A Cup of Sound
Sound Investigation

Name _____ Date _____ Class _____

Sound is created when air is made to vibrate or move back and forth rapidly. The vibrations of air can be amplified when they are passed through a cone shaped speaker such as a megaphone or the bell of a trumpet.

In this activity, you will investigate variables which affect the pitch of the sound produced by a simple noise maker made from a variety of materials.

Materials:

*cups of various sizes and materials (plastic, paper, etc.)
*2 or 3 kinds of different thicknesses of cotton string
*2 or 3 different thicknesses of monofilament nylon fishing line
*a nail, push pin, or sharpened pencil
*a paperclip, washer, button, or toothpick
*paper towel, wax paper, or sponge
*water
*scissors
*materials worksheet
*discussion questions worksheet

Procedure:

1. Work in groups of two.
2. Choose at least 3 cups and 4 strings to use for your experiment in making sounds.
3. Using a pointed object, poke a small hole in the bottom of a cup.
4. The remaining objects may be used in designing your experiment. You must first fasten one or more strings to the bottom of the cup.
5. Hold the cup in one hand and pinch the string between your thumb and forefinger, just below the cup.
6. Pinching the string firmly, pull your hand down to make the sound.
7. Now decide how you will use materials provided to make sound with your cup and string. Record materials used and a description of the sound that was produced.
8. Answer discussion questions orally as a group.

Discussion Questions

1. What happens when you pull your fingers down the string?

2. What causes the sound?

3. What variables do you think affect the pitch of the sounds produced by the noise-maker?

4. Do the sounds from the thick string and thin string differ? How?

5. Does wetting the string change the sound? How? Why?

6. Does pulling the string in short or fast strokes change the sound that is being made?

7. Does changing the cup sizes and materials make a difference in the sound?

8. Do some cups make louder sounds? Is the pitch different?

9. Can you make animal noises with the cup? Can you make human sounds?

10. What instruments can you imitate?

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Student Activity Sheet

Name _____ Date _____ Class _____

Trial	Cup	String	Pinching Material	Sound Description
1				
2				
3				
4				
5				
6				

A Cup of Sound

Teacher Strategy Section

Grade Level: K – 5

Time Required: 45 minutes

Standards Addressed:

The Rhode Island Science Framework
Technology and Science: Benchmark 1 & 2
Designs and Systems: Benchmark 1
Motion: Benchmark 3
Learning: Benchmark 1 & 2

National Science Education Standards
Teaching Standards: A, B,C,D,E
Content Standards: A,E

New Standards
Science: S1b; S4a,d; S6a,b; S7a; S8c
Mathematics: M2g; M4a,b,c,e; M6c
Applied Learning: A1a,b,c; A2a; A3b
English Language Arts: E2a; E3b; E4a

Motivation Activity:

Use this activity to demonstrate how the throat changes as the voice changes in pitch.

When you speak or sing, you push air from your lungs past your vocal cords, which are two flaps of tissue inside your vocal cords, you can make sound have a higher tone. Do this activity to explore how you change the shape of your throat to vary the tone of sound.

Observe throat vibrations

1. Hold your fingers against the front of your throat and say *Aaaaah.* Notice the vibration against your fingers.
2. Now vary the tone of this sound from low to high and back again. How do the vibrations change in your throat?
3. Change the sound to an *Oooooh.* What do you notice as you listen?
4. Hold your hand to your throat while speaking. Pitch varies with the emphasis given to different words. The last words of a question, for example is at a higher pitch.

Physics of A Cup of Sound

All sounds are made by creating vibrations. These vibrations move pulse-like waves of air to your ear where each wave pushes and pulls the drumhead-membrane of your ear against bones and sends signals through nerves which your brain interprets as sound. The rate that your eardrum moves back and forth determines what pitch you hear.

While all sound begins with vibrating things, there are different ways of making things vibrate.

A Cup of Sound is an example of a "*slip-stick*" method of generating sounds. Familiar examples of the slip-stick method of making sounds are chalk squeaking on a board, playing a violin with a bow, or rubbing a damp finger along the rim of a goblet to make it hum. The rubbing action needs to alternately slip a bit, then stick, then slip again, etc. in order to get an object vibrating.

Each tone is a result of your particular combination of cup, string, sponge, and the rubbing motion you use.

You may need to guide the students in attaching the string to their cup. One way is to:
1. Push one end of the string through the hole and into the cup.
2. Take the end of the string that is inside the cup and tie it firmly to a paperclip, button, washer, or toothpick.
3. Pull the string back through the hole until the paperclip or other object is flat against the inside bottom of the cup.

As the string slides through your fingers it begins to vibrate. The string causes the paper clip to vibrate the bottom of the cup. As the bottom of the cup vibrates, waves of compressed air (sound waves) are created. The shape of the cup concentrates and amplifies the sound waves.

Concepts

- Sounds are produced by vibrating objects and vibrating columns of air.
- Pitch and volume are two characteristics of sound.
- Changing the way an object vibrates can change the pitch and volume of the sound produced.
- Pitch is determined by the frequency of the vibrations; volume is determined by the amplitude of the vibrations.
- Changing the length, tension, or thickness of a string affects the frequency of vibration and, therefore, the pitch of the sound produced.
- The human ear has a membrane that vibrates when sound reaches it; the ear and the brain translate these vibrations into the sensation of sound. Students may visit the ***Discovery of Sound in the Sea*** web site to see the inner workings of a human ear as well as other animals. http://omp.gso.uri.edu/dosits.htm

- Sound is produced by the human vocal cords as air moves through the tightened cords. (See Science Museum of Minnesota Activity - Making Sounds with Air and Strings: Human Vocal Cords http://www.sci.mus.mn.us/sound/activity/ssl14.htm

Application

How are a guitar and a violin like the instrument you just made? What other musical instruments use vibrations to make sounds?

