Are We Hearing the Same Thing?

Student Activity Sheet

Name _____ Date _____ Class _____

Sound waves travel through all types of mediums. Humans hear sounds traveling through air. While all marine creatures hear sounds traveling through water. How does the medium affect the way the sound is heard?

Materials:

2 in. dia., 2 ft long PVC pipe
Garden hose 12 ft or longer
Hydrophone
Microphone
Mini amplifier/speaker
Computer w/ a microphone input
Aquarium, large sink or swimming pool
Amadeus II Software (Mac only) or similar sound recording and analysis program

Suggested construction supplies:
Aluminum foil
Wax paper
Nylon, polyester, cotton cloth
Plastic grocery bags
Plastic sandwich bags
Heavyweight trash bags
Latex rubber gloves
Rubber bands
Rubber sheets

Procedures for Activity 1:

1. Work in groups of 2 or 3. Assign each person in your group as either Sound Producer, Listener or Recorder. If in a group of 2, the Listener and Recorder can be the same person.
2. Construct a device using the PVC pipe (or hose) and one of the construction materials. Leave one end of the pipe open and the other end covered with a construction item.
3. Enter the equipment material used in Table 1. Include a sketch of the device in the appropriate column in Table 1.
4. Vocalize a 5-8 second sound into the open end of the pipe while the pipe is in the air. An example of a sound would be "ba ba ba ba"
5. Enter the description of the sound created and the sound heard into Table 1.
6. Connect the amplifying device into the hydrophone.

7. Place the hydrophone into the tank, pool, or sink.
8. Place your sound-producing device into the water, near the hydrophone with the open end out of the water. Do not rest the sound-producing device on the bottom of the tank.
9. Vocalize the same sound as in Step 4 into the open end of the tube.
10. Listen to the sound produced using the amplifying device.
11. Enter the description of the sound heard into Table 1.
12. Remove the sound-producing device from the water and remove the selected construction material.
13. Using other construction materials, make a new sound-producing device. You may combine construction materials, as different combinations of pipe and material may produce high quality sounds. Be sure to leave an open end to vocalize into.
14. Repeat steps 3 to 11. Be sure to vocalize the same sound as in Trial 1.
15. Continue process for 3 more trials, using different construction materials on your sound-producing device. Remember to use the same vocal sound for all trials and to enter the appropriate information into Table 1.

Procedures for Activity 2:

1. Attach microphone to the computer.
2. Run the sound recording and analysis program.
3. Using one of the sound-producing devices created in Activity 1, vocalize your sound in air and record 5 seconds of the sound to the program.
4. Save the sound clip.
5. Attach the hydrophone to the computer
6. Vocalize the sound into the water near the hydrophone.
7. Record 5 seconds of the sound heard to the program.
8. Save the sound clip.
9. Analyze each recording by measuring the frequency, wavelength and amplitude of the sounds recorded.
10. Enter the results in Table 2.

Table 1: Sounds Heard

Description of Sound Created:

Trial	Equipment Used	Drawing of Device	Description of Sound in Air	Description of Sound in Water
1				
2				
3				
4				
5				

Table 2: Frequency and Wavelength

Description of Sound Created:

	Frequency (Hz)	Wavelength (λ)	Amplitude (dB)
Sound in Air			
Sound in Water			

Description of Sound-Producing Device:

Discussion Questions for Activity 1:

1. How does changing the medium affect each sound?

2. Which sounds were easier to reproduce underwater? Why?

3. Which materials worked best for producing sounds underwater? Why?

Discussion Questions for Activity 2:

1. How did the medium affect the frequency, wavelength, and amplitude of each sound?

2. Share with another group your sound clips. Compare the frequency, wavelength, and amplitude of the two different sounds produced within the different mediums.

Teacher Strategy

Grade Level: High School (9-12)

Time Requirement: one or two 55-minute periods

Standards Addressed:

The Rhode Island Science Framework:

- The Nature of Technology: Technology and Science, Grades 9-12 (Benchmark 1 - 3)

High School Performance Standards (NCEE):

- S1(f) Physical Science Concepts
- S4(a) Scientific Connections and Applications
- S5(a)-f Scientific Thinking
- S6 (a-e) Scientific Tools and Technologies
- S7 (a-e) Scientific Communication

National Science Education Standards:

- Content Standards for A, B, and, E (Grades 9-12)

Objectives:

1. Students will demonstrate that certain materials produce sounds better in air and some materials produce sounds better in water.
2. Students will demonstrate that certain sounds are affected more by a change in medium than other sounds.
3. Students will demonstrate analytically, the affects of medium on the frequency, wavelength, and amplitude of a sound.

