Learning Mantras

LEARNING MANTRAS
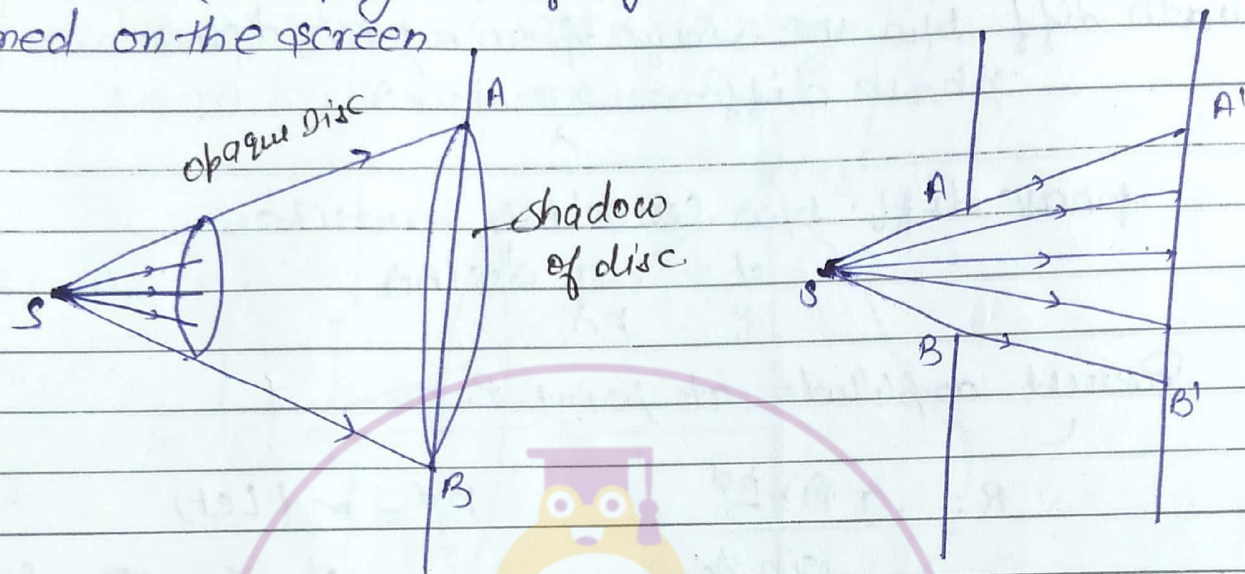
Handwritten Notes
On
Differaction

Diffraction

When an opaque object is placed b/w source and screen due rectalinear Propagation of Light a sharp image of object is formed on the screen

If Size of obstacle is comparable to the wavelength of light then Light wave deviate from its path at the edge of obstacle and enter the gemotrical shadow of object.

The Phenomina of deviation of light at the sharp edges of size comparable to wavelength of Light known as diffraction.

