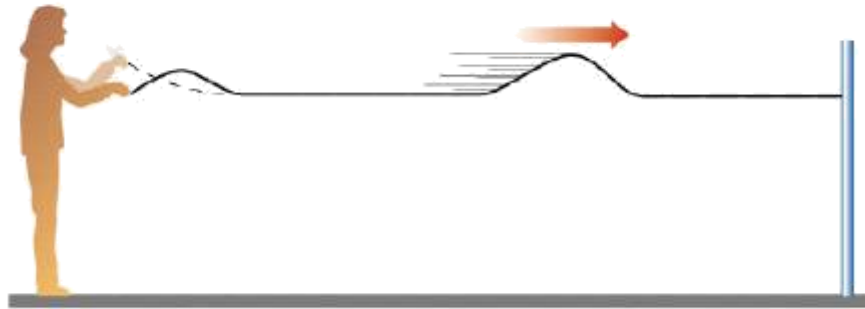


## Waves - Transverse and Longitudinal Waves

- A wave may be defined as a *periodic disturbance in a medium that carries energy from one point to another*.
- All waves require a *source* and a *medium* of propagation.
- Waves may lose energy as they propagate through a dense medium (attenuation).
- Waves that radiate *isotropically* (uniformly in all directions) from a source also lose intensity due to the fact that the energy they carry is spread out over an increasingly large area. This is known as the inverse square law.

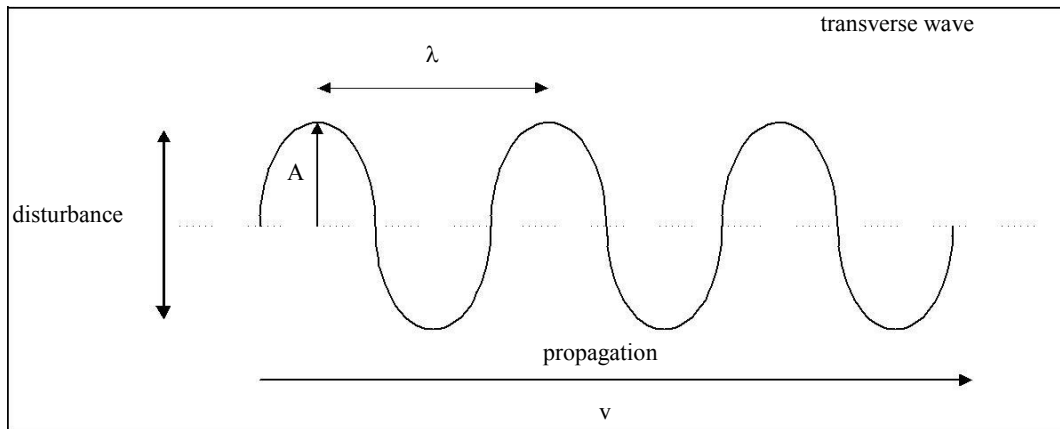


- There are two distinct types of waves: *Longitudinal* and *Transverse*. Sound waves are an example of longitudinal waves while electromagnetic waves, such as light, are examples of transverse waves.
- Transverse waves transfer energy in a direction perpendicular to the direction of the disturbance in the medium. A vibrating string is an example of a transverse wave. Although all points on the string itself are constrained to move only up and down, wave pulses move perpendicularly along the length of the string. The *wave speed* is the speed with which a pulse moves along the string.
- A transverse wave may consist of more than one pulse. Transverse waves consisting of many pulses result when the wave source oscillates about some equilibrium position for long periods of time. Under such conditions an initial pulse is followed immediately by another pulse of opposite displacement. A series of such alternating pulses is known as a *wave train*.

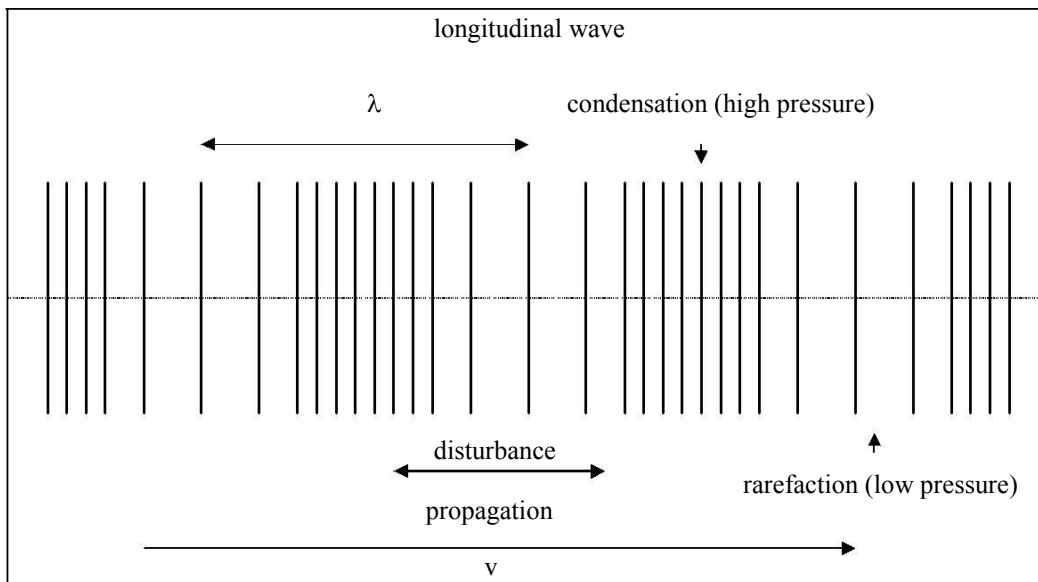


- If the oscillations are steady the resulting waveform is periodic. If the oscillations are *harmonic* in the series of pulses is known as a *harmonic wave train*. All of the electromagnetic spectrum, including light, consists of transverse waves that result from harmonic oscillations in molecular, atomic or nuclear structures.
- Longitudinal waves are waves that transfer energy in the same direction as the disturbance in the medium of propagation. Like transverse waves, longitudinal waves may consist of single or multiple pulses. All longitudinal waves consist of regions of high and low density known as condensations (compressions) and rarefactions that oscillate around local positions of equilibrium parallel to the path of energy transfer. Sound waves are longitudinal waves. Sound waves propagating through air consist of a series of pressure fluctuations above and below atmospheric pressure.

## Wave Properties



**A transverse waveform.**



**A longitudinal waveform. Areas of high pressure (pressure nodes) correspond to condensed regions of low molecular displacement (displacement antinodes).**

- Wavelength – the distance between the same points on successive waves (meters).
- Period – the amount of time it takes a wave to complete one oscillation or cycle, i.e., wavelength expressed in units of time (seconds).
- Frequency – number of oscillations per second ( $s^{-1}$  or Hertz).
- Amplitude - the maximum displacement of a wave media from its undisturbed position. In transverse waves, the amplitude is the maximum distance the disturbance moves from the axis of propagation (undisturbed position). In longitudinal waves the amplitude is usually related to the rise and fall of pressure within the wave medium.