Sensations of sound

The following series of tried and true activities explore the nature of sound. They can be set up as stations around the room, which students should be able to cycle through in one class period.

Feel the vibrations

Your vocal cords produce sound the same way everything else produces sound—by energy turned into waves. When your vocal cords vibrate, they push air molecules together—this part of the wave is called a compression. Behind the compression is an area where the air molecules are spread out; this is called the rarefaction (see Figure 1).

Purpose

To detect the vibrations of sound through touch.

Procedure

1. Place your fingers against your throat and say, "Sound moves in compression waves."
2. Describe what you feel.

Playing with pitch

Purpose

To compare the human voice to a stringed instrument.

Materials

- stringed instrument (guitar, violin, bass)

Background

Why do human voices sound different? How do you produce different sounds when you speak? Touch the center of your throat while you speak to feel vibrations inside your windpipe. Two flexible vocal cords are located in the larynx inside your windpipe. Air rushing past the vocal cords causes them to vibrate and create sound. The brain tightens or loosens the vocal cords, which causes them to vibrate at different speeds to create the different sounds.

Stringed instruments create sounds the same way. The thicker, looser strings create lower pitches because they vibrate slower. The thinner, tighter strings create higher pitches because they vibrate faster.

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Procedure

1. Observe each string on the instrument. Describe the thickness and tautness of each string.
2. Pluck each string and observe the sound made.
3. Adjust the tautness of each string and observe how it affects the sound. For example, how does the sound of a thick, loosely strung string compare to the sound of a thick, tightly strung string? Create a string chart to record your observations that includes information on string thickness and tautness. What can you infer from your observations?

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FIGURE 1 **Wave compression and rarefaction**

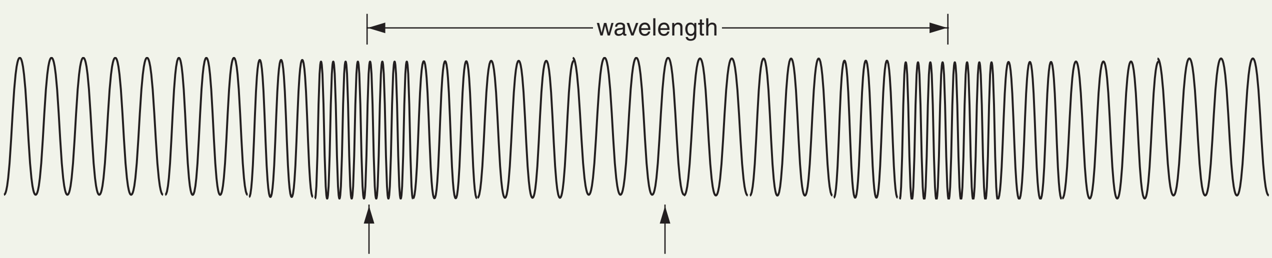


FIGURE 2 **Standing wave**

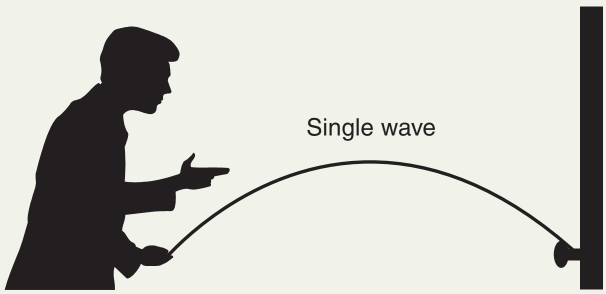
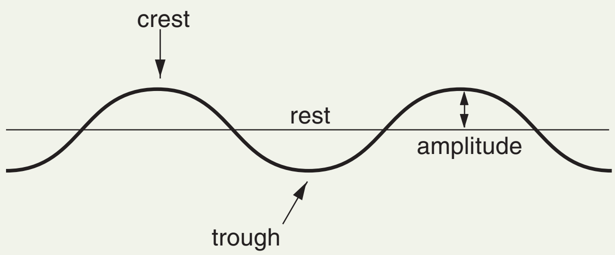


FIGURE 3 **Crests and troughs**



4. Adjust the tautness of two adjacent strings to see if you can make them create the same sound.

See the vibrations

If you toss a rock in the glassy water of a lake on a windless day, you will see the water undulate as it ebbs away from the source of the disturbance. The kind of wave generated, a standing wave, is the same type produced when you pluck the string of a guitar. A guitar string vibrates up and down, disturbing the air around it and making waves.

Purpose

To create disturbances and observe the waves generated to visualize how sound travels.

Materials

- length of rope about two meters long
- door with knob

Procedure

1. Tie one end of the rope to a doorknob. Step away from the doorknob until the rope only droops slightly between your hand and the knob.
2. Move your hand up and down vertically. Make a wave that has only one high point. The high point of the wave is called the crest. A wave that has only one crest is called a standing wave (see Figure 2).
3. You will repeat the same procedure. This time though, try to make a wave with more than one crest, or high spot (see Figure 3).

