Assignment-01

Course Name: Physics

Course code: Phy-201

Submitted To:

Shuva Saha
Lecturer Department of CSE
City University, Bangladesh

Submitted by:

MD.Rasel Hossain
ID: 163432521
Batch-43rd
Department of CSE

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Phy-201

MD. Rasel Hossain
ID- 163432521, CSE

Lecture-1

Wave: The periodic distance that advances through a material medium transfers energy from one place to another place but doesnot displaced the partical of the medium permanently is Known as wave:

wave classified into two types:

① Mechanical wave.

⑪ Electromagnetic wave.

Mechanical wave: The waves which require a material medium for their propagation are Known as mechanical waves.

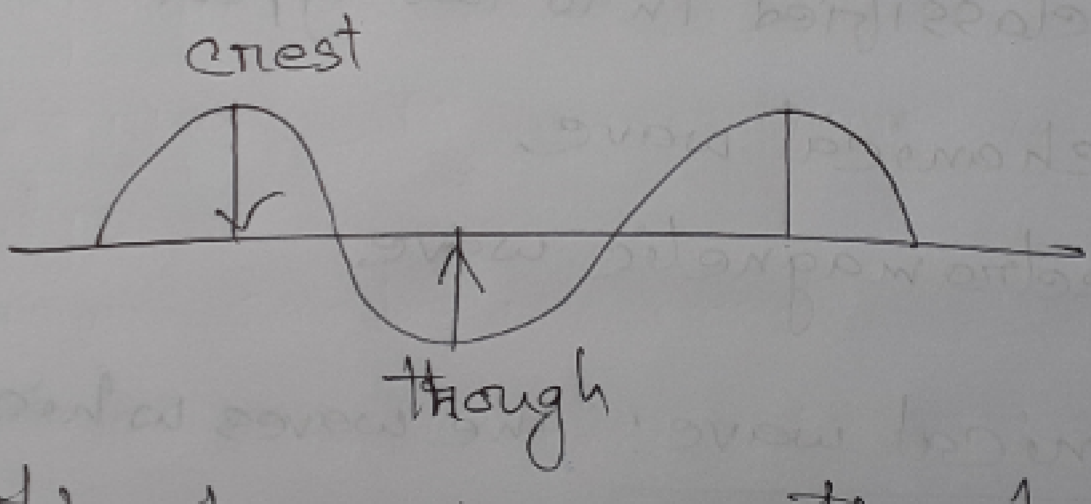
Exam: sound wave, vibrations wave. ~~ultra sound~~, water wave.

Two types of Mechanical wave:

(i) Transvers wave

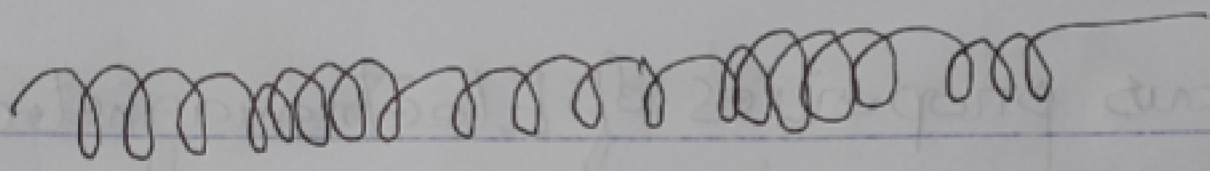
(ii) Longitudinal wave

(i) Transvers wave: which the particals of the medium oscillate about their mean positions at right angles to the direction of propagation of the wave, transvers wave.



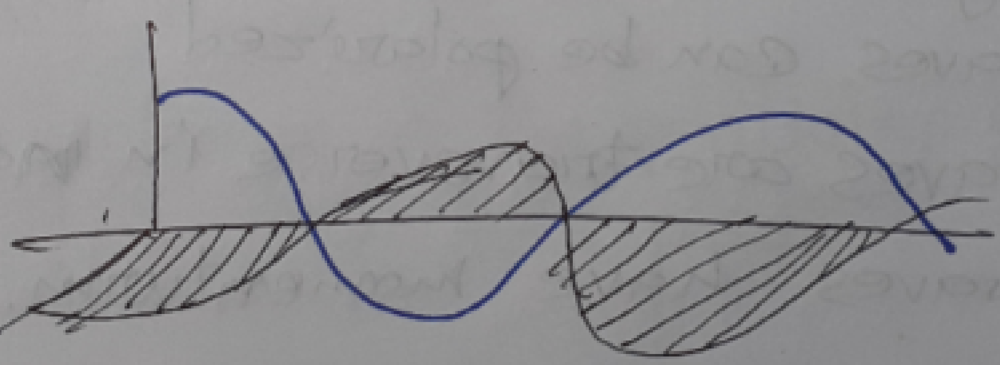
The position of maximum positive displacement is crest and the lowest point, the position of maximum displacement is called trough

(ii) <u>Longitudinal wave</u>: the particals of the medium oscillate about their mean positions in the direction of propagation of the wave is called longitudinal wave.



