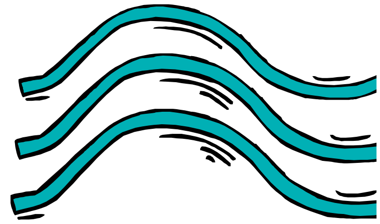
CATCH A WAVE



BENCHMARK and TASKS

SC.C. 1.2.2 The student knows that waves travel at different speeds through different materials.

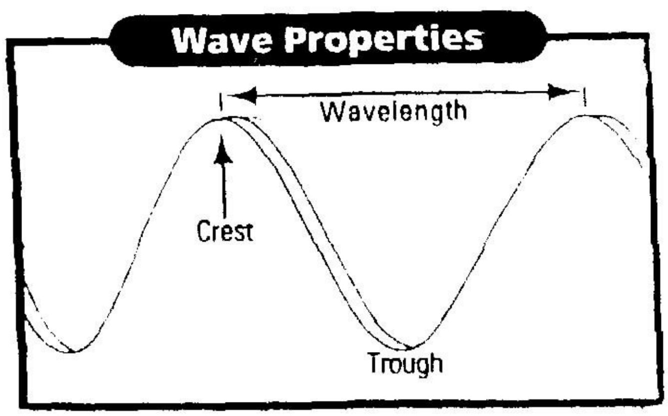
- The student uses a Slinky, rope, or spring to demonstrate that one way that energy is transported is through waves (oscillations – back and forth or up and down motions) that travel from one place to another.
- The student understands that waves (e.g., sound, light) travel at different speeds through different materials.
- The student draws and describes some characteristics of waves (e.g., crest [highest point], trough [lowest point], length).

KEY QUESTION

How do sound and light energy travel from one place to another?

BACKGROUND INFORMATION

Light and sound are forms of **energy**. Energy often travels as moving vibrations called waves. Some of these waves are easily visible and others are not. (See sketch.) Waves repeat themselves. How many times a wave repeats itself in a certain amount of time is called its frequency.



Sound: Sound travels in waves. Sound waves can move through things at different speeds. Sound waves move best through **solid** objects like the earth, metal (e.g., turning fork), and wood. Sound waves do not travel as well through a **gas** such as air or through spongy materials like a pillow that contains air pockets. Sound travels four times faster in water. All sound travels from a vibrating object through waves. The more the waves are squeezed together, the louder the sound. The waves travel out in all directions from the vibrating object in a pattern like the ripples on a lake. Sound travels about 1,100 feet per second, or 740 miles per hour.

Light: To better understand light waves, it is helpful to compare light to sound. Both sound and light travel in waves. Light travels much faster than sound. Sound travels like a snail when compared to light, which travels like a bullet. Light travels 186,282 miles per second. Sound waves need to travel through something to be heard. Light waves do not need to travel through anything to be seen. Light waves travel faster through air than through water, glass, or other substances. Light can go through some materials and not others.

MATERIALS

Teacher

2-3 foot rope or a Slinky
microwave popcorn (several bags) cooked
radio
1 bowl of water
1 tuning fork
glue bottle

Per group

1 clear plastic cup
½ cup oil
½ cup water
red food coloring
½ cup alcohol
1 straw
paper towels

TEACHING TIP

Set up containers of oil and alcohol and some measuring cups in a materials station.

ENGAGE

1. Start the lesson with a party. Bring in microwave popcorn to share with the class and play a radio.
2. Ask: *What do the microwave I used to prepare this popcorn, the radio, the lights in this room and the sun all have in common?* (All produce energy that moves in waves.) Have students draw a picture of what they think these waves look like.
3. Ask: *What do you think of when you hear the term "wave"?* Make a list or a Circle Map of anything the class suggests. Encourage students to add to or delete from the Circle Map as the lesson progresses.

EXPLORE AND EXPLAIN (Part 1)

1. Select a student volunteer and direct her to tightly hold one end of the Slinky or rope with both hands. Grasp the other end and move away from the student until the Slinky is loosely stretched between you.
2. Explain to the class that you are going to send a message to the student. Snap the Slinky up and down once to send a wave of energy to the student's hand. It will bounce back, or reflect, from the stationary end. Tell students that light reflecting from a shiny surface and even their reflections in mirrors are examples of light bouncing back.
3. As the student volunteer holds the end of the Slinky tightly, vigorously create a standing wave in the coils by moving your hand rhythmically up and down slowly. Each wave is made up of a crest (high half) and a trough (low half). Have the class note that the waves are long and that your hand is moving slowly. Then model short waves by moving your hand up and down rapidly. (Practice finding the right rhythm to keep it going!) This time students should note that the short waves seem to have a lot more energy than the long ones.
4. Draw waves on the board (See Background Information) and label the parts. Have students sketch long and short waves and label them.

