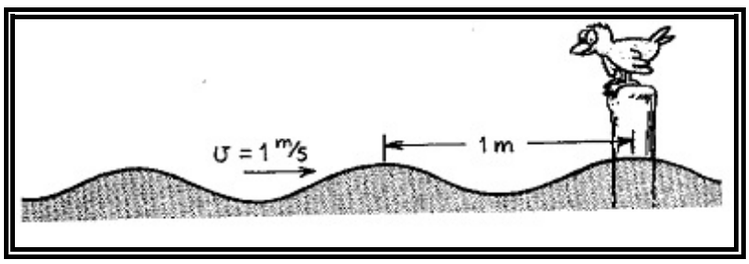
PHYSICS 2204
Unit 4: Waves
Worksheet #2: Speed of a Wave

Student Name:_____

Wave Speed is the distance traveled (one wavelength) divided by the time it takes (one period). It is how far the wave can travel in one second.



A wave moves with uniform motion. Therefore, in order to calculate the speed we must start with the formula:

$$Speed = \frac{Dis\tan ce}{Time}$$

In a time of one period, the wave has moved a distance of one wavelength. Combining this information with the equation for speed (speed=distance/time), it can be said that the speed of a wave is:

$$Speed = \frac{Wavelength}{Period} \qquad \text{Or} \qquad v = \frac{\lambda}{T}$$

Remember that $f = \frac{1}{T}$, therefore the universal wave equation becomes:

Frequency (hertz)

Speed (m/sec) → $v = f\lambda$ ← Wavelength (meters)

Wave Speed depends on type of vibrating source and medium through which it travels. The same type of wave moves at the same speed regardless of frequency, wavelength or amplitude.

Below are shown the prefixes (factors) used with units in physics:

PREFIXES		
Factor	Prefix	Symbol
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

Example 1:

If you attach one end of a slinky spring to a wall and hold the other end in your hand you can create a traverse wave with side to side movements of your hand. If you do this and produce a 0.70m long wave with a frequency of 3.0 Hz then what is the speed of the wave on the spring?

Example 2:

Twelve waves are observed to pass by a wharf in a time of 10 seconds. If the wavelength is approximately 1.6 m then what is the speed of the waves?

Example 3:

The center of the boat shown in the diagram is 28 m from the beacon on the buoy. The buoy rocks up and down 45 times in one minute. That is the speed of the waves?

PART A: MULTIPLE CHOICE

Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided

1. Which of the following affects the speed of a wave?

(A) Amplitude and period
(B) Amplitude and wavelength
(C) Frequency and wavelength
(D) Frequency and period

2. Which of the following represents a formula for calculating the speed of a wave?

(A) $v = f\lambda$
(B) $v = \frac{f}{\lambda}$
(C) $v = \frac{\lambda}{f}$
(D) $v = f + \lambda$

3. Besides Hertz, what is another unit for frequency?

(A) m
(B) m^{-1}
(C) s
(D) s^{-1}

4. Which of the following represents a formula for calculating the speed of a wave?

(A) $v = T\lambda$
(B) $v = \frac{\lambda}{T}$
(C) $v = \frac{T}{\lambda}$
(D) $v = T + \lambda$

5. What units are used to measure the speed of a wave?

(A) Centimeters
(B) Cycles per second
(C) Hertz per second
(D) Meters per second

6. Which statement is false, as suggested by the universal wave equation?

(A) If the frequency is held constant, the speed increases as the wavelength increases.
(B) Speed is the product of the frequency and the wavelength
(C) If the wavelength is held constant, the speed increases as the frequency decreases.
(D) If the speed is held constant, wavelength increases as the frequency decreases.

7. Assuming that the speed of a wave stays the same, what must happen for the frequency of the wave to increase?

(A) The amplitude must decrease
(B) The wavelength must decrease
(C) The amplitude must increase
(D) The wavelength must increase

8. What is the frequency of a wave that has a speed of 0.40 m/s and a wavelength of 0.020m?

(A) $8.0 \times 10^{--3}$ Hz
(B) 5.0×10^{-1} Hz
(C) 1.0×10^{1} Hz
(D) 2.0×10^{1} Hz

9. A wave traveling at 5.0×10^{4} m/a has wavelength of 2.5×10^{1} m. What is the frequency of the wave?

(A) 5.0×10^{-4} Hz
(B) 2.0×10^{3} Hz
(C) 5.0×10^{3} Hz
(D) 1.25×10^{6} Hz

10. The velocity of a particular wave is 23.8 m/s. Find the wavelength of this particular wave if the frequency is 11.0 Hz.

(A) 0.462 m
(B) 2.16 m
(C) 2.62 m
(D) 262 m

11. A tuning fork is used to produce waves with a frequency of 440 hertz. That waves travel through the air at 344 m/s. What is the wavelength of the sound waves?

