$I = A^2$

Date:
Page:

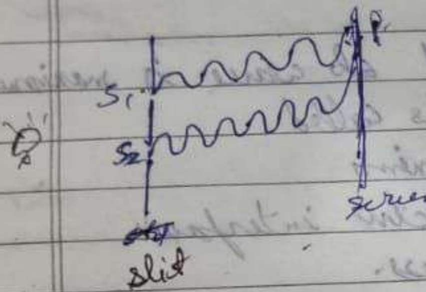
$y = a\cos\omega t + a\cos\omega t$

$y = 2a\cos\omega t$ $\{2a = \text{Amplitude}\}$

$I = (2a)^2$

$= 4a^2$

$= 4I_0$



$S_2P - S_1P = 6\lambda - 4\lambda$ $6\lambda - 4\lambda$

Path diff $= 2\lambda$

Phase diff $= 4\pi$

$y_1 = a\cos\omega t$

$y_2 = a\cos(\omega t + 4\pi)$

$y_2 = a\cos\omega t$

$y = y_1 + y_2$

$= a\cos\omega t + a\cos\omega t$

$= 2a\cos\omega t$

$I = (2a)^2$

$= 4a^2$

$\cancel{= 4I_0}$ $= 4I_0$

Path difference, λ, 2λ, 3λ ... $n\lambda$
and phase difference, 2π, 4π, 6π ... $2n\pi$

$I = 4I_0$

Intensity is maximum

So,

Path diff $= n\lambda$

where $n = 0, 1, 2, 3$

Phase diff $= 2n\pi$, where $n = 0, 1, 2, 3$.

Intensity of resultant wave is maximum

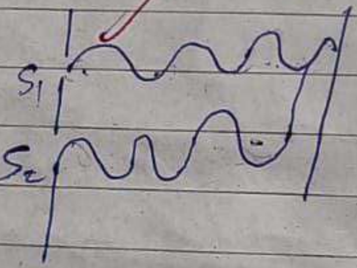
So, above condition is called

→ Condition of maxima

→ Condition of constructive ~~interfere~~ interference

→ condition of brightness.

Minima



$S_2P - S_1P = \frac{7\lambda}{2} - 3\lambda$

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

Phase diff $= \pi$

$y_1 = a\cos\omega t$

$y_2 = a\cos(\omega t + \pi)$

$y_2 = -a\cos\omega t$

$$\frac{d\nu}{\nu} = \frac{-d\lambda}{\lambda}$$

$$\boxed{\frac{\Delta \nu}{\nu} = \frac{-\Delta\lambda}{\lambda}}$$

Doppler shift can be expressed as

$$\boxed{\frac{\Delta \nu}{\nu} = \frac{-v_{radial}}{c}}$$

Combining

$$\boxed{\frac{\Delta \nu}{\nu} = \frac{-\Delta\lambda}{\lambda} = \frac{-v_{radial}}{c}}$$

v_{radial} is component of source velocity along the line joining observer to source relative to observer.

Coherent And Incoherent Addition of Waves

maxima,

$S_2P - S_1P = 6\lambda - 5\lambda$

Path diff $= \lambda$

Phase difference $= 2\pi$

$y_1 = a\cos\omega t$, $I_0 = a^2$

$y_2 = a\cos(\omega t + 2\pi)$, $I_0 = a^2$

$y_2 = a\cos\omega t$

$y = y_1 + y_2$

Phase diff $\pi, 3\pi, 5\pi$ ---

or Path diff $= (n + \frac{1}{2})\lambda$, where $n = 0, 1, 2, \ldots$

Phase diff $= (2n+1)\pi$, when $n = 0, 1, 2, \ldots$

Thus intensity of resultant wave is minimum that $I = 0$. Above condition is called
condition of minima interference
condition of destructive interference
condition of darkness

Obtain the condition for destructive and constructive interference.

$$y_1 = a\cos\omega t$$

$$y_2 = a\cos(\omega t + \phi)$$

$$y = y_1 + y_2$$

$$= a\cos\omega t + a\cos(\omega t + \phi)$$

$$= a2\cos\phi/2 \; \cos(\omega t + \phi/2)$$

$$y = 2a\cos\phi/2 \; \cos(\omega t + \phi/2)$$

$$I = (2a\cos\phi/2)^2$$

$$I = 4a^2\cos^2\phi/2$$

$$I = 4I_0\cos^2\phi/2$$

$$\boxed{I_{max} = 4I_0, \text{ when } \phi = 2n\pi \text{ or Path diff} = n\lambda}$$

