Pre-AP Physics Week 1: Day 1 Notes

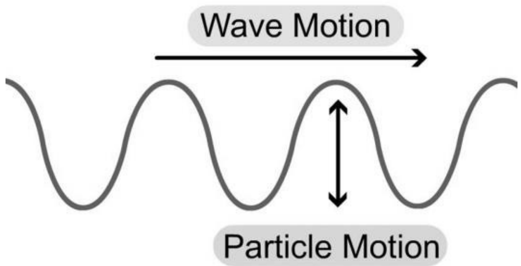
Waves: Types

Name: ___________________________

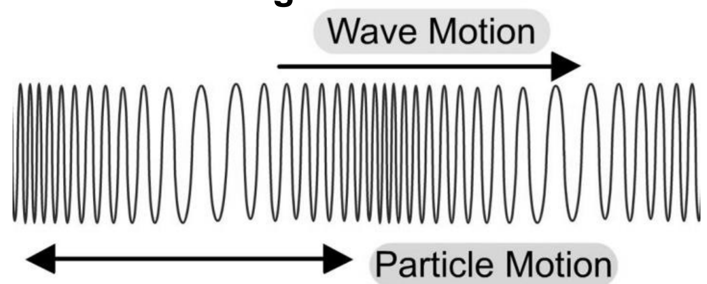
Instructions: Read through the information below. Then complete the statements at the bottom of the page using the BOLD words from the page.

A wave is a transfer of energy through a medium from one point to another. Some examples of waves include; water waves, sound waves, and radio waves. Waves come in two different forms; a **Transverse** Wave which moves the medium *perpendicular* to the wave motion, and a **Longitudinal** Wave, which moves the medium *parallel* to the wave motion.

Transverse Wave



Longitudinal Wave

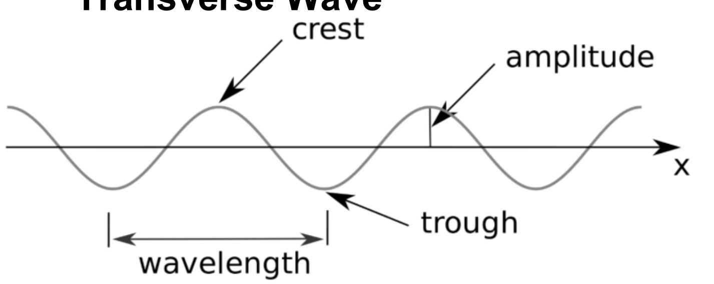


Examples of Transverse waves would be a vibrating guitar string or electromagnetic waves, while an example of a Longitudinal wave would be a "Slinky" wave that you push and pull.

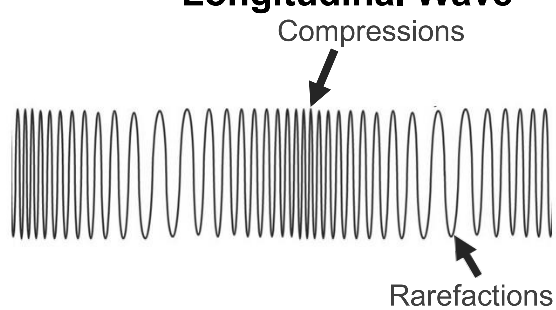
Waves have several properties which are represented in the diagrams below. In a Transverse wave the **Crest** and Troughs are the locations of maximum displacement up or down. The **Amplitude** is the measurement of maximum displacement. The **Wavelength** is the distance of one complete wave cycle. For example; the distance from crest to crest or trough to trough would be 1 wavelength.

In a Longitudinal wave, areas of maximum displacement are known as **Compressions** and **Rarefactions**. The stronger the wave, the more compressed and spread out the wave medium becomes.

Transverse Wave



Longitudinal Wave



Fill in the statements using the BOLD words from the above information.

1- Wave motion that is Parallel to wave direction describes a _______________ wave.

