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diffraction due to a single slit, width of central maxima

CLASS-XII

SUBJECT : PHYSICS
CHAPTER NUMBER: 10
CHAPTER NAME : Wave Optics

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LEARNING OUTCOME

- Understand the concept of bending of light.
- Understand the positions of maxima and minima in diffraction.
- To study intensity distribution curve.

Diffraction:-

Diffraction of light is the phenomenon of deviation of light from its rectilinear propagation or bending of light rays from sharp edges of an opaque obstacle/ aperture and spreading into geometrical shadow region.

Diffraction depends on two factors
(a) Size of obstacle or aperture (a)
(b) Wavelength of light

Diffraction due to single slit:-

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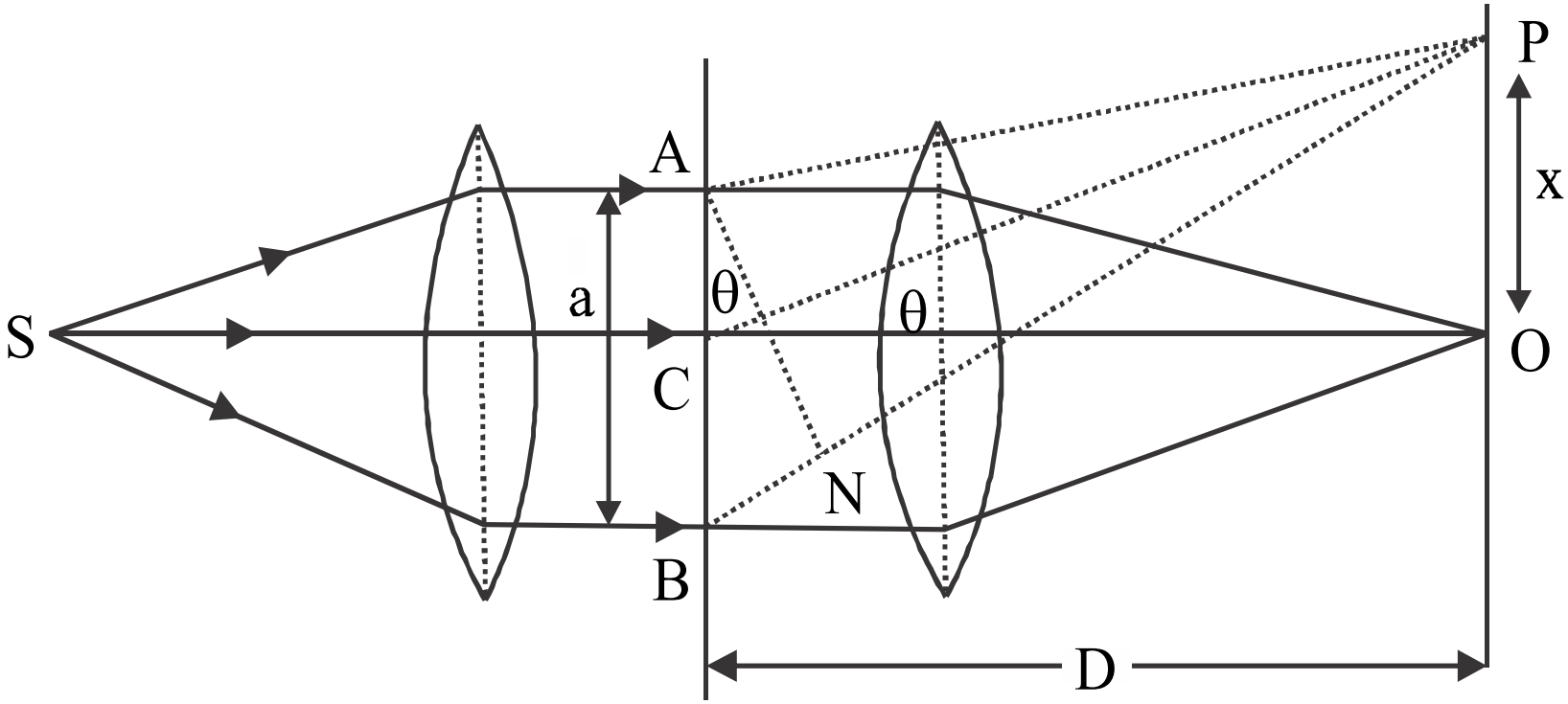