Date:
Page:

where $n = 0, 1, 2, 3 \ldots$

I_{min}, where $\phi = (2n+1)\pi$

Path diff $= (n+\frac{1}{2})\lambda$

where $n = 0, 1, 2, \ldots$

Cof CO ~~Maxima~~ Minima, CO distructive interference, CO darkness

This condition hold law of construction of energy.

When two wave travelling in same direction with constant phase difference superimpose with each other redistribution of energy takes place at some points intensity is maximum these points are called point of constructive energy. At some other points intensity is minimum these are called points of distructive energy. This phenomenon is called principle of superposition or Interference.

Conditions of ~~Interferance~~ Interference.

Coherent

Sources must be coherent i.e. phase diff. btw two interfering waves must be constant.

A source is said to be coherent if it produces waves having constant phase difference. ~~Eg~~ LASER is a complete coherent source. Colored soap bubble. CD appears colored.

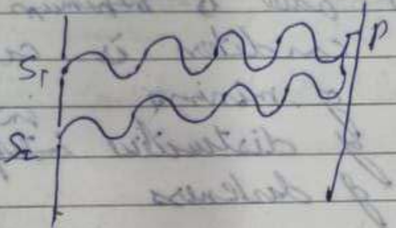
Date:
Page:

$y = y_1 + y_2$

$= a\cos\omega t + (-a\cos\omega t)$

$y = 0$

$I = 0$



$S_2P - S_1P = \cancel{4.5\lambda - 3\lambda}$

$= 1.5\lambda$

Path diff $= \frac{3\lambda}{2}$

Phase diff $= 3\pi$

$y_1 = a\cos\omega t$

$y_2 = a\cos(\omega t + 3\pi)$

or $y_2 = -a\cos(\omega t)$

$y = y_1 + y_2$

$= a\cos\omega t + (-a\cos\omega t)$

$y = 0$

$I = 0$

Thus we see that

Path diff $\frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}$ - - - -

$$(S_2P)^2 - (S_1P)^2 = D^2 + \left(x_n + \frac{d}{2}\right)^2 - \left[D^2 + \left(x_n - \frac{d}{2}\right)^2\right]$$

$$= \cancel{D^2} + \cancel{x_n^2} + \cancel{\frac{d^2}{4}} + x_n d - \cancel{D^2} - \cancel{x_n^2} - \cancel{\frac{d^2}{4}} + x_n d$$

$$(S_2P)^2 - (S_1P)^2 = 2x_n d$$

$$(S_2P - S_1P)(S_2P + S_1P) = \frac{2x_n d}{\cancel{(S_2P + S_1P)}}$$

$$S_2P - S_1P = \frac{2x_n d}{(S_2P + S_1P)}$$

If we introduce

$$S_2P + S_1P \approx 2D$$

Then there is negligible small error in the calculation. So, $S_2P - S_1P = \frac{2x_n d}{2D}$

$$\boxed{S_2P - S_1P = \frac{x_n d}{D}}$$

Position of bright fringe.

$$S_2P - S_1P = n\lambda$$

$$\frac{x_n d}{D} = n\lambda$$

$$\boxed{x_n = \frac{nD\lambda}{d}}$$

This is position of ~~the~~ n^{th} bright fring from the centre of screen

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Date:
Page:

Width of ~~dark~~ bright fringe (Fringe)

$$\cancel{\beta = x_{n+}}$$

$$\beta = x_{n+1} - x_n$$

$$= (n+1)\frac{D\lambda}{d} - \frac{nD\lambda}{d}$$

$$= \frac{nD\lambda}{d} + \frac{D\lambda}{d} - \frac{nD\lambda}{d}$$

$$\boxed{\beta = \frac{D\lambda}{d}}$$

$$\beta = \frac{D\lambda}{d\mu}$$ If whole apparatus is placed in the medium refractive index μ

