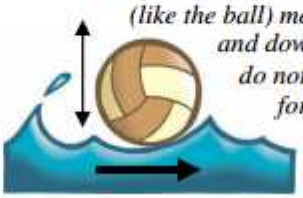
Name: _____

Period: _____

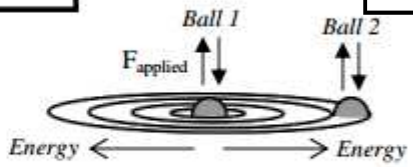
Waves

Waves are harmonic motion that moves thru a medium (matter). Water is the medium for water waves; a slinky is the medium when you shake a slinky. **The particles in the medium vibrate, but do not move. Only the energy of the wave moves**, transferring the energy. This is why waves seem to go thru things, like sound moving thru air.



Individual water molecules (like the ball) move up and down, but do not move forward.

Only the wave's energy moves forward.



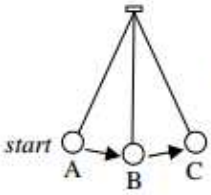
When ball 1 is moved, waves transfer the energy thru the water to ball 2. Ball 2 will vibrate with the same frequency as ball 1. Cell phones and radios work the same way: microwaves moving thru the air.

Harmonic Motion Basics

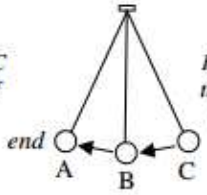
Cycle: the repeated part of the motion; must include all of the steps of the motion.

Period (T in sec): length of time for one cycle; how long it takes for one repetition. A slower object has a bigger (longer) period .

Frequency (f in Hz): number of cycles per second. Motion that repeats more often is more frequent and has a higher frequency.



From A to C is only half a cycle.



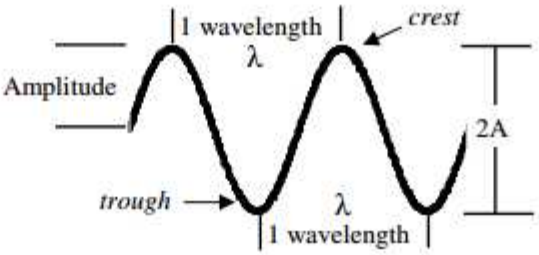
From C to A is the second half of the cycle.

The period (T) is the time from A back to A. T = 2 sec.

Only half of the cycle occurs in the first second, so the frequency is ½ cycle per second. f = 0.5 Hz.

Wavelength (λ)

The wavelength—λ [lambda] (in m) is the length of one wave between any two identical points on the wave (crest-to-crest or trough-to-trough, etc).



*Amplitude **does not** affect wavelength, just like amplitude doesn't affect period and frequency. Likewise, in the ocean bigger waves (greater amplitude) don't overtake (catch) smaller waves.*

Wave Speed (v)

Because waves move, it is obvious that they must have a speed. However, you may be surprised to know that amplitude, frequency, and wavelength don't change speed: only the medium it travels thru.

The Speed (velocity) of a Wave

velocity (m/sec) → $v = f\lambda$ ← frequency (Hz), wavelength (m)

Wave speed equals frequency times wavelength.

Since f = 1/T, the wave speed equation could also be written as:

$$v = \frac{\lambda}{T}$$

Ex. What is the speed of a 20 Hz wave that has a 5 meter wavelength.

f = 20 Hz λ = 5 m v = ____	v = fλ v = (20 Hz) x (5 m) v = 100 m/s

The speed of a wave changes only if the medium changes. Sound moves faster in more elastic substances. Sound is faster in colder water and in solids (rather than liquids) because the molecules are closer. The wave on a slinky moves faster if the slinky is pulled tighter. Yet, if the medium stays the same, the speed stays the same. **Different waves will have the same speed in the same medium.**

Changing frequency or wavelength does not change speed. Changing the wave changes what moves thru the medium, not the medium itself!

Period and Frequency are inversely related.

Period (in *secs*) → $T = \frac{1}{f}$ OR $f = \frac{1}{T}$ ← Period (in *secs*)

Frequency (in *hertz*)

As period increases, the frequency decreases.
As period decreases, the frequency increases.

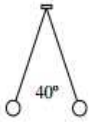
Ex: A pendulum has a frequency of 4 Hz. Find its period.	
f = 4 Hz T = ____	T = 1/f T = 1/4 T = 0.25 sec

Ex: A wheel has a period of 2 seconds. Find its frequency.	
T = 2 sec f = ____	f = 1/T f = 1/2 f = 0.5 Hz

Amplitude never affects period or frequency! A pendulum with more amplitude moves fast, but travels a long distance. A pendulum with less amplitude moves slow, but only travels a small distance. Either way, the period is the same.