The waves you created with the rope are called transverse waves. The trough is the low spot and the crest is the high spot. The wavelength is the distance from crest to crest on a transverse wave. The amplitude is the maximum movement from rest (from the horizontal center of the wave) to the top of the crest or the bottom of the trough.

Question

1. What happens when the wave hits the doorknob?

Hear the vibrations

All sound works the same way; a vibrating object creates a series of compressions and rarefactions.

Purpose

To explore the transfer of sound.

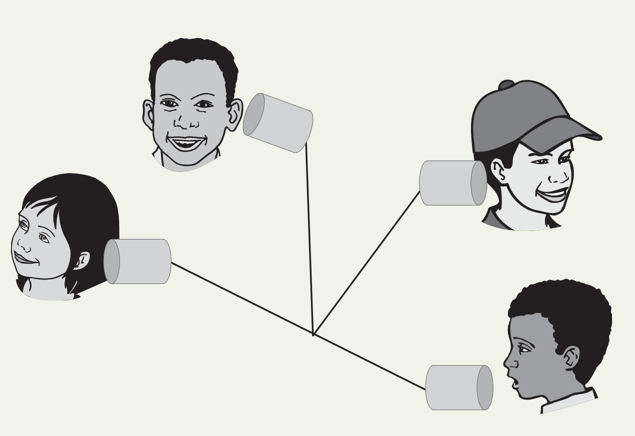
Materials (per pair of students)

- Two paper cups
- 4 meters of kite string
- ink pen

Procedure

1. Use the ink pen to punch a hole about 2 mm in diameter in the bottom of the paper cup.
2. Push one of the kite strings through the hole. Tie several knots in one end of the string and pull so that the knotted end is inside the paper cup.
3. Attach the second cup to the other end of the string by repeating steps 1 and 2.
4. Hold one cup in your hand, pass the other to your partner, and slowly back away from each other until the string is pulled taut between the two cups.
5. Hold the cup up to your ear while your partner speaks into the other cup. Then speak into your cup while your partner listens at the other end.
6. Apply your knowledge of sound to explain what you observed.
7. Work with another pair of students and have them cross your string line with their line as shown in Figure 4. Speak into your cup as the other three listen to their cups.

FIGURE 4 **Listening in**



8. Again, apply your knowledge of sound to explain what you observed.
9. Create other phones using tin cans instead of cups, or wire, yarn, or plastic cord instead of strings to see how the different materials affect the transfer of sound. Explain why the materials might affect the quality of transfer of sound.

Special (sound) effects

Purpose

To explore the amplification and transformation of sound.

Materials

- small slinky
- two 500-mL plastic cups (The plastic cups need to be stiff and sturdy. If no plastic cups are available, two-liter bottles with the spout end cut off can also be used.)

Teacher preparation

1. Punch two small holes about 15 mm apart in the bottom-center of the plastic cups.
2. Thread one end of the slinky wire through one hole in the cup. Use pliers to bend the same end of the slinky wire back through the other hole in the cup. Repeat this procedure with the second cup, using the other end of the slinky.

Procedure

1. Working with a partner, stretch the slinky between the two cups so the slinky is not resting on the floor.
2. Observe the sounds created when you tap or twist the slinky. Speak into one cup and observe how the slinky distorts your voice. Describe how each action affects the sound of your voice. How does the tautness of the slinky affect the sounds produced?
3. Do the sounds created by the slinky setup remind you of anything? (The sounds created will remind many students of sci-fi sound effects.)

In your glass

Purpose

To create waves that you can see, feel, and hear.

Materials

- tuning fork
- 250-mL beaker
- water
- rubber mallet

Procedure

1. Tap the end of the tuning fork with a rubber mallet and hold it near your ear. What do you observe?
2. Tap the fork again and hold it near the back of your hand so that the fork just barely touches the skin. What do you observe?
3. Diagram how the energy is transferred between the air, hammer, eardrum, fork, and your hand.
4. Fill a beaker halfway with water.
5. Tap the tuning fork again and hold it inside the beaker so that it just touches the surface of the water. (Avoid touching the glass itself. It could break.) What do you observe? Sketch what you see on top of the water. Label any compression waves or areas of rarefaction.
6. Suggest ways that you might change a variable in this setup and predict how the change would affect your observations.

CAUTION

Final note

These stations provide students with a basic understanding of sound. They can also serve as a launching point for student-designed experiments to explore further the phenomena of sound. As an extension, consider assigning readings from NSTA's new publication, *Sound*, from their *Stop Faking It!* series. *Sound* also contains additional activities that you can explore with your students.

Resource

Robertson, W.C. 2003. *Sound: Stop faking it! Finally understanding science so you can teach it*. Arlington, Va.: NSTA Press. Read the text online at *www.nsta.org/main/pdfs/store/PB169X4np.pdf*.