* Fraunhofer's single slit diffraction:
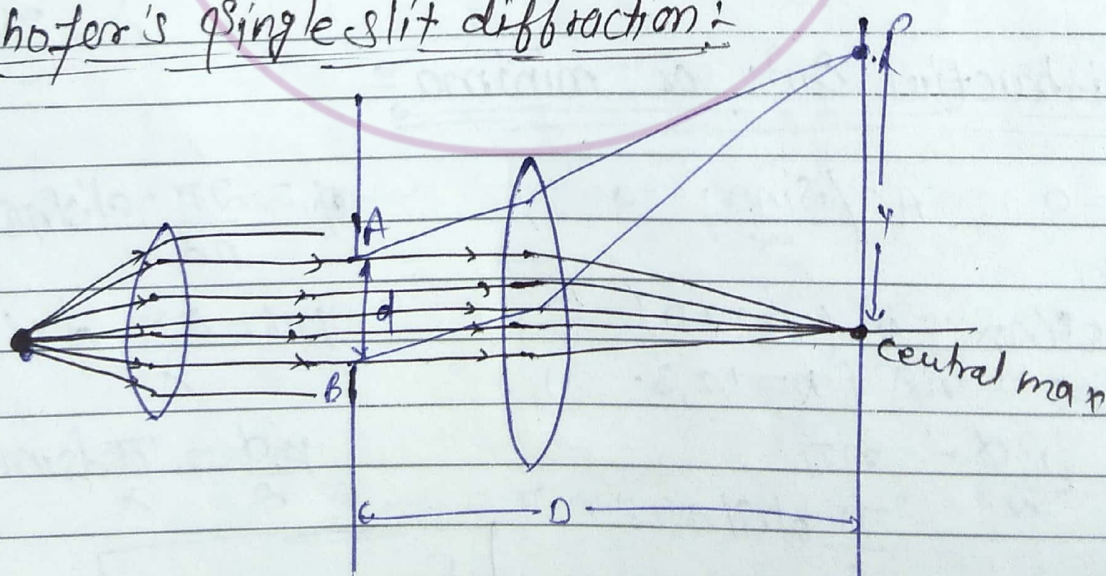
All the Particles in the slit become new source of light sending light on the screen.

Let P = total No. of particles b/w A & B $P \to \infty$
a - amplitude of wave from one particle
a- very small $\to 0$
Net Amp. = $pa = A$ (let)
Path diff b/w the rays from A & B = $d\sin\theta$
phase diff. = $\dfrac{2\pi}{\lambda} d\sin\theta$

phase diff. b/w conective particles
$$\phi = \dfrac{2\pi}{p\lambda} d\sin\theta$$

Result amplitude at point P.

$$R = \dfrac{a \sin\frac{p\phi}{2}}{\sin \phi/2} \qquad \dfrac{p\phi}{2} = \alpha \text{ (let)}$$

$$R = \dfrac{a\sin\alpha}{\sin\left(\frac{\alpha}{p}\right)} \qquad \dfrac{\phi}{2} = \dfrac{\alpha}{P} \text{ - very small}$$

$$R = \dfrac{a\sin\alpha}{\alpha/p} = \dfrac{pa\sin\alpha}{\alpha} \qquad \sin\dfrac{\alpha}{p} \approx \dfrac{\alpha}{p}$$

$$R = A\left(\dfrac{\sin\alpha}{\alpha}\right) \qquad \text{Intensity at } P \quad I \propto R^2$$

$$I \propto A^2 \left(\dfrac{\sin\alpha}{\alpha}\right)^2$$

⭐ <u>for distructive int or minima:-</u>

$I = 0 \qquad A^2\left(\dfrac{\sin\alpha}{\alpha}\right)^2 = 0 \qquad\qquad \phi = \dfrac{2\pi}{p\lambda} d\sin\theta$

when

$\sin\alpha = 0 \;(\alpha \neq 0) \qquad\qquad p\phi = \dfrac{2\pi}{\lambda} d\sin\theta$

$\alpha = n\pi \;(n = 1,2,3\cdots) $

$\dfrac{p\phi}{2} = n\pi \qquad\qquad\qquad \dfrac{p\phi}{2} = \dfrac{\pi d\sin\theta}{\lambda}$

$\dfrac{\pi}{\lambda} d\sin\theta = n\pi$

$$\boxed{d\sin\theta = n\lambda} \quad \text{minima}$$

1st minima   2nd minima

$$d\sin\theta = \lambda \qquad\qquad \sin\theta = \frac{2\lambda}{d}$$

$$\sin\theta = \frac{\lambda}{d}$$

Imp.