Ideas to Explore

How can you make a stringed instrument sound louder?
How do different materials for the sound device change the instrument's sound?
What materials produce the most pleasing sound?
What kinds of strings work best for low notes? For high notes?

Assessment

Observation of students during activity
Quick Write – Using pictures and/or words tell me what you learned from the *Cup of Sound* activity.

Extensions
Grades 6 – 12

- Design a data collection sheet you can use throughout the activity. As you investigate, carefully record what you did and what results you got in a format that is easy to follow and can be shared with others.

- Students design a new sound-producing device applying previously learned concepts. Ask your students to outline the way in which an idea begins and then evolves. Working in their cooperative learning groups, students will examine the instruments they have created, focusing on the physical creation of the instruments. One or two members should be selected by each group to illustrate the "manufacturing" process by diagram, computer graphics, drawings, videotapes or charts. At the completion of the project, the groups will display their creations to the class.

Extended Activities

Grades K - 5

- Set up student groups of three to four students, and provide each group with a meterstick or yardstick. Ask each student group to carry out investigations

to answer the question, "What sounds are produced when you vibrate the stick at different lengths?" For example, ask the class to compare the sound produced by vibrating a 15 cm. (6 inch) length to one that is 30 cm. long. Help the students to observe that the greater the length of the vibrating stick the lower the frequency. The differences in frequencies are perceived as sound of different pitches.

- Follow-up this activity by providing each student group with some type of string instrument (i.e., guitar, violin, cello). Or, bring one or two instruments into class and allow each group the opportunity to study them. Ask each group to come up with an explanation of how different musical notes of varying pitches are produced by the vibrating strings. Another interesting question for students to explore: "What properties of the strings affect the frequency of the vibration?"

- **High or Low Sounds?**

  Materials: 3 glasses or jars (all the same size), a metal spoon, water, food coloring, a grease pencil.

  Prior to the activity: Let students strike the empty glasses with the spoon to hear the sound they make. All 3 should make approximately the same sound.

  Pour colored water into each glass so that each one is filled to a different level. Now let students strike them again and see the different sounds they make. Have students arrange the glasses by sounds, from lowest to highest. Number the glasses 1, 2, and 3 with the grease pencil. Point out that the lowest sound is made by the glass with the most water, leaving only a little of the glass to vibrate. Match the 3 sounds to the first 3 of the scale and play *"Mary Had a Little Lamb"* by striking the glasses as follows:
  3212333 222333 3212333322321.

- **Good Vibrations Activity**

  By investigating how sound travels through air, solids, and water, the student will be able to explain why sound is an effective means of communication and navigation for whales.

  Sound travels more than four times faster in water than it does in air. Toothed whales probably receive most sounds through the lower jaw. A whale may also receive sound through soft tissue and bone surrounding its ear. A killer whale's fat-filled jawbone conducts sound through the jaw to bones in the middle ears.

Scientists have discovered that some toothed whales use sound to navigate and locate prey in dark or murky water. How? By sending sound waves into the water and listening for echoes. This system of sound is called *echolocation*.

When a toothed whale *echolocates,* sound waves travel through its *melon* and out into the water in front of the whale. By interpreting the echoes that bounce back from sounds they've produced, toothed whales can tell the shape, size, speed, and distance of objects in the water.

Materials: Tuning Forks and Shallow Pans of Water

Procedures:

Water

Holding the handle of the tuning fork, strike it on a hard solid surface. Hold the two tines in a shallow pan of water. Ask students to describe what they see. Movement causes vibrations, and vibrations produce sound waves. These waves move outward from the source. The vibrating tuning fork tines produce ripples in the water. Imagine that the tuning fork is an echolocating whale, and the ripples are sound waves produced by the whale.

Air

Strike the tuning fork on a hard solid surface. Ask students to describe what they hear. Even though we can't see the sound waves, striking the tuning fork against a hard solid surface causes the tuning fork tines to vibrate rapidly. As the sound travels through air, students may hear a faint hum.

Solids

Strike the tuning fork again and hold the tip of the handle to a student's lower jaw. Ask students to describe what they hear or feel. *(The hum is more audible).* In this case sound is conducted by the bone and tissues of the lower jaw. Since the molecules of solids are more densely packed than in air, sound can actually travel faster and farther through solids than through air.

Vocabulary

Sound
: Vibrations which produce the sensation of hearing by stimulating the auditory nerves; anything that is or can be heard

Vibration
: Rapid back and forth motion which can result in a sound wave

Pitch
: The "highness" or "lowness" of a sound, determined by frequency

Frequency
: The number of times the back-and-forth movement (sound wave) occurs in a second

Volume
: The loudness, strength or quantity of sound

Amplify
: To increase the strength or power of sound to hear it better

Related Links (August 9, 2002)

http://www.physicsclassroom.com/Class/sound/U11L5a.html
http://www.nsf.gov/od/lpa/nstw/teach/activity/u3a2.htm
http://www.planetary.org/learn/MarsMic/TSTW/3-1997/StringItAlong.html
http://www.scilitlinks.org/sounds.htm
http://www.mhschool.com/teach/science/mhscience/teachres/blm/pdf/gr2/practice/G2U3T5.pdf
http://wildnetafrica.co.za/envirokids/sound/cacophony.html
http://place.scholastic.com/magicschoolbus/games/sound/index.htm#
http://library.thinkquest.org/19537/
http://www.nidcd.nih.gov/health/kids/video/sound_vid1.htm#sound

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