2- A _______________ is the maximum upwards displacement in a Transverse wave.

3- One complete wave cycle is referred to as a _______________.

4- Wave motion that is Perpendicular to wave direction describes a _______________ wave.

5- A ____________ or ___________ is the maximum displacement in a Longitudinal wave.

6- An Ocean wave would be an example of a _______________ wave.

7- The distance from one trough to another trough is called a _______________.

8- The measurement of displacement is called a wave's_______________.

Pre-AP Physics Week 1: Day 1 Virtual Lab

Simulation A: Wave on a String

Open the PhET Lab Wave on a String Simulation. In the top left box, choose "Oscillate." In the top right box, choose "No End." In the box at the bottom, change Damping to "None."

1. Is this a transverse or longitudinal wave? How do you know?
____
____
2. Spend a few minutes exploring the amplitude of the wave by increasing and/or decreasing it. Describe *amplitude* in your own words:
____
____
3. Return the amplitude to 0.75 cm. Then, spend a few minutes exploring the frequency of the wave by increasing and/or decreasing it. Describe *frequency* in your own words:
____
____
4. Return the frequency to 1.50 Hz. Now focus your eyes on one bead of the string. (You may select "Slow Motion" for an easier view). Describe the motion of the bead:
____
____
5. Do waves transfer matter? Use evidence from the simulation to support your answer.
____
____

Simulation B: Sound

Open the PhET Lab Sound Simulation. Do not change any of the settings.

1. Is this a transverse wave or a longitudinal wave? How do you know?
____
____
2. Spend a few minutes exploring the frequency of the wave by increasing and/or decreasing it. Describe *frequency* in your own words:
____
____
3. Return the frequency to 515 Hz. Then, spend a few minutes exploring the amplitude of the wave by increasing/decreasing it. What happens to the compressions of the wave when you increase the amplitude?
____
____
4. Describe the amplitude of a longitudinal wave in your own words:
____
____

Summary

1. The arrows on the diagrams below represent the direction of particle motion.

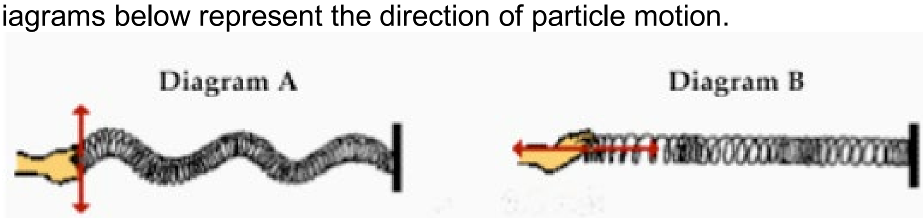


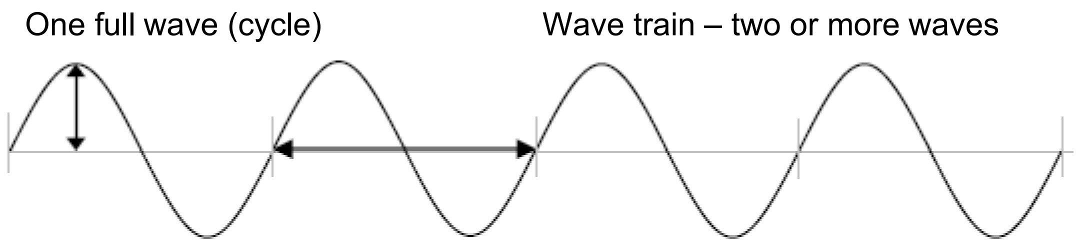
Diagram A shows a ____ pulse and diagram B shows a ____ pulse.
a. longitudinal, transverse b. transverse, longitudinal

2. Compare the direction in which particles of the medium vibrate for a longitudinal wave compared to a transverse wave. Reference the diagram in question #1 in your discussion.

