

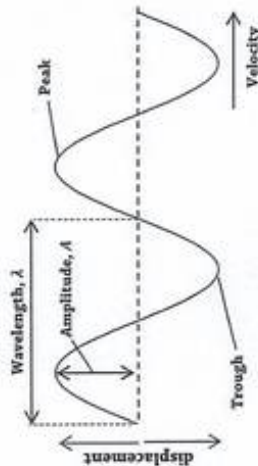
Progressive and stationary waves

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Progressive waves

Progressive wave:

A wave that transfers energy from one point to another without transferring any matter. The particles in the matter oscillate but do not move along the wave.



Properties of a wave

- Amplitude:** the maximum displacement from the equilibrium position
- Frequency, f :** the number of complete waves passing a point per second
- Wavelength, λ :** the minimum distance between two in phase points on peaks/troughs
- Phase difference:** the difference between the displacements of particles along a wave, or on different waves
- Time period, T :** the time it takes for a single point of the wave to undergo one whole oscillation

Phase difference can be measured in radians, degrees or fractions of a cycle - one full wave = 2π radians or 360°

Wave Equations:

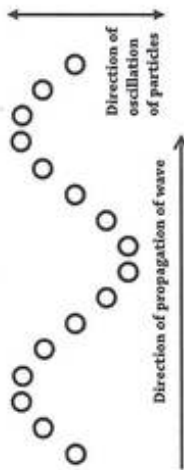
$$\text{velocity, } c = f\lambda$$

$$\text{frequency, } f = \frac{1}{T}$$

Longitudinal and transverse waves

Transverse wave:

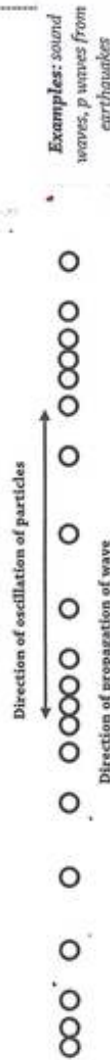
a wave in which the medium's particles are displaced perpendicular to the direction of energy transfer



Examples:
electromagnetic waves,
waves on a string

Longitudinal wave:

a wave in which the medium's particles are displaced in the same direction as energy transfer

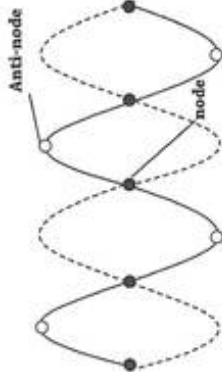


Examples: sound waves, p waves from earthquakes

Stationary wave

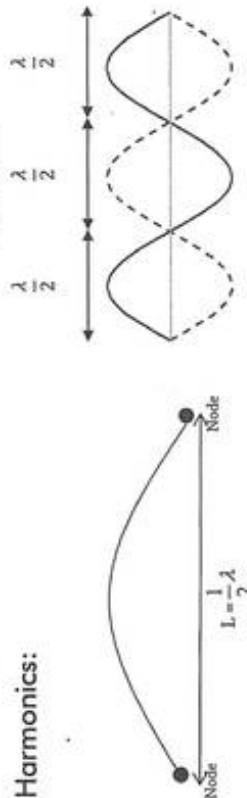
Formation of a stationary wave:

- A stationary wave is formed by two waves of the same frequency travelling in opposite directions.
- An antinode is formed from constructive interference between the two waves.
- A node is formed from destructive interference between the two waves in which the amplitudes of each wave at that point cancel each other out.
- A stationary wave can be obtained in several ways, for example:
 - a sound wave bouncing off a wall and then the reflected wave and the transmitted wave interfering
 - a string fixed at two ends and plucked whilst under tension
 - reflection of microwaves
- The wave appears stationary as its nodes and antinodes remain fixed.



$$\text{distance between adjacent nodes} = \frac{1}{2}\lambda$$

Harmonics:



$$\lambda_1 = 2L$$

$$\text{for first harmonic, } n=1$$

$$\text{nth harmonic: } \lambda_n = \frac{2L}{n}$$

Stationary wave equation:

$$\text{First harmonic: } f_1 = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$$

L = length of string
 T = Tension
 μ = mass per unit length of string ($\frac{m}{l}$)
 E_k = kinetic energy of electron

Investigating stationary waves
The effect of tension, length and mass per unit length of the string on the frequency of the stationary wave that forms can be investigated by varying one of the variables at a time, keeping the others constant.