<u>Exm.</u> spring

(b) <u>Electromagnetic wave</u>: when electric and magnetic fields fluctuate together they lead to formation of the propagation waves called Electromagnetic waves.



<u>Example</u>: Radio wave, Harmonic wave, light wave, x-ray wave

Simple harmonics and Sine ~~wave~~: waves generated by the simple harmonic motion of the practicles of a medium are called simple harmonics or Sine wave

The various properties of Electromagnetic waves:

(1). The velocity of electromagnetic wave in vacuum is 3×10^8 m/s

(2) The ~~ex~~istence of medium is not essential for propagation.

(3) In vacuum, E.M. waves travel with light valocity.

(4) E.M waves can be polarized

(5) E.M waves are transverse in nature

(6) E.M waves have momentum.

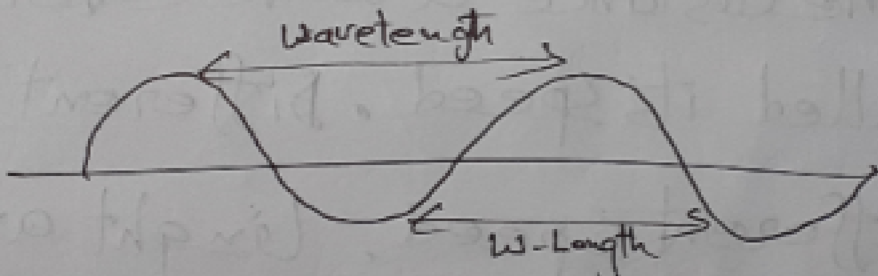
(7) There is no deflection on account of magnetic or electric field,

(8) They can exhibit diffraction and interference

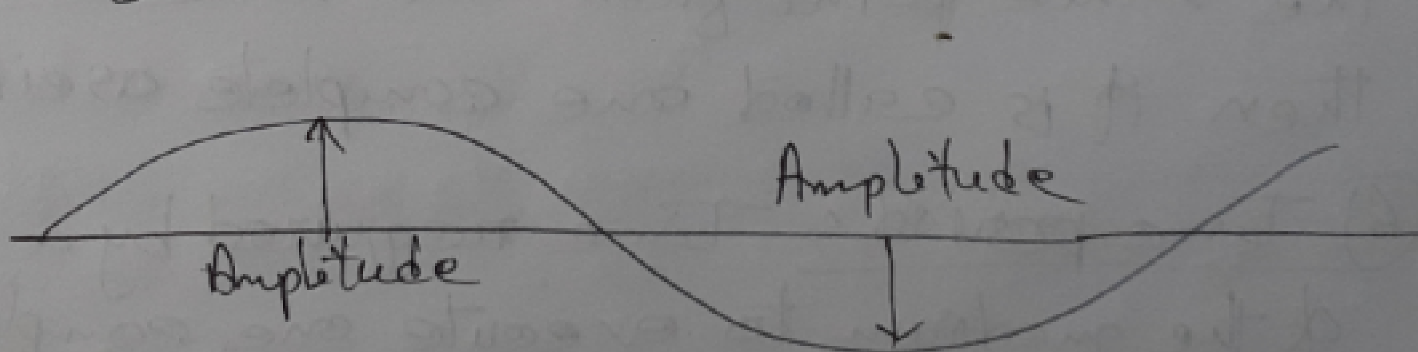
Characteristics of wave:

The basics terms to understand waves are amplitude, wavelength, frequency, speed, complete oscillation and time period.

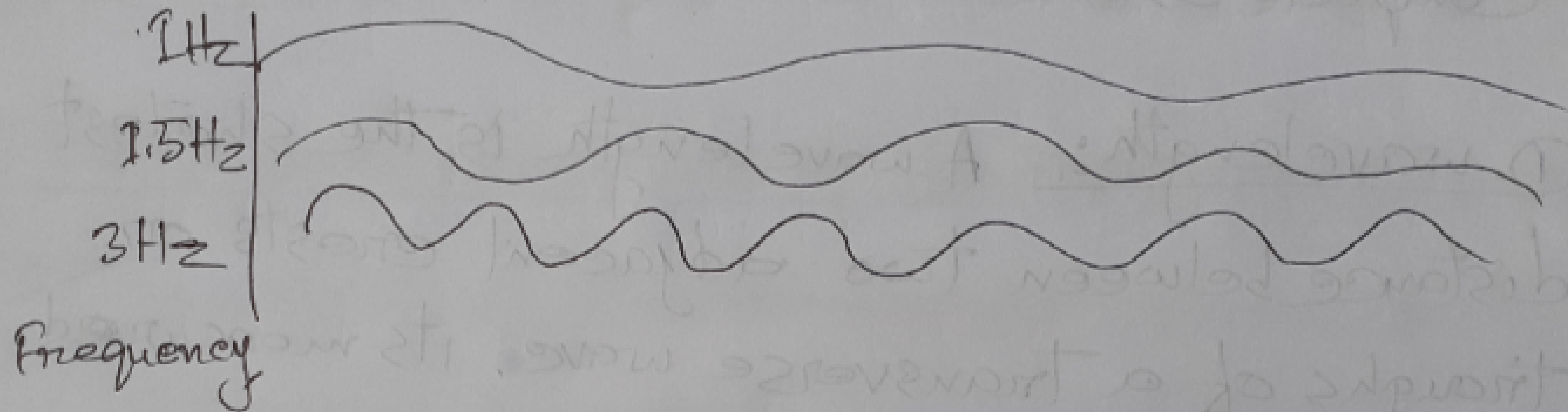
1. wavelength: A wavelength is the shortest distance between two adjacent crests or troughs of a transverse wave. its measured in meter (m)