Waves: Characteristics

Name ______________________

Instructions: Read through the information below. Then fill in the blanks on the characteristics of the two waves below.



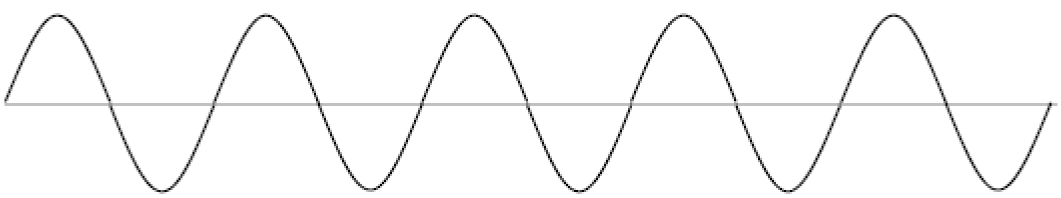
Amplitude – measures the energy of a transverse wave

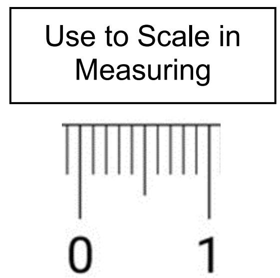
- measured from the resting position to the top of a crest or the bottom of a trough (see vertical arrow)

Wavelength – length of a single wave cycle (horizontal arrow double sided arrow)
Frequency-# of waves that pass a point in a given amount of time
Speed = wavelength x frequency

Fill in the information below using the definitions above. The time from the beginning to the end of the wave train in each situation is 1 second.

Wave 1

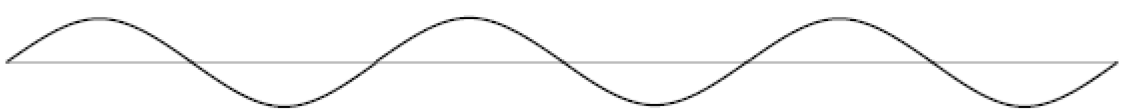




a) How many waves are there in this wave train? _________

b) Wavelength______cm c) Amplitude_______cm d) frequency _____Hz e) speed ______cm/s

Wave 2



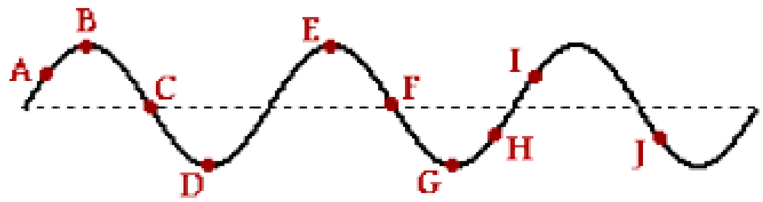
a) How many waves are there in this wave train? _____

b) Wavelength______cm c) Amplitude_______cm d) frequency______Hz e.) speed_____cm/s

Video Reinforcement: https://www.youtube.com/watch?v=RVyHkV3wIyk

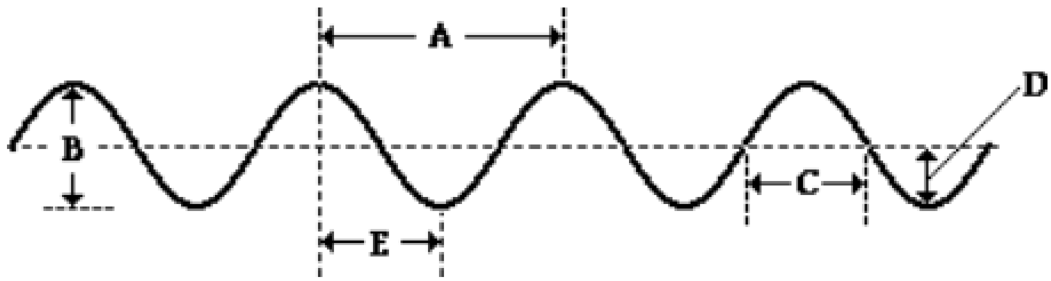
Waves: Characteristics

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.