Background Information:

The human ear is designed to operate in air. The speed of sound in air is 343 m/s and the speed of sound in fresh water is 1440 m/s at 20°C and 1 atmosphere. As a sound wave travels from one medium to another the wave speed changes, but the frequency stays the same. Thus the wavelength must increase. The wave speed (v) is related to frequency (f) and wavelength (λ) by the equation $v = f\lambda$ The amplitude of a wave represents the energy carried in the wave. The greater the amplitude, the greater the energy.

Instructional Strategies:

A. Preparation:

1. Assemble a kit for each group of students (maximum of 3 students per group). To save material, pre-cut the aluminum foil, wax paper, assorted plastic bags, rubber sheets (from inner tubes), and assorted cloths into 4 in. by 4 in. squares.
2. PVC pipe come in 8 ft. lengths. A hacksaw is needed to cut the 2 ft. length pieces.
3. If the classroom does not have a sufficient number of sinks and an aquarium or a pool is not available, large tubs or 10 gallon buckets should be used.
4. Warn the students ahead of time that they may get wet. Have plenty of sponges around to wipe up all the water that will drip everywhere.
5. Have Amadeus II or a similar sound recording and analysis program loaded on computers

B. Assessing Prior Knowledge:

Begin the class with a group discussion or short writing activity. Ask/Give the students the following questions/tasks:

1. Have the students list on paper as many description words for sound as possible in 1 minute or as a brainstorming session have the students say (with a recorder) as many description words for sound as possible in 1 minute (e.g., loud, soft, short, long, deep, sharp, shrill, high, low, pitch, tone, volume).
2. In a manner similar to one the above, have the students direct their attention to physics terms for sound (e.g., amplitude, frequency, wavelength, wave speed). If the students do not know the physics terms for sound, go over them before running the activity.

C. Procedural Tips:

1. Obtaining a hydrophone may be difficult. There are plans on the web for building simple hydrophones. Building a hydrophone is a project unto itself. However, these simple hydrophones are much less sensitive to sound than commercially available hydrophones (see References).
2. Finding a sound analysis program for the PC will take some work. Amadeus II for the Macintosh is available on the web or from the manufacturer (see References).
3. There may be difficulty in discerning whether the sound a student hears is through the hydrophone or through the air. The sound production may have to be isolated from the sound reception. The 12 ft. hose can be to produce sound from outside the classroom. Alternatively, a long cord attached to the hydrophone will also allow the listener to be isolated from the sound production.

Answers to Discussion Questions for Activity 1:

1. The sounds will appear muffled. There should be no appreciable difference in the pitch of the sound.
2. The answers will vary. Typically short duration sounds work better. Low tone sounds are usually easier to hear than higher tone sounds.
3. Aluminum foil on the end of the pipe produces better high tone sounds. The rubber and plastic bags produce better low and middle tone sounds.

Answers to Discussion Questions for Activity 2:

1. The frequency should remain unaffected while the wavelength should increase due to the change in wave speed (speed of sound). The amplitudes of each sound should decrease.
2. The answers will vary. The amplitudes of the low frequency sounds should be greater that the amplitudes of the higher frequency sounds.

Post Activity Assessment:

Each group makes a short presentation of their five sounds to the class. Each sound is demonstrated, the materials used are listed, and the effects of medium on each sound are described.

In addition to an oral presentation, a laboratory report is handed in after the presentation. Grading rubrics for the presentation and laboratory reports are left up to the teacher.

Extensions:

<u>Grades 4-6</u>

Run only activity 1 and not activity 2

<u>Grades 4–6, Middle School, or High School:</u>

If a pool or large tub is available, the students can use snorkels and put their heads underwater and listen to the sounds underwater and compare that sound to the sound they hear over the hydrophone.

<u>High School:</u>

1. The students can test the effects of temperature and salinity of the water on the speed of sound in water.
2. Students can attach a speaker to the end of the tube and play pure tones (single frequencies) at different amplitudes (volume) and measure the affects of water on

sound as a function of frequency and amplitude. This extension can be combined with extension 1 above.

Vocabulary:

Amplitude:
The maximum displacement from the rest or equilibrium position

Frequency:
The number of complete cycles or vibrations per second measured at a fixed location

Wave speed:
The product of the frequency and wavelength

Wavelength:
The shortest distance between points where the wave pattern repeats itself

Resources/References:

Printed Resources:

Watlington, F. 1979. How to Build & Use Low -Cost Hydrophones. Tab Books, Blue Ridge Summit, PA 140 pages.

Web Sites:

Information on Commercial Hydrophones
http://www.cetaceanresearch.com/hpinfo.html

Directory to find commercial hydrophones
http://www.ThomasRegister.com

Amadeus II software company
http://www.hairersoft.com

This activity was developed by Rhode Island school teacher Howie Chun during the *Discovery of Sound in the Sea* Teacher Institute. University of Rhode Island, Office of Marine Programs, 2002.