Home Connection:

Parent Background Information

Sound, a form of energy, is an acoustic wave that results when a vibrating source, such as a machine, produces a disturbance in an elastic substance like air or water. Noise can be considered sound that is unwanted, so a sound to one person could be a noise to another. Sound has several qualities that are used to identify and describe it: frequency, wavelength, speed, and loudness. The loudness of sound diminishes with distance from the source of the sound. A technical explanation of this can be found at http://www.osha.gov/dts/osta/otm/noise/health_effects/physics.html OSHA (Occupational Safety and Health Administration) is a government agency charged with maintaining safe and healthy work environments. Controlling sounds is a major concern in schools, workplaces, homes, and public spaces. If sounds become too loud, hearing loss can result. One way to address this problem is to reduce the level of sound in an environment; another way is to provide ear protection for people within the environment.

Activities to do with your child

1. **Demonstration**: your child could demonstrate the attenuation of sound as distance increases by moving a source of sound away from you in increments. Sources could include a portable radio, alarm clock, buzzer, bell, etc.

2. **Short activity**: Is sound attenuated when it has to travel around corners? Does the distance sound travels depend on the frequency or pitch of the sound?

3. **Problem to solve**: One room of your home seems particularly noisy and loud. Is there something you and your child can do to the room to make it less noisy?

4. **Research**: You and child could use the Internet to research the science of sound and how our ears detect sound. Some useful Web sites include OSHA’s Physics of Sound, What is Considered Noise and The Anatomy and Physiology of the Ear:


5. There are a number of free applications available on the Internet that enables your computer to measure, record, and analyze sound. Your computer might even have a built-in application that controls the sound input for the microphone built into most computers.

The complete lesson plan for this topic is included below.
It’s Too Loud!

Lesson Overview:
Sound and noise is all around us. We certainly need to hear sounds in order to work and survive in an environment. But sometimes the sounds can become too loud and then we need a way to reduce the sounds to a safer and more pleasant level. In this lesson, students will investigate the effect of using ear protectors to reduce sound levels.

Learning Objectives:
Students will be able to:
- work together to measure sound levels
- collect, organize, display, and analyze data about sound levels
- investigate the effect of wearing ear protection on the attenuation of sound

Academic Standards:
National Science Education Standards (SCES)
Abilities Necessary to Do Scientific Inquiry
- Design and conduct a scientific investigation
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop description, explanation, prediction, and models using evidence.

Physical Science
Transfer of Energy
- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei and the nature of a chemical. Energy is transferred in many ways.

Benchmarks for Science Literacy
Scientific investigations usually involve the collection of relevant data, the use of logical reasoning, and the application of imagination in devising hypotheses and explanations to make sense of the collected data. 1B/M1b*

Something can be "seen" when light waves emitted or reflected by it enter the eye—just as something can be “heard” when sound waves from it enter the ear. 4F/M2

Vibrations in materials set up wavelike disturbances that spread away from the source. Sound and earthquake waves are examples. These and other waves move at different speeds in different materials. 4F/M4
Time Frame: This lesson requires three 45 minute sessions. One session is to engage students and introduce the activity, a second session is for students to carry out the investigation and a third session to discuss and share results.

Background for the Teacher:
Sound, a form of energy, is an acoustic wave that results when a vibrating source, such as a machine, produces a disturbance in an elastic substance like air or water. Noise can be considered sound that is unwanted, so a sound to one person could be a noise to another. Sound has several qualities that are used to identify and describe it: frequency, wavelength, speed, and loudness. Controlling sounds is a major concern in schools, workplaces, homes, and public spaces. If sounds become too loud, hearing loss can result. One way to address this problem is to reduce the level of sound in an environment; another way is to provide ear protection for people within the environment.

This lesson involves students collecting data about sound attenuation due to wearing ear protection. The data students will collect in this inquiry lesson will be subjective because it will be based on student perceptions. (Had you access to expensive and specialized equipment, students would be able to collect objective data, i.e. data based on observable facts.) The nature of the data collected will be the distance from a sound source to a place at which students can no longer hear the sound. Since this involves students’ perceptions (plural), there will be variability in the data. Most likely there will be a range of distances reported, so the data will need to be looked at statistically and an average value calculated. The situation here is somewhat analogous to having a class of students throw a ball as far as they can with and without a jacket on then looking at the distances the ball was thrown to see if wearing a jacket affects how far a student can throw a ball. Instead of multiple throws by one student, we will look at one throw from many students.

To demonstrate that sound level diminishes with distance, a fundamental concept in this lesson, you can demonstrate and reinforce the concept several ways. One method would be to ask a student to move away from a constant-loudness sound source and report how loud the sound is at increasing distances from the source. A second method involves specialized equipment. If you have access to a sound-level meter, use that to illustrate the phenomenon. Perhaps you can access and use the input volume level for the built-in microphone your school computer likely has.

This lesson plan is meant to be flexible and can be adapted depending on the materials and equipment available to you and on your situation and the environment in which you’re teaching.