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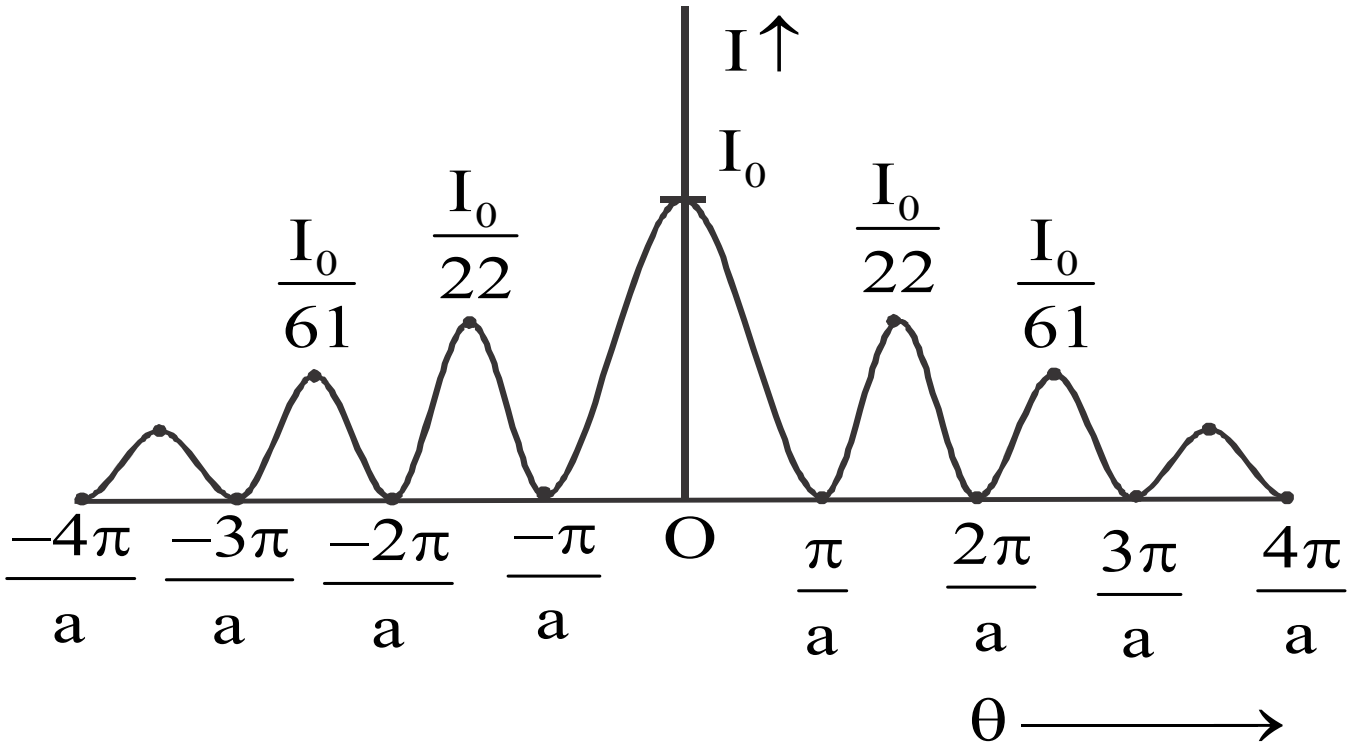
Diffraction due to single slit:-

(i)Central maximum

(ii)Condition for nth minimum is
$a \sin\theta = n\lambda$, where n= 1,2,3,...

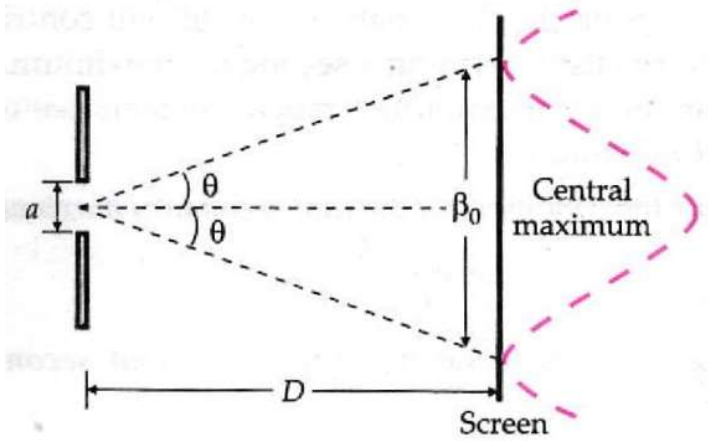
(iii)Condition of nth secondary maximum is
$a \sin\theta = (2n + 1)\frac{\lambda}{2}$, where n= 1,2,3,...

Intensity distribution curve:-



Angular and linear widths of central maximum.

$\beta_0 = D \times 2\theta = (2D\lambda)/a$



Linear width of a secondary maximum

Angular width of nth secondary maximum $= \theta_{n+1} - \theta_n = (n+1)\frac{\lambda}{a} - n\frac{\lambda}{a} = \frac{\lambda}{a}$

Hence the linear width of nth secondary maximum
$=$ Angular width $\times$ D

or $\beta = \frac{D\lambda}{a}$

Clearly, $\beta_0 = 2\beta$

Numerical

1.A parallel beam of light of 600 nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1.2 m away. It is observed that the first minimum is at a distance of 3 mm from the center of the screen. Calculate the width of the slit.

2.A parallel beam of light of wavelength 600 nm is incident normally on a slit of width ‘a’. If the distance between the slits and the screen is 0.8 m and the distance of 2nd order maximum from the center of the screen is 15 mm, calculate the width of the slit.

3.Two wavelengths of sodium light 590 nm 596 nm are used, in turn, to study the diffraction taking place at a single slit of aperture 4 mm. The distance between the slit and the screen is 2 m. Calculate the separation between the positions of first maximum of the diffraction pattern obtained in the two cases.

THANKING YOU

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