2 Amplitude: Amplitude of a wave is the mixture distance of the particles of the medium from the rest position.



(3) Frequency: The number of vibrations produced by a vibrating body in one sound is called its frequency.



(4) Speed: The distance a wave covers in units time is called its speed. Different waves travel at different speed. Light and sound.

(5) Complete oscillation: when an oscillating body starting from a point comes back to the same point from the same direction. then it is called one complete oscillation.

(6) Time period: Time required by a particle of the medium to execute one complete oscillation is called time period.

S:- [illegible]!

Difference between Transverse wave and Longitudinal wave:

Transverse	Longitudinal
The wave in which the particles of the medium vibrate perpendicular to the direction of propagation of the wave is called transverse wave	The wave in which the particle of the medium vibrates parallel to the direction of propagation of the wave is known as longitudinal wave
During propagation of the wave crests and throughs are produced in the medium.	During propagation of the wave compression and rarefaction of the medium take place

Q: wave এর মাধ্যমে কি Transfer করা হয়? [Energy, mass]?

Ans:- Energy.

math

(8)

a = ampletude

λ = wave length

f = frequency $f = \frac{N}{t}$

T = Time $t = \frac{1}{f} = \frac{t}{N}$

v = valuoity $v = \frac{d}{t}$ m/s $\frac{s}{t}$

$v = f\lambda$

Q: Frank is making waves on a rope by moving he's arm up and down, which he does 20 times in 10 seconds.

what is the frequency of the waves that Franks creates?

Solⁿ

Given,

Time = 10

N = 20

we know,

$$f = \frac{N}{t}$$

$$= \frac{20}{10}$$

$$= 2Hz$$

Q: Kelly is floating on an innertube in the ocean and notices that she bobs up and down 6 time period every minute.

what is the time period of the ocean on which kelly is floating?

Solⁿ

~~Given,~~

Given,

T = 60s

N = 6

we know

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

$$= \frac{t}{N}$$

$$= \frac{60}{6} = 10s \text{ Ans!}$$

Q3 What is the speed of a water wave (11)
that has a wavelength of 8 meters and
a period of 4 seconds?

