Wave Motion

A wave is a disturbance in a medium that carries energy without a net movement of particles. It may take the form of elastic deformation, a variation of pressure, electric or magnetic intensity, electric potential, or temperature.

About wave motion

- Transfers energy.
- Usually involves a periodic, repetitive movement.
- Does not result in a net movement of the medium or particles in the medium (mechanical wave).

Few basic terminology

(a) Wavelength (λ)

Wavelength is the distance between two successive identical parts of the wave.

(a) **Amplitude** (A)

Amplitude is the maximum displacement from the neutral position. This represents the energy of the wave. Greater amplitude carries greater energy. Displacement is the position of a particular point in the medium as it moves as the wave passes. Maximum displacement is the amplitude of the wave

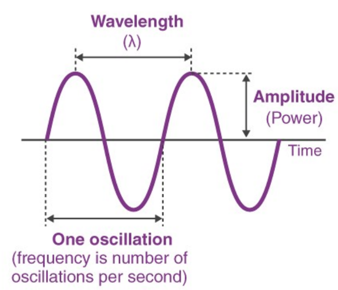
(c) Frequency (f **)**

Frequency (f) is the number of repetitions per second in Hz.

(d) Time period (T **)**

Period (T) is the time for one wavelength to pass a point.

(e) Velocity (v)



The velocity (v) of the wave is the speed at which a specific part of the wave passes a point. The speed of a light wave is c.

Types of Waves:

The types of waves are given below.

Transverse Waves

Waves in which the medium moves at right angles to the direction of the wave.

Examples of transverse waves:

- Water waves (ripples of gravity waves, not sound through water)

- Light waves
- S-wave earthquake waves
- Stringed instruments
- Torsion wave

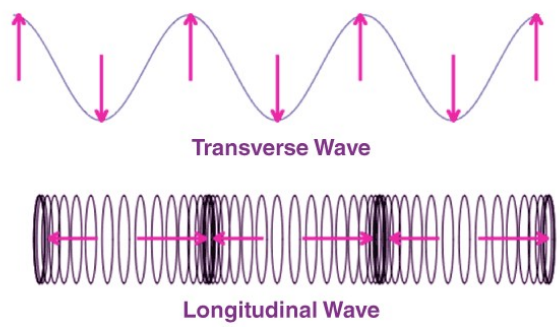
The high point of a transverse wave is a crest. The low part is a trough.

Longitudinal Wave:

A longitudinal wave has the movement of the particles in the medium in the same dimension as the direction of movement of the wave.

Examples of longitudinal waves:

- Sound waves
- P-type earthquake waves
- Compression wave



The displacement of medium particle can be written as follows

$y = A\sin(\omega t - kx)$

$A =$ Amplitude, $\omega =$ Angular frequency, $k = \frac{2\pi}{\lambda} =$ Wave vector, λ =Wavelength

Or $y = \sin\frac{2\pi}{\lambda}(vt - x)$ where $v = \frac{\omega}{k} =$ wave velocity=Phase velocity

$\Delta\phi =$ Phase difference

$\Delta x =$ Path difference

$\Delta t =$ Time difference

Important relation

$$\frac{\Delta\phi}{2\pi} = \frac{\Delta x}{\lambda} = \frac{\Delta t}{T}$$

Thus, $\Delta\phi = \frac{2\pi}{\lambda}\Delta x$

Particle velocity (v_p): The rate of change of displacement with respect to equilibrium.

$$v_p = \frac{dy}{dt} = -v\,(Phase\ velocity) \times Slope\,of\ y\,vs\,x\,curve$$

$$\frac{dy}{dt} = -\frac{\omega}{k} \times \frac{dy}{dx}$$

We know that,

$$y = A\sin(\omega t - kx)$$

$$v_p = \frac{dy}{dt} = A\omega\cos(\omega t - kx)$$

Acceleration of medium particle (a_p) **: Acceleration** (symbol: *(a)* is defined as the rate of change (or time derivative) of velocity.

$$a_p = \frac{d^2y}{dt^2}$$

$$a_p = -A\omega^2\sin(\omega t - kx)$$

The velocity of sound waves can be written as

$$a_p = -A\omega^2\sin(\omega t - kx)$$