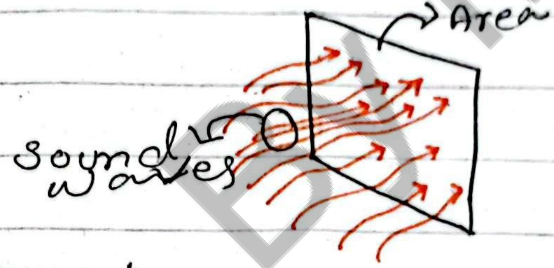
Waves:- → Mechanical / → electromagnetic

- (Disturbance in Medium) -

Stationary Waves Don't Transfer energy
Progressive waves Transfer energy

Intensity Of Waves

Intensity → شدت



$$\text{Intensity} = \frac{\text{Energy}}{\text{Area} \times \text{time}}$$

$$= \frac{\text{Energy}}{\text{time}} \times \frac{1}{\text{Area}} = \frac{J}{S} \times \frac{1}{m^2}$$

$$\text{Intensity} = \frac{\text{Power}}{\text{Area}} = \frac{\text{Watt}}{m^2}$$

∵ Energy = Work

$$\frac{\text{Work}}{\text{time}} = \text{Power}$$

~~Intensity of Sound:-~~

Sound energy passing per second through a unit area held perpendicular to the direction of propogation of sound waves is called in-tensity of sound.

Intensity, amplitude relation

$$\text{Intensity} \propto (\text{Amplitude})^2$$

SI unit :- Wm^{-2}

Intensity $\propto$ Energy (Frequency)

Intensity $\propto \frac{1}{\text{Area}}$

Intensity $\propto \frac{1}{\text{time}}$

Intensity $\propto$ Power

Intensity $\begin{cases} Jm^{-2}s^{-1} \\ Wm^{-2} \end{cases}$

Dimension (1) $Jm^{-2}s^{-1}$

$kg.m^2.s^{-2}$ m^{-2} s^{-1}

$[M][L]^2[T]^{-2}$ $[L]^{-2}$ $[T]^{-1}$

$[ML^2T^{-2}]$ $[L^{-2}]$ $[T^{-1}]$

$[MT^{-3}]$

(2) Wm^{-2}

$kgm^2s^{-2}.s^{-1}$ m^{-2}

kgm^2s^{-3} m^{-2}

kgs^{-3}

$[MT^{-3}]$.

"Doppler's Effect"

Introduction :-

The frequency of the sound we hear gets higher as the vehicle approaches you and lower as it moves away from you.

This phenomenon is one example of Doppler's effect named for Austrian Physicist christian Doppler (1803-1853), who discovered it in 1842

Statement :-

The apparent change in frequency of sound due to the relative motion between the listner and the source of sound is called Dopplers Effect

Explaination :-

In deriving dopplers effect, we assume the air is staitionary and all speed measurements are made relative to this stationary medium

Motion of a source of sound towards an observer increase the rate at which he or she recieves the vibrations The velocity of each vibrations is the speed of sound whether the sound is moving or not, Each vibration from an approaching source has a shorter distance to travel. The wavelength is shortened when the source is moving towards the observer and its lengthened when the source is moving away from the observer. The vibrations are therefore recieved at a higher frequency then they are sent. Similarly, sound waves from a receding source are recieved at a lower frequency then that at which they are sent.

Consider a source of Sound S emitting sound wave of velocity v, frequency f, and wavelength λ. when source S and Listner L are at rest then listner will recieve f number of waves per second, according to relation.

$$v = \lambda f$$

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

CASES :-

The source (s) is moving and listner (L) is at rest

a) when the source is moving towards stationary listner

Since,

$$\Delta\lambda = \lambda - \lambda' \text{ --- } i$$

source has a shorter distance to travel. The wavelength is shortened when the source is moving towards the observer and its lengthened when the source is moving away from the observer. The vibrations are therefore recieved at a higher frequency then they are sent. Similarly, sound waves from a receding source are recieved at a lower frequency then that at which they are sent.

Consider a source of Sound S emitting sound wave of velocity v, frequency f, and wavelength λ. when source S and Listner L are at rest then Listner will recieve f number of waves per second, according to relation.

$$v = \lambda f$$

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

CASES :-

The source (s) is moving and listner (L) is at rest

a) when the source is moving towards stationary listner

Since,

$$\Delta\lambda = \lambda - \lambda' \quad -i$$

i - when the source at rest:-

$$\Rightarrow \lambda = V/f \quad \text{--- ii}$$

ii - when the source moves towards stationary listner:-

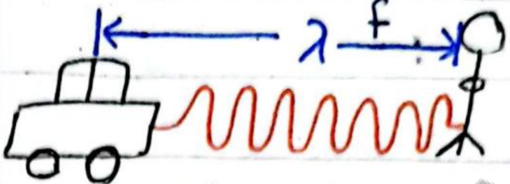
$$\Rightarrow \Delta\lambda = V_s/f$$

Putting eq (ii) and (iii) in eq (i), then

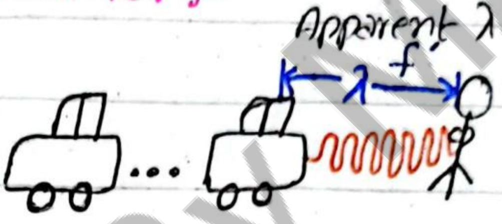
$$\Rightarrow \lambda = V/f - V_s/f$$

$$\lambda = \frac{V - V_s}{f}$$

Rest:-



Motion towards listner:-



Thus, the opponent frequency is changed due to change in wavelength:-

$$f' = \frac{V}{\lambda'}$$

$$f' = \frac{V}{V - V_s / f}$$

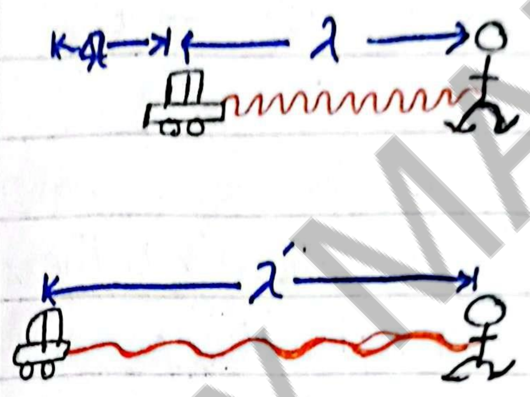
$$f' = \frac{Vf}{V - V_s} \times f$$

$$f' > f$$

Mak Special Tip

- Jab denominator chota ho numerator se tou overall fraction bara ho jaata he. Jis se L.H.S wala caponent R.H.S se bara consider ho ga.