Width of central maxima = $2y$

$$\tan\theta = \frac{y}{D} \qquad y = D\tan\theta$$

P 1st

1st minima.
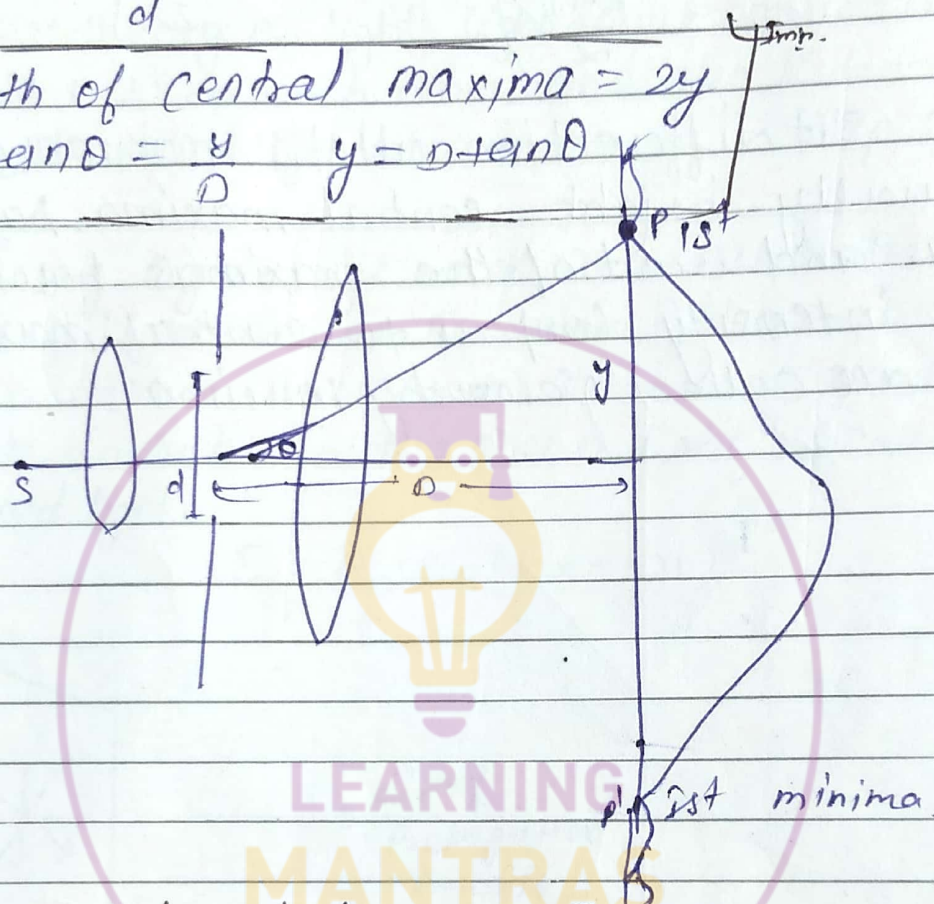
(ii) **For Constructive interference :** $I = max$

$$I \propto A^2 \left(\frac{\sin\alpha}{\alpha}\right)^2$$

$$\frac{df}{d\alpha} = 0 \qquad \frac{d}{d\alpha}\left(\frac{\sin\alpha}{\alpha}\right) = \frac{\alpha\cos\alpha - \sin\alpha}{\alpha^2}$$

$$\sin\alpha = \alpha\cos\alpha \qquad \boxed{\tan\alpha = \alpha}$$

$$\alpha = 0, \frac{3\pi}{2}, \frac{5\pi}{2}, \frac{7\pi}{2}$$

Central max

$$I \propto A^2 \left(\frac{\sin 0}{0}\right)^2 \propto A^2$$

1st max $I \propto A^2 \left(\frac{\sin 3\pi/2}{3\pi/2}\right)^2 \propto \frac{4A^2}{9\pi^2}$

2nd max

$$I \propto A^2 \left(\frac{\sin \frac{5\pi}{2}}{\frac{5\pi}{2}} \right)^2 \propto \frac{4A^2}{25\pi^2} \left\} \begin{array}{c} \text{secondary} \\ \text{maxima.} \end{array} \right.$$

In single slit differction all the maxima's are not equally bright central maxima have maximum Intensity and rest of the maxima's have very small intensity compare to central maxima. Hence these are called secondary maxima's.