Wave Basics **Name:** _____

Waves

Read from **Lesson 1** of the **Waves** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/waves/u10l1a.html
http://www.physicsclassroom.com/Class/waves/u10l1b.html
http://www.physicsclassroom.com/Class/waves/u10l1c.html

MOP Connection: Waves: sublevel 1

TRUE or **FALSE**: Identify the following statements as being either true (T) or false (F).

T or F?

_____ 1. Waves are created by a vibration.

_____ 2. As a wave moves through a medium, the individual particles of the medium move from the source of the wave to another location some distance away.

_____ 3. Waves are a means of transporting energy from one location to another without actually displacing matter from one location to another.

_____ 4. An ocean wave will transport ocean water from near the middle of the ocean to a location near the shore.

_____ 5. As mechanical waves move through a medium, particles of the medium undergo a periodic and repeated vibration about a fixed position.

Name: _____

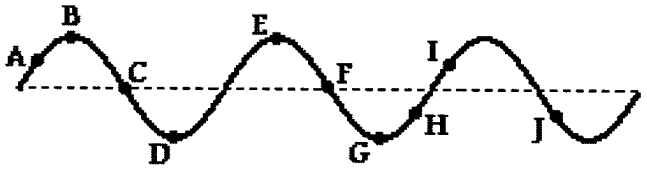
Describing Waves

Read from **Lesson 2** of the **Waves** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/waves/u10l2a.html
http://www.physicsclassroom.com/Class/waves/u10l2b.html
http://www.physicsclassroom.com/Class/waves/u10l2c.html
http://www.physicsclassroom.com/Class/waves/u10l2d.html

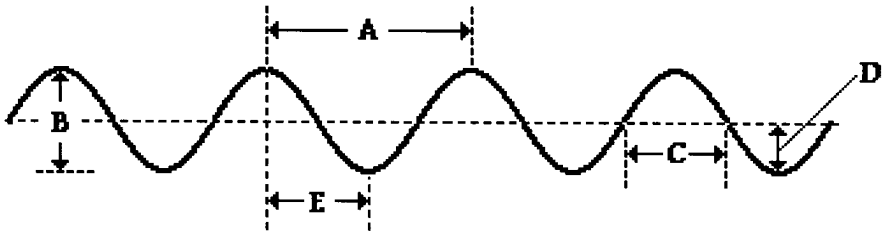
MOP Connection: Waves: sublevels 2 and 3

1. A wave is introduced into a medium and a snapshot of the medium at a particular instant in time is shown at the right. Several positions along the medium are labeled. Categorize the positions as either crests or troughs.

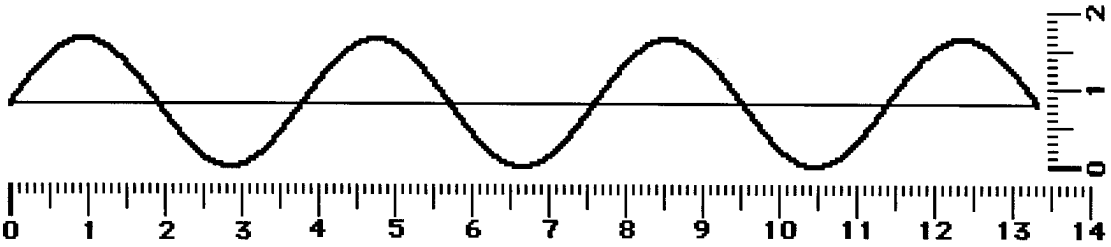


Crests: _____ Troughs: _____ Neither: _____

2. The wavelength of the wave in the diagram below is given by letter _____ and the amplitude of the wave in the diagram below is given by letter _____.



3. A sine curve that represents a transverse wave is drawn below. Use the centimeter ruler to measure the wavelength and amplitude of the wave (show units).

