Activity Description & Estimated Class Time

This activity is designed for one 50-minute class periods. Students connect what they have learned in previous lessons to sound, light, and earthquakes.

Correlations to NC Science Standards

PS.6.3.1 Use models of a simple wave to explain wave properties in seismic, light, and sound waves that include: waves having a repeating pattern with a specific amplitude, frequency, and wavelength, and the amplitude of a wave is related to the energy of the wave.

Learning Target

Students will demonstrate knowledge and understanding of the following ideas and content:

- waves transmit energy
- frequency of waves
- wavelength
- amplitude of waves

Students demonstrate this knowledge and understanding by changing these factors in a wave that they make with a spring. They also apply these ideas to examples of earthquakes, light, and sound.

Brief Science Background

Waves come in several forms. Some move side-to-side or up and down as they travel. For example, some earthquake waves travel horizontally, but the earth they travel through moves up and down. These are called transverse waves. Other waves alternately compress and spread out the material they travel through. For example, as a sound wave travels through air, it alternately compresses the air in one place and spreads it out in another. These are called longitudinal waves. Still other waves, such as water waves, combine different kinds of motion, causing the earth they move through to shift in a variety of patterns.

Types of Waves

Materials

Materials for the whole class

- spring toys, 1 per pair of students
- ability to project wave simulation
- balloon cups from Properties of Waves activity
- Types of Waves Guided Practice (SD 2), 1 copy per student

Materials for groups of 2 or 3 students

- 1 spring toy and a flat surface, wither a 5' table or uncarpeted floor space
- Types of Waves Student Activity Sheet (SD 1), 1 copy per student

Preparation

1. Check to see that wave animations requiring Quicktime function. Try the animation at http://www.physics.nyu.edu/~ts2/Animation/Trans_Long_Periodic_Waves.html. Click **Waves** and then click **Transverse, Longitudinal, and Periodic Waves.** If it does not work on your PC, download Quicktime for the PC. If you are using a Mac, you have Quicktime.
2. Arrange space for students to make waves with the springs.

Procedure

1. Give each group SD 1 and a spring. Ask them to use the spring to make a transverse wave. Then ask them to do the following and record on SD 1:
    a. increase the wave's frequency and describe what they did to increase it
    b. give evidence that the frequency increased (how it looked different from when its frequency was slower)
    c. increase the amplitude and describe what they did to increase it
    d. give evidence that the amplitude increased (how it looked different from when its amplitude was smaller).
2. Ask teams to make a longitudinal wave with the spring . Then ask them to do the following and record on SD 1:
    a. increase the frequency of the longitudinal wave and describe what they did to increase it,
    b. give evidence that the frequency increased.
3. Project http://www.physics.nyu.edu/~ts2/Animation/Trans_Long_Periodic_Waves.html. This page includes 3 types of waves. DO NOT run the top example labeled "transverse wave." Run the bottom two simulations only - "longitudinal wave" and "periodic transverse wave." After students watch, ask them to complete #4 on SD 1 with at least three similarities and three differences.
4. Discuss the students' lists.
    Possible answers include:
    Similar:
    - Both waves have a regular repeating pattern. The longitudinal wave has denser and more spread out areas that regularly repeat (a frequency). The transverse wave has ups and downs that repeat (a frequency).
    - Both waves move along the spring.
    - Both waves start with movement at one end.

    Difference:
    - The red balls in the longitudinal wave move forward and back, but in the transverse wave the balls move side to side or up and down.
    - The transverse wave takes up more space above and below the line while the longitudinal wave moves straight down the spring. Does that mean the longitudinal wave doesn't have an amplitude? Or might the longitudinal wave have a different kind of amplitude?
    - The balls in the longitudinal wave are sometimes spaced close together and sometimes farther apart, but those in the transverse wave seem to stay spaced more the same distance apart.
5. Pose the following question: If both kinds of waves have similar parts and properties, what do you think a crest or a trough might look like on a longitudinal wave? How might you measure a wavelength on a longitudinal wave? Introduce the terms **compression** and **rarefaction**. As longitudinal waves pass through a medium, the waves press the medium together in some places, or compress it. In other places, the waves separate particles of the medium, or rarefy it. With longitudinal waves, compressed and rarified areas of the medium alternate along the path of the wave.

Procedure cont.

With longitudinal waves, a complete wave (or cycle) is one compression and one rarefaction. A wavelength is the distance between one compression and the next compression (or between one rarefaction and the next rarefaction). A crest in a transverse wave corresponds to the place in a longitudinal wave where the medium is most compressed. A trough in a transverse wave corresponds to the place in a longitudinal wave where the medium is most rarefied. A longitudinal wave's amplitude is a measure of how tightly the compressions are packed together and how spread out the rare-factions are.

Interesting wave fact: the lowest pitch a human can hear is a sound wave with a wave length of about 7.3 yards, about the length of a classroom.

