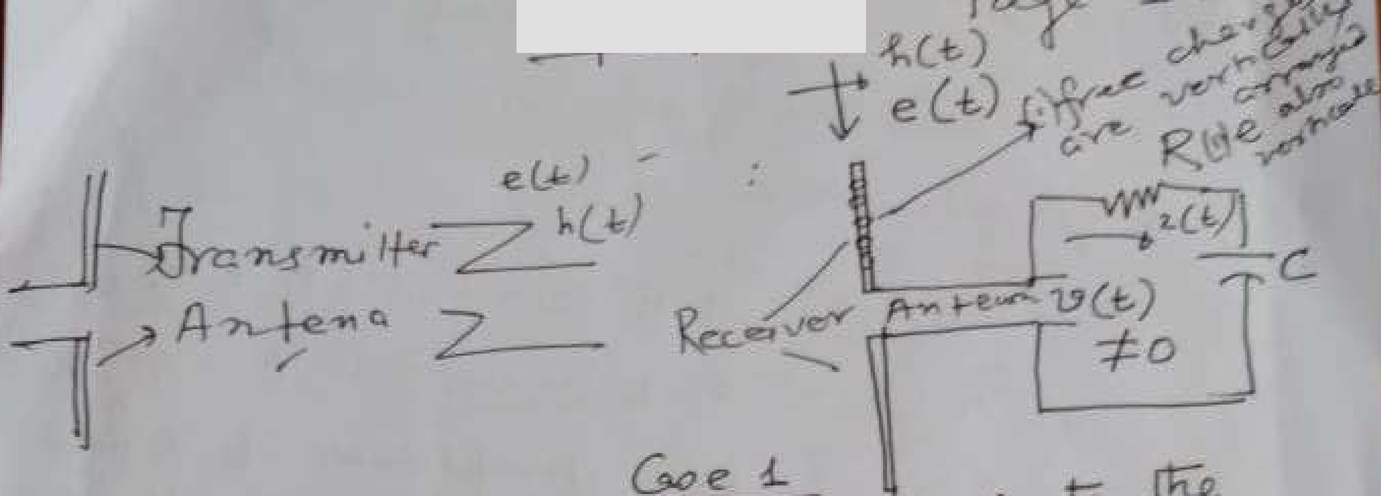
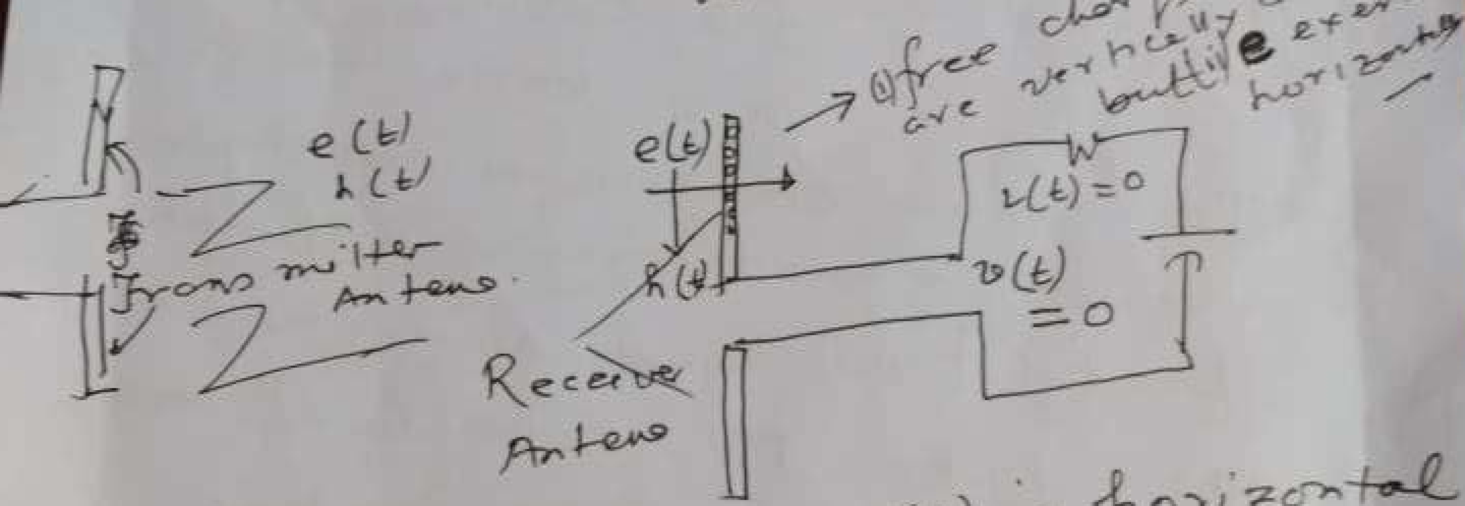