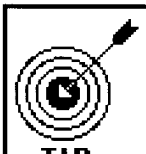


a. Wavelength = _____ b. Amplitude = _____

4. The number of cycles of a periodic wave per unit time is called the wave's _____.

5. Any repeated and periodic motion can be described by a frequency. For instance, the frequency of rotation of a second hand on a clock is _____.
a. 1/60 Hz b. 1/12 Hz c. 1/2 Hz d. 1 Hz e. 60 Hz

6. A pendulum makes 40 vibrations in 20 seconds. Calculate its period?



Throughout this unit, internalize the meaning of terms such as period, frequency, wavelength and speed. Utilize the meaning of these terms to answer conceptual questions; avoid *formula fixation.*

7. Olive Udadi accompanies her father to the park for an afternoon of fun. While there, she hops on the swing and begins a motion characterized by a complete back-and-forth cycle every 5.0 seconds. This statement provides info about the child's _____.
   a. speed b. frequency c. period

8. The frequency of Olive's periodic motion (in #7) is _____.
   a. 0.20 Hz b. 0.40 Hz c. 2.5 Hz d. 5.0 Hz

9. A period of 5.0 seconds corresponds to a frequency of _____ Hz.
   a. 0.2 b. 0.5 c. 0.02 d. 0.05 e. 0.002

10. The period of a 261 Hertz sound wave is _____.

11. As the frequency of a wave increases, the period of the wave _____.
    a. decreases b. increases c. remains the same

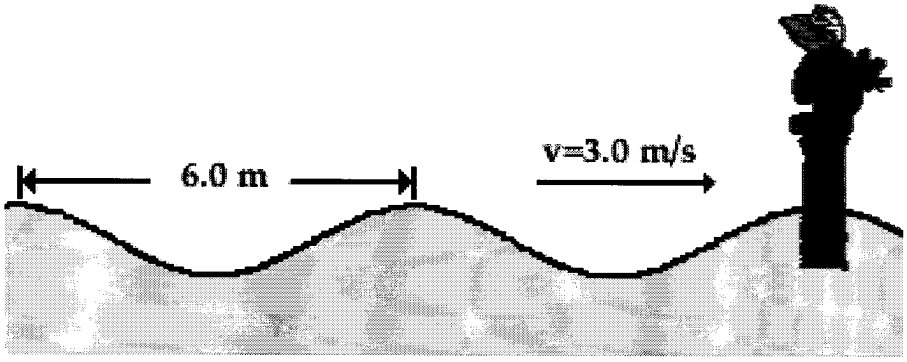
12. The speed of a wave refers to
    a. how often it vibrates to and fro.
    b. how high it vibrates.
    c. how much time it takes to vibrate to and fro.
    d. how far a given point (e.g., a crest) on the wave travels per unit of time.

13. Write the two equations which can be used to determine the speed of a wave.

14. Mac and Tosh are resting on top of the water near the end of the pool when Mac creates a surface wave. The wave travels the length of the pool and back in 25 seconds. The pool is 25 meters long. Determine the speed of the wave. **PSYW**

15. A fisherman uses a sonic ranger to determine the depth of a lake. The sound waves travel at 1210 m/s through the water and require 0.020 seconds to travel to the lake's bottom and back to the boat. How deep is the lake? **PSYW**

16. The water waves below are traveling with a speed of 3.0 m/s and splashing periodically against the Wilbert's perch. Each adjacent crest is 6.0 meters apart and splashes Wilbert's feet upon reaching his perch. How much time passes between each successive drenching? _____ Answer and explain using complete sentences or a calculation.



4. As the wavelength of a wave in a uniform medium increases, its speed will _____.
   a. decrease b. increase c. remain the same

5. As the wavelength of a wave in a uniform medium increases, its frequency will _____.
   a. decrease b. increase c. remain the same

6. The speed of a wave depends upon (i.e., is causally effected by) ...
   a. the properties of the medium through which the wave travels
   b. the wavelength of the wave. c. the frequency of the wave.
   d. both the wavelength and the frequency of the wave.

