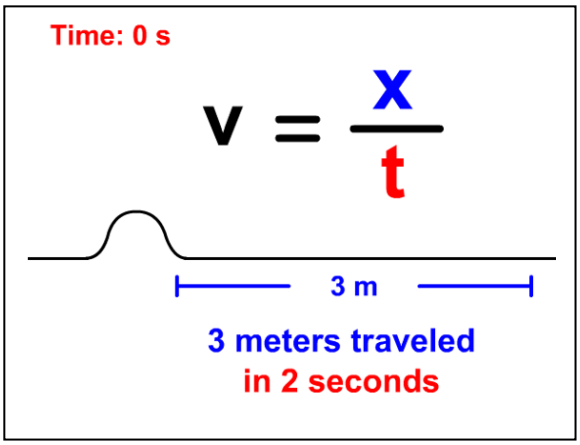
Name: _____ Period: _____ Date: _____

StickMan Physics Waves Math: https://www.stickmanphysics.com/stickman-physics-home/unit-10-waves/wave-math/

$v = \lambda f$ $v = \frac{x}{t}$ $T = \frac{1}{f}$ $f = \frac{1}{T}$ $T = \frac{time}{cycles}$ $f = \frac{cycles}{time}$

Name	Variable	Units
velocity		
$wavelength$		
Frequency		
Period		

Velocity Equals Distance Divided By Time

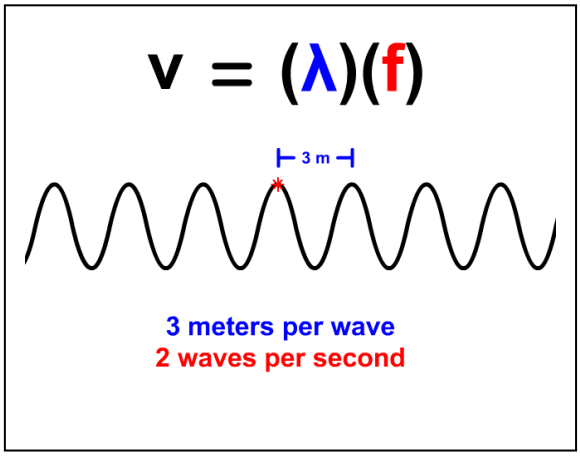


When a wave is treated like an object traveling a distance in a time, **v = x/t** is the equation you will use. Notice in the picture that the wave travels 3 meters in a total of 2 seconds. The resulting velocity using v = x/t is 1.5 meters per second.

v = x/t

v = 3/2 = 1.5 m/s

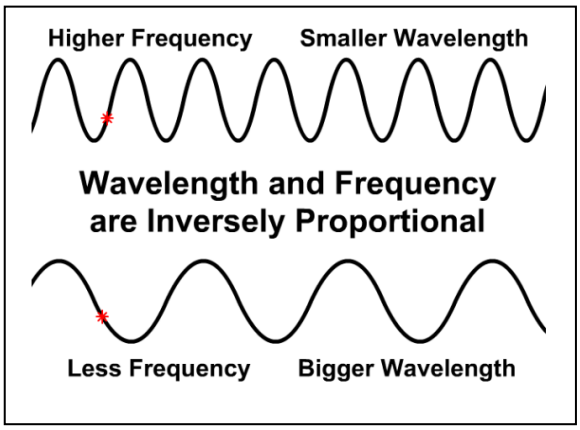
Wave Velocity Equals Wavelength Times Frequency



When you have a wave train, continuous waves each with the same wavelength (λ) pass a point. The frequency (f) of a wave is how many waves pass a point per second. When you have both wavelength and frequency you can use the equation **v = λf** to determine velocity. Frequency's standard unit is Hertz (Hz). Hertz equivalent unit is waves per second. 2 Hz means that two waves pass a point in a second. In our picture, each wave is three meters long. The frequency is 2 Hz so two waves pass each second. The resulting velocity using v = λf is 6 meters per second.

