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WAVE

Def^n :- (Propagation of energy in the form certain disturbance in a medium)

Type :- ① Mechanical Wave :- Which required medium for propagation

Ex:- Transverse & Longitudinal wave

12th ② E.M Wave :- which doesn't required medium for propagation.

(Electro-Magnetic wave)

Ex:- Light wave

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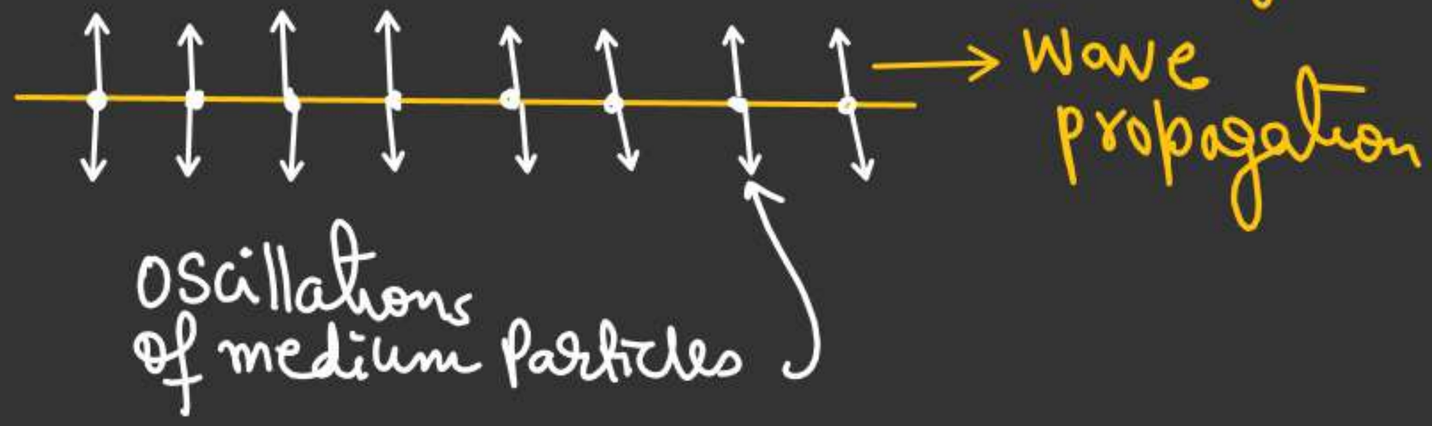
WAVE

Mechanical wave (On the basis of oscillation of medium particle)
(S·H·M)

Transverse wave

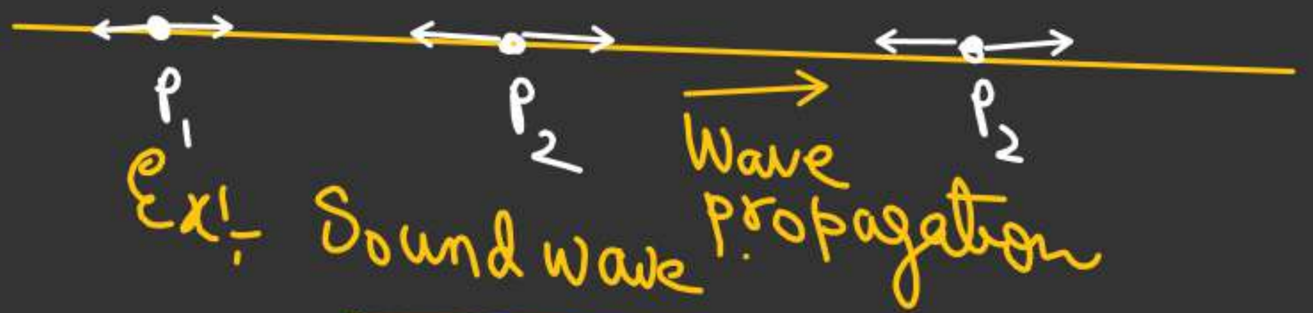
Medium particle oscillate perpendicular to wave propagation