7. A water gun fires 5 *squirts* per second. The speed of the *squirts* is 15 m/s.

   a. By how much distance is each consecutive *squirt* separated?

   b. What happens to the distance between the *squirts* if the rate of fire is increased?

   c. Explain how this example is analogous to the relationship between wave frequency and wavelength.

8. What is the speed of a wave which has a frequency of 200 Hz and a wavelength of 0.50 m? **PSYW**

9. Waves are observed to splash upon the rocks at the shore every 6.0 seconds. The distance measured from crest to adjacent crest is 8.0 m. The distance measured from the lowest to the highest point on the medium is 10.0 m. Determine the frequency, wavelength and speed of these waves. **PSYW**

Do you have *formula fixation*? A useful test: were you successful with questions #8-11?

10. The period of a wave is 0.0300 seconds. It travels at a velocity of 10.0 m/s. Determine the frequency and the wavelength of the wave. **PSYW**

11. A wave having a wavelength of 4.0 meters and an amplitude of 2.5 meters travels a distance of 24 meters in 8.0 seconds. Determine the frequency and the period of the wave. **PSYW**

12. Two boats are anchored 7.0 meters apart. They bob up and down, returning to the same up position every 10.0 seconds. The boats rise a vertical distance of 7.0 meters between their lowest and their highest point. When one is up the other is down. There are never any wave crests between the boats. Determine the period, frequency, wavelength, amplitude and speed of the waves. **PSYW**

Name: _____

Interference of Waves

Read from **Lesson 3** of the **Waves** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/waves/u10l3c.html

MOP Connection: Waves: sublevel 6

TRUE or **FALSE**: Identify the following statements as being either true (T) or false (F).

T or F?

_____ 1. When two pulses meet up with each other while moving through the same medium, they have a tendency to bounce off each other and return back to their origin.

_____ 2. Constructive interference occurs when a crest meets up with another crest at a given location along the medium.

_____ 3. Destructive interference occurs when a pulse with an amplitude of +5 units interferes with a pulse with an amplitude of -5 units.

_____ 4. Destructive interference occurs when a trough meets up with another trough at a given location along the medium.

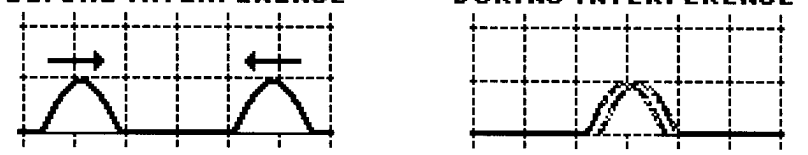
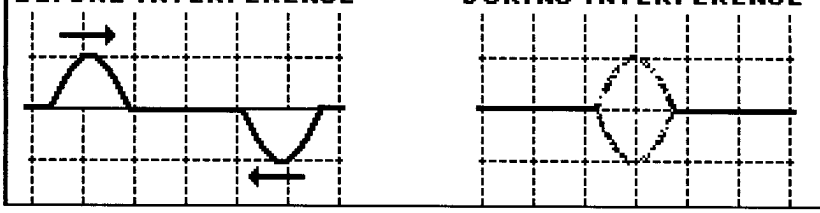
_____ 5. If a pulse with an amplitude of +5 units interferes with a pulse with an amplitude of +3 units, the resulting amplitude of the medium will be +4 units - the average of the two individual amplitudes.