Case 1

① (e(t) vertical to the vertical Antena) —



② Case-2 e(t) is horizontal to the vertical antena.

③ Adjustment of Receiving Antenna is required by rotation.

(4) Electromagnetic wave equation.

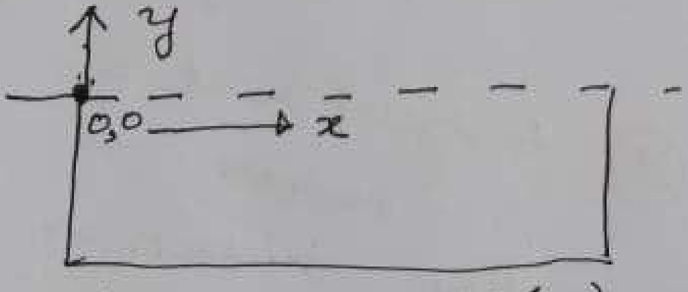
$$\vec{e}(t,x) = E \sin\left(2\pi f t + \frac{2\pi}{\lambda} x\right)$$

$$\vec{h}(t,x) = H \sin\left(2\pi f t + \frac{2\pi}{\lambda} x\right)$$

E = Amplitude of E field
H = " " H field
f = cyclic frequency
λ = wave length.

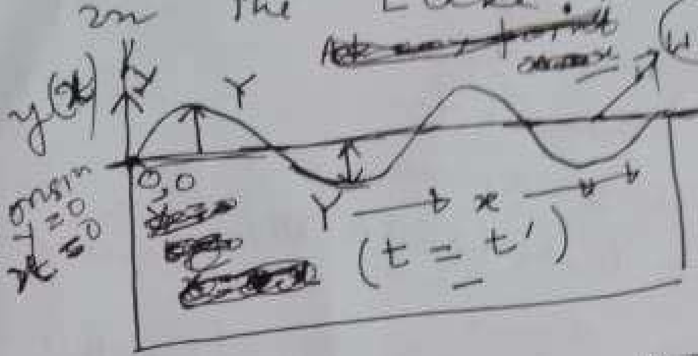
To understand and derive above equation as a function of t (time) and space (x) let us take the example of ~~wave~~ water wave of a Lake.

(5) Calm Lake



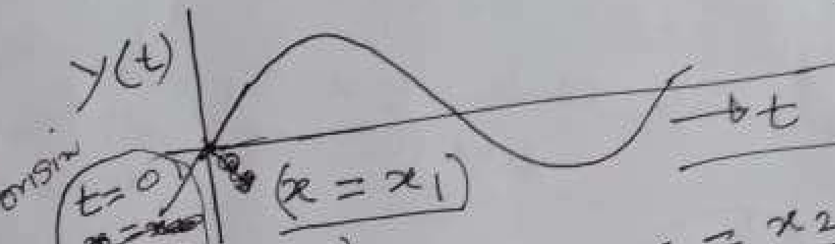
At any x $y(x) = 0$

(6) When water wave is set up in the Lake: At time $t = t_1 \Rightarrow$ Look at calm water level | all x points $y = 0$