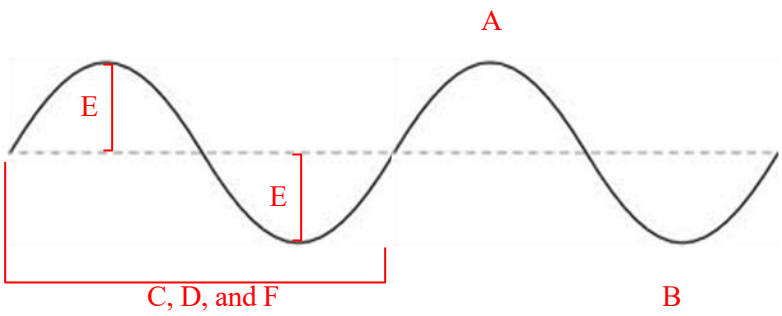
6. Explain that sound energy travels in longitudinal waves. Demonstrate with sound cups from properties of waves by having a student place a finger lightly on the balloon of one cup while, a few inches away, you snap the balloon of the other cup. Ask the student what they feel. Explain that the vibrations they feel are the compressions in the air striking the balloon they are touching.

Guided Practice/ Formative Assessment

1. Give each student a copy of SD 2. Ask students to define each term and label, as best they can, where each term occurs on the wave diagram. Let them know they can add lines to the diagram if they need to. Students will not be able to label frequency (G), but you do not need to tell them this.

   Answer Key:

   A. Crest
   B. Trough
   C. Wavelength
   D. Cycle
   E. Amplitude
   F. Period
   G. Frequency



   Student definitions should be as in step 2 below, but in their own words.

2. Go over the answers after they are done.
   - crest and trough: crest is the highest point of the wave; trough is the lowest point
   - Wavelength is the distance over which a wave's shape repeats, for example, from crest to the adjacent crest or from trough to adjacent trough.
   - A cycle is one complete shape of the wave, for example, from crest to crest or trough to trough.
   - Amplitude is the distance from the center point of the wave (also called the rest point) to the highest or lowest point.
   - The period is the time it takes for a wave's shape to repeat, for example, from crest to adjacent crest or trough to adjacent trough.
   - The frequency is the number of cycles of a wave that occur in a given amount of time. Frequency is often stated as the number of cycles per second.

Guided Practice/ Formative Assessment cont.

3. Ask students to imagine that each one of them is in charge of a group of 8 people. Explain that their task is to plan how these 8 people would move to demonstrate a transverse wave to the class. Give the students 5 minutes to work alone on their plans. Then divide the class into groups of 8 and give them 5 minutes to prepare their demonstrations.
4. Let each group present its wave. After all groups have done so, ask a group to demonstrate their wave again. At some point during the demonstration, call out "freeze!" With the wave frozen, ask other students in the class to identify a trough, a crest, and where a cycle starts and ends on the wave.
5. Challenge the groups to demonstrate a longitudinal wave. Give the groups five minutes to prepare, and then have them present their waves.

SD 1

Types of Waves Student Activity Sheet

1. With a partner, make a transverse wave with your spring. Make another one and increase the frequency. Describe how you did this AND what changed about the wave.

2. Make another wave that shows an increased amplitude. Describe how you did this AND what changed about the wave.

3. With a partner, make a longitudinal wave with your spring. Describe how you did this AND what changed about the wave.

4. Complete the chart below comparing and contrasting transverse and longitudinal waves. Use what you've learned in the prior lessons AND what you see in the simulations to list at least 3 similarities and differences. Don't forget to include things like medium through which they travel and types of energy that travel via the type of wave.

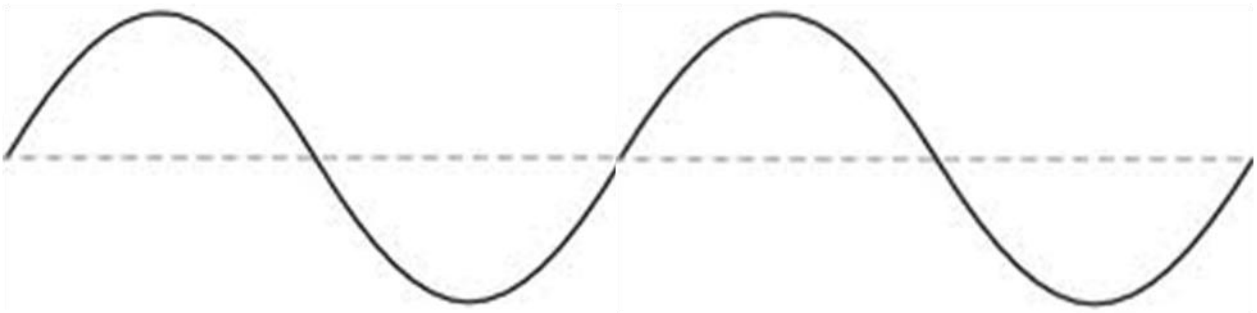
Similarities	Differences

SD 1

Types of Waves Guided Practice

Name:

Define each term below and label all the ones that you can on the wave diagram. You may add lines to the diagram if you need to.



A. Crest_____

B. Trough_____

C. Wavelength_____

D. Cycle_____

E. Amplitude_____

F. Period_____

G. Frequency_____