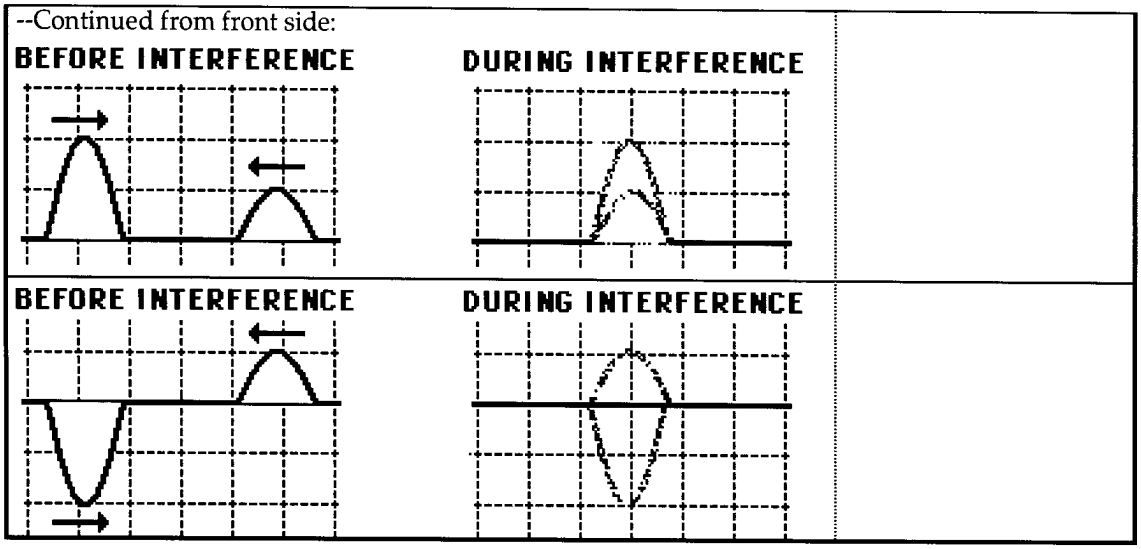
_____ 6. If a pulse with an amplitude of +5 units interferes with a pulse with an amplitude of -3 units, then neither constructive or destructive interference occurs.

_____ 7. Two sound waves could never interfere in such a manner as to cancel each other out and produce silence.

Principle of Superposition: The effect of two interfering waves upon a medium is to produce a resulting shape and size which is the combination of the shapes and sizes of the individual waves. The amount of displacement of the medium at any given location is simply the vector sum of the displacement of the two individual waves at that location.

8. The diagrams below depict two pulses traveling towards each other and at the moment when they are completely superimposed on each other. For each diagram, sketch the resultant of the two pulses during the interference. Finally, indicate if the example represents a case of constructive or destructive interference.

"Snapshot" of Two Pulses Before and During Interference	Constructive or Destructive?
	
	



9. Two waves are traveling along the same medium. The diagrams below show the waves on the medium at an instant in time. Utilize the principle of superposition in order to construct the shape of the medium at the instant shown in each diagram. To do so, begin by determining the resulting displacement of the medium at each of the marked locations (↑). Approximate the shape of the remainder of the medium by sketching *from dot to dot*.

Diagram A

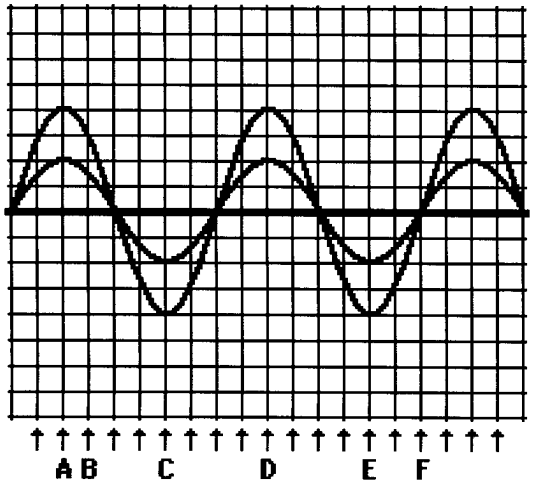
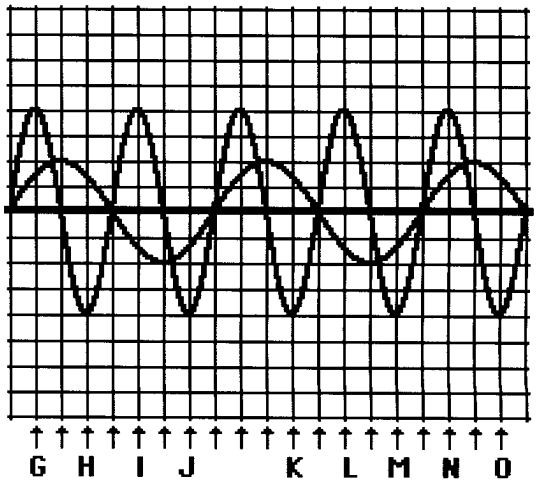


Diagram B



10. Several of the marked positions (↑) above are labeled with a letter. Categorize each labeled position along the medium as being a position where either constructive or destructive interference occurs.