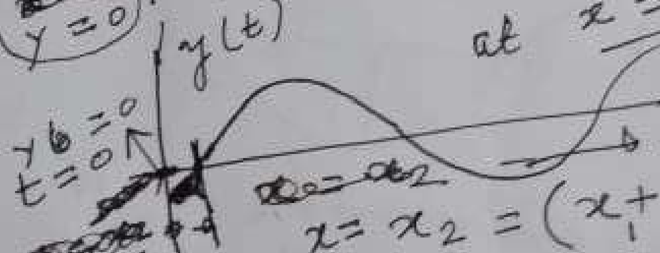


Y = Amplitude.
you shall see a physical sine curve.

(7) Look at the wave at any x point $x = x_1$ where wave starts.
Look at the time variation.



at $x = x_2 = (x_1 + \Delta x)$ variation



$x = x_2 = (x_1 + \Delta x)$
θ ~~Laging~~ Laging by angle θ

So here the wave starts at θ angle letter. $2\pi \Rightarrow T$

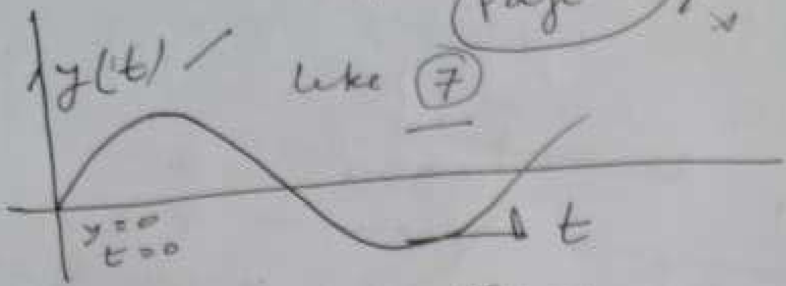
$x = x_3, x_4, x_5$ when $x_1 < x_2 < x_3 < x_5 \ldots$

wave start at letter point of time.

We say the wave travels.

(9) Page-4

like (7)



at $x = x_1$ —

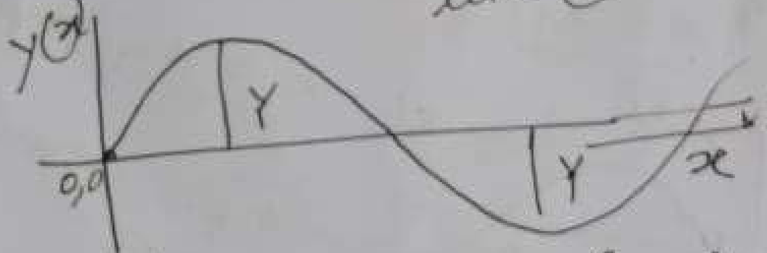
$y(t) = Y \sin(2\pi f t)$ f = cyclic frequency = $\frac{1}{T}$ (Time period)

