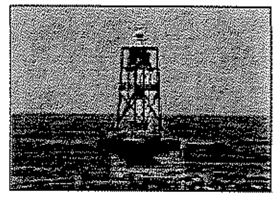
Name: ______________________________ Date: ____________________

Student Exploration: Waves

Vocabulary: amplitude, compression, crest, frequency, linear mass density, longitudinal wave, medium, period, power, rarefaction, transverse wave, trough, wave, wavelength, wave speed

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)



1. A buoy is anchored to the ocean floor. A large wave approaches the buoy. How will the buoy move as the wave goes by?

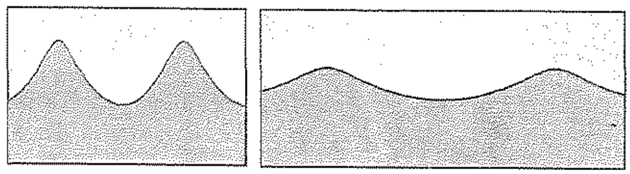
   ____

2. The two images show side views of ocean waves. How are the two sets of waves different?

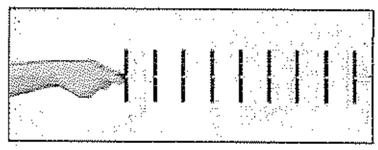
   ____

   ____

   ____



Gizmo Warm-up



Ocean swells are an example of **waves**. In the *Waves* Gizmo™, you will observe wave motion on a model of a spring. The hand can move the spring up and down or back and forth.

To begin, check that the **Type of wave** is **Transverse**, **Amplitude** is 20.0 cm, **Frequency** is 0.75 Hz, **Tension** is 3.0 N, and **Density** is 1.0 kg/m. (Note: In this Gizmo, "density" refers to the **linear mass density**, or mass per unit length. It is measured in units of kilograms per meter.)

1. Click **Play** (▶). How would you describe the motion of a **transverse wave**? ____________

   ____

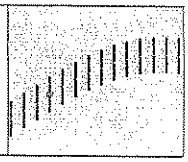
   Click **Pause** (⏸). Notice the **crests** (high points) and **troughs** (low points) of the wave.

2. Click **Reset** (↺). Choose the **Longitudinal** wave and increase the **Amplitude** to 20.0 cm.

   Click **Play**. How would you describe the motion of a **longitudinal wave**? ____________

   ____

   Click **Pause**. Notice the **compressions** in the wave where the coils of the spring model are close together and the **rarefactions** where the coils are spread apart.

Activity A: **Measuring waves**	Get the Gizmo ready: • Click **Reset**. Select **Transverse** waves. • Set **Amplitude** to 20.0 cm, **Frequency** to 1.0 Hz, **Tension** to 2.0 N, and **Density** to 2.0 kg/m.	

Question: How do we measure and describe waves?

1. Observe: Click **Play**. Observe the motions of the hand and of the green dot in the middle.

   A. What is the motion of the hand? _____

   B. Turn off the **Lights on** checkbox and observe the green dot. What is the motion of the green dot? _____

   C. Follow the motion of a single crest of the wave. How does the crest move? _____

   _____

   In a **transverse wave**, the motion of the **medium** (what the wave moves through—in this case, the spring) is perpendicular to the direction of the wave. So, each point of the spring moves up and down as the wave travels from left to right.

2. Measure: With the lights on, click **Pause**. Turn on **Show rulers**.

   A. Use the horizontal ruler to measure the horizontal distance between two crests. What is this distance? _____ This is the **wavelength** of the wave.

   B. What is the distance between the two troughs? _____

   The wavelength can be found by measuring the distance between two successive crests, two successive troughs, or any two equivalent points on the wave.

   C. Click **Reset**. Set the **Density** to 1.0 kg/m. Click **Play**, and then **Pause**. What is the wavelength of this wave? _____

3. Measure: Click **Reset**. The **amplitude** of a transverse wave is the maximum distance a point on the wave is displaced, or moved, from its resting position. Turn off the lights. Click **Play**, and then click **Pause**. Use the vertical ruler to measure the height of the green trace, showing how far the green dot moved up and down.

   A. What is the height of the green trace? _____

   B. The wave's amplitude is equal to half of this height. What is the amplitude? _____

(Activity A continued on next page)

Activity A (continued from previous page)

4. Observe: Click **Reset**. Select **Lights on** and turn off **Show rulers**. Select **Longitudinal** waves. Check that the **Amplitude** is 10.0 cm, the **Frequency** is 1.00 Hz, and the **Tension** is 2.0 N. Set the **Density** to 1.0 kg/m, and click **Play**.

   A. What is the motion of the hand? _____

   B. Turn the lights off. What is the motion of the green dot? _____

   C. Follow the motion of a single compression of the wave. How does the compression move? _____

   In a **longitudinal wave**, the motion of the medium is parallel to the direction of the wave. So, each point of the spring moves back and forth as the wave is transmitted from left to right.

5. Measure: With the lights on, click **Pause**. Turn on **Show rulers**.

   A. The wavelength of a longitudinal wave is equal to the distance between two successive compressions (or rarefactions). What is this distance? _____

   B. How does this compare to the wavelength of the comparable transverse wave? (See your answer to question 2C.) _____

6. Measure: Click **Reset**. The amplitude of a longitudinal wave is equal to the distance a point on the wave is displaced from its resting position. Turn off the lights. Click **Play**, and then click **Pause**. Use the horizontal ruler to measure the width of the green trace.

   A. What is the width of the green trace? _____

   B. The amplitude is equal to half of this distance. What is the amplitude? _____

7. Calculate: Click **Reset**. Select **Transverse** waves. Select **Lights on** and **Show grid** and turn off **Show rulers**. Set the **Frequency** to 0.50 Hz. A single cycle is the time it takes the hand to move up, move down, and then back up to the starting position. Click **Play**, and then click **Pause** after exactly one cycle. (This may take a few tries.)

   A. How long does one cycle take? _____ This is the **period** (T) of the wave.

   B. **Frequency** (f) is equal to 1 divided by the period: $f = \frac{1}{T}$. Frequency is measured in hertz (Hz), where 1 Hz = 1 cycle/sec. What is the frequency of this wave? _____