Soln

We know,

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

$v = f\lambda$ $[\because T = \frac{1}{f}$

$\Rightarrow v = \frac{\lambda}{T}$ $\Rightarrow f = \frac{1}{T}$

$\Rightarrow v = \frac{8}{4}$

$\therefore v = 2ms^{-1}$

Given,

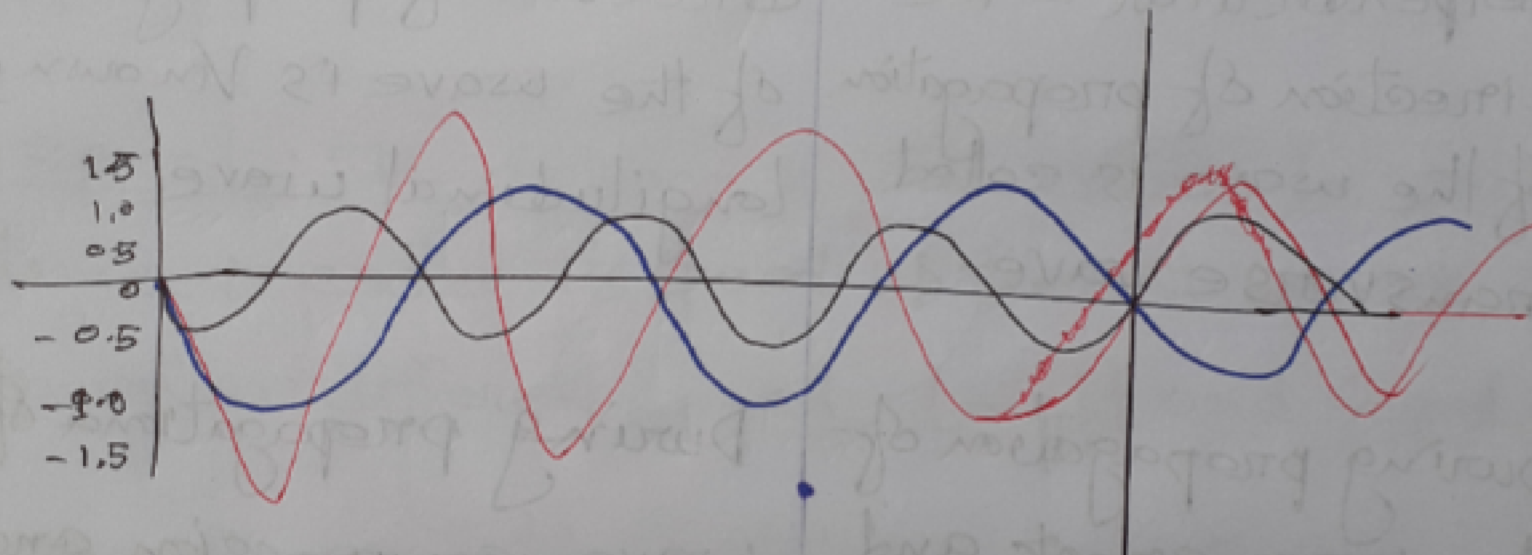
$\lambda = 8$

$T = 4 sec$

Lecture-2

The principle of Supur position of wave:

when two or more waves simultaneously pass through a point, the distrubance at the point is given by the vector sum of the distrubance each wave would produce in absence of the other wave.

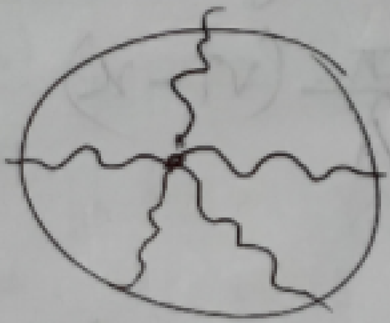


two waves passing through a point in a medium Let y_1 be the displacement of a particle at that point due to the first wave in the absence of second wave and y_2 be the displacement at that point due to the second wave in the absence of the first wave. The Resultant (R) point both wave act simultaneously is

$$R = y_1 \pm y_2$$

Progressive wave Periodic distrubance.
অগ্রগামী তরঙ্গ

Propagation from one layer to another layer of a wide medium and advances continuously in the forward direction is known as progressive wave.



Characteristics of progressive wave:

① Every particale of the medium executes periodic motion.

② The amplitude of each particle of the medium is same. but there exits phase difference between them

③ The distance between two successive crests of a transvers wave and distanece between a compression and rarefaction is a wavelength.

(4) The change is pressure and density of the medium are similar in progressive waves.

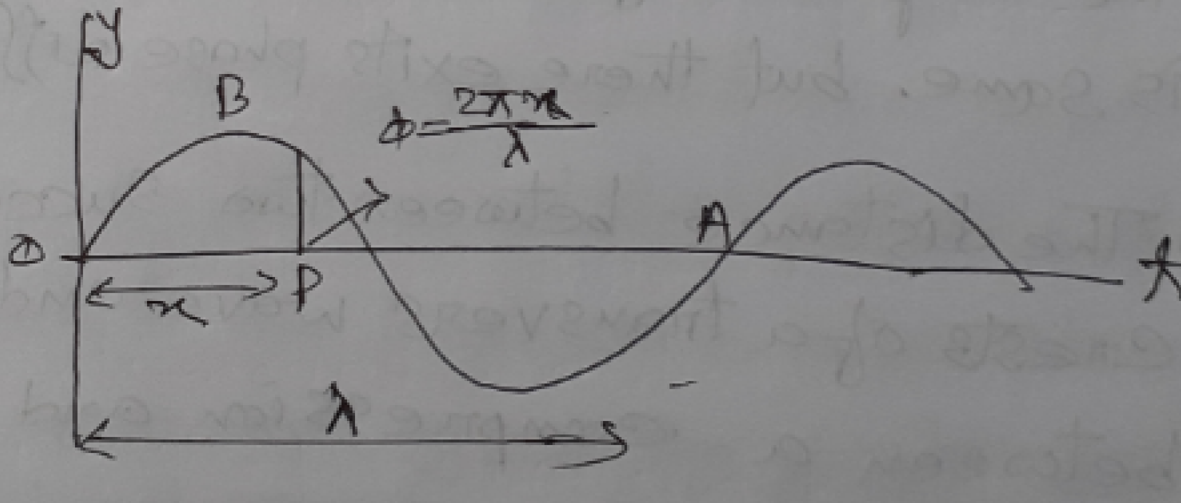
(5) In a progressive wave, the particeale of the medeum wave attains a stationary position

(6) The equation of a progressive wave is

$$y = A\sin\frac{2\pi}{\lambda}(vt - x)$$

Equation of a plane progressive wave:

Let us assumethat a progressive wave travels from the origin O ~~at~~ along the positive direction of X axis.



$$y = a\sin \omega t \quad \text{--- (1)}$$

where a is the amplitude of ~~the vibration~~ of the particle and $\omega = 2\pi n$.

