Sound Waves & Whale Communication

Subject: Physics

Grade Level: 11th Grade

Rational or Purpose: The purpose of this activity is to introduce how sound travels in the context of whale communication. This activity will sub-divide into small activities that will lead students to compare how sound travels in different media.

Materials:

- 2 plastic cups and a string (about 5 meters long) for each group
- Puncturing tool for bottom of cup
- Paper clips to tie and secure string to bottom of each cup, after threading it through the tiny hole at the base of both cups
- Tuning forks of different frequencies
- Several cups filled with water to a variety of levels
- Computer with Internet access and speakers
- Student lab journals to document predictions, observations, and conclusions

Lesson Duration: 30-45 minutes

Source of Lesson: *Hot Science – Cool Talks* CD-ROM # 45: "The History and Future of Whales"

TEKS Objectives:

§112.47. Physics.
(8A) examine and describe a variety of waves propagated in various types of media and describe wave characteristics such as velocity, frequency, amplitude, and behaviors such as reflection, refraction, and interference;
(8B) identify the characteristics and behaviors of sound and electromagnetic waves; and
(8C) interpret the role of wave characteristics and behaviors found in medicinal and industrial applications.

Whale Communication Pre-Activity:

Similar to humans, whales use their voices to communicate. Watch the section of *The Secret Lives of Whales* about whale songs (www.stanford.edu/group/Palumbi/microdocs.html#secret).

Background Information:

Whales use their voices to communicate very far distances. How does sound travel? Sound is a *mechanical wave* caused by vibration. The reason why a string plucked on a guitar would produce a sound is that the vibrations of the strings transmit waves *through* air (a gas) to our ears. The pitch of the guitar is dependent on the frequency of string vibration. The frequency of the string vibration is directly related to the energy of a sound wave. Therefore, a greater frequency possesses higher energy, which will contribute to a higher sound pitch (this is the reason we can hear someone screaming from a long distance).

For the sound waves to reach our ears, it must travel through a certain medium (like air, water, or a solid). It is easy for us to hear sound when it travels through air. Mechanical waves produced from sound bump into molecules (even gases have well-dispersed molecules) and send a chain reaction of sound waves through the medium. Sounds waves can be transmitted from one medium to another medium. When we are swimming, we can still hear something in the water (a liquid), but the sound is muffled. When we stick our ears against a wall, we can hear something from the opposite of the wall. Can we hear anything in the vacuum of outer space? The answer is, no. There are no molecules to carry the mechanical sound waves. So, the next time you are watching a science fiction movie and see a spaceship explode, if you hear a KABOOM then you will know that it is false because you could never hear it (or anything) in outer space.

There are two kinds of waves: *transverse* and *longitudinal* waves. Sound waves are longitudinal waves. Longitudinal (or compressional) waves are characterized by their parallel displacement and motion. Transverse waves, on the other hand, are characterized by traveling in a direction perpendicular to their displacement. In this exercise, we will focus on how sound travels through different media.

Procedure:

As you conduct the following activities, keep a journal to document your hypotheses, observations, and conclusions.

Activity One: Vibration through string

Each group will have two cups and a string. You will make an "ancient telephone" by connecting two cups with the string. Compare the differences in sound when you pull the string tight and when you leave the string loose. In your journals, describe the differences of the voice that you hear. Express it in terms of *vibration*.

Procedure:

1. Using a sharp instrument (like a pencil, pen, poker, or compass), poke a hole about the size of the string at the center of the bottom of each of 2 plastic cups (use same kind of cups).
2. Push one end of the piece of string (about 5 meters long) from the outside of the cup through the hole to the inner bottom side of the cup. Pull the string up far enough so that you can tie a paper clip to the end of the string. This will act as an anchor, keeping the string in the cup.
3. Repeat this with the other end of the string for the second cup.
4. Now that the ancient telephone is completed, take one end of the phone and walk away from your lab partner. He/she will take the other end of the "phone" and place one cup to his/her ear, while you speak into the cup. Let the string be LOOSE between you. Describe the result.

5. Repeat step 4. pulling the string tight. Describe the results. You and your group members can also switch roles in the experiment.

Activity Two: Vibration through liquid

Each group will be given a tuning fork and a cup of water. Each tuning fork has a designated frequency. When you hit a tuning fork properly, it will emit a sound wave with a constant frequency.

Now, hit the tuning fork to produce a sound. Immediately immerse the tuning fork in water. One group member can put his/her ear on the wall of the cup and hear the differences. What has happened? What is the difference between sound traveling in air and in water? Describe the traveling of sound in a liquid in terms of vibration.

Activity Three: Vibration through solid

Assign one group member to put his/her ear on a lab bench or chair. Hit the tuning fork the same way you did in activity two, and place it on the bench. What is the quality of the sound? Describe the traveling of sound through a solid in terms of vibration.

Activity Four (Optional): Doppler Effect

As stated in activity two, the tuning fork produces a sound with designated frequency (or pitch). Hold the tuning fork with one hand and extend your arm as far as you can. Move the tuning fork very quickly toward your ear and move it away very quickly. Perform this step several times. What do you hear? Do you hear changes in pitch while you move the tuning fork?

Activity Five: Imagine you are a whale…

In activity two, we experienced sound traveling differently through air and liquid (the pitch of a sound we hear in air is different from the pitch in water). If you speak under water while swimming, another person will hardly hear what you have said. Now, imagine you are a whale in an ocean. Write a paragraph to explain how whale communication is different than human communication. Address and explain any communication difficulties that may be encountered by whales.

Extension Activity:

Play the Blue Whale song clips from the National Oceanic and Atmospheric Administration (NOAA)'s acoustics site: http://www.pmel.noaa.gov/vents/acoustics/sounds_whales.html