ACTIVITY

AIM

To observe diffraction of light due to a thin slit.

MATERIAL REQUIRED

Two razor blades, adhesive tapes, a screen a source of monochromatic light (laser pencil) black paper, and a glass plate.

THEORY

Diffraction is a phenomenon of bending of light around the comers or edges of a fine opening or aperture. Diffraction takes place when the order of a wavelength is comparable or small to the size of the slit or aperture. The diffraction effect is more pronounced if the size of the aperture or the obstacle is of the order of the wavelength of the waves. The diffraction pattern arises due to interference of light waves from different symmetrical points of the same wavefront. The diffraction pattern due to a single slit consists of a central bright band having alternate dark and weak bright bands of decreasing intensity on both sides.

For diffraction,

$$d \sin\theta = n\lambda$$

Here,

d = size of aperture or slit

θ = angle of diffraction

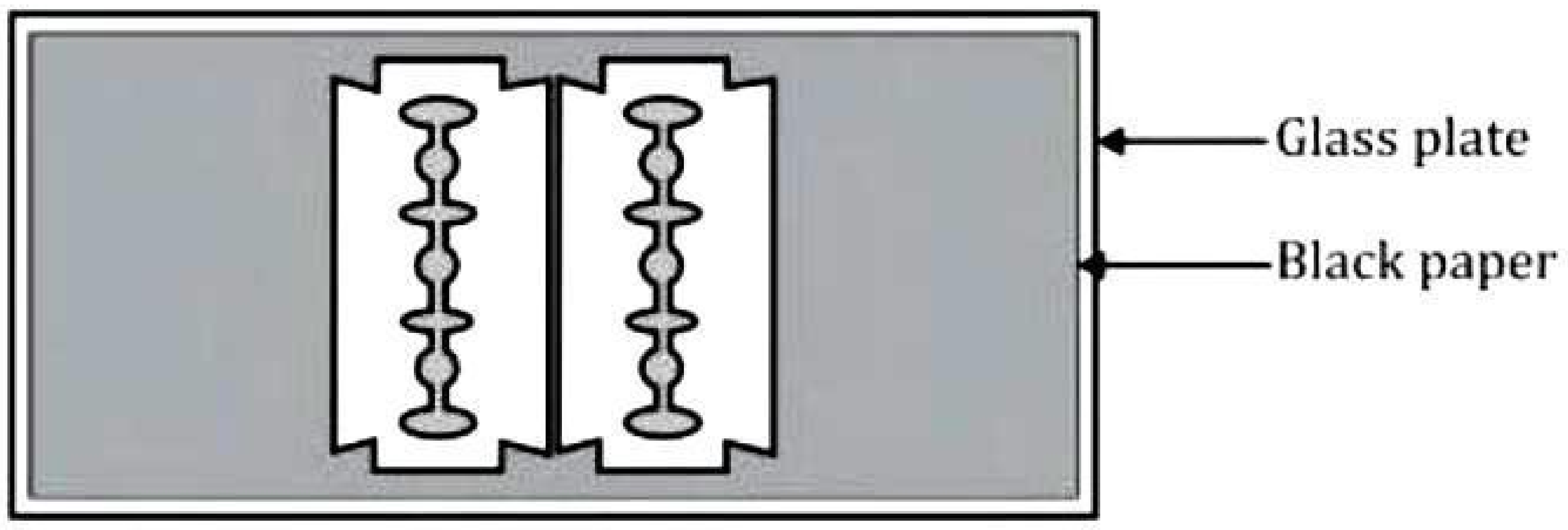
n = order of diffraction

λ = wavelength of light

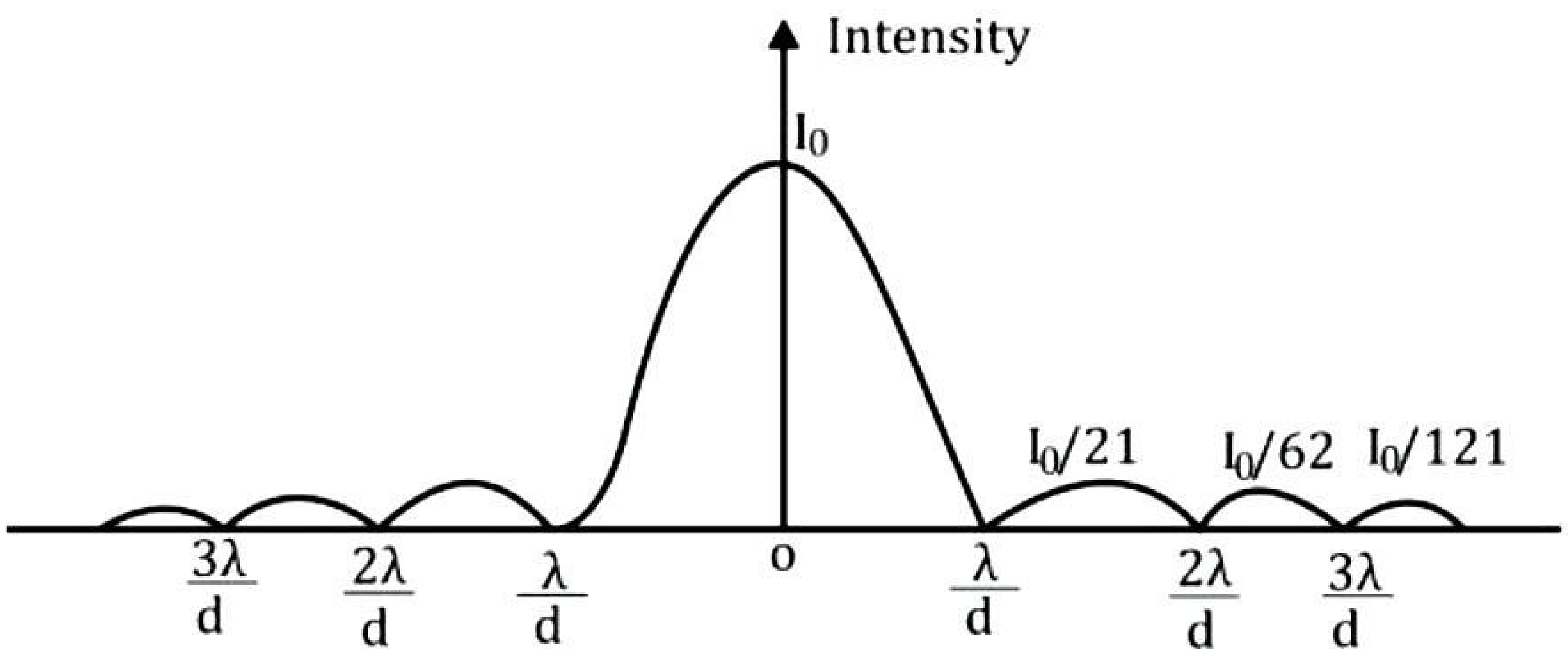
PROCEDURE

1. Fix the black paper on the glass plate by using adhesive.
2. Place two razor blades so that their sharp edges are parallel and extremely close to each other to for a narrow slit in between.
3. Cut the small slit in between the sharp edges of the blades and place it at a suitable distance from a wall or screen of a dark room.
4. Throw a beam of light on the slit with the laser pencil.
5. A diffraction pattern of alternate bright and dark bands is seen on the wall.

OBSERVATION



A thin slit made by using two razer blades, black paper and a glass plate.



RESULT

When light waves are incident on a slit or aperture they bend away (spread) at the comers of the slit showing the phenomena of diffraction of light.

PRECAUTION

1. Air gaps should not be left between glass plates and black paper.
2. The razor blades should be placed extremely closed as possible.
3. Diffraction patterns should be seen on a wall of a dark room.
4. A point source of monochromatic light like a laser torch should be used.

SOURCE OF ERROR

1. If the width of the slit is not accurately measured, it can lead to errors in predicting the diffraction pattern.
2. Ambient light or stray light in the surroundings may interfere with the observed diffraction pattern, causing inaccuracies.
3. The observer's eye position or focus may introduce errors in recording the diffraction pattern, especially if not done with precision.

VIVA- VOCE

Q 1. What do you mean by diffraction of light?

Ans. Diffraction is the phenomenon of bending of light around corners of an obstacle or aperture in its path due to which light spreads or penetrates the geometrical shadow of the obstacle or the slit.

Q 2. Is there any diffraction in sound waves?