v = λf

v = (3)(2) = 6 m/s

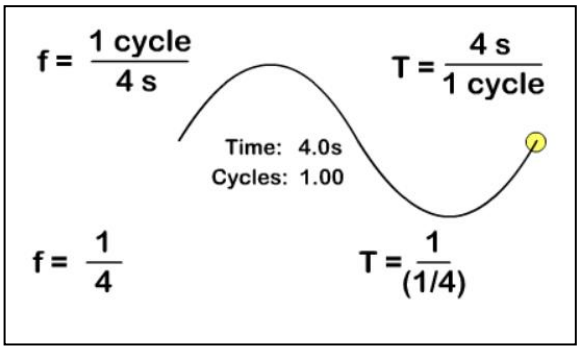


Wave Speed

In the **same medium wave-speed will be the same**
Wavelength and frequency are **inversely proportional**

- **If wavelength is greater frequency will be less**
- **If frequency is greater wavelength will be less**

Wave Period and Frequency



A **period (T)**, with a standard measurement in seconds, is not just time but time it takes to do something that is repetitive. A period for a wave is the **time it takes for a complete wavelength**. You can solve for period from the number of cycles "or waves" and time with the formula:

T = time/cycles

Frequency (f), with a standard measurement in **Hertz**, is **how many repetitions occur per second**. You can solve for frequency from the number of "wave" cycles and time with the formula:

f = cycles/time

Frequency and period are inverse since frequency is cycles per time and period is time per cycles. Solve for either with the either frequency or period as a given by taking the inverse:

T = 1/f **f = 1/T**

Example Problems

1. A typical tsunami wave can travel as fast as a jet plane at 194.4 meters per second while in deep waters of the ocean. If the ocean were entirely deep water, how long would it take a wave to travel from uninhabited island X to uninhabited island B 1,205,000 meters away ?

2. At the shoreline, a tsunami travels around 8.5 m/s. How long would it take a tsunami to travel 500 meters from the shoreline of island B to the middle of the island?

3. On a hot summer day, 15 wave crests pass a surfer floating on a board in 45 seconds.

a. What is the frequency of this wave?

b. What is the period of this wave?

4. What is the wavelength of a 94.1×10^6 Hz radio wave traveling through air at 3.0×10^8 m/s?

5. Velocity, average wavelength, and average frequency of the 7 types of electromagnetic waves in space.

	Radio	**Microwave**	**Infrared**	**Visible**	**Ultraviolet**	**X-Ray**	**Gamma Ray**
Velocity in Air	3.0×10^8 m/s	3.0×10^8 m/s	3.0×10^8 m/s	3.0×10^8 m/s	3.0×10^8 m/s	3.0×10^8 m/s	3.0×10^8 m/s
Wavelength	1×10^3 m	1×10^{-2} m	1×10^{-5}	3.0×10^{-7}			
Frequency				1×10^{15} Hz	1×10^{16} Hz	1×10^{18} Hz	1×10^{20} Hz

Solve for the following missing parts of the table showing your work:

A. Ultraviolet Wavelength:

B. X-Ray Wavelength:

C. Gama Ray Wavelength:

D. Radio Frequency:

E. Microwave Frequency:

F. Infrared Frequency:

6. What is the velocity of a 900 Hz sound wave traveling through the air when the wavelength is 0.381 meters per wave?

7. What is the period of a 900Hz sound wave?

A student records the following speeds for identical sound waves in three different mediums

(Use the table for #8, #9)

	Underwater	**Air**	**Wood**
Speed of Sound (m/s)	1,484 m/s	343 m/s	3,962 m/s

8. What relationship could the student draw between the speed of sound and the type of medium based on this data?
   A. As the medium gets denser, the speed of the sound wave increases
   B. As the medium gets denser, the speed of the sound wave decreases
   C. As the medium gets less dense, the speed of the sound wave increases
   D. The density of the medium does not affect the speed of the sound wave

9. What is the frequency of a 1.855 m wave of sound traveling underwater at the speed in the table?

10. How many times different is frequency if wavelength has increased by three times?