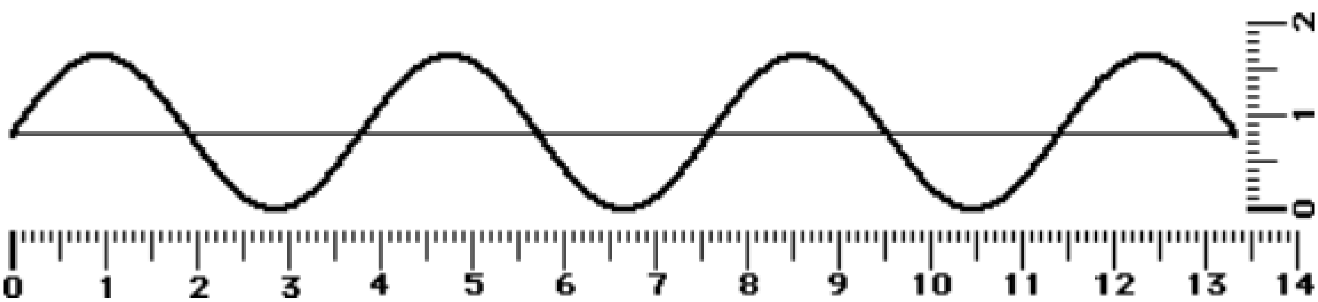


Crests: ______________ Troughs: ______________ Neither: ______________

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 = ______________

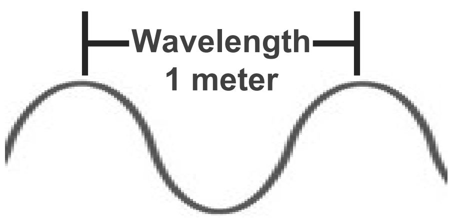
Extra Practice:
https://www.physicsclassroom.com/Concept-Builders/Waves-and-Sound/Wavelength/Concept-Builder

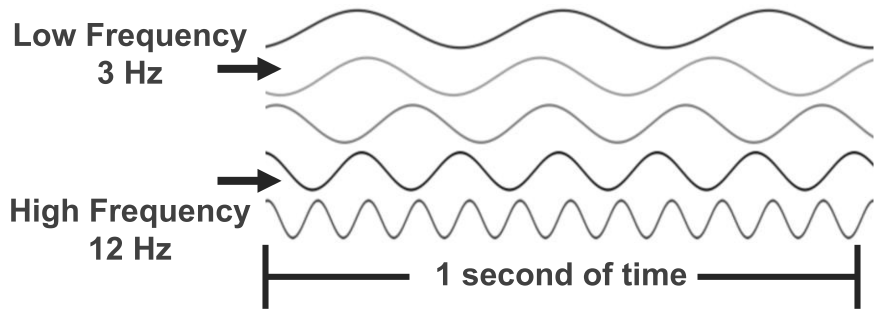
Virtual Lab for Extra Understanding:
https://www.physicsclassroom.com/Physics-Interactives/Waves-and-Sound/Simple-Wave-Simulator/Simple-Wave-Simulator-Exercise-1

Waves: Velocity and Frequency

Instructions: Read through the information below. Then complete the calculation problems at the bottom of the page.

The velocity of a wave is dependent upon the medium through which it travels through. Example being how a sound wave travels differently through air than it travels through water. Though the only way to change wave velocity (or wave speed) is through the changing the medium, the velocity of a wave can be calculated if you have enough information. First you need to know the *Wavelength*, or the length of one complete wave cycle. This could be measured Crest to Crest, Trough to Trough, or any other complete cycle of a wave. The second aspect you need is the wave *Frequency*, or the number of waves or vibrations produced per second. The frequency is measured in Hertz and the Wavelength is measured in meters.