The particle P at a distance x from O at a given instant is given by.

$$y = a \sin(\omega t - \phi) \quad \text{---} \; (2)$$

If two particles are separated by a distance λ, they will differ by a phase of 2π, the phase ϕ of ~~the~~ particle P at a distance x is $\phi = (2\pi/\lambda)x$

$$y = a \sin(\omega t - 2\pi x/\lambda) \quad \text{---} \; (3)$$

Since $\omega = 2\pi n = 2\pi (v/\lambda)$, the equation is given by.

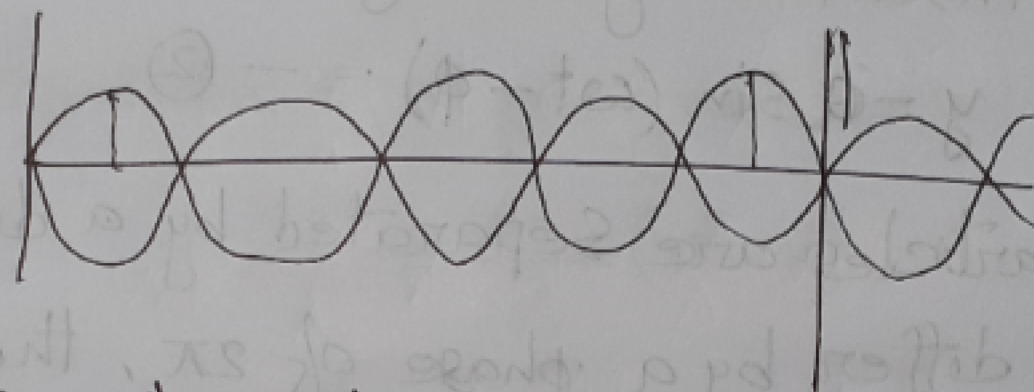
$$y = a \sin[(2\pi vt/\lambda) - (2\pi x/\lambda)]$$

$$y = a \sin 2\pi/\lambda (vt - x) \quad \text{---} \; (4)$$

if the wave travels in opposite direction. The equation becomes,

$$y = a \sin 2\pi/\lambda (vt + x) \quad \text{---} \; (5)$$

Stationary wave (স্থিরতরঙ্গ)**:** The resultant wave produce by the superposition of two progressive waves having same wavelength and amplitude, travelling is called stationary waves.



Characteristics of progressive wave:

1. Only the particles other than those at the nodes execute periodic motion.
2. The phase difference between particles of the medium is small, but amplitude is different.
3. The distance between ~~three~~ successive nodes or anti-nodes is called a wavelength.
4. a stationary wave, pressure and density ~~and~~ remains almost unchanged at the nodes, while the changes are minimum at the anti-nodes.

(5) The equation of stationary wave is

$$y = A\sin\frac{2\pi}{\lambda}(vt)$$

Equation of a standing wave:

A harmonic wave traveling to the right along the x-axis is described by the equation.

$$y_1 = a\sin\frac{2\pi}{\lambda}(vt-x) \quad \text{---} (1)$$

an identical harmonic wave traveling to the left described by the equation

$$y_2 = a\sin\frac{2\pi}{\lambda}(vt+x) \quad \text{---} (2)$$

where a = amplitude, 2π = frequency

λ = wavelength

So the equation wave y will be the sum y_1 and y_2

$$y = y_1 + y_2$$

$$y = a\sin\frac{2\pi}{\lambda}(vt - x) + a\sin\frac{2\pi}{\lambda}(vt + x)$$

$$y = 2a\sin\frac{2\pi}{\lambda}\left(\frac{vt - x + vt + x}{2}\right)\cos\frac{2\pi}{\lambda}\left(\frac{vt - x - vt - x}{2}\right)$$

$$\sin a + \sin b = 2\sin\left(\frac{a+b}{2}\right)\cos\left(\frac{a-b}{2}\right)$$

