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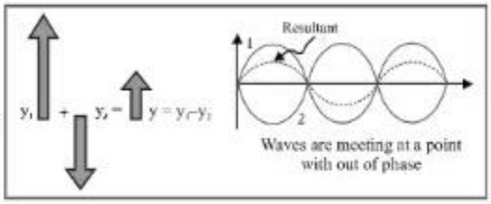
Class 12Sc Sub Physics(Unit 06) Dt 23 09 XX

(ii)



3.2 Phase/Phase difference/Path difference/Time difference

(i) Phase : The argument of sine or cosine in the expression for displacement of a wave is defined as the phase. For displacement $y = a \sin \omega t$; term ωt = phase or instantaneous phase

(ii) Phase difference (ϕ) : The difference between the phases of two waves at a point is called phase difference *i.e.* if $_1 = a_1 \sin \omega t$ and $y_2 = a_2 \sin(\omega t + \phi)$ so phase difference $= \phi$

(iii) Path difference (Δ) : The difference in path length's of two waves meeting at a point is called path difference between the waves at that point. Also $\Delta = \frac{\lambda}{2\pi} \times \phi$

(iv) Time difference (*T.D.*) : Time difference between the waves meeting at a point is $T.D. = \frac{T}{2\pi} \times \phi$

3.3 Resultant amplitude and intensity

If suppose we have two waves $y_1 = a_1 \sin \omega t$ & $y_2 = a_2 \sin(\omega t + \phi)$; where a_1, a_2 = Individual amplitudes, ϕ = Phase difference between the waves at an instant when they are meeting a point. I_1, I_2 = Intensities of individual waves

Resultant amplitude : After superimposition of the given waves resultant amplitude (or the amplitude of resultant wave) is given by $A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\phi}$

For the interfering waves $y_1 = a_1 \sin\omega t$ and $y_2 = a_2 \cos\omega t$, Phase difference between them is 90°. So resultant amplitude

$A = \sqrt{a_1^2 + a_2^2}$

Resultant intensity : As we know intensity $\propto$ (Amplitude)^2

$\Rightarrow I_1 = ka_1^2, I_2 = ka_2^2$ and $I = kA^2$ (k is a proportionality constant). Hence from the formula of resultant amplitude, we get the following formula of resultant intensity

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

The term $2\sqrt{I_1 I_2}\cos\phi$ is called interference term. For incoherent interference this term is zero so resultant intensity $I = I_1 + I_2$.

3.4 Coherent sources

The sources of light which emits continuous light waves of the same wavelength, same frequency and in same phase or having a constant phase difference are called coherent sources.

4. INTERFERENCE OF LIGHT

When two waves of exactly same frequency (coming from two coherent sources) travels in a medium, in the same direction simultaneously then due to their superposition, at some points intensity of light is maximum while at some other points intensity is minimum. This phenomenon is called Interference of light.

4.1 Types of Interference

Constructive interference	Destructive interference
(i) When the waves meets a point with same phase, constructive interference is obtained at that point (*i.e.* maximum light)	(i) When the wave meets a point with opposite phase, destructive interference is obtained at that point (*i.e.* minimum light)
(ii) Phase difference between the waves at the point of observation $\phi = 0°$ or $2n\pi$	(ii) $\phi = 180°$ or $(2n-1)\pi$; $n = 1, 2, ...$ or $(2n+1)\pi$; $n = 0, 1, 2, ...$
(iii) Path difference between the waves at the point of observation $\Delta = n\lambda$ (*i.e.* even multiple of $\lambda/2$)	(iii) $\Delta = (2n-1)\frac{\lambda}{2}$ (*i.e.* odd multiple of $\lambda/2$)
(iv) Resultant amplitude at the point of observation will be maximum $a_1 = a_2 \quad \Rightarrow A_{min} = 0$ If $a_1 = a_2 = a_0 \quad \Rightarrow A_{max} = 2a_0$	(iv) Resultant amplitude at the point of observation will be minimum $A_{min} = a_1 - a_2$ If $a_1 = a_2 \Rightarrow A_{min} = 0$
(v) Resultant intensity at the point of observation will be maximum $I_{max} = I_1 + I_2 + 2\sqrt{I_1 I_2} \quad I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$ If $I_1 = I_2 = I_0 \Rightarrow I_{max} = 2I_0$	(v) Resultant intensity at the point of observation will be minimum $I_{min} = I_1 + I_2 - 2\sqrt{I_1 I_2} \quad I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$ If $I_1 = I_2 = I_0 \Rightarrow I_{min} = 0$