The equation for calculating the velocity of a wave is:

Velocity = Wavelength x Frequency $v = \lambda \times f$

This equation works for any wave form, water, sound, or radio waves.

EXAMPLE: A wave as a Wavelength of 5 meters and a Frequency of 10 Hz. What is its velocity?

V = 5 x 10 → V= 50 meters per second

Solve using the wave velocity equation: (*Show your equation set up and math work)*

1- A wave has a Wavelength of 12 meters and a Frequency of 10 Hz. What is its velocity?

2-A wave has a Wavelength of 3 meters and a Frequency of 15Hz. What is its velocity?

3-A wave has a Wavelength of 18 meters and a Frequency of .5 Hz. What is its velocity?

4- A wave has a Wavelength of .5 meters and a Frequency of 100 Hz. What is its velocity?

Pre-AP Physics — Week 1: Day 3 Practice

Instructions: Solve using the wave velocity equation. ***(Show your equation set up and math work)***

Problems:

1. What is the wavelength of a sound wave with a frequency of 50 Hz? The speed of sound is 342 m/s.
2. A sound wave in a steel rail has a frequency of 620 Hz and a wavelength of 10.5 m. What is the speed of sound in steel?
3. What is the velocity of a wave with a frequency of 760 Hz and a wavelength of 0.45 m?
4. What is the frequency of a pendulum that is moving at 30 m/s with a wavelength of 0.35 m?
5. What is the wavelength of a sound wave moving at 340 m/s with a frequency of 256 Hz?
6. A wave with a frequency of 14 Hz has a wavelength of 3 meters. At what speed will this wave travel?
7. The speed of a wave is 65 m/s. If the wavelength is 0.8 meters, what is the frequency of the wave?
8. A wave has a frequency of 46 Hz and a wavelength of 1.7 meters. What is the speed of this wave?
9. A wave traveling at 230 m/s has a wavelength of 2.1 meters. What is the frequency of this wave?
10. A wave with a frequency of 500 Hz is traveling at a speed of 200 m/s. What is the wavelength?

Clap Wave Lab

In this lab, you will determine the relationship between the frequency and the wavelength of a wave.

Information:
Frequency = # of waves in 1 second
Wavelength = distance between 2 like parts on a wave (distance between two hands)

Hypothesis:
If I increase the wavelength of the wave, the frequency ________________because _______________
____.

Procedure:
1. Appoint a person as the clapper and a person as the timer.
2. Count the number of claps the clapper can make at a distance of 5 cm apart for 1 minute.
3. Record claps in data table below.
4. Repeat step 2 and 3 for a distance of 30 cm and then 100 cm.

Data
Wavelength = 5 cm
Total # of Claps = _____________
Frequency = $\dfrac{\_\_\_\_\_\_\_\_\_\text{claps}}{1\text{ min}} \times \dfrac{1\text{ min}}{60\text{ s}} = \_\_\_\_\_\_\_\_\text{claps/s}$

Wavelength = 30 cm
Total # of Claps = _____________
Frequency = $\dfrac{\_\_\_\_\_\_\_\_\_\text{claps}}{1\text{ min}} \times \dfrac{1\text{ min}}{60\text{ s}} = \_\_\_\_\_\_\_\_\text{claps/s}$

Wavelength = 100 cm
Total # of Claps = _____________
Frequency = $\dfrac{\_\_\_\_\_\_\_\_\_\text{claps}}{1\text{ min}} \times \dfrac{1\text{ min}}{60\text{ s}} = \_\_\_\_\_\_\_\_\text{claps/s}$

Questions: *Answer in complete sentences.*
1. In which demonstration was the clapper able to clap the greatest number of times?

2. Why was the clapper unable to clap as many times in the third demonstration?

3. What was the relationship between the distance between the hands and the number of times the student clapped?

4. What is the relationship between frequency and wavelength?

Pre-AP Physics Week 1: Day 4 Practice

Instructions: Answer the following questions based on the information collected from Day 3 and 4.

