Diffraction at Straight edge :-

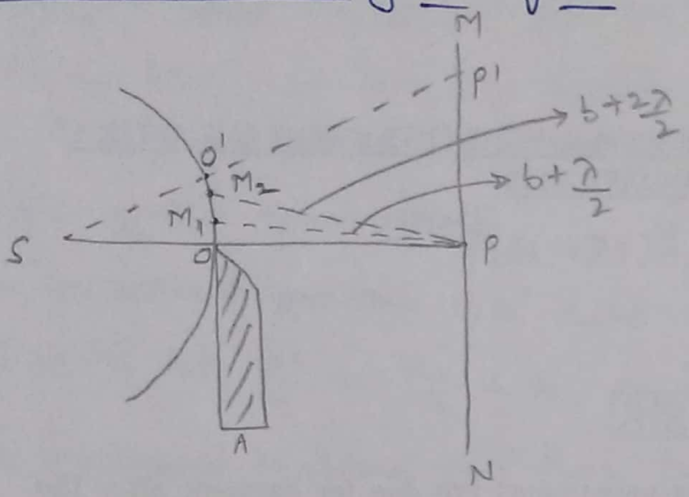
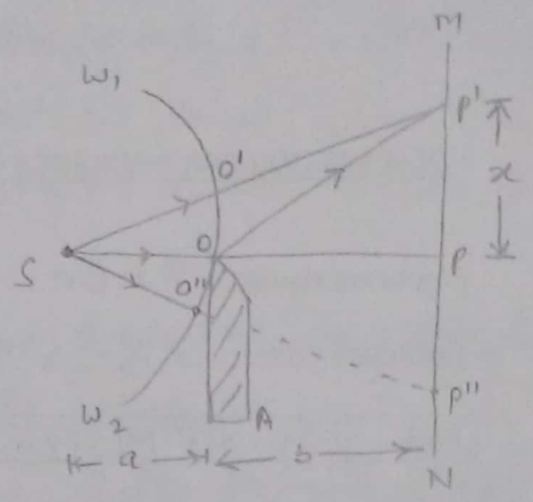


fig (2)



fig(1)

Let S : narrow slit illuminated by a monochromatic source of light of wavelength λ.

$W_1 W_2$: A cylindrical wavefront.

OA : A straight edge

$SO = a$ & $OP = b$.

'P' is a point on the screen as in fig (1).

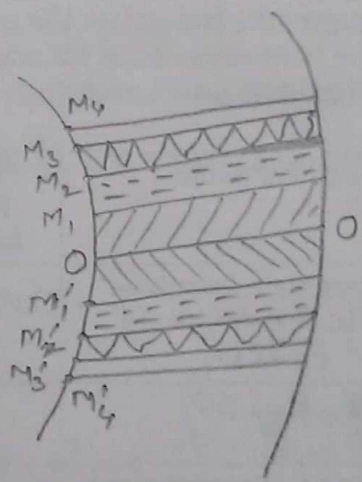


fig (3)

Below point 'P' is the geometrical shadow and above 'P' is the illuminated portion. But actually it is observed that there are a few unequally spaced diffraction fringes in the illuminated region close to 'P' & in the region of darkness the intensity does not become zero at 'P', but it falls rapidly & becomes zero at a finite distance from 'P'.

P' is the point in illuminated portion. To find intensity at P' the wavefront is divided into half period strips w.r. to P'. ~~The~~ O' is the pole of wavefront w.r.to P'. With P' as centre and radii equal to $P'O'+\frac{\lambda}{2}$, $P'O'+\frac{2\lambda}{2}$ etc. the points on wavefront are marked. We may take $P'O' \approx b$ so distances will be $b+\frac{\lambda}{2}$, $b+\frac{2\lambda}{2}$, – etc. as shown in fig (2).

The half period strips are shown in fig (3). With increase in the order of the strip, the area of the strip decreases.

The whole wave front is divided into two parts i.e. $O'W_1$ and $O'W_2$. The intensity at P' will depend mainly on the number of half period strips between O & O'.

The amplitude at P' due to entire upper half i.e. $O'W_1$ of the wavefront $= \frac{R_1}{2}$

If the exposed portion OO' has one half period strip, the amplitude at $P' = \frac{R_1}{2} + R_1 = \frac{3R_1}{2}$ (max.)

If the exposed portion OO' has two half period strips, the amplitude at $P' = \frac{R_1}{2} + R_1 - R_2 = \frac{3R_1}{2} - R_2$ (min.)

So P' will be of max. intensity, if the number of half period strips b/w OO' is odd & the intensity at P' will be minimum if the no. of half period strips b/w OO' is even.