$$y = 2a\sin\frac{2\pi}{\lambda}vt\cos\frac{2\pi}{\lambda}(-x)$$

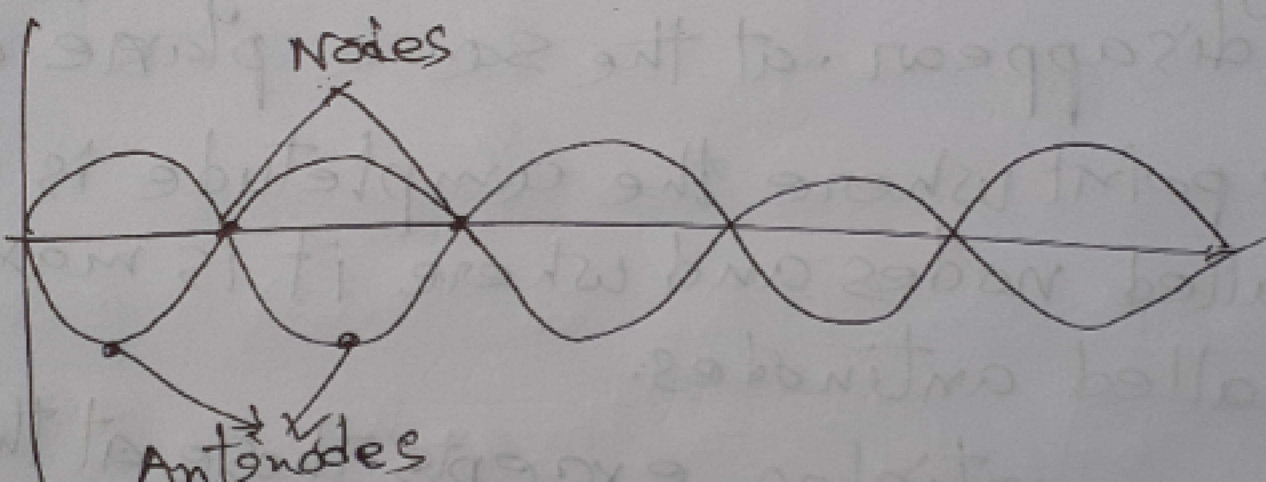
$$y = 2\cos\frac{2\pi}{\lambda}x\sin\frac{2\pi}{\lambda}vt$$

$$y = A\sin\frac{2\pi}{\lambda}vt$$

where $A = 2a\cos\frac{2\pi}{\lambda}x$

Antinode: The points on the Stationary wave where the particales of the medium vibrate with maximum amplitude are called antinode.

Node: The points on the stationary wave where partcles of the medium remain static, the displacement of the particles are zero are called nodes.



The distance between Nodes or between two Antinodes is half a wavelength.

Node এবং Antinodes এর মধ্যে দূরত্ব $\frac{\lambda}{4}$

২টি Node অথবা Antinodes " " " $\frac{\lambda}{2}$

৩টি " " " " " " λ

Characteristics of stationary wave:

1. Stationary waves are produced when two identical progressive waves travelling along the same straight line but in opposite direction are superposed.
2. Crests and trough or compression and rarefraction do not progress forward through the medium but simply appear and disappear at the same place alternately.
3. The point where the ampletude is zero is called nodes and where it is maximum is called antinodes.
4. All the particles, excepts those at the nodes, execute simple harmonic motion.
5. The distance between two adjacent nodes, or antinodes is equal to half of the wavelength.
6. There is no propagation of energy is stationary wave.

(x) Stationary waves are produced both by transverse & Longitudinal waves.

Math

Q: The phase defference between two particles of a wave seperated by a distance of 0.325m is 3.14 rad. if the frequency of the wave is 512Hz, calculate the velocity of the wave in the medium.

Soln phase difference = 3.14 rad φ

path difference = 0.325m x

$f = 512Hz$

$v = ?$

$$\phi = \frac{2\pi}{\lambda} \times x \qquad v = f\lambda$$

$$= 512 \times 0.650$$

$$\Rightarrow \lambda = \frac{2\pi x}{\phi} \qquad = 332.96\ ms^{-1}\ \text{Ans}$$

$$= \frac{2 \times 3.1416 \times 0.325}{3.14}$$

$$= 0.650$$

Q2 The equation of a progressive wave is $y = 0.5 \sin(20t - 0.57x)$, find the amplitude, frequency, velocity and time period for the wave

Soln

$$y = 0.5 \sin(20t - 0.57x) \quad \text{--- (1)}$$

$$y = a \sin \frac{2\pi}{\lambda}(vt - x) \quad \text{--- (2)}$$

$\therefore a = 0.5$ Ans.

$a = ?$

$f = ?$

$v = ?$

$T = ?$

$$\frac{2\pi x}{\lambda} = 0.57x$$

$$\lambda = \frac{0.57\cancel{x}}{2 \times 3.1416 \cancel{x}}$$

$$= 0.090$$

$$\frac{2\pi}{\lambda} v\cancel{t} = 20\cancel{t}$$

$$\Rightarrow v = \frac{20\lambda}{2\pi}$$

$$= \frac{20 \times 0{\cdot}090}{2 \times 3.1416}$$

$$= 0.286 \text{ Ans.}$$

$$v = f\lambda$$

$$\Rightarrow f = \frac{v}{\lambda}$$

$$= \frac{0{\cdot}286}{0{\cdot}090}$$

$$f = 3.1830 \text{ Ans.}$$

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

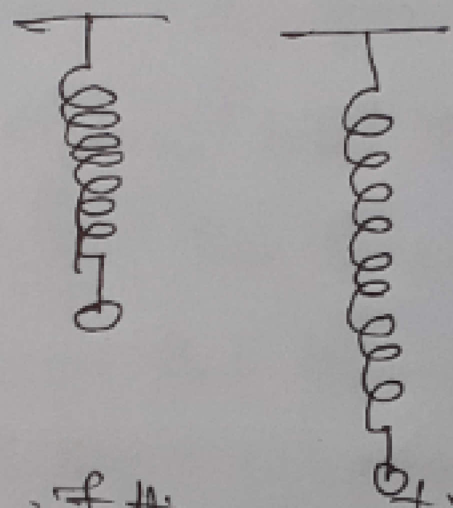
$$= \frac{1}{3.1830}$$

$$= 0.3144 \text{ Ans.}$$

Lecture-3

Oscillations: oscillation refers to any Periodic Motion moving at a distance about the equilibrium position and repeats itself and over for a period of time.

