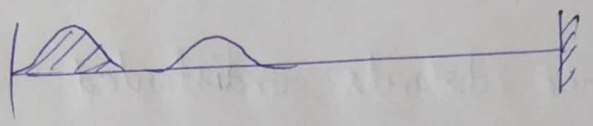
:- Lecture Notes :-

What is a wave?-

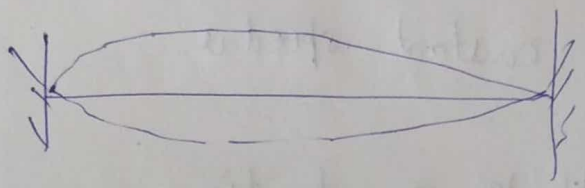
A wave is a disturbance that travels from one place to another.

Does a wave mean that the disturbace has to travel from one plan to another?

Let us consider a string:-



→ travelling wave



standing wave

So wave is a disturbance created at one place and travelling another place (travelling waves)

And An standing disturbace (Standing wave).

How we describe a wave:-

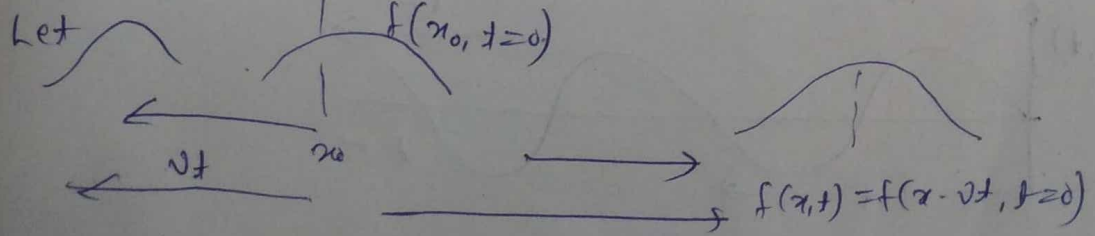
$$y(x,t) = A\sin 2\pi\left(\frac{x}{\lambda} - ft\right)$$

or $A\cos 2\pi\left(\frac{x}{\lambda} - ft\right)$

$$v = f\lambda$$

λ = wavelength

f = frequency



$$f(x,t) = f(x + vt, t=0)$$

So any disturbance created at origin may be any type of function/or will be given as a function of time as.

$$f(x,t) = f(x-vt,\ t=0)$$

→ travels right

$$f(x+vt,\ t=0)$$

→ travels left

Condition:-

- the disturbance travels undistorted.
- travels with constant speed v

Another way to write a function:-

$$f\left(t+\frac{x}{v}\right) \longleftarrow \text{left}$$

$$f\left(t-\frac{x}{v}\right) \longrightarrow \text{right}$$

Also a wave can be described as

$$f(x+vt)\ f(x-vt).$$

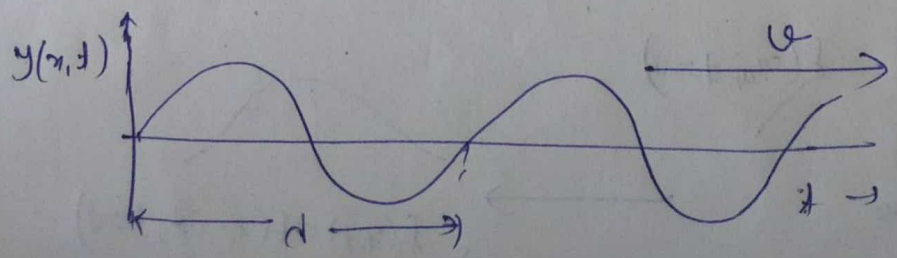
Travelling waves:-

$$y(x,t) = A\sin\left(2\pi\left(\frac{x}{\lambda}+t\right)\right)$$

displacement ↑ amplitude.