Position of Maximum & Minimum Intensity :

The path diff. b/w the rays reaching at P' is:

$$\Delta = OP' - O'P' = OP' - [SP' - SO'] = (b^2 + x^2)^{\frac{1}{2}} - \left[\{(a+b)^2 + x^2\}^{\frac{1}{2}} - a\right]$$

as $SO' \simeq a$

So On solving above relation we get :

$$* \quad \Delta = \frac{x^2}{2} \cdot \frac{a}{b(a+b)}$$

for max. intensity at P' : $\Delta = (2n+1)\lambda/2$, $n = 0, 1, 2, \ldots$

i.e. $\frac{x^2}{2} \cdot \frac{a}{b(a+b)} = (2n+1)\frac{\lambda}{2} \Rightarrow \boxed{x \text{ or } x_n = \sqrt{\frac{(2n+1)(a+b)b\lambda}{a}}}$ *

for min. intensity at P' : $\Delta = n\lambda$; $n = 0, 1, 2 \ldots$

i.e. $\frac{x^2}{2} \cdot \frac{a}{b(a+b)} = n\lambda \Rightarrow \boxed{x \text{ or } x_n = \sqrt{\frac{2n(a+b)b\lambda}{a}}}$ *

Intensity distribution curve in Straight edge :-

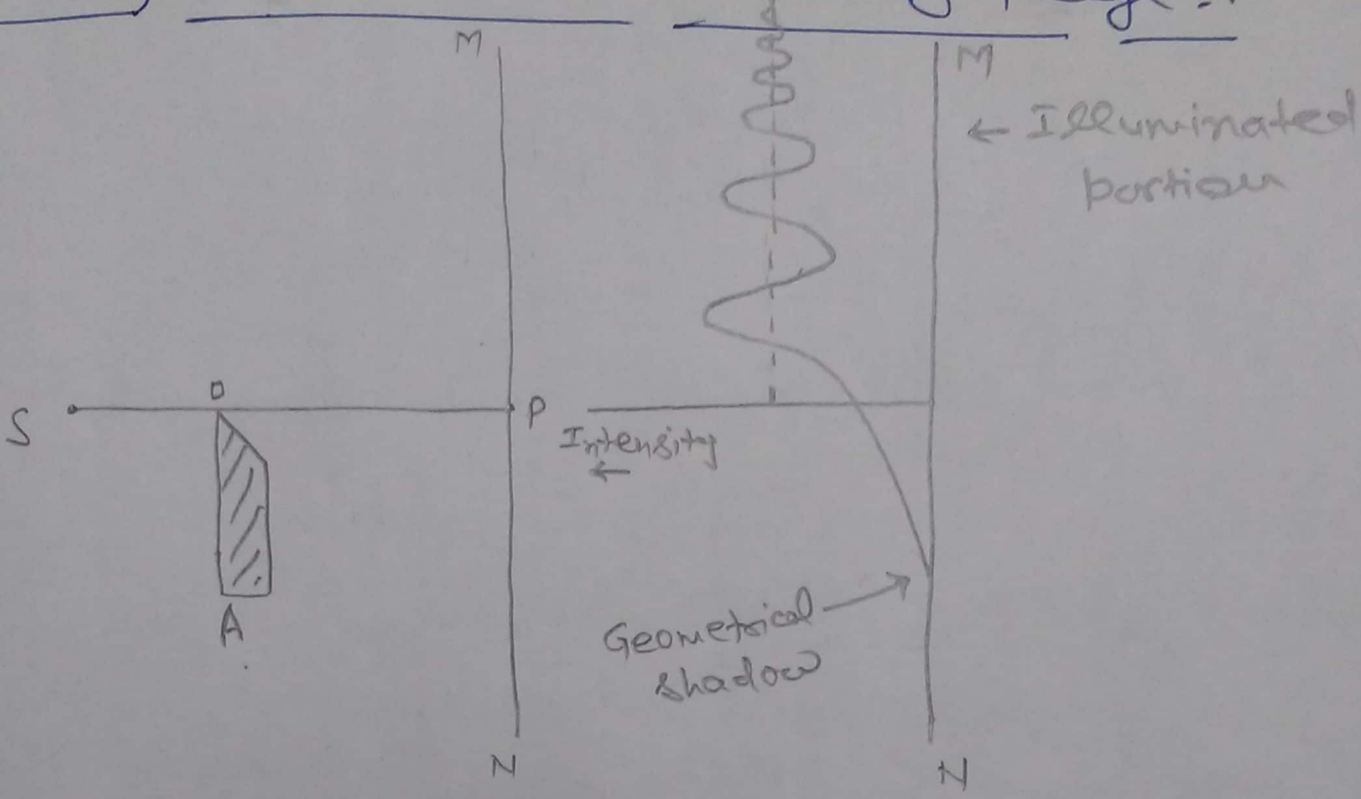


fig (4)

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