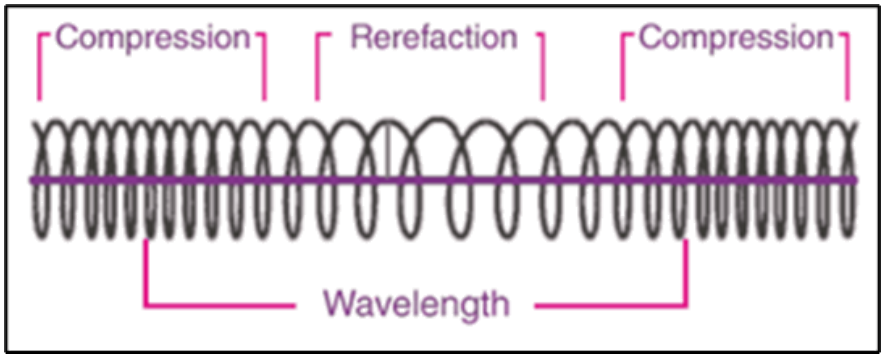
FlexiPrep

Longitudinal Waves, Longitudinal Wave, Sound Waves, Longitudinal Wave Formula (For CBSE, ICSE, IAS, NET, NRA 2022)

Longitudinal Waves

- In a longitudinal wave the particle displacement is parallel to the direction of wave propagation.
- Mechanical waves are classified as longitudinal waves and transverse waves.
- Longitudinal waves occur in the large solids and in engineering fluids. Longitudinal waves include sound waves, seismic P-waves, and ultrasound waves.
- The particles do not move down the tube with the wave; they simply oscillate back and forth about their individual equilibrium positions.
- These waves are known as compression waves as they develop compression and refraction while traveling through any medium.

Longitudinal Wave

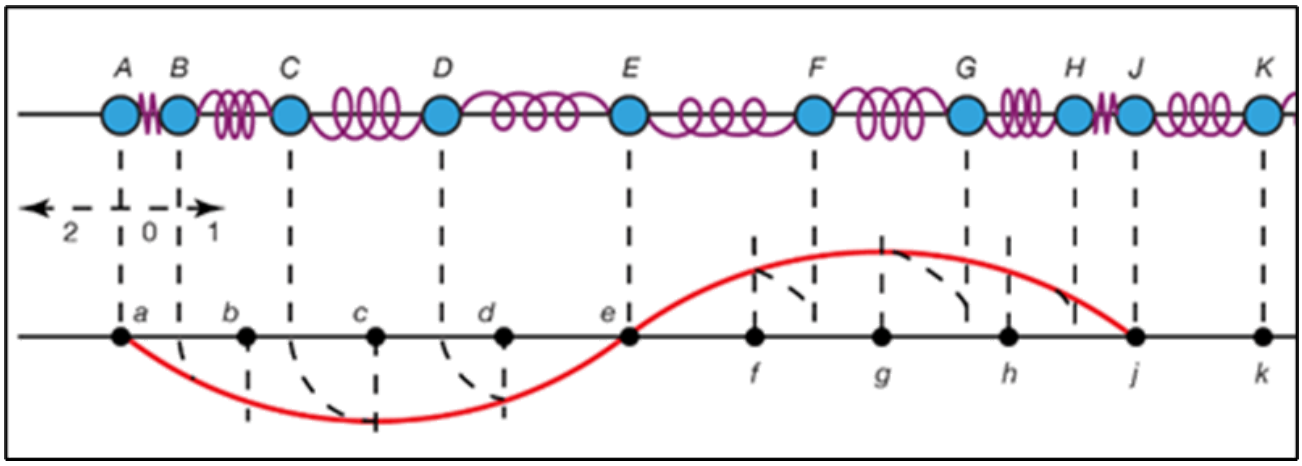


- As in the above figure, When the particles are together, pressure is high and the region is known as compression and when the particles are apart, the pressure is low and the region is known as rarefaction.
- These other mechanical waves are known the transverse and are defined as the wave where the displacement of the medium is at right angles to the direction of propagation and are known as t-waves.
- The waves need a medium to travel through. A wave along with the length of a spring is a good visualization where the distance between the coils increases or decreases.

What is Longitudinal Wave?

- These waves are the waves where the displacement of the medium is in the same direction, or in opposite direction, and direction of the travel of the wave.
- The distance between the centers of two consecutive regions of compression or the rarefaction is defined by wavelength, λ .

Mechanical Model



- A mechanical model is helpful in explaining longitudinal waves.
- At the top of the figure, small masses A, B, C, etc. are joined together by coiled springs to represent a transmitting medium that has properties of both inertia and elasticity.
- Because mass B has inertia, motion of A toward the left (arrow 2) extends the spring it is attached to and motion to the right (arrow 1) compresses it. A corresponding motion will be communicated to B through the spring, except that there will be a slight lag in phase.
- Mass B will impart its motion to its partner C, and so on, the impulse travelling from A to K and the lag progressively increasing.
- At the instant shown, A leads J in phase by 360°; A is starting its second vibration, whereas J is just beginning its first.

Sound Waves

- It is an example of a longitudinal wave and is produced by the vibrating motion of the particles that travel through a conductive medium.
- The example of is tuning fork.
- In Sound waves, the amplitude of the wave is the difference between the maximum pressure caused by the wave and the pressure of the undisturbed air.
- The propagation speed of sound depends upon the type, composition of the medium and temperature through which it propagates.

Longitudinal Wave Formula

$$y(x,t) = y_0 \cos\left[\omega\left(t - \frac{x}{c}\right)\right]$$

Where,

- y is the displacement of the point on the traveling sound wave
- x is the distance the point traveled from the wave's source
- t is the time elapsed
- y_0 is the amplitude of the oscillations
- c is the speed of the wave
- ω is the angular frequency of the wave
- Quantity $\frac{x}{c}$ = time (wave takes to travel the distance x) .
- Frequency (f) of the wave is given by the formula:

  $$f = \omega 2\pi$$

Difference between Longitudinal and Transverse Wave

Longitudinal Wave	**Transverse Wave**
A wave that moves in the direction of its propagation	A wave that moves in the direction perpendicular to its propagation
A sound wave is an example of a longitudinal wave	Water waves are an example of a transverse wave
It is made of refractions and compressions	It is made of troughs and crests
This wave can be produced in any medium such as gas, liquid or solid	This wave can be produced in solid and liquid's surface

Difference between Longitudinal and Transverse Wave

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