Ex:- Wave pulse in a string



Longitudinal wave

Medium particles oscillate along the direction of wave propagation



Ex:- Sound wave

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Important points

WAVE

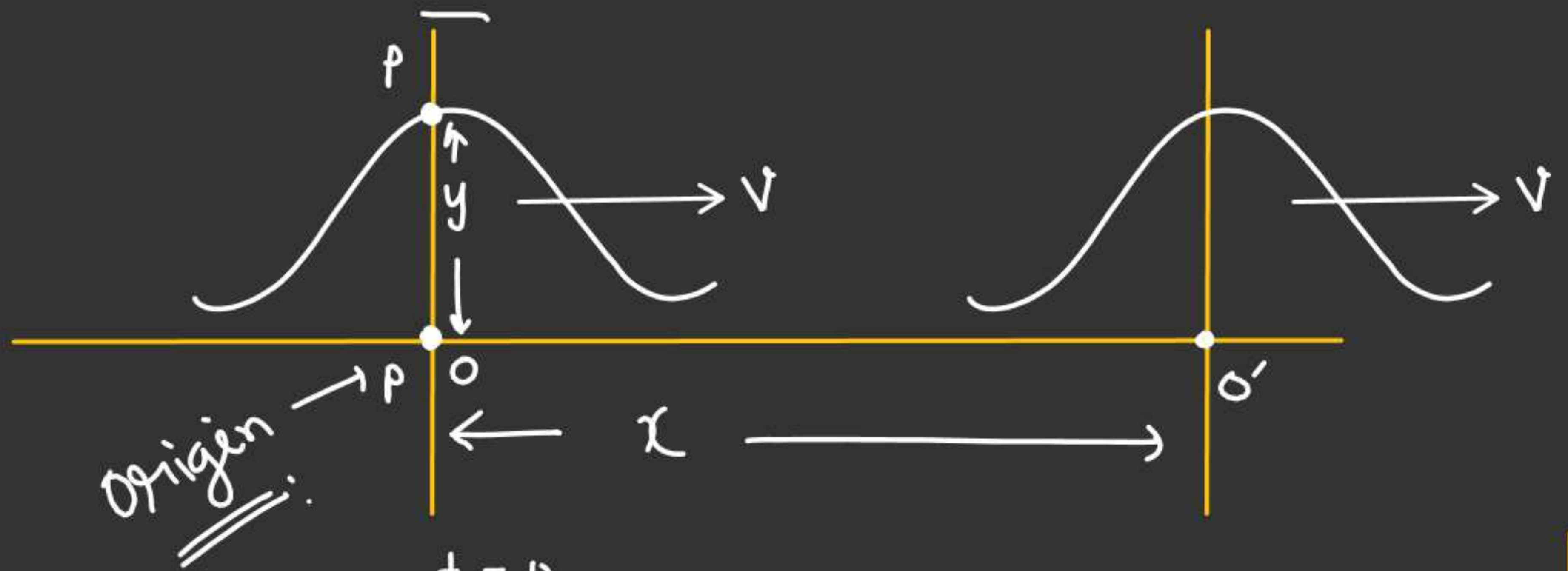
→ In Longitudinal wave disturbance propagate in the form of Compression & rarefraction zone.

→ In Compression zone medium particles are close to each other and in rarefraction zone medium particles are frar apart.

→ In Compression zone displacement of particles min but excess pressure Maxium
but in rarfraction zone displacement of particles max but excess pressure Min.

WAVE

Travelling wave Equation



$t = 0$ $\qquad$ $t = t$

$$\boxed{y = f\left(t + \frac{x}{v}\right)}$$

↓

Propagating in $-x$ direction

$$x = vt$$

$$t = \left(\frac{x}{v}\right)$$

After 't' time identical wave pulse

$v =$ wave velocity

If o as refrance

$$y = f(t)$$

If o' as refrance.

$$\boxed{y = f\left(t - \frac{x}{v}\right)}$$

↓

General travelling wave propagative in $+ve$ x-direction

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$$y = f\left(t - \frac{x}{v}\right)$$

$$y = f\left[\frac{1}{v}(vt - x)\right]$$

$$y = f\left[\underbrace{\left(-\frac{1}{v}\right)}(x - vt)\right]$$

$$\boxed{y = g(x - vt)}$$

Travelling wave Equation in +x direction.

$$\boxed{y = g(x + vt)}$$

Travelling wave in − x direction.

