Exploring Waves

Purpose:

To explore a few simple characteristics of waves traveling along a rope and sound waves traveling through air.

Getting Ready:

Navigate to the **Simple Wave Simulator** Interactive at The Physics Classroom website:
http://www.physicsclassroom.com/Physics-Interactives/Waves-and-Sound/Simple-Wave-Simulator

Navigational Path:

www.physicsclassroom.com ==> Physics Interactives ==> Waves and Sound ==> Simple Wave Simulator

Getting Acquainted:

Once you've launched the Interactive and resized it, experiment with the interface. Tap on the **Slow Motion**, **Real Time**, and **Fast Motion** tabs at the top of the interface to observe how to control the tempo of the animation. Toggle back and forth between a sound wave and a rope wave by tapping on the **Show Wave as ...** button. Finally, observe the sliders at the bottom of the interface for controlling the **Frequency**, **Wave Speed**, and **Wave Amplitude**.

Exploring Waves on a Rope

Set the animation to **Show Waves on a Rope u**sing a **Real Time** tempo and **Frequency**, **Wave Speed**, and **Wave Amplitude** values of 0.10 Hz (approximately), 100 cm/s, and 2 cm respectively. Then use the controls on the animation to answer the following questions.

1. In Physics, we distinguish between **wave motion** and **particle motion**. Wave motion refers to the movement of a wave-like pattern from one location on the medium to another. When you view a water wave moving along the surface of water, you are observing wave motion. There is a very obvious movement of a collection of crests and troughs along the water surface. In the Simple Wave Simulator, there is a collection of crests and troughs moving through a rope; this is *wave motion*. But there are also three points on the rope that are colored red. When you observe the motion of these points, you are observing *particle motion* - the motion of particles of the rope. Describe the motion of these particles.

2. If you observe closely, you will notice that the particles leave a trail behind them as they move. The longer the trail, the faster that the particle is moving. During any up-and-down cycle of the particle, does it move with a constant speed or with a changing speed? If the speed is changing, at what point during its motion does it move with the greatest speed? the smallest speed? Discuss fully.

3. There are a variety of ways to categorize waves. One way is to categorize waves as being transverse waves, longitudinal waves, or surface waves. Waves in each of these categories differ from one another in terms of how the direction of the particle motion compares to the direction of the wave motion. The waves traveling through the rope are **transverse waves**. For transverse waves, compare the direction that the particles move to the direction that the wave moves?

4. Now use the **Frequency** slider to increase the frequency to a high value. Compare the motion of the particles when the frequency is high to the low-frequency motion. How would you describe the difference?

5. This next step is going to take some skill and some careful observation. The wave speed is associated with the movement of crests and troughs along the medium. Faster waves will have crests that move from the left side of the screen to the right side of the screen in less time; that is the crests move from left to right *faster*. Set the animation to a low frequency (about 0.1 Hz) and observe the wave speed. It might help to put your finger or a pen cap on a crest and follow move your finger (or pen cap) from left to right along with the crest. Then repeat for a high frequency (about 1.0 Hz). Make the same observation of wave speed - the speed of the crest moving from let to right across the screen. Does this ten-fold increase in frequency - from about 0.1 Hz to about 1.0 Hz - have any noticeable and appreciable effect upon the wave speed? Explain your answer and discuss your observations.

6. Does moving the Frequency slider from a low to a high value change the listed **Wave Speed** in this animation? Circle: Yes No

7. Change the **Wave Amplitude** from a high value to a low value. In terms of particle motion, how would you describe the difference between a high amplitude wave and a low amplitude wave?

8. Does a change in amplitude effect the wave speed? Run two tests with high and low amplitude using a similar procedure used in **Question #5**. Make a claim and support your answer with evidence.

9. The **wavelength** of a wave refers to the length of the repeating pattern of crests and troughs. Long wavelength waves have crests that are spaced relatively far apart. Short wavelength waves have crests that are relatively close to each other. Use the controls to determine two ways to increase the wavelength of the waves. Describe what you did to increase the wavelength.

Exploring Sound Waves

Set the animation to **Show Waves as Sound u**sing a **Real Time** tempo and **Frequency**, **Wave Speed**, and **Wave Amplitude** values of 0.10 Hz (approximately), 100 cm/s, and 2 cm respectively. Then use the controls on the animation to answer the following questions.

9. Observe the motion of the three colored air particles. Describe the motion of these particles for a sound wave moving through air.

10. Use the **Frequency** slider to observe the effect of frequency upon the motion of particles in the medium. How does the particle motion differ for a high frequency wave compared to a low frequency wave?

11. Sound waves traveling through air are a type of wave known as a **longitudinal wave**. For longitudinal waves, compare the direction that the particles move to the direction that the wave moves?

Assessment

Use your explorations of waves on a rope and waves through the air to answer these questions.

1. As a transverse wave travels through a rope from left to right, the parts of the rope _____.
   a. move along a line from left to right
   b. oscillate back and forth about a fixed location
   c. move along a sine-wave like path from left to right

2. For a **transverse wave**, the particles of the medium move _____ to the direction that the wave moves.
   a. perpendicular b. parallel c. diagonal

3. For a **longitudinal wave**, the particles of the medium move _____ to the direction that the wave moves.
   a. perpendicular b. parallel c. diagonal

4. The frequency of a wave describes _____.
   a. how fast a point on the wave moves along the medium
   b. how often particles of the medium oscillate back and forth
   c. how far particles move away from their normal resting position

5. Increasing the frequency with which particles within a rope vibrate will cause the speed of waves to _____.
   a. increase b. decrease c. ... nonsense! Frequency changes do not affect speed.

6. The amplitude of a wave describes _____.
   a. how fast a point on the wave moves along the medium
   b. how often particles of the medium oscillate back and forth
   c. how far particles move away from their normal resting position

7. Increasing the amplitude of a wave within a rope vibrate will cause the speed of waves to _____.
   a. increase b. decrease c. ... nonsense! Amplitude changes do not affect speed.

8. The wavelength of a wave increases if the _____. Select two answers.
   a. frequency increases b. amplitude speed increases c. speed increases
   d. frequency decreases e. amplitude decreases f. speed decreases