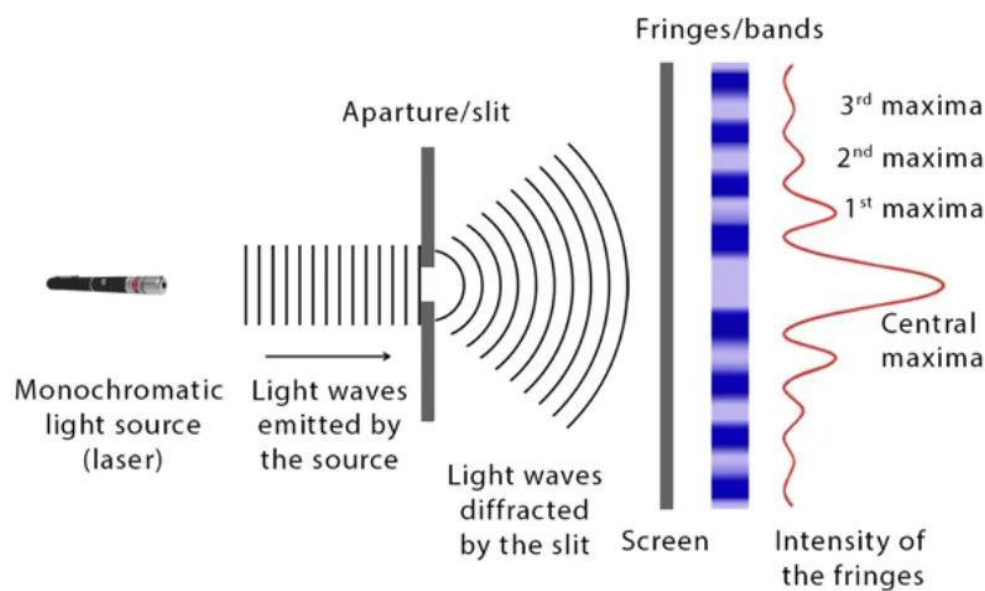


Diffraction of Light – Single Slit Experiment

1. What is diffraction of light?

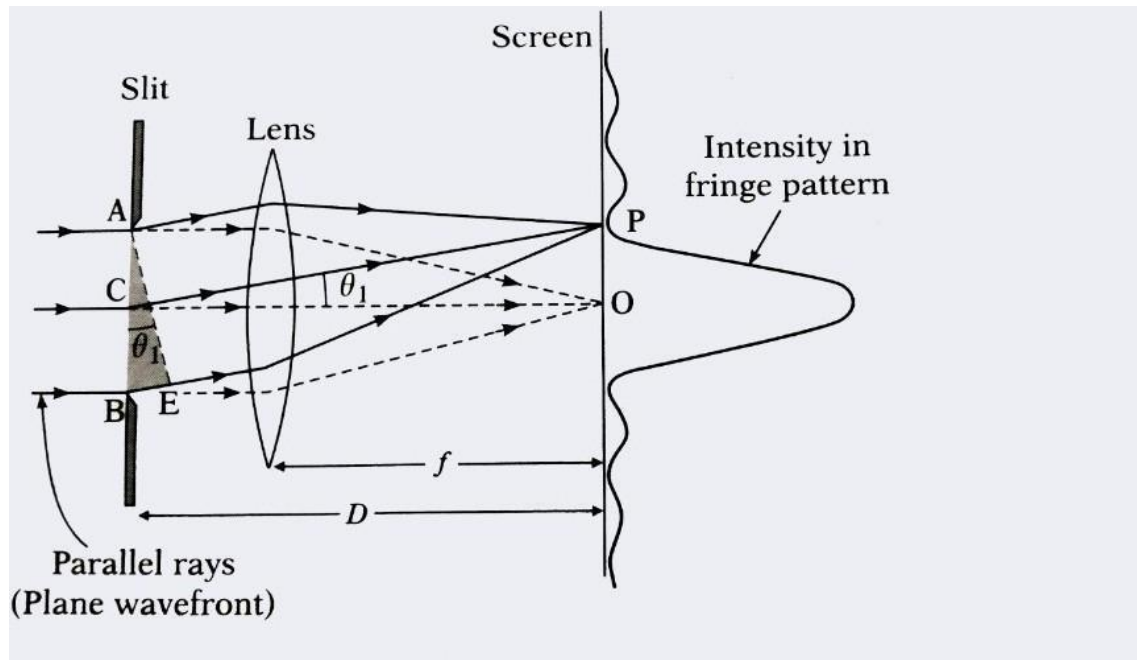
Diffraction of light is the phenomenon of bending and spreading of light waves when they pass through a narrow slit or around the edge of an obstacle.

Diffraction is clearly observed when the size of the slit or obstacle is comparable to the wavelength of light.



2. Single Slit Experiment

In this experiment, monochromatic light of wavelength λ falls on a narrow slit of width a . The diffracted light forms a pattern of bright and dark fringes on a distant screen.



Let:

- a = width of the slit
- λ = wavelength of light
- θ = angle of diffraction
- D = distance between slit and screen
- y = distance of a fringe from the central axis

For small angles,

$$\sin\theta = \tan\theta = \theta = y/D$$

3. Condition for Central Maximum

At the centre of the diffraction pattern, the path difference between light rays from different parts of the slit is zero. Therefore, all the waves interfere constructively.

Condition for central maximum:

$$\theta=0$$

or

$$a \sin\theta = 0$$

Since $\theta=0$, the central maximum occurs at ($y=0$).

Important: The central maximum is the brightest and widest fringe in the single-slit diffraction pattern.

4. Condition for Minima (Dark Fringes)

Dark fringes are formed when light waves from different parts of the slit cancel one another through destructive interference.

Condition for minima:

$$a \sin \theta = n \lambda$$

where,

$$n = 1, 2, 3, \dots$$

Here, n is the order of the minimum.

For small angles, the position of the minima on the screen is

$$Y = n \lambda D / a$$

Examples:

First minima; $a \sin \theta = \lambda$

Second minima: $a \sin \theta = 2\lambda$

Third minima: $a \sin \theta = 3\lambda$

5. Condition for Secondary Maxima (Bright Fringes)

Secondary maxima are the bright fringes on either side of the central maximum.

The exact condition for secondary maxima is obtained by differentiating the single-slit intensity equation. It is

The solution $\theta = 0$ corresponds to the central maximum. The nonzero solutions give the secondary maxima.

For approximate calculations, the positions of secondary maxima are often taken as

$$a \sin \theta = (2n + 1) \lambda / 2$$

where ($n = 1, 2, 3, \dots$ when counting outward from the first minimum).

This is an approximation, not the exact condition.