1. Stan and Anna are conducting a slinky experiment. They are studying the possible effect of several variables upon the speed of a wave in a slinky. Their data table is shown below. Fill in the blanks in the table, analyze the data, and answer the following questions.

Medium	Wavelength	Frequency	Speed
Zinc, 1-in. dia. coils	1.75 m	2.0 Hz	
Zinc, 1-in. dia. coils	0.90 m	3.9 Hz	
Copper, 1-in. dia. coils	1.19 m	2.1 Hz	
Copper, 1-in. dia. coils	0.60 m	4.2 Hz	
Zinc, 3-in. dia. coils	1.82 m	2.2 Hz	
Zinc, 3-in. dia. coils	0.95 m	4.2 Hz	

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

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

4. The speed of a wave depends upon (i.e., is causally affected 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.

5. A water gun fires 5 squirts per second. The speed of the squirts is 15 m/s.
   i. By how much distance is each consecutive squirt separated?

   ii. What happens to the distance of squirts if the rate of fire is increased?

   iii. Explain how this example relates to the relationship between wave frequency and wavelength.

Waves: Sound Characteristics

Instructions: Read through the information below. Then fill in the blanks on the characteristics of the two waves below.

Since sound is a wave, we can relate the properties of sound to the properties of a wave. The basic properties of sound are: pitch and loudness.

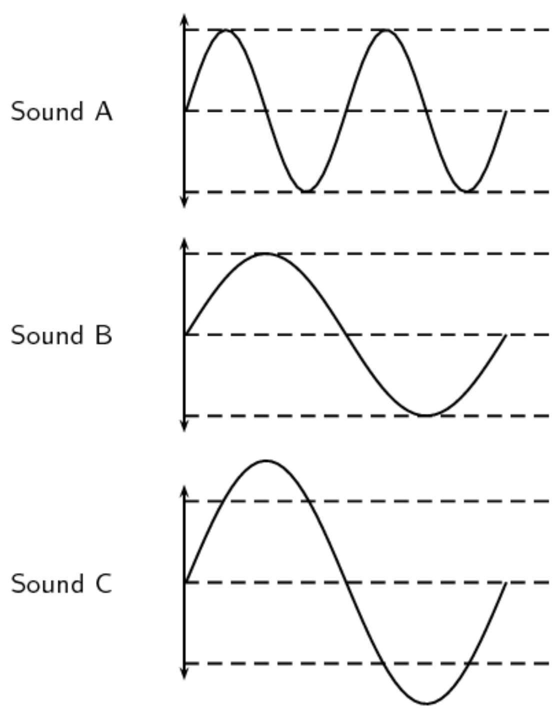
<u>Pitch</u>

The frequency of a sound wave is what your ear understands as pitch. A higher frequency sound has a higher pitch, and a lower frequency sound has a lower pitch. For instance, the chirp of a bird would have a high pitch, but the roar of a lion would have a low pitch.

<u>Loudness</u>

The amplitude of a sound wave determines its loudness or volume. A larger amplitude means a louder sound, and a smaller amplitude means a softer sound. The vibration of a source sets the amplitude of a wave. It transmits energy into the medium through its vibration. More energetic vibration corresponds to larger amplitude. The molecules move back and forth more vigorously.

Use the diagrams below to answer the following questions.