at $x = x_2$ —

$y(t) = Y \sin(2\pi f t - \theta)$

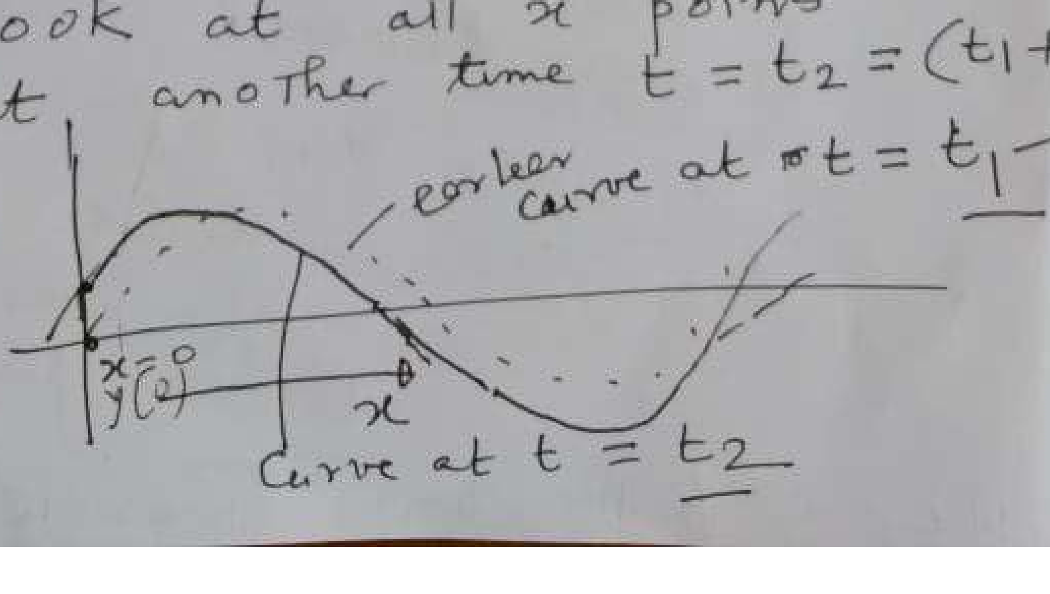
(10) Now look at the variation of y w.r.t space.

At any time $t = t_1$ like (6) Look at all x points you will see a sine wave

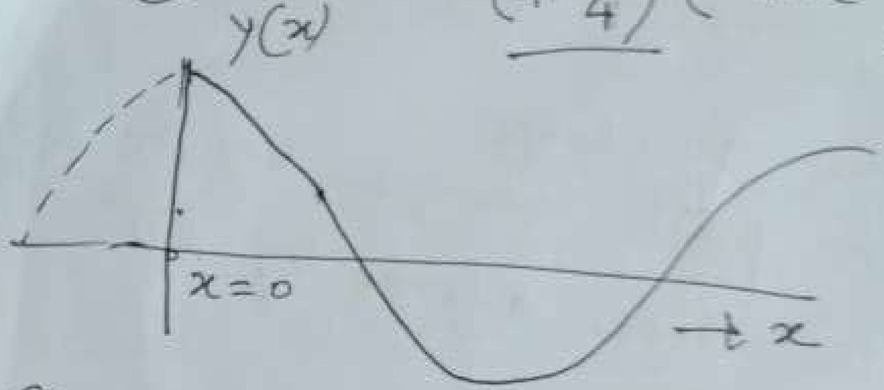


$y(x) = \cancel{Y \sin 2\pi f x}$
$= Y \sin(\beta x)$ where β is a constant

(11) Look at all x points at another time $t = t_2 = (t_1 + \Delta t)$

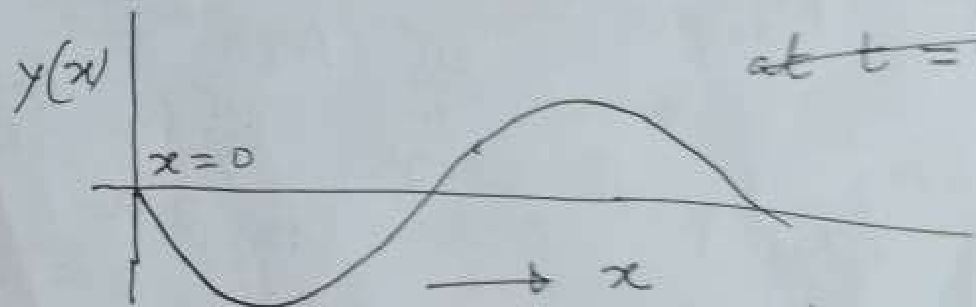


(12) at $t = \left(t_1 + \frac{T}{4}\right)$ (time period)



