Dept. of Physiotherapy

Diffraction

Diffraction of light is defined as the bending of light around the corners such that it spreads out and illuminates areas where a shadow is expected. It happens bcz, according to HUYGEN'S PRINCIPLE

OR

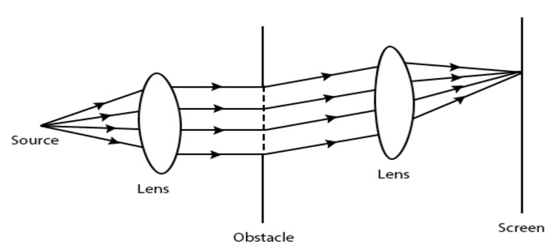
The bending of a wave or its deviation from the original direction of propagation when it meets a small obstacle is called diffraction.

OR

The bending of light waves around an obstacle whose dimension is comparable to the wavelength of incident light and hence it's spreading into the geometrical shadow

Types of diffraction:

Fraunhofer diffraction:



The source of light and screen are at infinite distance from obstacle .

This is the phenomenon in physics where light waves encounter an aperture or obstacle and diffract, spreading out into a pattern of bright and dark fringes.

This occurs when source of light is far away from object, resulting in parallel incident rays.

It can be observed when light passes through narrow slit, apertures.

About figure:

- Source is a point source therefore it will give spherical wavefront.
- Width of slit is 0.1mm or 0.2mm. very small slit is taken
- The lens is used is biconvex lens bcz not possible to keep source at infinite distance and screen also at infinite distance.
- Biconvex lens is used bcz source will emit spherical wavefront and that spherical wavefront is converter into plane wavefront and that wavefront will strick on the slit and ray may get diffracted may be in upward and downward .
- So there is a direction angle ɵ here these diffracted rays will again get converted by using biconvex lens and these rays will get incident on the screen at point P.
- At point P the resultant will shown in the form of frindges.

Fresnel diffraction:

In this source and screen are at finite distance from obstacle.

It is the phenomenon that occurs when light waves encounter an obstacle or aperture and exhibit interference patterns due to bending around the edges of obstacle.
It is commonly observed in various optical systems and has applications in field such as microscopy, astronomy and laser technology.

About figure:

- Either source of light or screen or both are at finite distance from the diffracting device the diffraction is called Fresnel type and the pattern is the shadow of diffracting device modified by diffracting effects
- In this source and the screen are at finite distance from obstacle.
- No biconvex lens is used, can perform this experiment anywhere
- Need a point source, slit and a screen.
- Source will emit spherical or may be sometimes cylindrical wave front that will get incident on the slit and again the slit will diffracts these rays.
- These diffracted rays will converge at point P on the screen
- And on the screen diffraction pattern can be shown, known as Fresnel diffraction.

Difference between frauhofer diffraction and Fresnel diffraction:

S.No	Fraunhofer diffraction	Fresnel diffraction

1.	Source and screen are at infinite distances from slit	Source and screen are finite distance from slit
2	Incident wavefront on the aperture	Incident wavefront is either spherical or cylindrical
3.	The diffracted wavefront is plane	The diffracted wavefront is either spherical or cylindrical
4.	2 biconvex lenses are required	No convex lenses are required
5.	Many applications in designing the optical	Less applications designing the optical instruments.

Clinical relevance of diffraction

Optical Imaging Techniques

- **Diffraction Limited Imaging**: Many imaging systems, including microscopes and some medical imaging modalities, are limited by diffraction. Understanding and managing diffraction effects are essential for enhancing image resolution and quality.

Retinal Imaging

- **Optical Coherence Tomography (OCT)**: This technique relies on the principles of diffraction to provide high-resolution cross-sectional images of the retina. It is crucial for diagnosing and monitoring retinal diseases, such as macular degeneration and diabetic retinopathy.

Vision Testing

- **Pinhole Tests**: In vision assessments, pinhole apertures exploit diffraction principles to improve focus for patients with refractive errors. This can help determine whether corrective lenses are needed.

Corneal Topography

- **Wavefront Analysis**: Diffraction plays a role in measuring how light interacts with the cornea. This analysis helps in diagnosing corneal irregularities and planning refractive surgery, such as LASIK.

Laser Applications

- **Surgical Techniques**: Lasers used in surgical procedures (e.g., LASIK) rely on diffraction principles for precision and accuracy. Understanding diffraction helps optimize laser systems for various applications.