Interference of Sound Waves.

When two waves of same frequency, same wavelength, same velocity (nearly equal amplitude) moves in the same direction, their superimposition results in the interference. Due to interference the resultant intensity of sound at that point is different from the sum of intensities due to each wave separately. This modification of intensity due to superposition of two or more waves is called interference.

Let at a given point two waves arrives with phase difference ϕ and the equation of these waves is given by

y1 = a1 sin ωt, y2 = a2 sin ($\omega t+\phi$) then by the principle of superposition

$\vec{y}=\vec{y}_1+\vec{y}_2$ · y = A sin $(\omega t+\theta)$ where $A=\sqrt{a_1{}^2+a_2{}^2+2a_1a_2\cos\phi}$ and tan θ = $\dfrac{a_2\sin\phi}{a_1+a_2\cos\ \phi}$

and since Intensity $\propto A^2$.

So I = $a_1{}^2+a_2{}^2+2a_1,a_2\cos\phi \Rightarrow I=I_1+I_2+2\sqrt{I_1I_2}\cos\phi$

Important points

(1) Constructive interference: Intensity will be maximum

When $\phi=0,2\pi,4\pi,......\ 2\pi n$; where n = 0,1,2 ....

When x = 0, · , 2 · , ... n · ; where n = 0, 1 ....

Imax = I1 + I2 + $2\sqrt{I_1I_2}$ = $\left(\sqrt{I_1}+\sqrt{I_2}\right)^2\propto(A_1+A_2)^2$

It means the intensity will be maximum at those points where path difference is an integral multiple of wavelength λ. these points are called points of constructive interference or interference maxima.

(2) Destructive interference: Intensity will be minimum

When $\phi=\pi,3\pi,5\pi......\ (2n-1)\pi$; where n= 1, 2, 3 ....

When x = · /2, 3 · /2, ... (2n-1) · · · ; where n = 1, 2, 3........

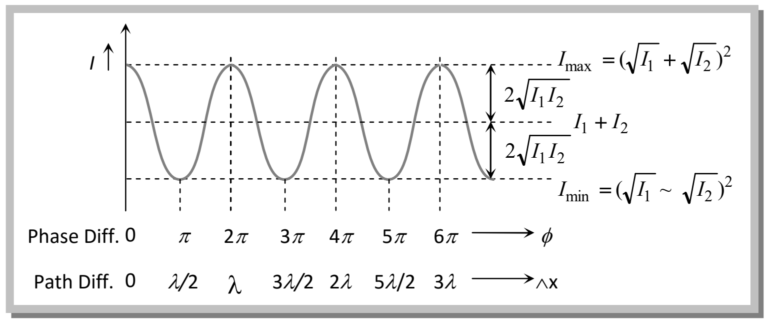
Imin = I1+I2 – 2 $\sqrt{I_1I_2}$ · Imin = $\left(\sqrt{I_1}-\sqrt{I_2}\right)^2\propto(A_1\sim A_2)^2$

(3) All maxima are equally spaced and equally loud. Same is also true for minima. Also interference maxima and minima are alternate as for maximum $\Delta x = 0, \lambda, 2\lambda ....etc.$ and for minimum $\Delta x = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2} .... \, etc$.

(4)

$$\frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{I_1} + \sqrt{I_2}\right)^2}{\left(\sqrt{I_1} \sim \sqrt{I_2}\right)^2} = \frac{(A_1 + A_2)^2}{(A_1 \sim A_2)^2} \text{ with } \frac{I_1}{I_2} = \frac{A_1{}^2}{A_2{}^2}$$

(5) If $I_1 = I_2 = I_0$ then Imax = $4I_o$ and Imin = 0



(6) In interference the intensity in maximum $\left(\sqrt{I_1} + \sqrt{I_2}\right)^2$ exceeds the sum of individual intensities (I1 + I2) by an amount $2\sqrt{I_1 I_2}$ while in minima $\left(\sqrt{I_1} \sim \sqrt{I_2}\right)^2$ lacks $(I_1 + I_2)$ by the same amount $2\sqrt{I_1 I_2}$.

Hence in interference energy is neither created nor destroyed but is redistributed.