(A) 0.15 m
(B) 0.39 m
(C) 0.78 m
(D) 1.28 m

12. What is the wavelength of a sound wave with a frequency of 256 Hz, travelling at 340 m/s?

(A) 0.75 cm
(B) 0.75 m
(C) 1.33 cm
(D) 1.33 m

13. Red light has a frequency of 4.0×10^{14} Hz and a speed of 3.0×10^{8} m/s. What is its wavelength?

(A) 1.3×10^{-9} m
(B) 7.5×10^{-7} m
(C) 1.3×10^{6} m
(D) 1.2×10^{23} m

14. Hits FM is transmitted with a frequency of 99.1 MHz and travels with a speed of 3.0×10^{8} m/s. What is the wavelength of this radio wave?

(A) 3.0 m
(B) 3.3m
(C) 3.0×10^{6} m
(D) 3.3×10^{6} m

15. What is the frequency for a wave of red light travelling at 3.0×10^{8} m/s and having a wavelength of 450 nm?

(A) 1.5×10^{-15} Hz
(B) 1.5×10^{-6} Hz
(C) 6.7×10^{5} Hz
(D) 6.7×10^{14} Hz

16. An earthquake creates a seismic wave that travels at 3500 m/s with a wavelength of 1750 m. What is the frequency of the seismic wave?

(A) 0.50 Hz
(B) 2.0 Hz
(C) 5.3×10^{3} Hz
(D) 6.3×10^{6} Hz

17. A periodic wave in a rope has a wavelength of 0.50 m. Two complete waves pass a knot on the rope in 2.0 s. What is the speed of the wave?

(A) 0.25 m/s
(B) 0.50 m/s
(C) 1.0 m/s
(D) 2.0 m/

18. A floating leaf oscillates up and down two complete cycles in one second as a water wave passes by. The wave's wavelength is 10 meters. What is the wave's speed?

(A) 2 m/s
(B) 40 m/s
(C) 10 m/s
(D) 20 m/s

19. A skipper on a boat notices wave crests passing the anchor chain every 5.0 seconds. The skipper estimates the distance between crests is 15 m. What is the speed of the water waves?

(A) 3.0 m/s
(B) 5.0 m/s
(C) 15 m/s
(D) Not enough information given

20. An ultrasound wave travels in body tissue at 1540 m/s. What is the wavelength of this wave if the period is 25.0 kHz?

✔ (A) 6.16×10^{-2}m
(B) 61.6m
(C) 3.85×10^{4} m
(D) 3.85×10^{7} m

PART B: WRITTEN RESPONSE

1. A water wave has a frequency of 2 Hz and a wavelength of 5 m. Calculate its speed. **(Answer is 10 m/sec)**

2. A wave has a speed of 50 m/sec and a frequency of 10 Hz. Calculate its wavelength. **(Answer is 5 m)**

3. A wave has a speed of 30 m/sec and a wavelength of 3 meters. Calculate its frequency. **(Answer is 10 Hz)**

4. A wave has a period of 2 seconds and a wavelength of 4 meters. Calculate its frequency and speed. **(Answer is frequency = 0.5 Hz; speed = 2 m/sec)**

   Note: Recall that the frequency of a wave equals 1/period and the period of a wave equals 1/frequency.

5. A sound wave travels at 330 m/sec and has a wavelength of 2 meters. Calculate its frequency and period**. (Answer is frequency = 165 Hz; period = 0.006 sec)**

6. The frequency of wave A is 250 hertz and the wavelength is 30 centimeters. The frequency of wave B is 260 hertz and the wavelength is 25 centimeters. Which is the faster wave? **(Answer is A's speed is 75 m/sec, and B's speed is 65 m/sec, so A is faster.)**

7. The period of a wave is equal to the time it takes for one wavelength to pass by a fixed

point. You stand on a pier watching water waves and see 10 wavelengths pass by in a time of 40 seconds.

a. What is the period of the water waves? **(Answer is 4 sec)**
b. What is the frequency of the water waves? **(Answer is 0.25 Hz)**
c. If the wavelength is 3 meters, what is the wave speed? **(Answer is 0.75 m/sec)**

8. An air mattress floating on a lake bobs up and down 45 times in 5.0 minutes. Calculate the speed of the water waves produced if the distance between their crests is 4.0 m.

9. A student was able to generate six full waves on a 15.0 m slinky. If a single pulse could move up and down the slinky in 1.8 s, what would be the student's hand frequency to achieve the six wavelengths? **Answer is 3.3 Hz**

10. While anchored off in boat one day you notice waves bobbing the nose of the boat upward every 6 seconds. When you look you notice that your boat, a 5.0 m craft, snugly fits from crest to crest of the wave. How fast are the waves moving?
Answer is 0.83 m/s

11. A 1.00 x10^3 Hz wave travels with a speed of 50.0 m/s along a wire. How far apart are the crests? **Answer is 0.05 m**

12. A wave on a rope has a speed of 12 m/s. If the wavelength is 230 cm, determine the frequency. **Answer is 52 Hz**

13. While sitting on the wharf one day, a fisherman notices that a buoy bobs up and down six times every ten seconds with the approaching wave crests. He estimates that the waves are about 1 fathom (say 1.8 metres) long. How fast are the waves moving?
Answer is 1.1 m/s

14. In the picture below the wave generator vibrates through 24 complete cycles in 1.0 minute. The water wave thus created has a wavelength of 1.5 m. If the disturbance takes 12.1 s to travel the length of the tank, how long is the tank? **Answer is 7.3 m**