Constructive Interference	Destructive Interference

INTERFERENCE WORKSHEET

1. On the diagram to the right:

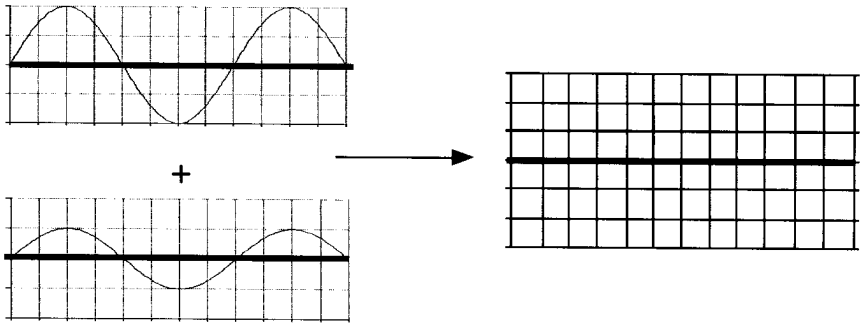
   A. label the nodes and antinodes.

   B. What is its wavelength if the distance between nodes is 2 m? _____

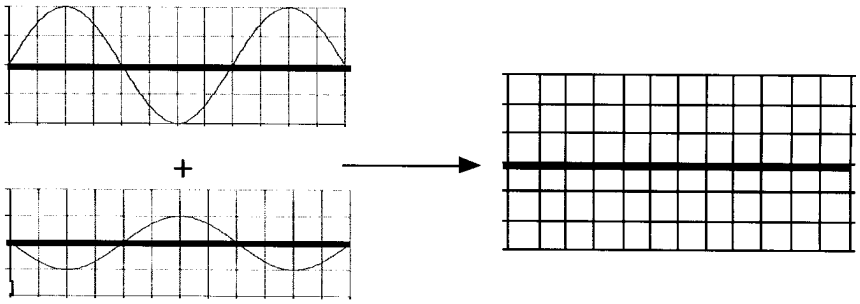
   C. If the person is shaking her hand up-and-down 12 times per second, what is the wave velocity? (Show Work)

2. In each set of waves below, the two waves at the left represent two waves traveling at the same time. You are to combine the two waves and show the results at the right.

a)



b)

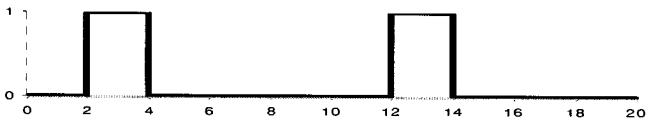


c) In the top example, (constructive, destructive) _____ interference produces a (louder, softer) _____ sound.

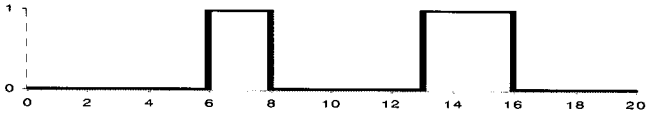
d) In the bottom example, (constructive, destructive) _____ interference produces a (louder, softer) _____ sound.

