

Making Waves

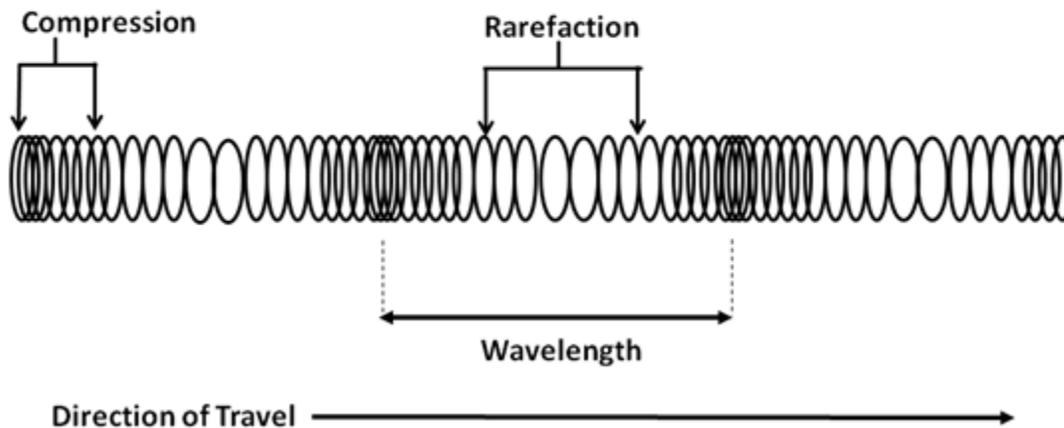
Strand	Force, Motion, and Energy
Topic	Investigating sound
Primary SOL	5.2 The student will investigate and understand basic characteristics of sound and how it behaves. Key concepts include a) compression waves; b) vibrations, compression, wavelength, frequency, amplitude; d) uses and applications of 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 h) predictions are made using patterns from data collected, and simple graphical data are generated; i) inferences are made and conclusions are drawn; j) models are constructed to clarify explanations, demonstrate relationships, and solve needs; k) current applications are used to reinforce science concepts.

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.

Compression (Longitudinal) Wave



Sound travels more quickly through solids than through liquids and gases because the molecules of a solid are closer together and 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 nor hear. Musical instruments vibrate to produce sound.

Remind children that sound travels slower than light, which is why they'll usually see a flash of lightening before they hear the crack of thunder; both happen at the same time, but light reaches us before the sound does.

Musical instruments vibrate to produce sound. There are many different types of musical instruments and each instrument causes the vibrations in different ways.

Stringed instruments produce sound when their strings are caused to vibrate. The strings can be plucked, bowed or struck, depending upon the instrument.

A percussion instrument is any instrument whose sound is generated by striking, rubbing, shaking or otherwise impacting a surface to create audible vibrations. The bigger a percussion instrument is, the lower its pitch.

Any instrument that produces sound from having air blown into it or across it can be considered a wind instrument.

Materials

- Speaker with removable cover
- Walking spring toy
- Pictures of various musical instruments including string, percussion, and wind instruments
- A variety of supplies for the construction of musical instruments by each team (e.g., shoe boxes with lids, string, rubber bands, paper clips, pipe cleaners, straws, fishing line, bottles and water, paper plates, empty oatmeal or cornstarch containers, sticks made from dowel, old hose, funnels, etc.)
- Student journals

Vocabulary

wave, frequency, vibrations, pitch, sound, wavelength, refraction, energy, string instrument, percussion instrument, wind instrument

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

Introduction

1. Ask the students whether they have ever *felt* a sound wave.
 - They have heard sounds, of course, but how about *feeling* sounds? If they have ever been next to a speaker with very loud bass tones being emitted, such as those in some cars, then it is likely they have.
 - Could a person who is deaf or hearing impaired *feel* a sound?
2. Have students discuss experiences at a concert, an amphitheater, a movie, or any other place near a vibrating speaker.
3. Show the students a loudspeaker with the cover removed.

4. Explain that the speaker is made up of two main parts: the tweeter and the woofer. Ask why they think these names were used to name these parts. (*The tweeter makes the higher pitched sounds and the woofer makes the lower pitched sounds. They do this by moving a membrane back and forth, in and out, to push the air and make it vibrate.*)
5. If the speaker can be connected to a CD player, play some music, and let the students watch the membranes moving.
6. Take the class outside to the playground or an area around the school. Have the students bring their science journals.
7. Ask them to sit as quietly as they can and listen to their surroundings. (You may want them to close their eyes to help them concentrate.)
8. Have the students write down the sounds that they hear.
9. When you return to the classroom, have the students put an “L” by the sounds they heard which were loud and a “Q” by the sounds that were quiet. Also have them write an “H” by the sounds they heard that were high pitched and a “W” by the sounds which were low pitched.

Have your students share their findings with the class. You can write the sounds on the board or on a chart, and build a graph of what was heard.

