Making Waves, Music, and Noise

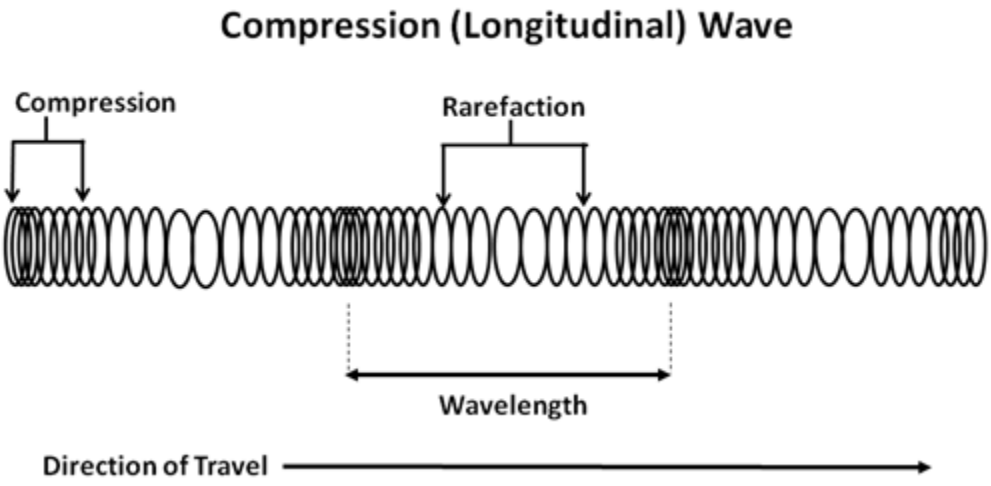
Strand Force, Motion, and Energy
Topic Investigating sound
Primary SOL 5.2 The student will investigate and understand basic characteristics of sound and how it behaves. Key concepts include
- b) vibration, compression, wavelength, frequency, amplitude;
- d) uses and applications of sound waves.

Related SOL 5.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
- b) estimates are made and accurate measurements of length, mass, volume, and temperature are made in metric units using proper tools;
- c) estimates are made and accurate measurements of elapsed time are made using proper tools;
- d) hypotheses are formed from testable questions;
- g) data are collected, recorded, analyzed, and communicated using proper graphical representations and metric measurements;
- j) models are constructed to clarify explanations, demonstrate relationships, and solve needs.

Background Information

Sound is a form of *energy* produced and transmitted by vibrating matter. Sound waves caused by such vibrations move through a medium (a solid, liquid, or gas) in all directions from their source. However, the medium just vibrates back and forth and transfers the *energy*; the medium is not carried along with the sound wave.

Sound waves can be described by the wavelength and frequency of the waves.



The frequency of the vibrations determines how high or low the pitch of the sound is. The faster the object vibrates, the higher the frequency and the higher the perceived pitch; the slower the object vibrates, the lower the frequency and the lower the perceived pitch. The size and shape of an object will affect the pitch at which it resonates.

Sound travels more quickly through solids than through liquids and gases because the molecules of a solid are closer together and, therefore, can transmit the vibrations (energy) faster.

Sound travels most slowly through gases because the molecules of a gas are farthest apart. Some animals make and hear frequencies of sound vibrations (pitches) that humans cannot make and/or hear. Musical instruments vibrate to produce sound.

Musical instruments vibrate to produce sound. There are many different types of musical instruments and each instrument causes the vibrations in different ways. The most widely accepted way to classify musical instruments is to classify them by the way in which the sound is produced by the instrument. The four basic classifications are percussion instruments (e.g., drums, cymbals), stringed instruments (e.g., violin, piano, guitar), wind instruments (e.g., flute, clarinet, trumpet, trombone), and electronic instruments (e.g., electronic organ, electric guitar).

Materials

- Instruments of teacher choosing (two to three instruments including a guitar)
- Drinking straws made of paper, not plastic – one per student
- Rulers
- Watches
- Copies of activity sheet “Squawker: A Sound Exploration”

Vocabulary

wave, frequency, vibrations, pitch, sound, resonator

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Explain that sound plays a critical role in our everyday lives. One way sound brings enjoyment to people is through music. Explain that in this lesson the students will begin exploring some musical sounds.
2. Play an instrument and discuss how it makes sounds with the students.
3. Ask students what part of the instrument is making the sound. For example, if you are playing a stringed instrument, ask:
    - How do the strings affect the sound?
    - How do the strings vary?
    - Does the hole in the center affect the sound?
    - What part of the instrument resonates?
    - What happens if the force that is put on the instrument is changed (blow harder, strum harder, faster)?
    - Discuss frequency and pitch.

4. Explore a couple of instruments and discuss how the sound is made by each instrument before asking the students to begin their hands-on investigation.