Ans. Yes, it is more pronounced in sound and radio waves.

Q 3. State an example of the diffraction of sound waves.

Ans. If there is a loud sound produced in a room, the sound can be heard in an adjoining room also, even though the two rooms are not directly connected, as the sound waves bend and spread at the open-windows or door and reach the adjoining room.

Q 4. What do you observe on a screen placed in front of a very narrow slit illuminated by white light?

Ans. We will observe a central bright fringe having alternate dark and weak bright fringes of decreasing intensity on both sides of the central bright fringe.

Q 5. Why do you need a very narrow slit for observing the diffraction of light and not for sound waves?

Ans. Since the wavelength of light waves is very small to sound waves.

Q 6. If the width of the slit is made double the original width, how will it affect the size and intensity of the central diffraction band?

Ans. The half angular width of the central maximum is given by $\theta = \frac{\lambda}{a}$ where a is slit width. Hence, the size will become half. The intensity (I) will become 4 times as $I \propto \frac{1}{a^2}$.

Q 7. When a tiny circular obstacle is placed in the path of light from a distant source, a bright spot is seen at the centre of the shadow of the obstacle. Why?

Ans. Light waves diffracted from the edges of the circular obstacle interfere constructively at the centre of the shadow resulting in the formation of bright spots.

Q 8. Two persons separated by a 10 m wide portion can hear but cannot see each other, though both sound and light waves can bend around corners. Why?

Ans. Because the diffraction of light is negligible for that of the sound.

Q 9. Why is the diffraction of light not common? Explain mathematically.

Ans. We know that for diffraction, we have,

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

For light $\lambda \approx 10^{-7}\ m$ and let the distance between the source and screen be ' a '.

Here, $a = 10\ m$,

So, $\sin\theta = \frac{\lambda}{a} = \frac{10^{-7}}{10} = 10^{-8}$ i.e., $\theta \to 0$.

Therefore, the light goes almost unbent.

For sound waves of frequency, 1000 Hz (say) and velocity in air,

$v = 330\ ms^{-1}$ (say)

The wavelength of sound waves, $\lambda = \frac{330}{1000} = 0.33\ m$ and diffraction, $\sin\theta = \frac{\lambda}{a} = \frac{0.33}{10} = 0.033m$.

Hence, sound waves bend around the partition and the two persons can hear each other.

Q 10. Give the difference between interference of light and diffraction of light.

Ans. In interference of light, the resultant intensity at a point is obtained by considering the superpositions of two wavefronts coming from two coherent sources, while in the case of diffraction of light, the resultant intensity at a point is due to the interference between the secondary wavelets from a single wavefront.