Procedure

Activity 1 – Modeling a Compression Wave (1)

1. Model a sound wave by stretching out a walking spring toy on a table or desk. Hold one end, and have a student hold the other. Give your end of the walking spring toy a pulse by pushing it forward a little very quickly and immediately pulling it back to the starting position.
2. Ask students to identify where the compressed coils are, and identify those areas as the *compression wave* that move down the walking spring toy from one end to the other.
3. Explain that this model looks like the movement of a compression wave or sound wave. Your hand is acting like the speaker diaphragm that makes the air vibrate.

Activity 2 – Modeling a Compression Wave (2)

4. For this demonstration make sure students will be able to have some room to move.
5. Have most of the students stand in a row at one side of the classroom, facing out into the classroom. Let some of the students stand across the room from the line so that they can see the "waves."
6. Starting with the student at one of the lines, have the line make a compression wave.
7. Have the students start with their arms out straight in front of them. As the wave goes by, each student will swing both arms first toward, and then away, from the next student in line.
8. Let the students take turns being the first in line, being in line, and watching the line from the other side of the room.

Activity 3 – Classroom Musical Group

1. Divide the class into three groups.
2. Give one group pictures of stringed instruments (e.g., guitar, violin, harp, piano, etc.), one group pictures of percussion instruments (e.g., drum, cymbals, bells, etc.), and one group pictures of wind instruments (e.g., flute, clarinet, trombone, French horn, harmonica, etc.). Have the groups conduct research about the kinds of instruments that

are in the pictures and how those kind of instruments produce sound (how they produce vibrations).

3. Have each group tell the class about their instruments.
4. Tell the students that they are going to work in pairs to create a musical instrument. The pairs should each be assigned a particular kind of instrument (stringed, percussion, or wind) that they will make. You can assign the instrument that each team will make in a variety of ways. You can have them make the kind of instrument they explored with the pictures or you can put the words string, percussion, and wind on small strips of paper and have each team draw a type of instrument to make.
5. Once each team knows which kind of instrument they are going to make, give them the activity sheet for their instrument. Set out the various supplies you have gathered for them to select to use, and have them follow the instructions on their activity sheet.

Conclusion

1. Have each pair display their instrument, demonstrate how it works, and explain how it makes sound.
2. Have all the pairs play the song “Mary Had a Little Lamb” with their instruments together as a musical group. Do this several times so that every student has the opportunity to actually play their instrument.
3. Hold a class discussion on what the students have seen in the demonstrations and with their instruments. Make certain that students understand that when a sound wave travels through a medium, individual molecules of the medium (air, water, solid) do not change location; they just vibrate back and forth, transferring the vibration from one molecule to the next to the next: *energy*, not matter, is transferred. Put another way, sound waves are *energy* moving from one place to another through a medium, but the molecules of the medium (e.g., the air or water molecules) do not move with the wave but merely vibrate to transfer the energy along.

Assessment

- **Questions**
 - What is sound?
 - How is sound made?
 - How does sound travel?
 - Explain how a stringed instrument produces sound.
 - Explain how a percussion instrument produces sound.
 - Explain how a wind instrument produces sound.
- **Journal/writing prompts**
 - Draw a compression wave and label the parts of the wave.
- **Other**
 - Compare the compression and rarefaction parts on a sound wave.

Extensions and Connections (for all students)

- Have students draw a diagram of what happens in the air when a sound wave travels from a sound source to their ear. Drawings should include the source of the vibrations, an accurate illustration of the vibrations, and an ear.

- Have student conduct research about unusual musical instruments or historical musical instruments.
- Have the students play a variety of tunes with their musical instruments (e.g., “Row, Row, Row Your Boat,” “If You’re Happy and You Know It,” etc.).

Strategies for Differentiation

- Provide students the opportunity to place their hands on a stereo speaker to actually feel the sound waves, or hold a balloon while loud music is playing.
- Have students glue cotton balls or other round objects to a poster to represent the molecules during compression and rarefaction with a model of a sound wave above.

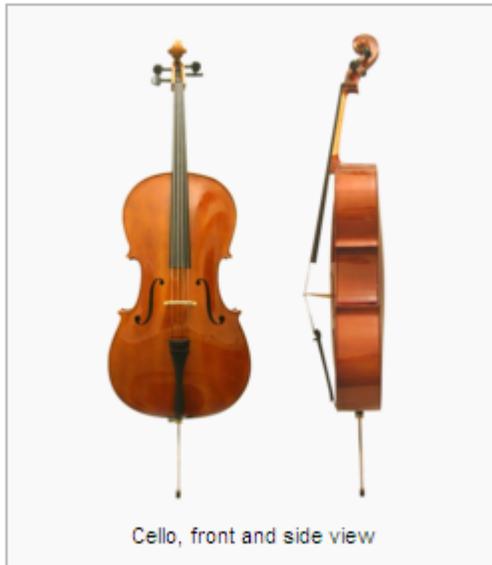
Stringed Instrument Construction

Names: _____ Date: _____

DIRECTIONS:

1. Examine the pictures of the stringed instruments and conduct research to gather information about stringed instruments and how they produce sound.