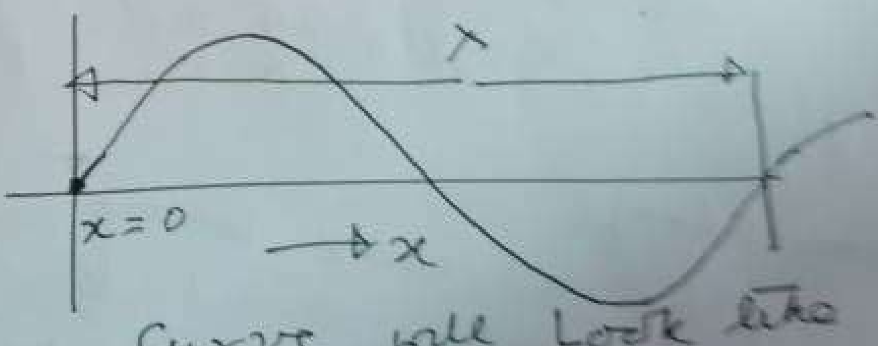
(13) at $t = \left(t_1 + \frac{T}{2}\right)$

~~at $t = \left(t_1 + \frac{T}{2}\right)$~~



Just opposite to

(14) at $t = (t_1 + T)$



Curve will Look like at $t = t_1$

we say the wave has advanced at length of λ in time T path length $\lambda \longrightarrow T \longrightarrow 2\pi$ Angle.

In time T change

path changes by λ

The Angle change by 2π

$\lambda \xrightarrow[\text{path change}]{} 2\pi$ Angle change

$1 \longrightarrow \frac{2\pi}{\lambda}$ Angle change

x path change $\frac{2\pi}{\lambda} x$ Angle change.

$= \beta x$ "

where $\beta = \frac{2\pi}{\lambda}$

(15) Therefore the variation of the wave w.r.t x where t is constant

$$y(x) = Y \sin \frac{2\pi}{\lambda} . x.$$

~~time change~~

(16) We already know variation of the wave w.r.t t when x = constant,

$$y(t) = Y \sin 2\pi \frac{t}{T}$$

$$= Y \sin (2\pi f t)$$

Now combining (15) and (16)

variation w.r.t $\underset{\text{time}}{t}$ and $\underset{\text{space}}{x}$ —

$$y(t) = Y \sin\left(2\pi f t + \frac{2\pi}{\lambda} \cdot x\right)$$

where the constant λ = wave length = distance between two consequitive space points with the same phase (both ~~[illegible]~~ $y = 0$ or both $y = Y$) at a particular time $t = t$

(17) From 14 we have seen that the wave advances λ distance in (travels)

Time $T \longrightarrow \lambda$ distance.

T time — $\frac{\lambda}{T} = f\lambda$ distance

1 "

velocity of wave $v = f\lambda$

(18) Similar manner with transmitter Antena.

$v = v(t)$ of transmitter is $= V \sin 2\pi f t$

Then $\vec{e}(t) = E \sin 2\pi f t$
$\vec{h}(t) = H \sin 2\pi f t$

transmitter Antena point $x = 0$

Therefore the wave equation at distance x from tramitter Antene.

$$\vec{e}(t,x) = E \sin\left(2\pi f t + \frac{2\pi}{\lambda} x\right)$$

$$\vec{h}(t,x) = H \sin\left(2\pi f t + \frac{2\pi}{\lambda} x\right)$$

(19) Particle Mode and wave Mode energy transfer :—

(i) Particle Mode:

A particle of mass m and velocity v has kinetic energy —

$$E = \frac{1}{2} m v^2$$

If you throw this particle to a football on ~~wave~~ water. The football start moving. Here the energy is transferred in particle mode. The particle carrying the energy actually moves.

(ii) Wave mode of energy transfe.

you stir water at the edge of the pond ⟹ wave set up ⟹ In the wave no water particle moves from their mean position ⟹ wave reaches the ball and moves it.