EXPLORE AND EXPLAIN (Part 2)

1. Tell the class that this activity will show how light travels through air.

2. Ask a student to come to the front of the room. The rest of the class should sit at their desks with their chairs pulled in, leaving the aisles clear. They are simulating the great amount of space between particles in a gas such as air.
3. Assign one student to be the timer. When you say "GO," the timer will time the student as he/she walks as quickly as possible from the front of the room to the back.
4. Say "GO." The student will walk from the front to the back.
5. After the student walks from the front to the back, record the time on the front board next to the words, *Light wave traveling through air*.
6. Tell the class that the next activity will show how light travels as it goes through clear water.
7. Ask the student to return to the front of the room. The rest of the class should sit near their desks with their chairs pulled out slightly, leaving aisles partially clear. They are simulating the amount of space between particles in a liquid, which would be less than the space between gas molecules.
8. Prepare the timer. When you say "GO," the timer will time the student as he/she walks as quickly as possible from the front of the room to the back.
9. Say "GO." The student will walk from the front of the room to the back.
10. After the student walks from the front to the back, record the time on the front board next to the words, *Light wave traveling through clear water.*
11. Tell the class that the next activity will show how light travels as it goes through translucent glass, a solid.
12. Ask the student to return to the front of the room. The rest of the class should sit near their desks with their chairs pulled out slightly into the aisles and their arms stretched out to block the aisles a bit more. They are simulating the amount of space between particles in a solid, which will be far less than a liquid or gas.
13. Prepare the timer. When you say "GO," the timer will time the student as he/she walks as quickly as possible from the front of the room to the back.
14. Say "GO." The student will walk from the front to the back.
15. After the student walks from the front to the back, record the time on the front board next to the words, *Light wave traveling through translucent glass.*
16. *Through which kind of material you tested did the light travel the fastest?* (through gas)
17. *Through which kind of material you tested did the light travel the slowest?* (through solids)

EXPLORE (Part 3)

1. Have each group send someone to a materials station to measure ½ cup of oil and ½ cup of alcohol for the group.
2. Students should pour ½ cup of water and add several drops of red food coloring.
3. Students should pour ½ cup of oil and ½ cup of alcohol into a clear plastic cup along with ½ cup of water colored light red.
4. Have one student in each group place a straw in the glass. Ask students to discuss what they observe and to work together to write a short explanation of why it appears that way. (The straw will appear to be bent because light is traveling through the different liquids, or materials, at different speeds.)

EXPLAIN (Part 3)

Have a spokesperson for each group read the group's explanation of why a straw passed through three different liquids appears to be bent.

EXTEND/APPLY

1. Ask: *How do you think you can stop light from reaching you?* (Block it with some barrier that will make the light waves slow down or stop.)
2. Tell students that not all waves (e.g., sound) can be easily seen by the naked eye. Do this by striking a tuning fork on a glue bottle and holding it up. Most students will not be able to detect the wavering of the prongs. Dip the ends of the fork in a bowl of water and have students observe the ripples caused by the motion of the fork in the water.

EXTENSION

1. Tell students that there are many different kinds of waves and that waves can vary from one another by their frequency or by the number of times a wave repeats itself in a certain amount of time. Waves look and act differently. Explain that waves travel through space at the speed of 186,000 miles each second. If we think of their movement in terms of steps, the tall waves can take longer steps so we say they have longer wavelengths. The short ones travel just as fast, but they must take many small steps more frequently. We say that the longest waves have the lowest frequency and the shortest waves have the highest frequency and therefore the highest energy.
2. Write the names of different types of waves on the board and briefly introduce each one:
   Radio waves are the longest electromagnetic waves. Radios convert radio wave energy to sound energy.
   Television waves are used to carry messages to a special device, the television.
   Microwaves act on the motion of molecules. They travel in straighter lines than radio waves
   Infrared waves are commonly known as heat.
   Visible lights are red, yellow, orange, green, blue, indigo, and violet; each color is a different sized wave. We have special sensors for detecting visible light – our eyes.
   Ultraviolet waves are sometimes called black light. Ultraviolet waves are absorbed by our skin and can cause sunburn.
   X-rays can pass right through our skin, but not our bones.
   Gamma radiation comes from certain elements in the earth's crust. They can pass through thick concrete walls.
   Cosmic rays are the highest energy waves and the deadliest! They come from deep space and can pass through the earth.
3. Choose eight students of varying heights. Give each student a sign labeled with one of the types of waves. Have them stand in a line shoulder-to-shoulder with the tallest person first, representing radio waves, the next tallest representing television waves, and so on to the shortest student representing cosmic rays. Tell them they will be creating waves similar to ones that might be seen in a baseball stadium. Each wave will have its own characteristics.
4. Go down the line of students and ask each one, starting with radio as the tallest and slowest, to bend at the knees, up and down, when you give the signal. Each person should bend up and down a little faster than the taller one beside him. Cosmic should be moving rapidly – representing the highest frequency wave with the most energy.

ASSESSMENT

Draw pictures of waves at the beach, from small ones to huge ones. Label the parts of the wave: crest, wavelength, trough. Explain what waves of water have in common with sound and light.