$x \rightarrow$ displacement of wave in transverse direction

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

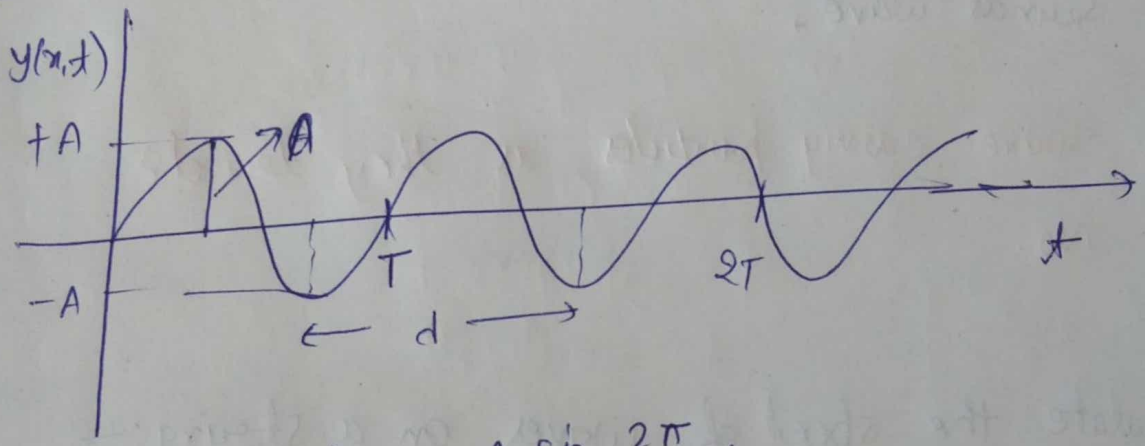


Amplitude:- Maximum displacement from equilibrium. denoted by A.

wavelength:- Minimum distance b/w two points having the same phase is called wavelength (λ).

period:- Time taken to complete one oscillation (T)

frequency:- No. of oscillation per unit time (f).



$$f(x, t=0) = A \sin \frac{2\pi}{\lambda} x$$

Wavenumber, $k = \frac{2\pi}{\lambda}$

$v = f\lambda$ → velocity of wave

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

$T = \frac{2\pi}{\omega}$ → angular frequency

Sinusoidal wave:-

$$y(x,t) = A \sin 2\pi \left(\frac{x}{\lambda} - ft \right)$$

Thus Two Kinds of Waves:-

① Transverse wave:-

$y(x,t)$ is $\perp$ to to travel direction.

e.g. waves on string, *

② Longitudinal wave:-

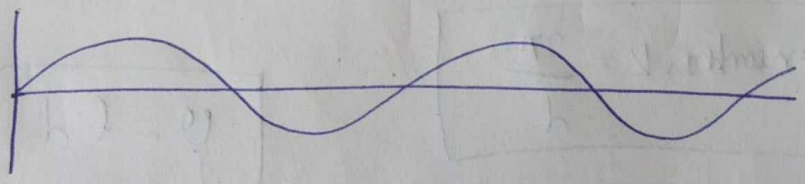
Disturbance is in the same direction as the direction of motion of wave.

e.g. Sounds wave,

Q. Do wave carry particles as they travel?

Ans - No.

① Calculate the speed of waves on a string:-



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

$$\boxed{v = \frac{\omega}{k}}$$

→ For waves on a string, the restoring force is provided by the tension T in the string. The inertial property will in this case be linear mass density μ, which is equal to $\frac{m}{L}$,

Thus if T and μ are assumed to be the only relevent physical quantities

$$v = c\sqrt{\frac{T}{\mu}}$$

for experiment $c = 1$

$$\# \quad \boxed{v = \sqrt{\frac{T}{\mu}}} \rightarrow$$ speed of transverse waves on a stretched string.

(11) Calculate the speed of sound waves:- (longitudinales wave)

→ Sound waves travel in the form of compressions and rare fractias of small volume elemets of air.

So the bulk modulus of the medium defined

$$\boxed{B = -\frac{\Delta P}{\Delta V/V}}$$

where ΔP = change in pressure

& $\frac{\Delta V}{V}$ = Volume strain.

from calculation we get

$$\boxed{v = \sqrt{\frac{B}{\rho}}}$$ → longitudinal waves in a medium.

ρ → density of medium.

For a linear medium like a solid bar:-

speed of waves $\boxed{v = \sqrt{\frac{Y}{\rho}}}$

Y = Young's modulus of the material.