Energy: $\boxed{E}$ Waves transport energy.

Vibration / oscillation: Something must be vibrating / oscillating in order to create a wave.

Medium: Waves must travel in a medium with one important exception. Electromagnetic waves are the only type of wave that <u>do not require</u> a medium at all.

Frequency: $\boxed{f}$ Number of vibrations, oscillations, cycles, revolutions, etc. that take place each second.

Period: $\boxed{T = 1/f}$ Time for one complete vibration / oscillation.

Wavelength: $\boxed{\lambda}$ The length on a single wave. Measure to the same point on the next wave.

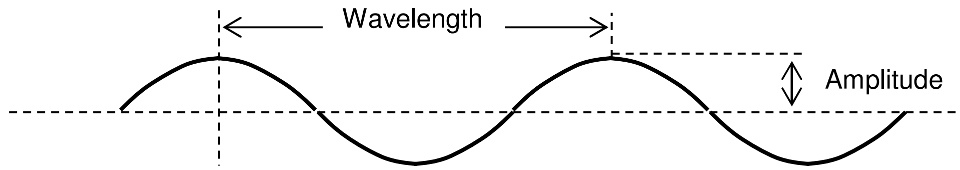
Velocity: $\boxed{v = f\lambda}$ Wave velocity depends on the elasticity of the medium. Sound travels faster in metal than in water and faster in water than in air. Light, however, is unusual. It is fastest in a vacuum and slows slightly in air, and to a greater extent in water.

Amplitude: $\boxed{A}$ Maximum displacement from the equilibrium position (midline on the graph).

Transverse Wave: Particles vibrate in a direction perpendicular to the wave direction & velocity.

Longitudinal Wave: (also Compression, or Shock) Particles vibrate in a direction parallel to wave direction & velocity.

Sinusoidal: When a vibrations displacement is graphed against time a sinusoidal function is plotted. It is the graphical representation for any wave phenomenon, and looks like a transverse wave. However, any wave, even longitudinal waves, follows the same sinusoidal pattern.

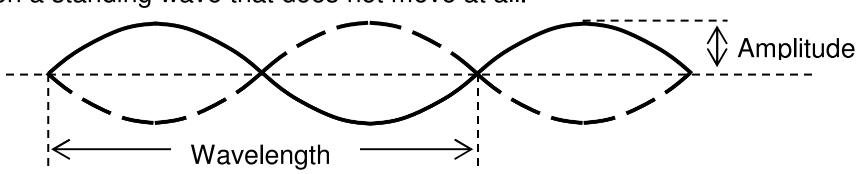


Pulse: A single wave.

Continuous Wave: A series of equal pulses equally spaced moving together.

Standing wave: When a continuous wave strikes a barrier and reflects back on itself it will create an interference pattern (see interference below). If the phase (see phase below) of the reflected wave is exactly opposite to the incoming wave they will superimpose creating a standing wave.

Node: A point on a standing wave that does not move at all.



Speed depends on the mediums elasticity. When a wave travels from one medium to a different medium the speed & wavelength change. However the frequency remains the same.

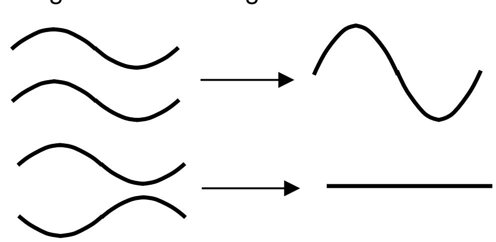
Interference: When two or more wave meet, the amplitudes add.

In phase: Waves are in phase when they have the same wavelength and the crests are aligned.

Out phase: Waves are out of phase when they the crest on one wave aligns with the trough of another.

Constructive Interference: If the waves are in phase you add them to construct a larger amplitude.

Destructive Interference: If the waves are out phase you add them to destroy the amplitude. The waves shown have the same amplitude and wavelength, but any kind of wave can interfere, so different amplitudes and wavelengths can result in many unique new wave functions.

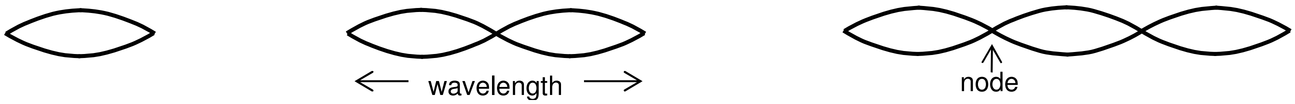


Sound: The speed of sound in air at 25° C is 343 *m/s* (often rounded to 340 *m/s*). The speed of sound changes with temperature since the density and elasticity of air change as temperatures fluctuate.

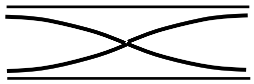
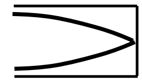
Pitch: Frequency ***Loudness***: Amplitude

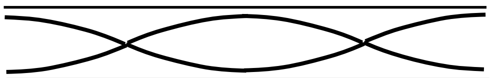
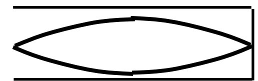
Sound waves can originate from vibrating strings or in tubes. This is the basis for musical instruments. There are two types of tubes: those open at both ends & those closed at one end.

Strings: Only multiples of ½ wavelengths can fit on a vibrating string that is held fixed at each end.



Open Tubes: Same as strings, multiples of ½ waves. But the waves look a little different, since the ends aren't fixed.
Closed Tubes: Closed tubes hold multiples of ¼ waves.

1/2 wavelength  1/4 wavelength 

2/2 wavelength  1/2 wavelength 

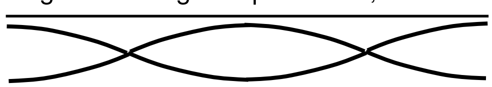
Adjustments to the velocity equation. The simplest case is the minimum number of wavelengths. So we will work with the ***fundamental***, strings or open tubes that have a ½ wavelength, and closed tube holding ¼ wavelength.

Normal wave velocity $\boxed{v = f\lambda}$

Strings: $\boxed{v = f2L}$ If ½ wavelength fits on the string, then $\lambda = 2 \times String\ \ Length = 2L$.

Open tubes: $\boxed{v = f2L}$ If ½ wavelength fits in the tube, then $\lambda = 2 \times Tube\ \ Length = 2L$.

Closed tubes: $\boxed{v = f4L}$ If ¼ wavelength fits in the tube, then $\lambda = 4 \times Tube\ \ Length = 4L$.

To adjust for more than ½ wavelengths in strings & open tubes, and ¼ wavelengths in closed tubes you divide ***L*** by the number of nodes. Example:  This tube contains two nodes. $\boxed{v = f\frac{2L}{n}}$

More on velocity: Sound also follows the normal velocity equation $\boxed{v = d/t}$. You can time the distance to lightening by counting the seconds between the flash and the thunder. But, if you're timing sound that makes a round trip (like an echo, or sonar) you have to divide your final answer by 2.

Resonance: Everything has a natural vibration frequency. If you can match the natural vibration and add more wave energy at the right frequency and wavelength you can shatter the object. Breaking a crystal glass with your voice, or the Tacoma Narrows Bridge are examples.