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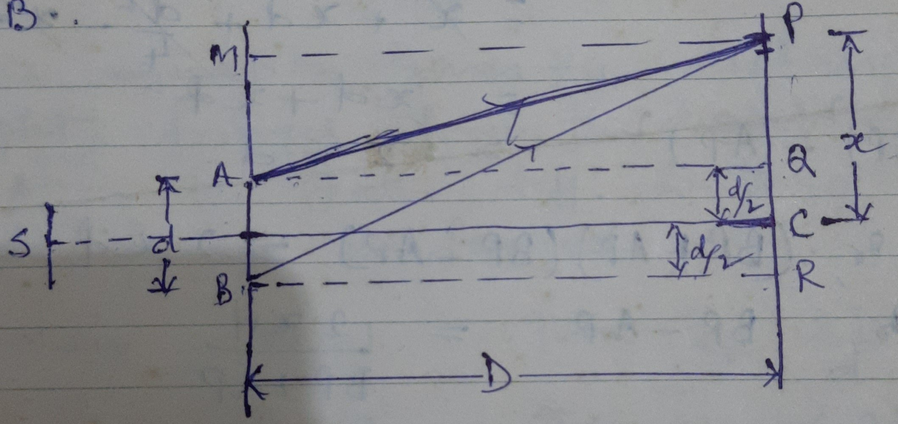
Date :

Theory of Interference fringes:—

Let us consider a narrow monochromatic source S and two pinholes A and B which is equidistant from S. A and B act as two coherent sources seperated by a distance d. Let a screen be placed at a distance D from the coherent sources.
The point C on the screen is equidistant from A and B.



Therefore, the path difference between the two waves is zero. This means the point C has max^{m} intensity

1 Now consider a point P at a distance x from C. The waves reach at the point P from A & B.

Here $PQ = PC - QC = x - \frac{d}{2}$

$PR = PC + CR = x + d/2$

MB=PR

Now, In ΔMPB

$(BP)^2 = (MP)^2 + (MB)^2$

$= D^2 + (x + d/2)^2$

Teacher's Signature

Also from Δ MPA,

$MA = PQ$

$$(AP)^2 = (MP)^2 + (MA)^2$$
$$= D^2 + \left(x - \frac{d}{2}\right)^2$$

$$\therefore (BP)^2 - (AP)^2 = \left\{D^2 + \left(x + \frac{d}{2}\right)^2\right\} - \left\{D^2 + \left(x - \frac{d}{2}\right)^2\right\}$$

$$= \cancel{D^2} + \left(x + \frac{d}{2}\right)^2 - \cancel{D^2} - \left(x - \frac{d}{2}\right)^2$$
$$= x^2 + \cancel{2}x\frac{d}{\cancel{2}} + \frac{d^2}{4} - \left(x^2 - \cancel{2}x\frac{d}{\cancel{2}} + \frac{d^2}{4}\right)$$
$$= \cancel{x^2} + xd + \cancel{\frac{d^2}{4}} - \cancel{x^2} + xd - \cancel{\frac{d^2}{4}}$$
$$= xd + xd$$
$$(BP)^2 - (AP)^2 = 2xd.$$

or, $(BP + AP)(BP - AP) = 2xd$

or, $BP - AP = \dfrac{2xd}{BP + AP}$

The value of D is very very large in comparison to x and d

$\therefore$ $BP = AP = D$. (Approximately)

or. $BP - AP = \dfrac{2xd}{D + D} = \dfrac{\cancel{2}xd}{\cancel{2}D} = \dfrac{xd}{D}$

$\therefore$ Path diff $= BP - AP = \dfrac{xd}{D}$. ——— (i)

Phase diff $= \dfrac{2\pi}{\lambda} \times$ Path diff

or. $\delta = \dfrac{2\pi}{\lambda} \times \dfrac{xd}{D}$ ——— (ii)

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For Bright fringes:—

If the path difference is a whole number multiple of wavelength λ, the point P is bright.

$$\therefore \frac{xd}{D} = n\lambda$$

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

or $$x = \frac{n\lambda D}{d} \quad \text{——— (ii)}$$

This equation gives the distances of the bright fringes from the point C.

At C the path diff. is zero, so the bright fringe is formed.

when $n = 1$ then $x_1 = \frac{\lambda D}{d}$

$n = 2$ then $x_2 = 2\frac{\lambda D}{d}$

$n = 3$ then $x_3 = 3\frac{\lambda D}{d}$

$\ldots \ldots \ldots$

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

Therefore the distance between two consecutive bright fringes

$$x_2 - x_1 = \frac{2\lambda D}{d} - \frac{\lambda D}{d} = \frac{\lambda D}{d}$$

——— (iii)