistinresidence.ca> See Science Lesson Plans, Physical Science Lessons, Electricity with Applications, Lesson 5, Speakers. <http://scientistinresidence.ca/science-lesson-plans/electricity-with-applications/>

2. <http://www.josepino.com/?homemade-hifi-speaker> 'Hi-fidelity Homemade Loudspeaker,' from the website 'Jose Pino's Projects & Tidbits.' A written guide, illustrated and with video, on building a homemade speaker simialr to the one described in this lesson.

3. <http://en.wikipedia.org/wiki/Sound> 'Sound' entry on Wikipedia [Explains the propagation, perception, and physics of sound.]

Extension of Lesson Plan

1. Have multiple materials available with which students can make improvements on their speaker.

2. To judge the quality of the homemade speakers, bring in a commercial type of speaker (e.g., from an old computer tower) and plug it into the music player as a comparison. If the speaker is coming from an old stereo system, remove the cone assembly from the housing in which it is installed to make a fair comparison.