Part I

WAVE

Wave is distributed energy or distributed "disturbance".

MECHANICAL WAVES

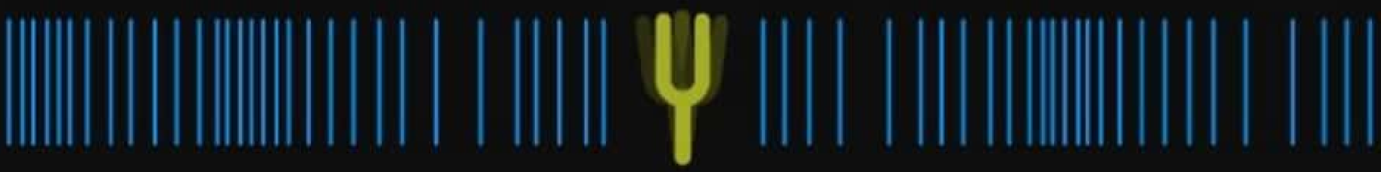
Mechanical waves orginate from a disturbance in the medium (such as a stone dropping in a pond) and the disturbance propagates through the medium.

Mechnical waves are further classified in two categories such that:

1. Transverse waves (waves on a string)

If the disturbance travels in the x direction but the particles move in a direction, perpendicular to the x axis as the wave passes, it is called transverse waves.

2. Longitudinal waves (sound waves)



Longitudinal waves are characterized by the direction of vibration (disturbance) and wave motion. They are along the same direction.

NON-MECHANICAL WAVES

These are electromagnetic waves. The motion of the electromagnetic waves in a medium depends on the electromagnetic properties of the medium.

PARTICLE VELOCITY AND ACCELERATION

$$V_P = \frac{\partial}{\partial t} y(x, t) = \frac{\partial}{\partial t} A\sin(kx - \omega t) = -\omega A\cos(kx - \omega t)$$

$$a_P = \frac{\partial}{\partial t} V_P = \frac{\partial}{\partial t}\{-\omega A\cos(kx - \omega t)\} = -\omega^2 A\sin(kx - \omega t) = -\omega^2 y$$

ENERGY CALCULATION IN WAVES

Part II

1. KINETIC ENERGY PER UNIT LENGTH

The velocity of string element in transverse direction is greatest at one mean position and zero at the extreme positions of waveform.

$$K_L = \frac{dK}{dx} = \frac{1}{2}\mu\omega^2 A^2 \cos^2(kx - \omega t)$$

- RATE OF TRANSMISSION OF KINETIC ENERGY

$$\frac{dK}{dx} = \frac{1}{2}\mu v \omega^2 A^2 \cos^2(kx - \omega t)$$

2. ELASTIC POTENTIAL ENERGY

The Elastic potential energy of the string element results as string element is stretched during its oscillation.

- POTENTIAL ENERGY PER UNIT LENGTH

$$\frac{dU}{dx} = \frac{1}{2}\mu\omega^2 A^2 \cos^2(kx - \omega t)$$

- RATE OF TRANSMISSION OF ELASTIC POTENTIAL ENERGY

$$\frac{dU}{dt}\Big|_{avg} = \frac{1}{2} \times \frac{1}{2}\mu v \omega^2 A^2 \frac{1}{4}\mu v \omega^2 A^2$$

3. MECHANICAL ENERGY PER UNIT LENGTH

$$E_L = \frac{dE}{dx} = 2x\frac{1}{2}\mu\omega^2 A^2 \cos^2(kx - \omega t) = \mu\omega^2 A^2 \cos^2(kx - \omega t)$$

4. AVERAGE POWER TRANSMITTED

The average power transmitted by wave is equal to time rate of transmission of mechanical energy over integral wavelengths.

$$P_{avg} = \frac{1}{2}\rho s v \omega^2 A^2$$

5. ENERGY DENSITY

$$u = \frac{1}{2}\rho v w^2 A^2$$

6. INTENSITY

Intensity of wave (I) is defined as power transmitted per unit cross section area of the medium.

$$I = \rho s v \omega^2 \frac{A^2}{2s} = \frac{1}{2}\rho v w^2 A^2$$

PHASE DIFFERENCE BETWEEN TWO PARTICLES IN THE SAME WAVE:

$$\Delta x \Longrightarrow \frac{\Delta\phi}{k}$$