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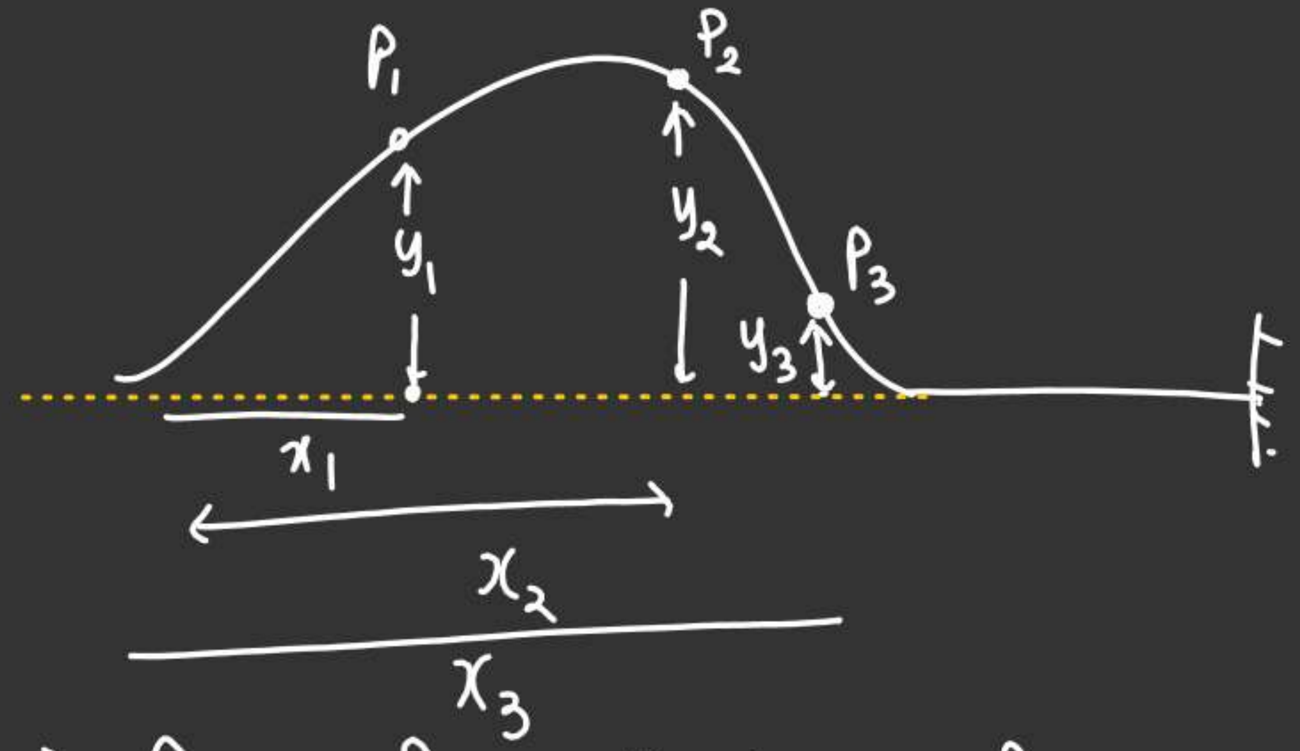
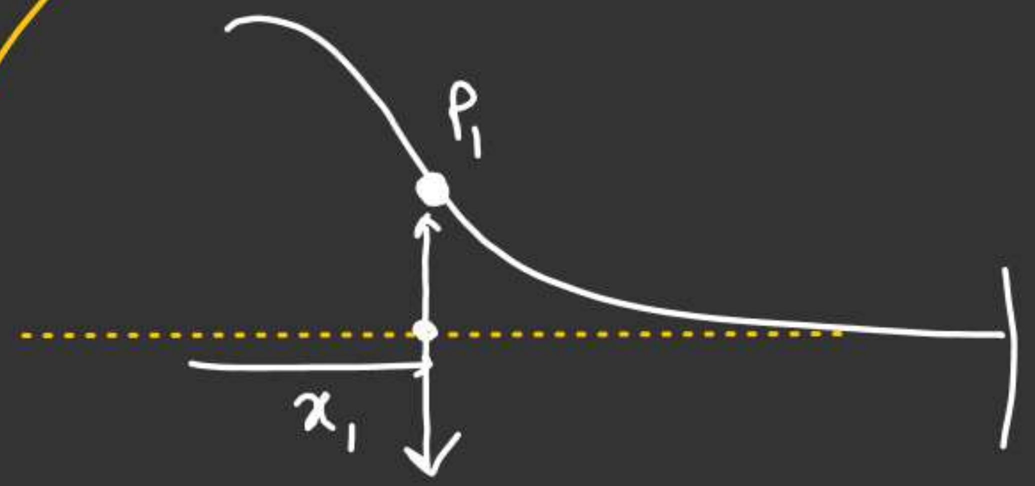
$$\boxed{y = f\left(t - \frac{x}{v}\right)}$$

if $t \to$ fixed, $x \to$ vary



gives information of shape of wave pulse

if $x \to$ fixed, $t \to$ vary.



Gives information of single particle w.r.t time.