3. The waves shown in the diagram below are square pulse waves. If wave I meets wave II, show their superposition on the line below:

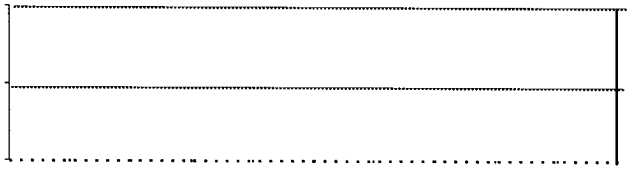
I



II

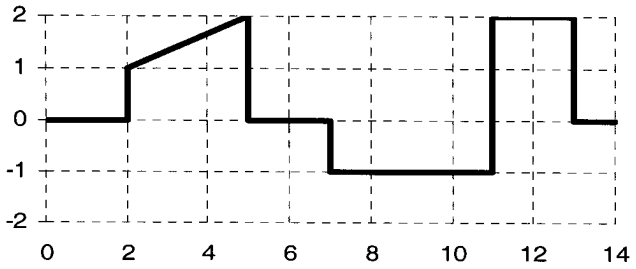


I + II

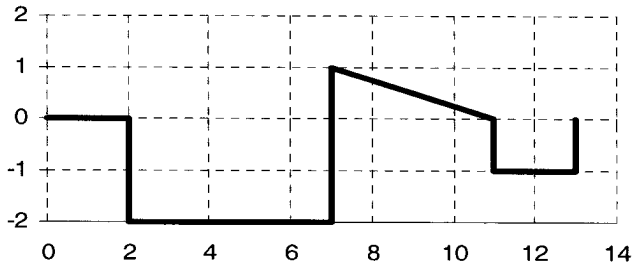


4.

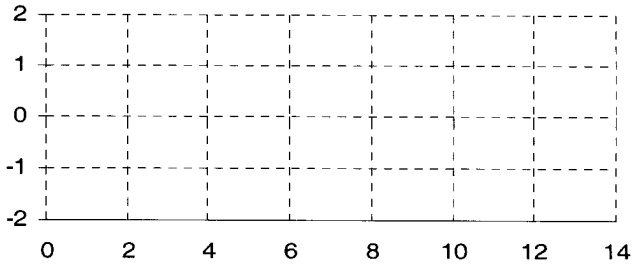
I



II



I + II



 Name: _____

Standing Wave Mathematics

Read from **Lesson 4** of the **Waves** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/waves/u10l4a.html
http://www.physicsclassroom.com/Class/waves/u10l4b.html
http://www.physicsclassroom.com/Class/waves/u10l4c.html
http://www.physicsclassroom.com/Class/waves/u10l4d.html
http://www.physicsclassroom.com/Class/waves/u10l4e.html

MOP Connection: Waves: sublevels 7 and 8

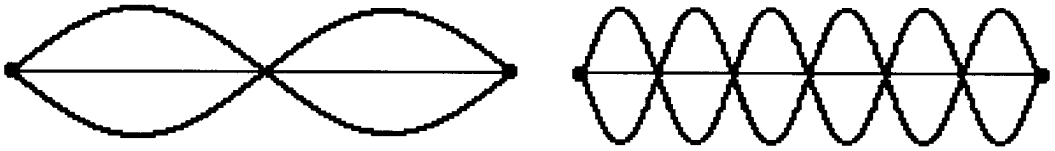
A standing wave pattern results in a string, rope or snakey as a result of the interaction between the waves introduced on one end with the reflection of the waves returning from the opposite end. At certain frequencies, a pattern will be established within the medium in which there are positions that always appear to be stationary. Midway between each of these stationary positions are positions which are undergoing rapid motion between a maximum positive and maximum negative displacement from their resting position.

1. The positions along the medium that appear to be stationary are known as _____. They are points of **no di**splacement.

2. The positions along the medium that are undergoing rapid motion between a maximum positive and maximum negative displacement are known as _____. They are the **opposite of** the points of **no di**splacement.

3. Label the nodes (**N**) and antinodes (**AN**) in the following standing wave patterns.

4. In each of the two diagrams of standing wave patterns, count the number of nodes and antinodes.



5. Each node is separated by the adjacent node by a distance that is equal to _____ wavelength.

6. Draw the standing wave pattern that would result on the string below if the string vibrated with the first, second, and third harmonic wave patterns. State the relationship between length and wavelength for each of the three patterns.