Procedure

1. Distribute paper straws, scissors, and copies of the attached worksheet "Squawker: A Sound Exploration" to the students.
2. Have the students measure and then flatten one inch of the one end of their straw, using a ruler for both tasks.
3. Then have students make two diagonal cuts with scissors to the flattened end of their straws, as shown on the worksheet "Squawker: A Sound Exploration."
4. Have one student use the stopwatch to write down the start time and end time of blowing into the squawker. Tell the students to blow through the open end of their straw for as long as possible, but at least greater than three seconds. Have students record the elapsed time that they blew on the squawker. Blowing on their squawker should create a "squawking" sound.
5. Ask them what part of the straw is vibrating to make the sound and what part of the straw is acting as a resonator. Ask the students what they think will happen if the straw is shortened.
6. Have the students predict how the pitch will change and have half the class test the prediction by cutting their straws to a shorter length. Then conduct a sound comparison by having these students blow their squawkers one at a time, followed immediately by several students blowing their original-length squawkers one at a time. Blow on the squawkers in this experiment for at least three seconds as well. Ask them to record their start time and stop time and then find the elapsed time they blew on the squawker.
7. Compare the sounds of the shorter squawkers with the sounds of the longer ones and draw a conclusion about how pitch changes with length.
8. Ask students to use their watches and explore using different time lengths to test their squawkers. Ask them to record their start time and stop time, then find the elapsed time they blew on the squawker.

Observations and Conclusion

1. Discuss that the squawkers make sound by producing vibrations. Moving air causes the pointed ends of the straw to move rapidly back and forth — that is, to vibrate. Woodwind instruments, such as clarinets, use a reed that vibrates in a manner similar to the pointed end of the squawker. The length of the straw, in part, determines the kazoo-like sound that is created by the squawker. As the length of the straw is shortened, the pitch of the sound produced becomes higher. This is because the air in the shorter straw naturally resonates at a higher frequency. Sound waves with a higher frequency cause sound with a higher pitch.
2. Discuss how the time of blowing in the squawker affected the experiment. What role did the time play?
3. Have students complete the questions at the bottom of the "Squawker: A Sound Exploration" worksheet.

Assessment

- **Questions**
  - What causes the sound the squawkers make? (Vibrations cause sound. Vibrating objects transmit sound waves to other media, such as air, and they travel in all directions.)
  - Compare the sounds of the shorter squawkers with the sounds of the longer ones and draw a conclusion about how pitch changes with length.
  - What is resonating?
- **Journal/writing prompts**
  - Reflect on the different experiences you have had with the sound experiments today.
- **Other**
  - Do one of the following demonstrations for the class: resonating box and tuning fork, singing tube, popping tube. Have the students explain the science behind the demonstration, using science language and the basic concepts they have learned about sound. Encourage students to include diagrams with their explanations.

Extensions and Connections (for all students)

- Have students design and make an instrument that (1) is durable and can be played, (2) can play both high and low pitches, and (3) can be played both loudly and softly. For the design process, encourage them to focus on cause/effect relationships and use a flow chart as a graphic organizer.
- Have students design an advertisement for the instrument they made, including the following: an original name, a list of features or things the instrument can do, a diagram illustrating how it works, and a scientific explanation of why it works.
- Invite a musician who plays a stringed instrument to discuss pitch in relation to their instrument.
- Have students use an application on a hand-held device to show the change in pitch. Students can record the change in pitch every second they are having on the straw.

Strategies for Differentiation

- Visually show waves on audio editing software using popular music of interest to students and then make comparisons to classroom made instruments or music instruments available through the school music teachers. (Audio editing software is available free of charge online.)
- Visually represent sound waves by gluing string or a similar item down in a pattern to model sound waves.
- Include a reflection journal comparing symphony music to rock, rap or other types of music relating to sound waves and movement.
- In lieu of journal writing, allow students to draw pictures or take pictures with added captions using word processing software.
- Create a T-chart with the sound label on one side and an approximate representation of its frequency on the other side. For example, you could write “dog whistle” at the top

paired with a very fast frequency and a tuba at the bottom paired with a very slow frequency. This may need to be modeled or completed together.

- Fill glasses with varying amounts of water and gently tap with a spoon to observe the relationship between the amount of water and the pitch of the sound. Other examples include blowing in bottles with varying amounts of water or using crystal glasses with a damp finger around the rim.
- Take a field trip to a church, chapel, organ factory, or Luray Caverns to examine the relationship between size and pitch.
- Place all of the vocabulary words in a cup. Select a speaker. Have the speaker pull out one word at a time from the cup and take only one minute to give clues in order to get the rest of the class to guess the term. Rotate the role of speaker among the students.

Squawker: A Sound Exploration

Name: _____ Date: _____

Directions

Make a squawker from a paper drinking straw, test it, and answer the questions.

Procedure

1. Use a ruler to measure a distance of one inch from one end of your straw. Mark this point. Use the ruler again to carefully flatten one inch of the end of the straw.
2. Make two diagonal cuts with scissors to the flat end of the straw, as shown below.

3. Test your squawker by blowing through the open end.
4. Which part of the straw vibrates? _____

   _____
5. Which part of the straw is the resonator? _____

   _____
6. What will happen if you cut your straw shorter? _____

   _____

   _____
7. How does the frequency of a sound wave relate to the pitch of the sound produced?

   _____

   _____

   _____

   _____