Position ~~width~~ of dark fringes

$$S_2P - S_1P = \left(n+\frac{1}{2}\right)\lambda$$

$$\frac{x_n d}{D} = \left(n+\frac{1}{2}\right)\lambda$$

$$\boxed{x_n = \left(n+\frac{1}{2}\right)\frac{D\lambda}{d}}$$

Width of ~~bright~~ dark fringe

$$\beta = x_{n+1} - x_n$$

$$= \left(n+1+\frac{1}{2}\right)\frac{D\lambda}{d} - \left(n+\frac{1}{2}\right)\frac{D\lambda}{d}$$

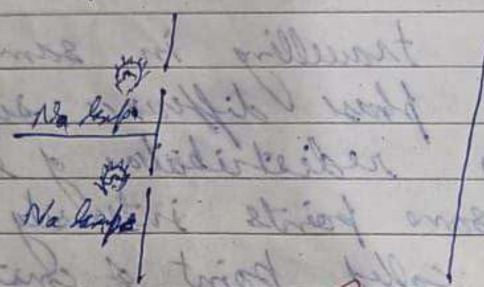
Date:
Page:

(ii) Light should be monochromatic that is frequency should be constant.

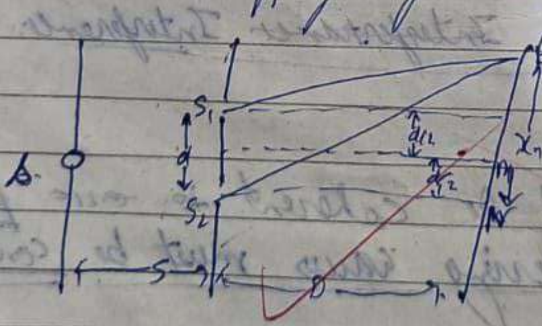
(iii) If two interfering beams (waves) are polarised there state of polarisation must be same.

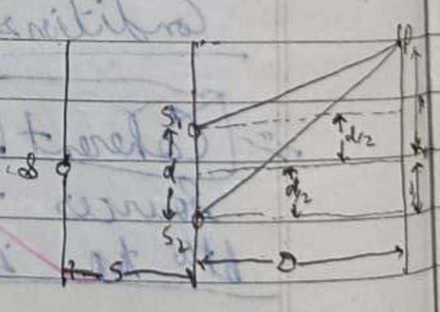
Interference of Light Waves Young's experiment

Two independent light sources cannot produce interference



Light waves emitted from ordinary source like sodium lamp undergoes abrupt phase change in time of order of 10^{-10} sec. Therefore ~~uniform illumination~~ illumination is observed due to overlapping of maximas & minimas.





Condition of Interference.

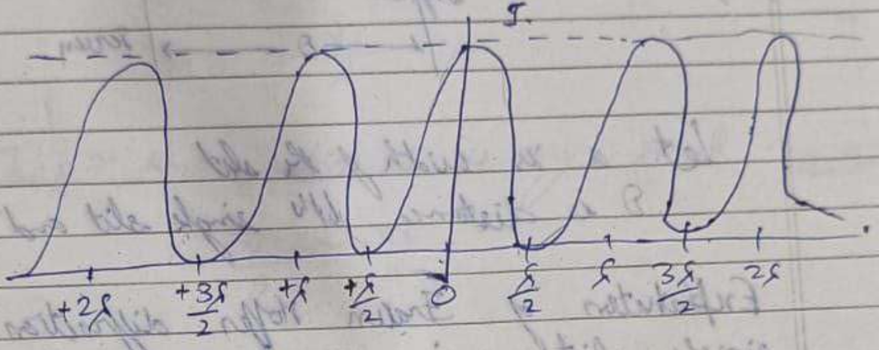
$$\frac{\Delta}{S} < \frac{\lambda}{d}$$

Date:

Page:

$$= \left(x + 1 + \frac{\lambda}{2} - x - \frac{\lambda}{2}\right)\frac{D\lambda}{d}$$

$$\boxed{\beta = \frac{D\lambda}{d}}$$



Intensity distribution in young's double slit experiment

Diffraction :-

Bending of light from obstacle or aperture into its geometrical shadow is called diffraction.

Condition of Diffraction.

When order of wavelength of light is equal to order of size of obstacle

Diffraction due to single slit →