Materials for the teacher:
- blackboard or chart paper
- sound level meter (optional)
- computer with sound application (optional)
- sound source (radio, alarm clock, buzzer, electric fan or other motor, etc.)
- meter stick, several
Materials for each student:

- ear protectors*
- notebook and pencil

* If you choose to use 3M™ Disposable Earplugs acquire enough so each student has their own pair. If you use 3M™ Ear Muffs wipe them with a cloth moistened with an antibacterial soap or alcohol after each student use.

Classroom Activities:

Engage

1. Take a survey of students by asking how many have ever been asked by their parents to turn down the volume of the music they’re listening to. Use student responses to initiate a discussion about sound, loudness of sound, hearing, and the human ear. Make note of responses so you can tailor the lesson to student levels of understanding, including misconceptions, about sound and hearing.

2. Ask students if they don’t agree that protecting one’s hearing is important. Further, ask for ways students know about ways to protect hearing and list these on the board or chart paper. These ways might include not standing too close to loudspeakers, using protection such as ear plugs or ear protectors, turning music down, and holding one’s hands over one’s ears.

Explain

1. Ask students to describe what happens to the loudness of sound when the sound gets further away. Can they share experiences when they’ve noticed this? Ask a student to demonstrate sound getting softer as the source of the sound moves away. If you have access to a sound-level measuring device or a computer that can show the volume of a sound, use this technology to demonstrate in a measurable way how sound diminishes with distance.

2. Explain to students that the investigation in this lesson will use subjective data instead of the more traditional objective data. Explain and discuss the difference with students. Further, explain that they will be collecting data (about sound) that varies from person to person, just as does the height of individual students in a class. Briefly discuss how heights of students, if displayed on a number line, would be distributed with a few short students, more students with medium heights, and a few tall students. Mention and review the concept of range and average.

3. Write the following prompt on the board: Does wearing ear protection reduce the loudness of a sound, and if so, by how much?
Explore

1. Group students in fours and give them time to brainstorm the design of an investigation to answer the prompt above. Share designs as a class.

2. Use one group’s design if possible; otherwise present this design:
   
a. Find a quiet location and gather all students together. Turn on the sound source and have student 1, without ear protection, carefully back away from the sound, stopping at 1 meter intervals to listen for the sound. If they can hear the sound, they should continue backing away from the sound until they can no longer hear the sound. Record this distance for student number 1. Repeat for additional students; the more students, the better. Use only whole meter intervals, not fractions. One student could record the data on the board for all students to see and copy.
   
b. Repeat step a above but this time each student will wear ear protection. (To keep the variables as constant as possible, all students should wear the same type of hearing protection. If this is not possible, use that fact as an opportunity to talk about the importance of keeping as many variables in an investigation as possible the same.)
   
c. Plot the distances measured for no hearing protection (a) on a number line and calculate an average distance. Do the same for using hearing protection (b).
   
d. Possible sound sources: radio, alarm clock, buzzer, electric fan or other motor, etc. The sound source should be fairly consistent and not vary in loudness from student to student.
   
e. Possibilities for ear protection:
      • 3M Conservation Products can be researched at this website:
        http://solutions.3m.com/wps/portal/3M/en_US/Health/Safety/Products/Catalog/?PC_7_RJH9U5230GE3E02LES9MG812H2_nid=7QZ6QNF15LbeQQFFG1G8R7gl
        These include ear plugs, hearing protectors, and ear muffs. Another option could be to use audio earphones without the input signal. (Again, if you do use earphones, wipe them with a cloth moistened with warm water after each student use.)

3. Let students work in their groups to chart, discuss, and analyze the data and answer the prompt.

Explain

1. Gather students together to discuss the class data and each group’s conclusions. How did they answer the prompt? Was there any difference between the two averages? Was there a big spread in the data? What were some of the issues with this particular design? How could it be made better to answer the question?
Extend

1. There are several opportunities for research on the Internet for students. Students could visit the Occupational Safety and Health Administration (OSHA) Web site on the Physics of Sound (http://www.osha.gov/dts/osta/otm/noise/health_effects/physics.html) to research the science behind this lesson. Another OSHA Site (http://www.osha.gov/dts/osta/otm/noise/health_effects/physiology.html) provides information about the anatomy and physiology of the ear. The Canadian equivalent of our OSHA Web site http://www.ccohs.ca/oshanswers/phys_agents/noise_basic.html#_1_15) provides information about sound, noise, the workplace, and the scale of power as it applies to sound waves. Learn more about the science of sound from the Franklin Institute (http://www.fi.edu/pieces/dukerich/sound/soundscience.html) their web site.

2. Sound waves travel of course through solids as well as air and water. Provide opportunities for students to experience sound travelling through meter sticks, tabletops, floors, walls, and other easy-to-access solids. Can they detect a reduction in loudness in solids as the distance between source and listener increases?

Evaluate

1. Name some ways to reduce the loudness of a sound.
2. Describe evidence that supports the idea that wearing ear protection reduces the loudness of sound.

Scoring Key for Evaluate

1. The loudness of sound can be reduced by turning down the volume of the source of the sound, moving away from the source of the sound, wearing ear protection, or holding your hands over your ears.

2. When we moved away from the source of a sound, the sound was not as loud. At a certain distance, we couldn’t hear the sound any more. When we wore ear protection, the distance where we couldn’t hear the sound anymore was less.