WAVE

Differential Equation of travelling wave

$$y = f\left(t - \frac{x}{v}\right)$$

Differentiating both side w.r.t time

$$\frac{\partial y}{\partial t} = f'\left(t - \frac{x}{v}\right)\frac{\partial}{\partial t}\left(t - \frac{x}{v}\right)$$

Assume constant

$$\frac{\partial y}{\partial t} = f'\left(t - \frac{x}{v}\right)(1)$$

Again differentiating w.r.t time

$$\frac{\partial^2 y}{\partial t^2} = f''\left(t - \frac{x}{v}\right)(1) \quad \text{—} (1)$$

Differentiating w.r.t x. Constant

$$\frac{\partial y}{\partial x} = f'\left(t - \frac{x}{v}\right)\frac{\partial}{\partial x}\left(t - \frac{x}{v}\right)$$

$$\frac{\partial y}{\partial x} = f'\left(t - \frac{x}{v}\right)\left(\frac{-1}{v}\right)$$

Again differentiating

$$\frac{\partial^2 y}{\partial x^2} = f''\left(t - \frac{x}{v}\right)\left(\frac{-1}{v}\right) \times \left(\frac{-1}{v}\right)$$

$$\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2} f''\left(t - \frac{x}{v}\right) \quad \text{—} (2)$$

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WAVE

Differential Equation of travelling wave

$$\frac{\partial^2 y}{\partial t^2} = f''\left(t - \frac{x}{v}\right)(1) \quad \text{—} (1)$$

$$\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2} f''\left(t - \frac{x}{v}\right) \quad \text{—} (2)$$

From (1) & (2)

$$\boxed{\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\left(\frac{\partial^2 y}{\partial t^2}\right)}$$

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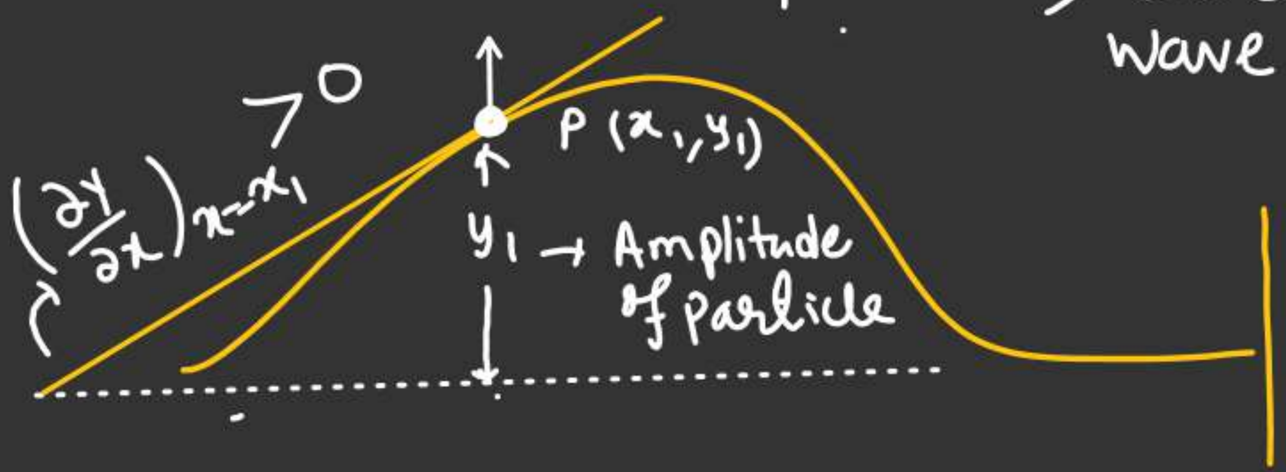
$$\left(\frac{\partial y}{\partial t}\right) = f'\left(t-\frac{x}{v}\right)(1)$$

$$\left(\frac{\partial y}{\partial x}\right) = f'\left(t-\frac{x}{v}\right)\left(\frac{-1}{v}\right)$$

From above Equation

$$\boxed{\underbrace{\frac{\partial y}{\partial x}}_{\text{Slope of tangent drawn on the wave pulse}} = -\underbrace{\frac{1}{v}}_{\text{Wave velocity}}\underbrace{\left(\frac{\partial y}{\partial t}\right)}_{\text{Particle velocity}}}$$

At t = t, (P seem's to be moving upward.) direction of wave propagation ??



$$\left[\begin{array}{l} v_p > 0 \text{ given} \\ \left(\frac{\partial y}{\partial x}\right)_{x=x_1} > 0 \end{array}\right.$$

$$\underbrace{\left(\frac{\partial y}{\partial x}\right)}_{+ve} = -\underbrace{\frac{1}{v}}_{??}\underbrace{\left(\frac{\partial y}{\partial t}\right)}_{v_p > 0}$$

$v = -ve$ ⇒ wave travelling in $-ve$ x-direction.