b) When the source is moving away from stationary listner:-



Since,

$$\Delta\lambda = \lambda' - \lambda$$

$$\Delta\lambda + \lambda = \lambda'$$

$$\lambda' = \Delta\lambda + \lambda \quad \text{--- (i)}$$

when the source is at rest :-

$$\boxed{\lambda = \frac{V}{f}} \quad \text{--- (ii)} \qquad \because V = f\lambda$$

when the source moves away from stationary listners:-

$$\Delta\lambda = \frac{V_s}{f} \quad \text{--- (iii)}$$

Putting equation ii) and (iii) in (i)

$$\lambda' = \frac{V_s}{f} + \frac{V}{f}$$

$$\lambda' = \frac{V_s + V}{f} \quad \text{--- (iv)}$$

Thus the apparent frequency changes due to apparent wavelength :-

$$f' = \frac{V}{\lambda'}$$

$$f' = \frac{V}{\frac{V_s + V}{f}}$$

$$f' = \frac{V}{V_s + V} \times f$$

$$f' < f$$

13-NOV-2024

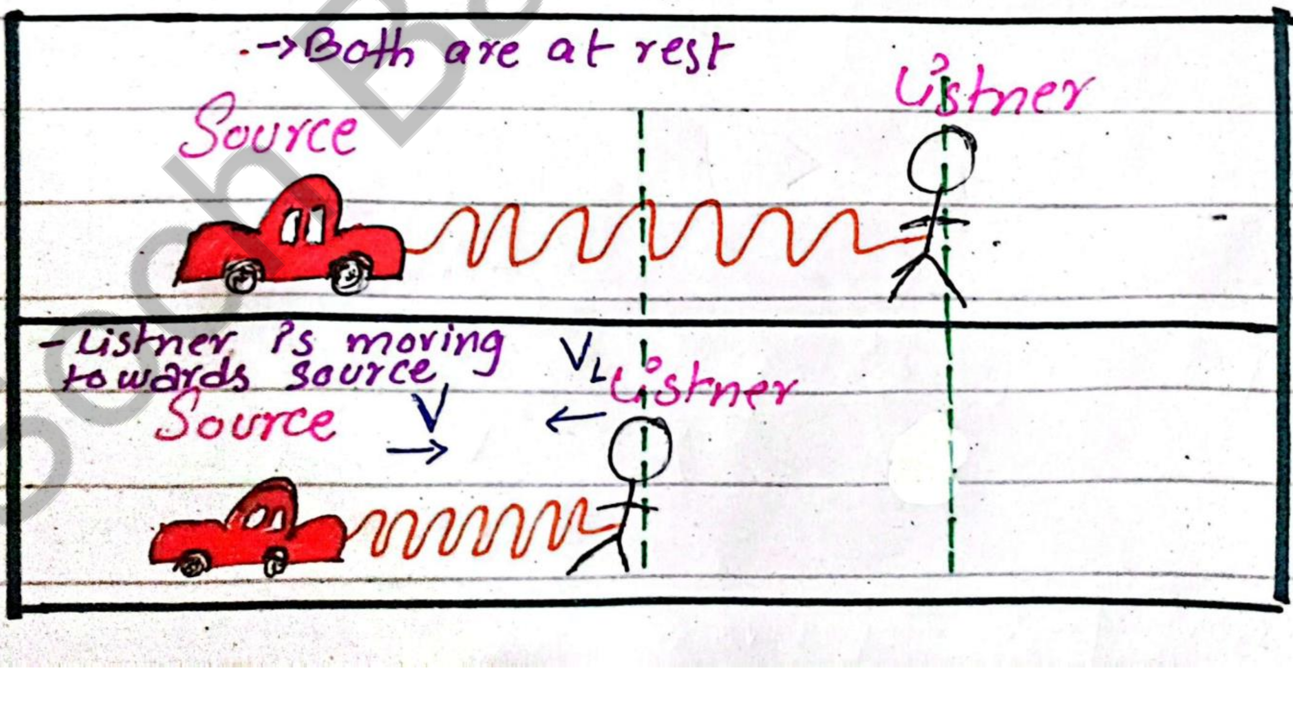
CASE #02

The source is at rest and the listner is moving

a- Listner is moving towards stationary source

$$f' = \frac{V'}{\lambda}$$

Diagramatically,



The apparent frequency (f') is given by:-

$$\Rightarrow f = \frac{v'}{\lambda} \quad \text{— i}$$

where,

$$\boxed{v' = v + v_L} \quad \text{— ii}$$

Putting eq ii in i, then;

$$f' = \frac{v + v_L}{\lambda} \quad \text{— iii}$$

where,

$$\lambda = v/f \quad \text{— iv}$$

Putting eq. iv in iii, then

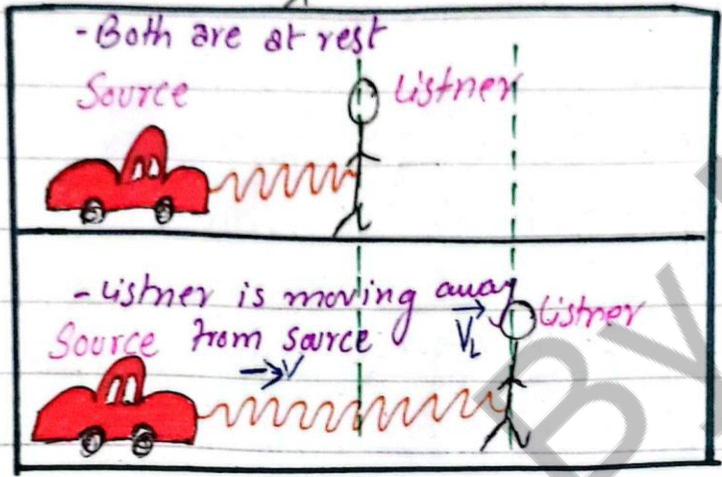
$$\Rightarrow f' = \frac{(v + v_L)}{(v/f)} = \frac{v + v_L}{v} \times f$$

Therefore;

$$f' > f \qquad \text{and} \quad \frac{v + v_L}{v} > 1$$

b- Listner moves away from the stationary Sou...

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



$$V' = V - V_L$$

The apparent frequency is given by:-

$$\Rightarrow f' = \frac{V'}{\lambda} \quad \text{— i}$$

where, the listner is moving away from the stationary source. so, the speed will be given as:-

$$V' = V - V_L \quad \text{— ii}$$

Putting eq ii in eq i then :-

$$\Rightarrow f' = \frac{(V - V_L)}{\lambda}$$

$$\because \lambda = \frac{V}{f}$$

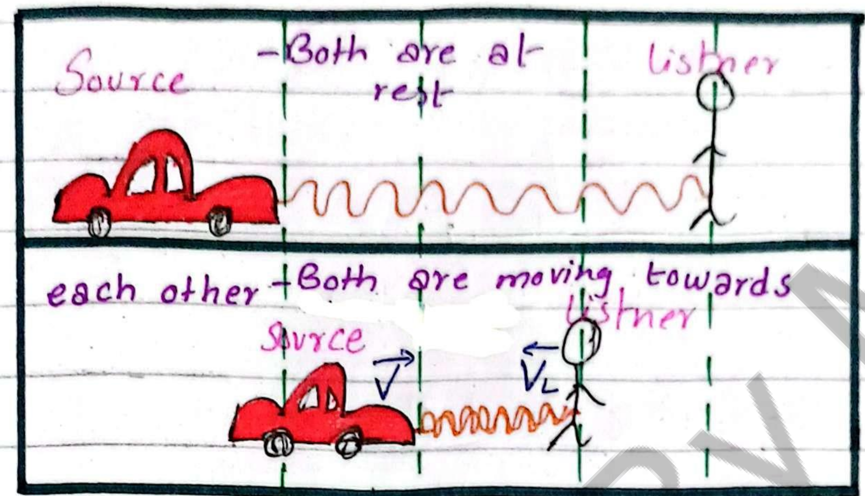
Therefore,
$f' < f$
$\frac{V - V_L}{V} < 1$

Thus,

$$f' = \frac{(V - V_L)}{(V/f)} = \frac{V - V_L}{V} \times f$$

CASE # 03

When the source and listner both will move towards each other :-



$$\lambda' = (V - V_s)/f$$

$$V' = V + V_L$$

The apparent frequency (f') is given as:-

$$f' = \frac{V'}{\lambda'} \quad \text{— i}$$

Since, the source and the listner both are moving towards each other, thus, there will be change in speed as well as in λ which is written as,

$$\Rightarrow \lambda' = \frac{V - V_s}{f} \quad \text{— ii}$$

and,

$$\Rightarrow V' = V + V_L \quad \text{— iii}$$

Putting (ii) and (iii) in (i)

$$\Rightarrow f' = \frac{V + V_L}{V - V_s} \times f$$

Therefore,

$$\frac{V + V_L}{V - V_s} >> 1$$

$$\Rightarrow f'' >> f$$

CASE #04

When the source and listner Both are moving away from each other :-

The apparent frequency (f) is given as :-

$$\Rightarrow \boxed{f' = \frac{V'}{\lambda'}} \quad \text{--- } i$$

Since, the source and the listner both are moving away from each other then;

$$\Rightarrow \lambda' = \frac{V + V_s}{f} \quad \text{--- } ii$$

and,

$$\Rightarrow V' = V - V_L \quad \text{--- } iii$$

Putting eq (ii) and (iii) in eq (i), then

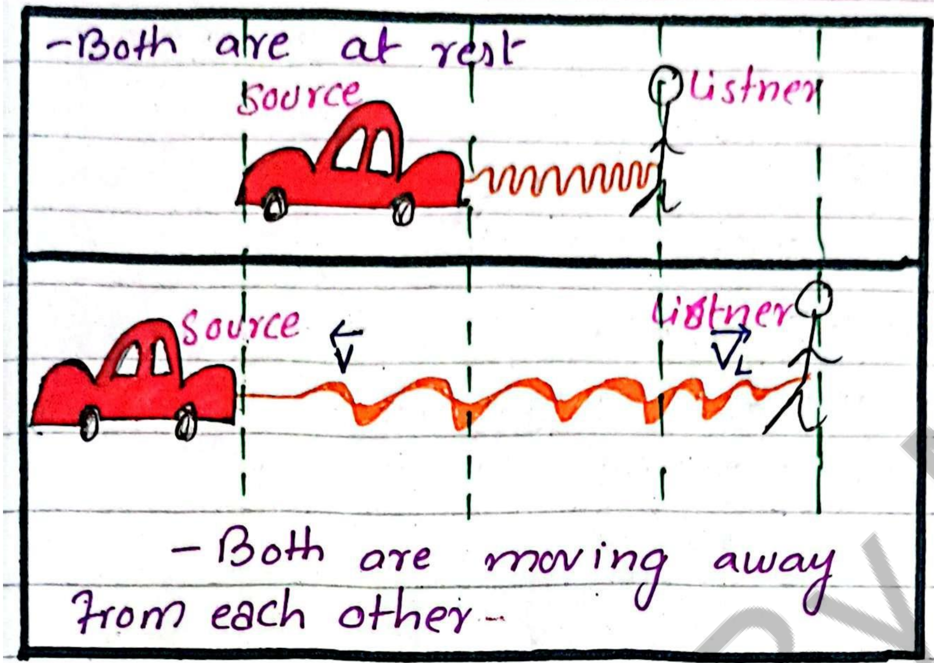
$$\Rightarrow f' = \frac{V - V_L}{\left(\frac{V + V_s}{f}\right)}$$

$$\Rightarrow f' = \frac{V - V_L}{V + V_s} \times f$$

where $\frac{V - V_L}{V + V_s} << 1$

Thus, $\boxed{f' << f}$

Thus, the apparent frequency will decrease when the source and the listner move away from each other.



Applications Of Doppler's Effect

Q: How the dopplers effect help us in phenomenon of Sonars?

Sound Navigation and Ranging System

① helps to detect speed of

① Ships ② Aeroplanes ③ Submarines

When the sound waves are reflected back from the bodies, thier frequency change and Through this Change in frequency we can calculate speed and direction.

→ Velocity of Earths Satilite can be determined through this phenomenon.

→ Aeroplane also uses this system. Radar Systems wave are transmitted all around. If the reflected frequency is decreased then the aeroplane is moving closer and if the frequency inc. then the aeroplane is moving away.

The goal is to make aeroplane invisable to radars. there are 2 methods to do that.

1)- Reflect waves in a direction that they move away from the radar equipment.

2-)- The aeroplane should be made from materials that absorb radar waves.

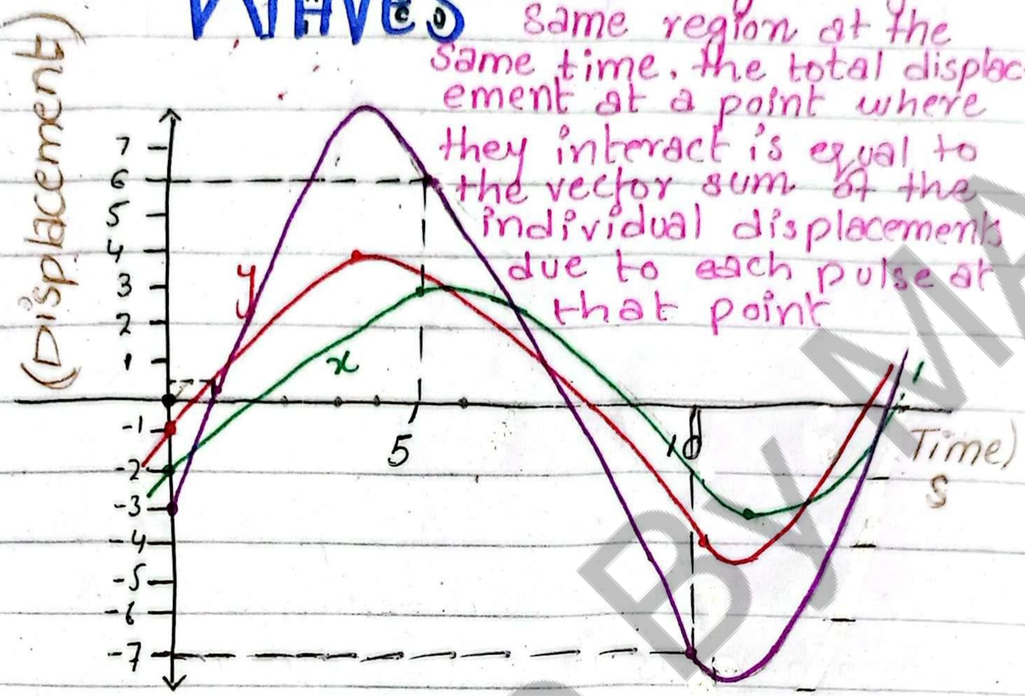
→ Astronomers Research. (movement of Galaxies and Stars)

→ Cardiology (Behavior of arteries & Blood)

Super Position Of Waves

15-Nov-2024

when 2 or more waves are passing throught the same region at the same time, the total displacement at a point where they interact is equal to the vector sum of the individual displacements due to each pulse at that point



At 't = 0' seconds

Net displacement = $x + y$

$Z = x + y$

$Z = (-2) + (-1)$

Therefore the net displacement at 0s = -3m

$\boxed{Z = -3m}$

At 't = 1' second

net displacement $= x + y$

$= -0.8 + 1$

$\boxed{= +0.2m}$

At 't = 5' seconds

Net displacement $= x + y$

$= 3 + 3$

$\boxed{= 6m}$

t = '10' sec

$Z = x + y$

$= (-4) + (-3)$

$\boxed{= -7}$

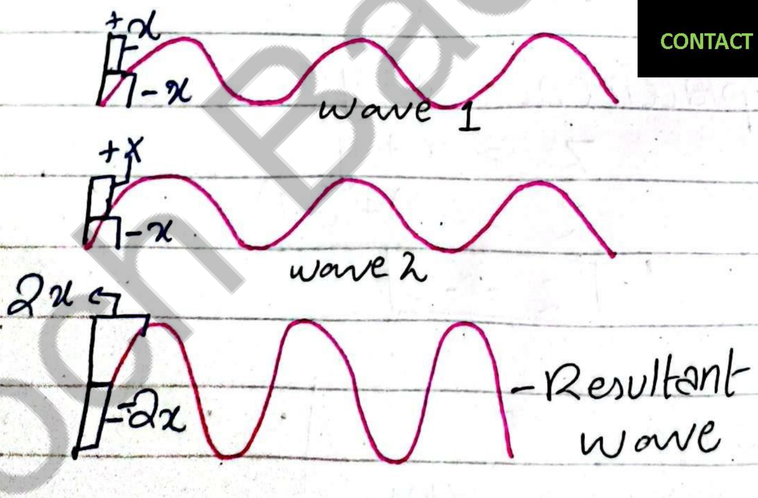
"INTERFERENCE"

The effect produced due to the super-Position of waves from 2 coherent Sources is known as Interference

Two types of Interference

* Constructive Interference

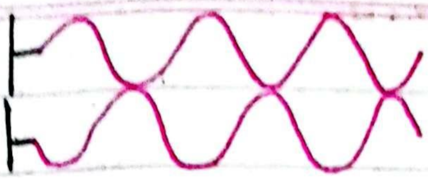
When 2 waves overlap at a point in the same phase then 2 waves reinforce each other. This is called constructive Interference.

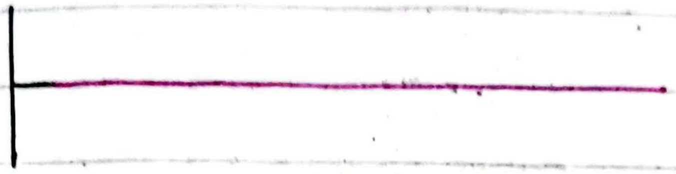


* Destructive Interference

When 2 waves overlap at a point out of phase (180°) then 2 waves cancel each other. This is called Destructive Interference

2452-13





Conditions for Interference

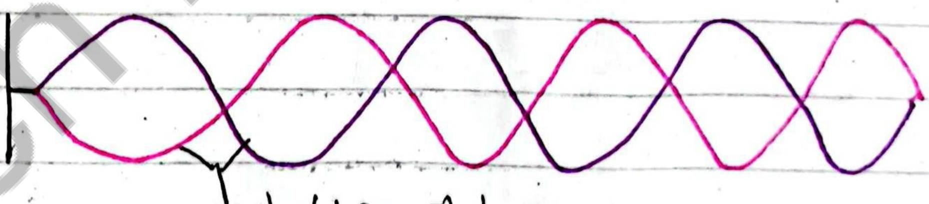
* Same direction of propogation
* Same arrival time
* Phase

1- Constructive Interference

→ In Phase (waves are in phase havin d/f of 0°)

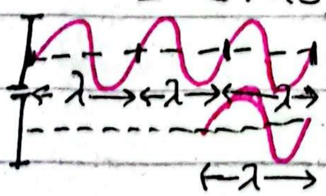
2-D.I (Trough/trough)

→ Out of Phase (Two waves are out of Phase difference 180°)



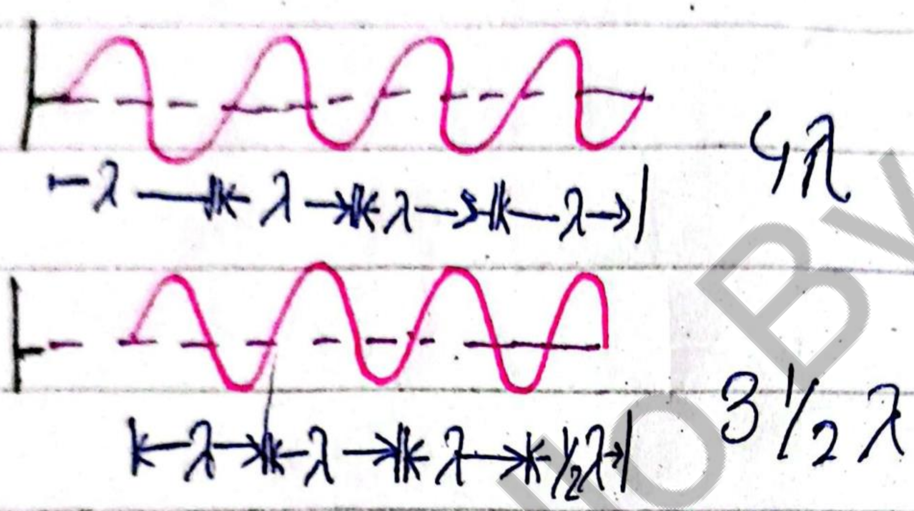
* Path difference

1- Constructive Interference



$P.d = m\lambda$ where $m = 0, 1, 2, \ldots$

Destructive Interference :-



$$P.d = 4\lambda - 3\tfrac{1}{2}\lambda$$

$$= 4\lambda - \tfrac{7}{2}\lambda$$

$$= \frac{8\lambda - 7\lambda}{2}$$

$$= \frac{\lambda}{2}$$

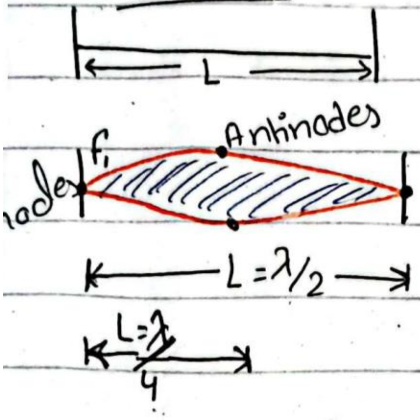
$$\boxed{P.d = \frac{1}{2} \times \lambda}$$

STATIONARY WAVES

- * No Change in speed
- * " " " Amplitude
- * " " " frequency
- * Donot Transfer energy

Stationary Waves In a String

Case 1 → String Plucked from Mid



We Plucked the String from middle then, 2 nodes are formed both ends & the Anti nodes will be formed in the middle

$$L = \frac{\lambda_1}{2} \Rightarrow \lambda_1 = 2L \quad \text{— i}$$

If 'M' is the total mass of string, the speed "V" of wave along the string is:

$$\Rightarrow V = \sqrt{\frac{T \times L}{M}} = \sqrt{\frac{T}{(M/L)}}$$

[T = Tension, L = length, M = mass]

'm' is mass per unit length

$$\Rightarrow m = M/L$$

Therefore $V = \sqrt{\frac{T}{m}}$ — ii

So,

$V = f_1 \lambda_1 \Rightarrow f_1 = V/\lambda_1$

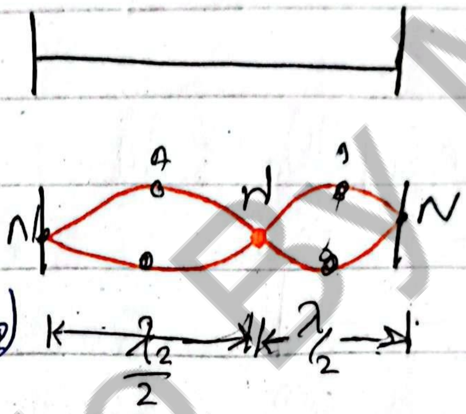
By putting values,

$$f_1 = \frac{1}{2L} \times \sqrt{\frac{T}{m}} \quad \text{(OR)} \quad f_1 = V/2L$$

Here 'f' is called as first harmonic
fundamental frequency (OR) 1st mode of vibration

CASE #02

when the string is plucked from its 1/4 (Quater) length.



$$\Rightarrow L = \frac{\lambda_2}{2} + \frac{\lambda_2}{2}$$

$$L = \lambda_2\left(\frac{1}{2} + \frac{1}{2}\right) = 1(\lambda_2)$$

$$L = \lambda_2$$

from wave eq:

$$\Rightarrow v = f_2 \lambda_2$$

$$\Rightarrow f_2 = \frac{v}{\lambda_2}$$

$$f_2 = \frac{v}{L} \quad \because L = \lambda_2.$$

Multiplying & div by 2

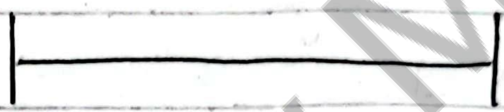
$$f_2 = 2\left(\frac{v}{2L}\right)$$

$$f_2 = 2(f_1)$$

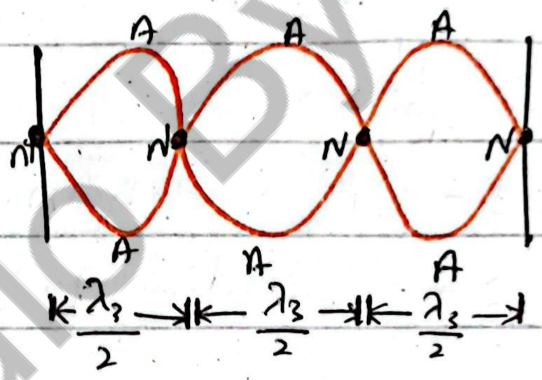
$$\therefore f_2 = 2f_1$$

CASE # 03

when the string is Plucked from its one sixth of its length.



$$\Rightarrow \quad L = \frac{\lambda_3}{2} + \frac{\lambda_3}{2} + \frac{\lambda_3}{2}$$



$$L = \lambda_3 \left(\frac{3}{2}\right)$$

$$L = \lambda_3 \times \frac{3}{2}$$

$$\boxed{\lambda_3 = \frac{2L}{3}}$$

$$V = f_3 \lambda_3$$

$$f_3 = \frac{V}{\lambda_3} = \frac{V}{2L/3} = V \times \frac{3}{2L} = 3\left(\frac{V}{2L}\right)$$

$$f_3 = 3f_1 \qquad \because f_1 = \frac{V}{2L}$$

21 Nov 2024

"STATIONARY WAVES"
"IN AIR COLOUMN"

Standing waves can also be generated in Air coloumns such as organ pipe. There are 2 types of organ pipe

1- Open Organ pipe
2 - Closed organ pipe

Open Organ Pipe

Let a vibrating tuning fork be held at one end of open end pipe of Length L. There are antinodes at both ends with a node at the middle. The modes of vibration in open organ pipe are given below.

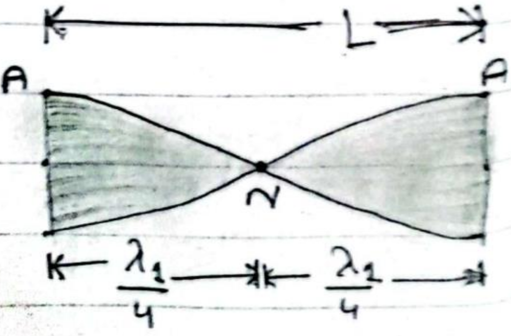
FUNDAMENTAL FREQUENCY :-

Since,

$$\Rightarrow L = \frac{\lambda_1}{4} + \frac{\lambda_1}{4}$$

$$= \frac{\lambda_1}{2}$$

$$\boxed{\lambda_1 = 2L} \text{ — i}$$



Since, wave Speed is given by : $\boxed{v = f_1 \lambda_1}$ — ii

By Putting (ii) in (i)

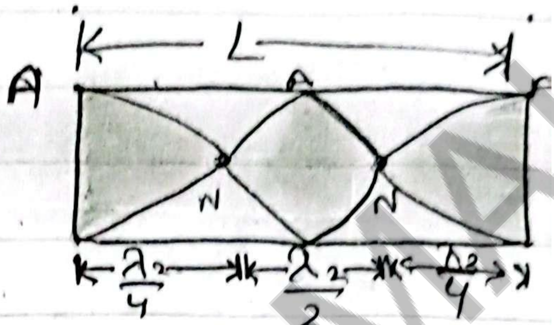
$$v = f_1(2L) \Rightarrow \boxed{f_1 = \frac{v}{2L}}$$

SECOND HARMONIC

Since

$$L = \frac{\lambda_2}{4} + \frac{\lambda_2}{2} + \frac{\lambda_2}{4}$$

$$\boxed{L = \lambda_2} \quad \text{— iii}$$



From wave eq.

$$V = f\lambda$$

$$\boxed{f_2 = \frac{V_2}{\lambda_2}} \quad \text{— iv}$$

Putting iii in iv then,

$$f_2 = \frac{V}{\lambda_2}$$

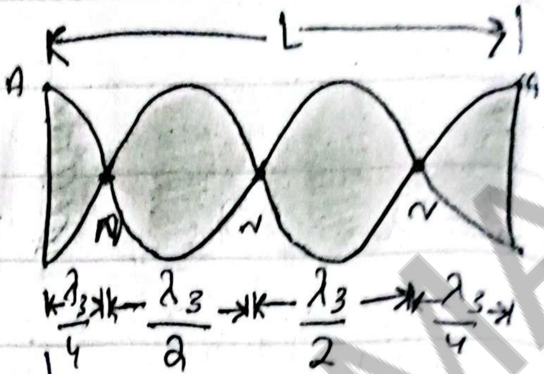
$$f_2 = \frac{V}{L}$$

Multipling and Dividing by 2

$$f_2 = \frac{2V}{2L} \Rightarrow 2\left(\frac{V}{2L}\right)$$

$$\boxed{f_2 = 2f_1}$$

Third Harmonic



Since,

$$L = \frac{\lambda_3}{4} + \frac{\lambda_3}{2} + \frac{\lambda_3}{2} + \frac{\lambda_3}{4}$$

$$L = \lambda_3\left(\frac{1}{4} + \frac{1}{2} + \frac{1}{2} + \frac{1}{4}\right)$$

$$L = \lambda_3\left(\frac{3}{2}\right)$$

$$L = \frac{3\lambda_3}{2}$$

$$\lambda_3 = \frac{2L}{3}$$

As $V = f_3\lambda_3$

$$f_3 = \frac{V}{\lambda_3}$$

$$\lambda_3 = \frac{V}{} \div \frac{2L}{3}$$

$$\lambda_3 = V \times \frac{3}{2L}$$

$$\lambda_3 = 3\left(\frac{V}{2L}\right)$$

$$\lambda_3 = 3\lambda_1$$

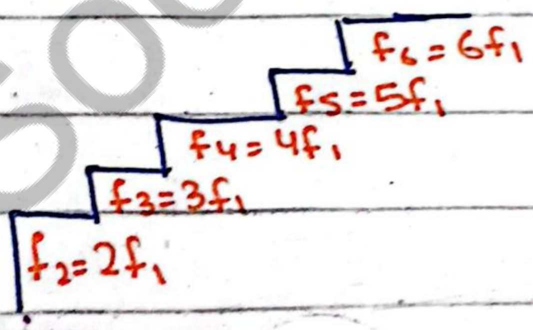
Hence We Can Conclude That :—

$$\lambda_n = \frac{2L}{n}$$

$$f_n = nf_1$$

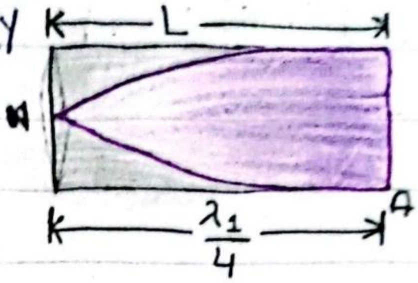
$$f_2 = 2f_1$$
$$f_3 = 3f_1$$
$$f_4 = 4f_1$$
$$\vdots \qquad \vdots$$
$$f_n = nf_1$$

The values of frequency are Quantized.



Closed Organ Pipe

"Fundamental frequency"



Since,

$$\Rightarrow L = \frac{\lambda_1}{4}$$

$$\Rightarrow \boxed{4L = \lambda_1} \text{ — i}$$

As, wave equation is given as:-

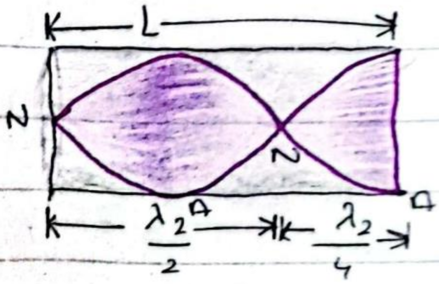
$$V = f_1 \lambda_1$$

$$f_1 = \frac{V}{\lambda_1} \text{ — ii}$$

Putting the value of i in ii

$$f_1 = \frac{V}{4L}$$

"Second Hormonic"



Since,

$$\Rightarrow L = \frac{\lambda_2}{2} + \frac{\lambda_2}{4}$$

$$\Rightarrow L = \frac{3\lambda_2}{4} \Rightarrow \boxed{\lambda_2 = \frac{4L}{3}} \text{ — i}$$

from wave equation

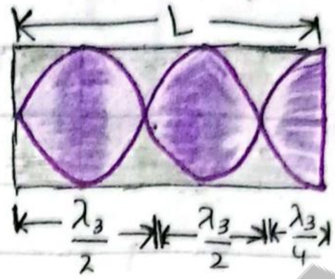
$$V = f_2 \lambda_2 \Rightarrow \boxed{f_2 = \frac{V}{\lambda_2}} \text{ — ii}$$

By Putting values in (ii)

$$f_2 = V \times \frac{3}{4L} = \left(\frac{V}{4L}\right)3 \quad \because f_1 = \frac{V}{4L}$$

$$f_2 = 3f_1$$

"Third Harmonic"



Since,

$$\Rightarrow L = \frac{\lambda_3}{2} + \frac{\lambda_3}{2} + \frac{\lambda_3}{4}$$

$$\Rightarrow L = \frac{5\lambda_3}{4} \Rightarrow \lambda_3 = \frac{4L}{5} \quad \text{— i}$$

From Wave Equation

$$\Rightarrow V = \lambda_3 f_3 \Rightarrow f_3 = \frac{V}{\lambda_3} \quad \text{— ii}$$

By Putting Values of i in ii

$$f_3 = V \times \frac{5}{4L}$$

$$f_3 = 5\left(\frac{V}{4L}\right)$$

$$\boxed{f_3 = 5f_1}$$

So, we conclude that,

$$\Rightarrow f_1 = \frac{V}{4L}$$

$$\Rightarrow f_2 = 3\left(\frac{V}{4L}\right)$$

$$\Rightarrow f_3 = 5\left(\frac{V}{4L}\right)$$

$$\Rightarrow f_4 = 7\left(\frac{V}{4L}\right)$$

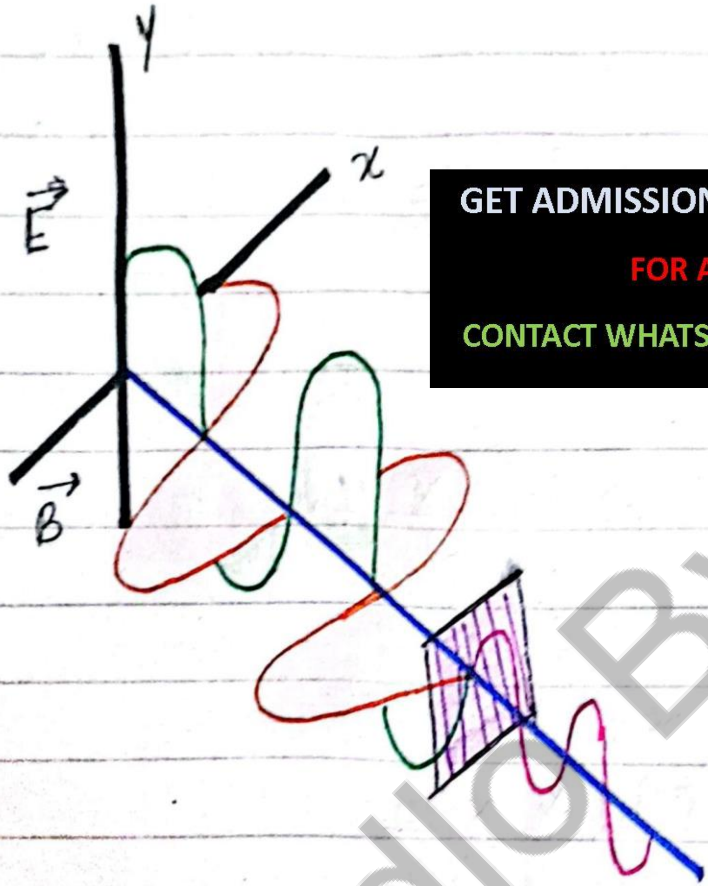
$$\Rightarrow f_5 = 9\left(\frac{V}{4L}\right)$$

$$\boxed{f_n = (2n-1)f_1}$$

(OR)

$$\boxed{f_n = (2n-1) \times \frac{V}{4L}}$$

"POLARIZATION"



'Polarization by reflection'

Unpolarized light can also be polarized by reflection from non-metallic surfaces like glass, water etc.

The ammount to which polarization occurs is dependent upon the angle at which the light incident to the surface and material of the surface.

Note that:- Metallic Surfaces reflect light with a variety of vibrational directions, such light is unpolarized.

Explaination

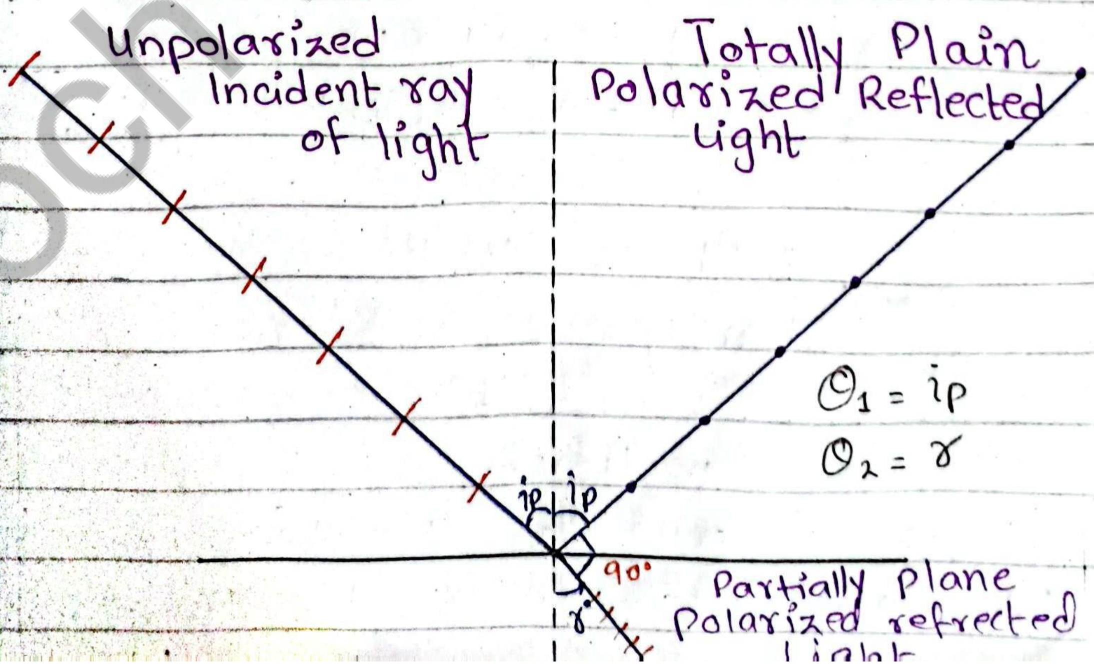
When unpolorized light falls on glass/water the reflected light wave is in general partially plane polarized but at a certain angle of incidence called Polarizing Angle.

The polarization is completed at this angle. The reflected and refracted ray in the transmitted medium are found to be at right angle to each other.

'Mathematical Explaination'

By applying snell's law:-

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \quad \text{--- } (x)$$



By putting values in eq(x) then,

$$\Rightarrow n_1 \sin(ip) = n_2 \sin(r) \text{ — (i)}$$

Since, $ip + 90^\circ + r = 180^\circ$

$$r = 180^\circ - ip - 90^\circ$$

$$r = 90^\circ - ip \text{ — (ii)}$$

Putting eq(ii) in (i) then,

From trignometry,

$$\sin(\alpha - \beta) = \sin\alpha \cos\beta - \cos\alpha \sin\beta$$

$$\sin(90 - ip) = \sin(90)\cos(ip) - \cos(90)\sin(ip)$$

$$\sin(90 - ip) = 1(\cos(ip)) - 0(\sin(ip))$$

$$\sin(90 - ip) = \cos(ip)$$

From eq(i)

$$n_1 \sin(ip) = n_2 \sin(r)$$

$$n_1 \sin(ip) = n_2 \cos(ip)$$

$$\frac{n_2}{n_1} = \frac{\sin(ip)}{\cos(ip)}$$

$$\tan(ip) = \frac{n_2}{n_1}$$

Conclusion

This is known as Brewster's law

For glass refractive index is 1.55, the

angle of incidence should be 57°.

Uses of Polaroids :-

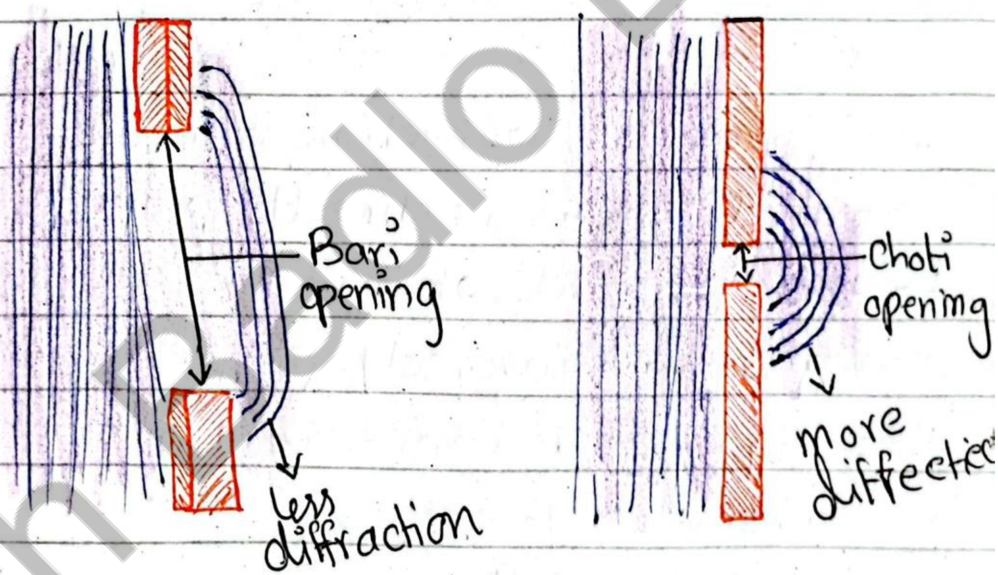
→ To make art asthetic or beautiful

→ Photography

→ Stress Analysis

(ROY GBIV, VIBGYOR) → d/f directio

"DIFFRACTION"



* Shadi Wali Example

* Political Parties ki Example

The Bending of waves around Sharp edges or corners of an obstacle (or slits) & Spreading into its geometrical Shadow is called diffraction