Example: The oscillation up and down of a Spring.



Periodic Motion: if the motion of a particle is such that it passes through a certain point from the same direction after a definite interval of time, then the motion is called periodic Motion.

Exam: the motion of the electric fan,

Simple Harmonic oscillation:

The type of vibratory motion of a body such that the restoring force on the acceleration acting on the body is directly proportional to the displacement from the mean position and always directed towards the mean position is called the simple Harmonic motion.

The relationship between acceleration a and displacement x is

$$a \propto x$$
$$\text{or } a = kx$$

Characteristics of simple Harmonic motion:

1. Its motion is periodic
2. At particular time interval the motion opposite
3. Its motion is along a straight line,
4. Its acceleration is proportional to the displacement
5. Acceleration is opposite to displacement,
6. Acceleration points toward the mean position of the object

Lecture-4

Angular Frequency:

$$W = \frac{2\pi}{T}$$
$$= 2\pi n$$
$$= 2\pi \times \frac{1}{2\pi}\sqrt{\frac{K}{m}}$$
$$= \sqrt{\frac{K}{m}}$$

Energy in Simple Harmonic oscillation:

Suppose amplitude a angular frequency ω, and phase constant δ. If the displacement of the particle in time t is x then,

$$x = a\sin(\omega t + \delta) \cdots (1)$$

potential Energy:

$$u = \int_0^x F dx$$
$$= \int_0^x Kx\,dx = K\left[\frac{x^2}{2}\right]_0^x = \frac{1}{2}Kx^2$$

Since $x = a\sin(\omega t + \delta)$.

$$\therefore u = \frac{1}{2}Ka^2\sin^2(\omega t + \delta)$$

Kenetic energy:

Kinetic energy of the particle is

$$K = \frac{1}{2} mv^2$$

velocity $v = \frac{dx}{dt} = \omega a \cos(\omega t + \delta)$

$$\therefore K = \frac{1}{2} mv^2$$

$$= \frac{1}{2} m\omega^2 a^2 \cos(\omega t + \delta)$$

$$= \frac{1}{2} m \frac{K}{m} a^2 \cos^2(\omega t + \delta)$$

$$\therefore K = \frac{1}{2} Ka^2 \cos^2(\omega t + \delta)$$

Total energy:

$$E = K + U$$

$$= \frac{1}{2} Ka^2 \sin^2(\omega t - \delta) + \frac{1}{2} Ka^2 \cos^2(\omega t + \delta)$$

$$= \frac{1}{2} Ka^2$$

Average Kinetic energy:

$$K.E_a = \frac{\int_0^T (K.E)\,dt}{\int_0^T dt}$$

$$= \frac{1}{T}\int_0^T \frac{1}{2} m\omega^2 A^2 \cos^2(\omega t + \delta)\,dt$$

$$= \frac{m\omega^2 A^2}{4T}\left[\int_0^T dt + \int_0^T \cos 2(\omega t + \delta)\,dt\right]$$

$$= \frac{m\omega^2 A^2}{4} + \frac{m\omega^2 A^2}{8\omega T}\left[\sin 2(\omega t + \delta) - \sin 2\delta\right]$$

$$= \frac{m\omega^2 A^2}{4} \left[\because \sin 2(\omega t + \delta) = \sin 2\delta\right]$$

$$= \frac{kA^2}{4} \quad [k = m\omega^2$$

Average potential energy:

$$P.E_a = \frac{\int_0^T (PE)\,dt}{\int_0^T dT}$$

$$= \frac{kA^2}{2T}\int_0^T \frac{1}{2}\left[1 - \cos 2(\omega t + \delta)\right] dt$$

$$= \frac{kA^2}{4T}\left[\int_0^T dt - \int_0^T \cos 2(\omega t + \delta)\,dt\right]$$

$$= \frac{kA^2}{4T}\left\{[T]_0^T - \left[\frac{\sin 2(\omega t + \delta)}{2\omega}\right]_0^T\right\} = \frac{kA^2}{4}$$

$$\therefore P.E_a = \frac{m\omega^2 A^2}{4}$$

mechanical energy:

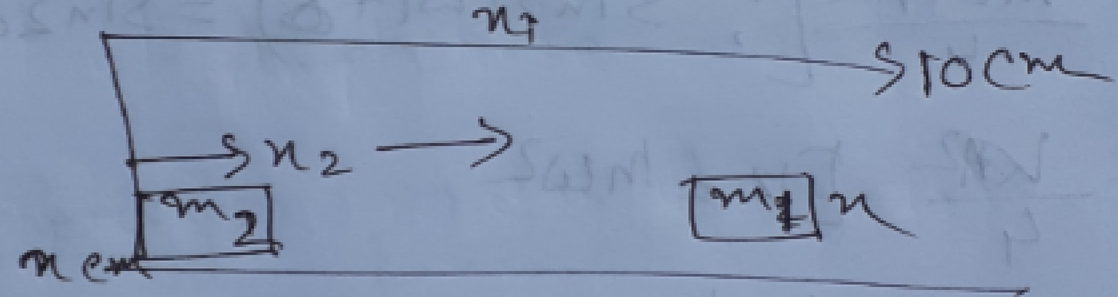
$$\frac{1}{2}m\omega^2 x^2 + \frac{1}{2}m\omega^2(A^2 - x^2)$$

$$= \frac{1}{2}m\omega^2 x^2 + \frac{1}{2}m\omega^2 A^2 - \frac{1}{2}m\omega^2 x^2$$

$$= \frac{1}{2}m\omega^2$$

Two body oscillations:

Two particles m_1 and m_2



$\rightarrow F$ $\quad\leftarrow -F \quad F = -Kx$

$$m_1 \frac{d^2x_1}{dt^2} = Kx \quad \text{--- (1)}$$

$$m_2 \frac{d^2x_2}{dt^2} = -Kx \quad \text{--- (2)}$$

Multiplying (1) m_2 and eqn (2) m_1 we get

$$m_1 m_2 \frac{d^2x_1}{dt^2} = -Km_2 x \quad \text{--- (3)}$$

$$m_1 m_2 \frac{d^2x_2}{dt^2} = -Km_1 x \quad \text{--- (4)}$$

Subtracting (3) − (4) we get

$$m_1 m_2 \frac{d^2x_1}{dt^2} - m_1 m_2 \frac{d^2x_2}{dt^2} = -Km_2x - Km_1x$$

$$\frac{d^2x}{dt^2} + \frac{K}{m}x = 0$$

Combination of simple harmonic oscillation:

$$y_1 = a_1 \sin(\omega t + \phi_1) \quad \text{--- (1)}$$

$$y_2 = a_2 \sin(\omega t + \phi_2) \quad \text{--- (2)}$$

$$y = y_1 + y_2$$

$$= \cancel{a_1 \sin(\omega t + \phi_1)}$$

$$= a_1(\sin\omega t \cos\phi_1 + \cos\omega t \sin\phi_1) +$$
$$a_2(\sin\omega t \cos\phi_1 + \cos\omega t \sin\phi_2)$$

$$= (a_1\cos\phi_1 + a_2\cos\phi_2)\sin\omega t + (a_1\sin\phi_1 + a_2\sin\phi_2)\cos\omega t \quad \text{--- (3)}$$

$$= a_1\cos\phi_1 + a_2\cos\phi_2 = A\cos\phi \quad \text{--- (4)}$$

$$a_1 \sin\Phi_1 + a_2 \sin\Phi_2 = A \sin\Phi \quad \cdots (5)$$

$$y = A\cos\Phi \sin\omega t + A\sin\Phi \cos\omega t$$

$$y = A\sin(\omega t + \Phi) \quad \cdots (6)$$

$(4)^2$ and $(5)^2$ we found

$$a_1^2 (\sin^2\Phi_1 + \cos^2\Phi_1) + a_2^2 \sin^2\Phi_1 + \cos^2\Phi_1) + 2a_1a_2$$
$$\sin\Phi_1 \sin\Phi_2 + \cos\Phi_1 \cdot \cos\Phi_2)$$

Resultant Ampletude

$$\Rightarrow A^2 = a_1^2 + a_2^2 + 2a_1a_2\cos(\Phi_1 - \Phi_2) \quad \cdots (7)$$

$$\tan\Phi = \frac{A\sin\Phi}{A\cos\Phi}$$

$$\tan\Phi = \frac{a_1\sin\Phi_1 + a_2\sin\Phi_2}{a_1\cos\Phi_1 + a_2\cos\Phi_2}$$

$$\Phi = \tan^{-1}\left(\frac{a_1\sin\Phi_2 + a_2\sin\Phi_2}{a_1\cos\Phi_1 + a_2\cos\Phi_2}\right)$$

Same phase:

$$\cos(\phi_1 - \phi_2) = 1 \text{ and}$$

$$A^2 = a_1^2 + a_2^2 + 2a_1a_2$$

$$= (a_1 + a_2)^2$$

$$\therefore A = a_1 + a_2$$

$$\tan\phi = \frac{(a_1+a_2)\sin\phi}{(a_1+a_2)\cos\phi} = \tan\alpha$$

Opposite phase:

$$\cos(\phi_1 - \phi_2) = -1$$

$$A^2 = a_1^2 + a_2^2 - 2a_1a_2$$

$$= (a_1 - a_2)^2 = a_1 - a_2$$

$$A = 2a \text{ and } A^2 = 4a^2$$