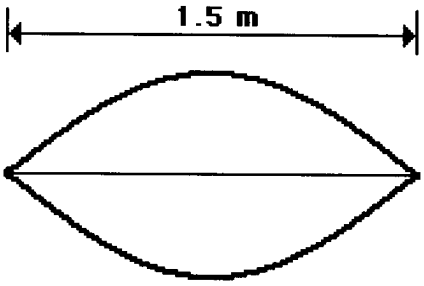
1st Harmonic **2nd Harmonic** **3rd Harmonic**

L = _____ λ **L = _____ λ** **L = _____ λ**

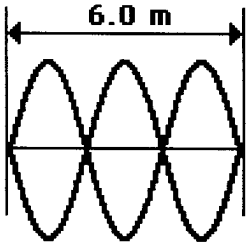
7. Suppose that the string in the above diagram is 1.2 meters long. Determine the wavelength of the waves shown in each of these three patterns.

1st Harmonic **2nd Harmonic** **3rd Harmonic**

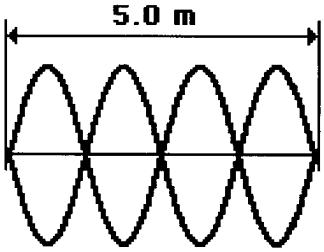
8. The string at the right is 1.5 meters long and is vibrating as the first harmonic. The string vibrates up and down with 33 cycles in 10 seconds. Determine the frequency, period, wavelength and speed for this wave. **PSAYW**



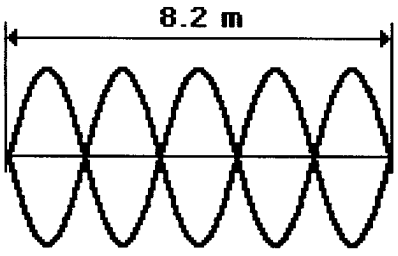
9. The string at the right is 6.0 meters long and is vibrating as the third harmonic. The string vibrates up and down with 45 cycles in 10 seconds. Determine the frequency, period, wavelength and speed for this wave. **PSAYW**



10. The string at the right is 5.0 meters long and is vibrating as the fourth harmonic. The string vibrates up and down with 48 cycles in 20 seconds. Determine the frequency, period, wavelength and speed for this wave. **PSAYW**



11. The string at the right is 8.2 meters long and is vibrating as the fifth harmonic. The string vibrates up and down with 21 cycles in 5 seconds. Determine the frequency, period, wavelength and speed for this wave. **PSAYW**



 Name: _____

Waves

Read from **Lesson 1** of the **Waves** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/waves/u10l1a.html
http://www.physicsclassroom.com/Class/waves/u10l1b.html
http://www.physicsclassroom.com/Class/waves/u10l1c.html

MOP Connection: Waves: sublevel 1

TRUE or **FALSE**: Identify the following statements as being either true (T) or false (F).

T or F?

_____ 1. Waves are created by a vibration.

_____ 2. As a wave moves through a medium, the individual particles of the medium move from the source of the wave to another location some distance away.

_____ 3. Waves are a means of transporting energy from one location to another without actually displacing matter from one location to another.

_____ 4. An ocean wave will transport ocean water from near the middle of the ocean to a location near the shore.

_____ 5. As mechanical waves move through a medium, particles of the medium undergo a periodic and repeated vibration about a fixed position.

6. Describe how a wave is different than a pulse.

7. Mechanical waves propagate or move through a medium because _____.
   a. the particles of the medium are able to move along the curved wavelike pathway
   b. one particle pushes or pulls on the adjacent particle which pushes or pulls on the next particle which ...
   c. the initial vibration of the medium causes the medium to assume the wavelike shape and this shape subsequently moves from one location to another.

8. Which of the following categories of waves require a medium in order to transport energy from one location to another?
   a. mechanical
   b. electromagnetic