Amplitude (A in m, cm, or degrees): maximum distance or angle from the equilibrium (center) position. Wider swing = more energy = more amplitude.

Amplitude = ½(distance side-to-side)



Amplitude = 20°
More energy

Amplitude = 10°
Less energy

f is the variable for _____ and is measured in _____.

λ is the variable for _____ and is measured in _____.

T is the variable for _____ and is measured in _____.

v is the variable for _____ and is measured in _____.

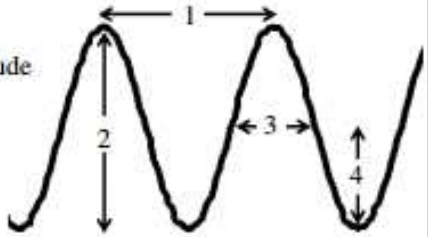
Transverse or Longitudinal Waves?

A. _____ You move the slinky left and right.
B. _____ You push the slinky forward.
C. _____ Sound, if a radio's speaker moves in and out.
D. _____ Earthquakes.
E. _____ Vibrates up and down and moves to the right.

A wave is 8 meters long and has a frequency of 3 Hz. Find speed.

Which number shows:

A._____ Double the amplitude
B._____ Amplitude
C._____ Wavelength
D._____ Half λ



Wave A has a wavelength of 2 meters and a frequency of 1.5 Hz. Calculate the wave's speed.

Wave B has a frequency of 18 Hz in the same medium. What is Wave B's speed?

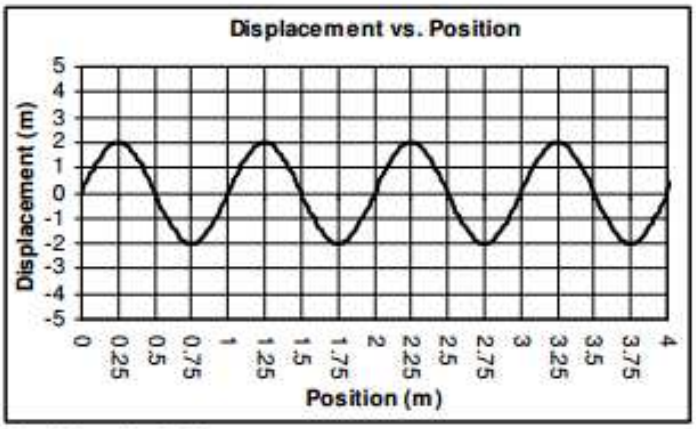
Calculate Wave B's wavelength.

So, as f increases in the same medium, λ _____.

Faster or slower wave speed?

A. ____ The medium gets colder.
B. ____ The amplitude gets bigger.
C. ____ A slinky gets looser.
D. ____ The medium turns from solid to liquid.
E. ____ The wavelength gets shorter.

Wave 1: f = 25 Hz; Wave 2: f = 40 Hz. Which one will be faster in water?



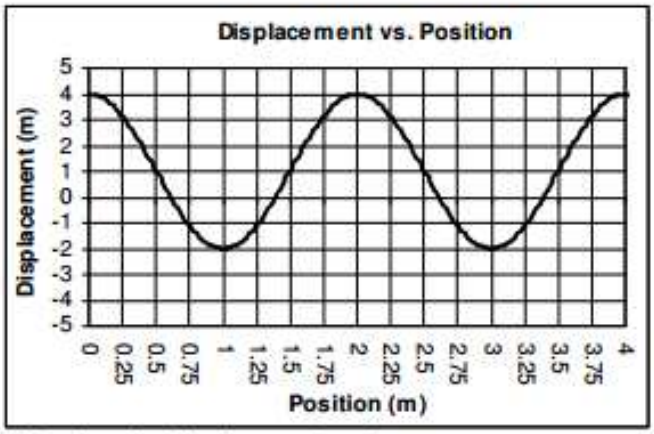
Mark 1 cycle of the wave.

Starting at 0.75 m, where does the 2nd cycle end:

Number of complete cycles: Mark the third crest.

Wavelength: Amplitude:

If f = 4 Hz, find speed:



Mark 1 cycle of the harmonic motion.

Starting at 1.5 secs, when does half a cycle end:

Number of complete cycles: Number of troughs:

Wavelength: Amplitude:

If f = 50 Hz, find speed: