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Sem - 2 / MJC-2 (CT) / Unit - 3 / Sub - physics
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Topic : Interference :— The modification of intensity due to the superimposition/ superposition of ~~the~~ waves is known as interference of waves.

Equation of interference :— Now, consider on the superposition of two waves having same frequency but different in phase.

let y_1 and y_2 are the displacements of two waves and then it is expressed as

$$y_1 = a_1 \cos \omega t \quad \text{—— (1)}$$

$$y_2 = a_2 \cos(\omega t - \delta) \quad \text{—— (2)}$$

where δ is the phase difference between two waves.

If x_1 and x_2 are path lengths, then the superposed phase difference (δ) is given by,

$$\delta = \frac{2\pi}{\lambda}(x_2 - x_1) \quad \text{—— (3)}$$

Now, ~~the~~ from principle of superposition of waves, the resultant displacement is given by

$$Y = y_1 + y_2 = a_1 \cos \omega t + a_2 \cos(\omega t - \delta)$$

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

$$\therefore Y = A \cos(\omega t - \phi) \quad \text{—— (4)}$$

where, $A \cos\phi = a_1 + a_2 \cos\delta$

$A \sin\phi = a_2 \sin\delta$

$$\therefore A^2 = a_1^2 + a_2^2 + 2a_1 a_2 \cos\delta \quad \text{—— (5)}$$

The equation (4) and (5) shows the resultant displacement and amplitude of two harmonic waves.

The resultant intensity of two waves are given by

$$I^2 = A^2 = a_1^2 + a_2^2 + 2a_1a_2\cos\delta \quad \text{—(6)}$$

The individual intensities of two waves are $I_1 = a_1^2$ and $I_2 = a^2$.
The term $2a_1a_2$ are called interference term.

The constructive interference is given by

$$I_{max.} = (a_1 + a_2)^2 \quad \text{——} \quad (7)$$

similarly, destructive interference is given by

$$I_{min.} = (a_1 - a_2)^2 \quad \text{——} \quad (8)$$

If the amplitude of the intereing waves are becomes $a_1 = a_2 = a$ (say) then, the resultant intensity is given by

$$I = a^2 + a^2 + 2a^2\cos\delta$$
$$= 2a^2 + 2a^2\cos\delta$$
$$= 2a(1 + \cos\delta)$$

$$\therefore I = 2a^2(1 + \cos\delta) = 4a^2\cos^2\delta/2 \quad \text{—(9)}$$

This is the required equation of interference.