Cello



Guitar



Banjo



Grand Piano



Strings of a Grand Piano



2. Using the information you found about stringed instruments, design your own stringed instrument. Before you begin the construction of your string instrument, complete the following:
 - a. Examine the materials that will be available to your team.
 - b. Brainstorm a design for your string instrument. Be sure when you design your instrument, you will be able to play the tune “Mary Had a Little Lamb” using your instrument.
 - c. Make a drawing of your design.
 - d. Send your group’s “Materials Manager” to get the supplies you will need.
 - e. Construct your instrument and test it. Make sure that you can play “Mary Had a Little Lamb.” If needed, make modifications to your instrument’s design, reconstruct your instrument, and retest it. Continue this process until you have a success!
 - f. Be prepared as a team to explain how your instrument was constructed and how it produces sound.
3. Once all teams have completed their instruments, you will take turns with your partner to be part of the class musical group and the musical group will play “Mary Had a Little Lamb” together.

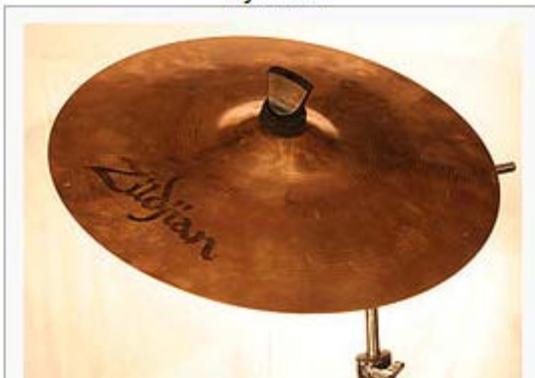
Percussion Instrument Construction

Names: _____ Date: _____

DIRECTIONS:

1. Examine the pictures of the percussion instruments and conduct research to gather information about percussion instruments and how they produce sound.

Cymbal



Snare drum



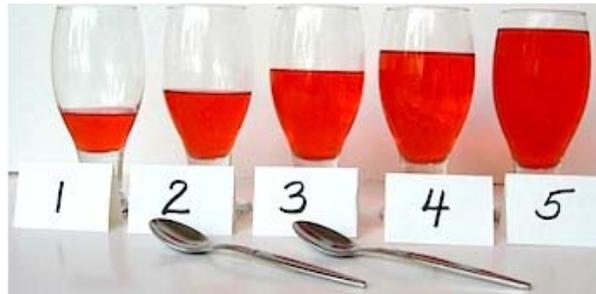
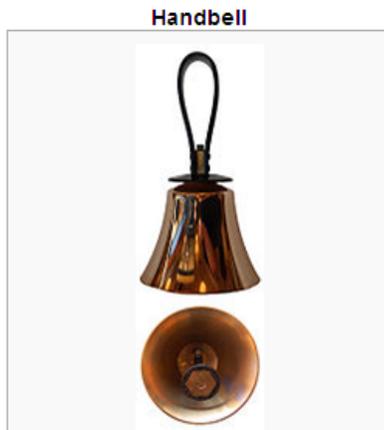
Bongo drum



A pair of bongos

Xylophone





2. Using the information you found about percussion instruments, design your own percussion instrument. Before you begin the construction of your percussion instrument, complete the following:
 - a. Examine the materials that will be available to your team.
 - b. Brainstorm a design for your percussion instrument. Be sure when you design your instrument, you will be able to play the rhythm for the tune “Mary Had a Little Lamb” using your instrument.
 - c. Make a drawing of your design.
 - d. Send your group’s “Materials Manager” to get the supplies you will need.
 - e. Construct your instrument and test it. Make sure that you can play the rhythm for the tune “Mary Had a Little Lamb.” If needed, make modifications to your instrument’s design, reconstruct your instrument, and retest it. Continue this process until you have a success!
 - f. Be prepared as a team to explain how your instrument was constructed and how it produces sound.
3. Once all teams have completed their instruments, you will take turns with your partner to be part of the class musical group and the musical group will play “Mary Had a Little Lamb” together.

Wind Instrument Construction

Names: _____ Date: _____

DIRECTIONS:

1. Examine the pictures of the wind instruments and conduct research to gather information about wind instruments and how they produce sound.

Horn



Recorder



Trombone



Clarinet



Trumpet



2. Using the information you found about wind instruments, design your own wind instrument. Before you begin the construction of your wind instrument, complete the following:
 - a. Examine the materials that will be available to your team.

- b. Brainstorm a design for your wind instrument. Be sure when you design your instrument, you will be able to play the tune “Mary Had a Little Lamb” using your instrument.
 - c. Make a drawing of your design.
 - d. Send your group’s “Materials Manager” to get the supplies you will need.
 - e. Construct your instrument and test it. Make sure that you can play “Mary Had a Little Lamb.” If needed, make modifications to your instrument’s design, reconstruct your instrument, and retest it. Continue this process until you have a success!
 - f. Be prepared as a team to explain how your instrument was constructed and how it produces sound.
3. Once all teams have completed their instruments, you will take turns with your partner to be part of the class musical group and the musical group will play “Mary Had a Little Lamb” together.