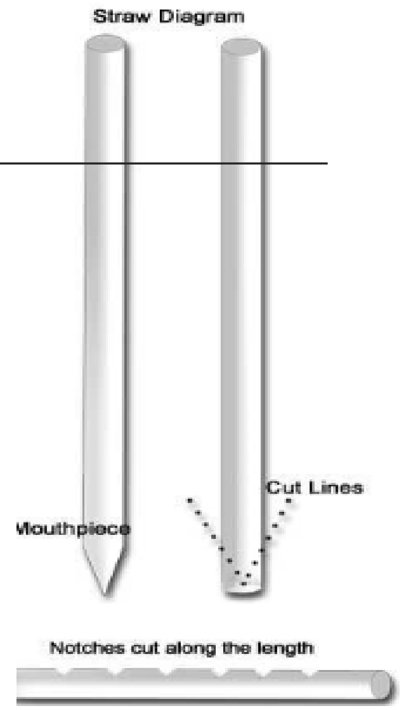
1. Which sound wave has the *highest frequency*? ____________________
2. Which sound wave would have the *highest pitch*? ____________________
3. Explain your answer above.
4. Which sound wave has the *largest amplitude*? ____________________
5. Which sound wave would be the *loudest*? ____________________
6. Explain your answer above.

At Home Fun: **Straw Oboe**

- Get 2-3 straws
- Cut one end of each straw like it shows in the diagram
- The sides should be even

Straw 1: Cut the end as shown
Straw 2: Cut the end as shown and cut the whole straw in half
Straw 3 Optional: Cut the end as shown and cut 2-3 slits on one side of the straw.

1. In your own words, what is the relationship between pitch, frequency, and length of the straw? Why?



Pre-AP Physics   Week 1: Day 5 Practice

Match the following wave quantities to the mini-definition. Place the letter in the blank.

A. Frequency   B. Period   C. Speed   D. Wavelength   E. Amplitude

_______ 1. *How fast* the wave moves through the medium.

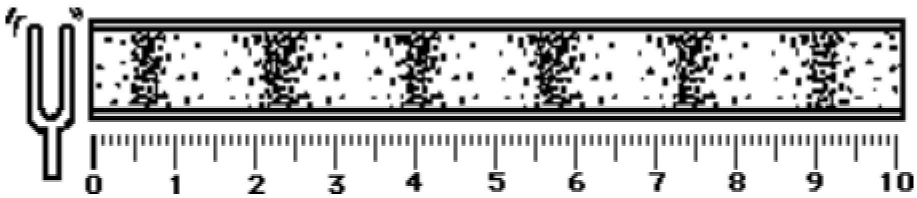
_______ 2. *How long* the wave is.

_______ 3. *How often* the particles vibrate about their fixed position.

_______ 4. *How much time* it takes the particles to complete a vibrational cycle.

_______ 5. *How far* the particles vibrate away from their resting position.

6. A sound wave with its characteristic pattern of compressions and rarefactions is shown below. A centimeter ruler is included below the pattern. The wavelength of this sound wave is _____ cm.



7. The pitch of a sound is directly related to the _________ of the sound wave.
   a. frequency   b. wavelength   c. speed   d. amplitude

8. High pitched sounds have relatively large _______ and small _______.
   a. period, wavelength
   b. speed, period
   c. frequency, wavelength
   d. period, frequency
   e. amplitude, wavelength
   f. amplitude, speed

9. As the frequency of a sound increases, the wavelength _______ and the period _______.
   a. increases, decreases
   b. decreases, increases
   c. increases, increases
   d. decreases, decreases

10. A sound wave is described as being 384 waves/s. This quantity describes the wave's ________.
    a. frequency   b. period   c. speed   d. wavelength

11. The speed of a sound wave depends upon the ______.
    a. frequency of the wave
    b. wavelength of the wave
    c. amplitude of the wave
    d. properties of the medium through which it moves

12. If a person yells (as opposed to whispering), then it will cause ______.
    a. air molecules to vibrate more frequently
    b. the sound wave to travel faster
    c. air molecules to vibrate with greater amplitude

13. If a person yells (as opposed to whispering), then it will cause ______.
    a. the pitch of the sound to be higher
    b. the speed of the sound to be faster
    c. the loudness of the sound to be louder

Video Reinforcer: https://www.youtube.com/watch?v=-_xZZt99MzY