# Previous Years

## Examination Questions

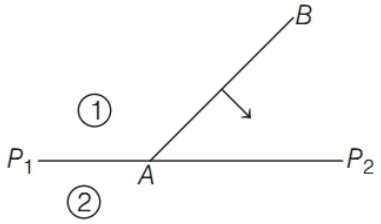
### 1 Mark Question

**1.** When light travels from a rarer to a denser medium, the speed decreases. Does this decrease in speed imply a decrease in the energy carried by the light wave? Justify your answer. **All India 2010**

### 2 Marks Question

**2.** Define the term wavefront of light. A plane wavefront $AB$ propagating from denser medium (1) into a rarer medium (2) is incident on the surface $P_1P_2$ separating the two media as shown in figure.

Using Huygens' principle, draw the secondary wavelets and obtain the refracted wavefront in the diagram. **Delhi2020**




## 3 Marks Questions

**3.** Define the term wavefront. Using Huygens' wave theory, verify the law of reflection. **Delhi 2019**

**4.** Define the term refractive index of a medium. Verify Snell's law of refraction when a plane wavefront is propagating from a denser to a rarer medium. **Delhi 2019**

**5.** Explain the following giving reasons:

(i) When monochromatic light is incident on a surface separating two media, then both reflected and refracted light have the same frequency as the incident frequency.

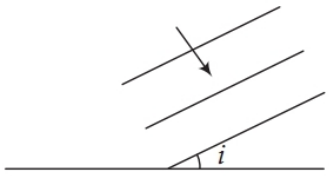
(ii) When light travels from a rarer to a denser medium, then speed decreases. Does this decrease in speed imply a reduction in the energy carried by the wave?

(iii) In the wave picture of light, intensity of light is determined by the square of the amplitude of the wave. What determines the intensity in the photon picture of light? **Delhi 2016**

**6.** Define the term wavefront. State Huygens' principle. Consider a plane wavefront incident on a thin convex lens. Draw a proper diagram to show how the incident wavefront traverses through the lens and after refraction focusses on the focal point of the lens, giving the shape of the emergent wavefront. **All India 2016**

**7.** Use Huygens' principle to show how a plane wavefront propagates from a denser to rarer medium ? Hence, verify Snell's law of refraction. **Delhi 2015**

**8.** A plane wavefront propagating in a medium of refractive index '$\mu_1$' is incident on a plane surface making an angle of incidence $i$ as shown in the figure. It enters into a medium of refraction of refractive index '$\mu_2$' $(\mu_2 > \mu_1)$.




Use Huygens' construction of secondary wavelets to trace the propagation of the refracted wavefront. Hence, verify Snell's law of refraction. **Foreign 2015**

**9.** Using Huygens' principle, draw a diagram showing how a plane wave gets refracted, when it is incident on the surface separating a rarer medium from a denser medium? Hence, verify Snell's laws of refraction. **All India 2015; All India 2011; Delhi 2013**

**10.** Define a wavefront. Use Huygens' geometrical construction to show the propagation of plane wavefront from a rarer medium (1) to a denser medium (2) undergoing refraction, hence derive Snell's law of refraction. **Foreign 2012**

**11.** (i) Use Huygens' geometrical construction to show the behaviour of a plane wavefront,

(a) passing through a biconvex lens

(b) reflected by a concave mirror.

(ii) When monochromatic light is incident on a surface separating two media, why does the refracted light have the same frequency as that of the incident light? **Foreign 2012**

**12.** Using Huygens' geometrical construction of wavefronts, show how a plane wave gets reflected from a surface? Hence, verify laws of reflection. **All India 2011**

**13.** Use Huygens' principle to verify the laws of refraction. **Delhi 2011**

## 5 Marks Questions

**14.** (i) Define a wavefront. How is it different from a ray?

(ii) Depict the shape of a wavefront in each of the following cases.

(a) Light diverging from point source.

(b) Light emerging out of a convex lens when a point source is placed at its focus.

(c) Using Huygen's construction of secondary wavelets, draw a diagram showing the passage of a plane wavefront from a denser into a rarer medium. **All India 2015C**

**15.** State Huygens' principle. Using this principle draw a diagram to show how a plane wavefront incident at the interface of the two media gets refracted when it propagates from a rarer to a denser medium. Hence, verify Snell's law of refraction. **Delhi 2013**

**16.** (i) Use Huygens' geometrical construction to show how a plane wavefront at $t = 0$ propagates and produces a wavefront at a later time?

(ii) Verify, using Huygens' principle, Snell's law of refraction of a plane wave propagating from a denser to a rarer medium.

(iii) When monochromatic light is incident on a surface separation two media, the reflected and refracted light both have the same frequency. Explain why? **Delhi 2013C**

**17.** (i) A plane wavefront approaches a plane surface separating two media. If medium 1 is optically denser and medium 2 is optically rarer, using Huygens' principle, explain and show how a refracted wavefront is constructed?

(ii) Verify Snell's law.

(iii) When a light wave travels from a rarer to a denser medium, the speed decreases. Does it imply reduction in its energy? Explain. **Foreign 2011**

## Explanations

**1.** Speed decreases due to decrease in wavelength of wave but energy carried by the light wave depends on the amplitude of the wave. Thus, energy carried by the wave remains unchanged. **(1)**

**2.** Refer to text given on pages 300 and 301. (Wavefront and law of refraction on the basis of Huygens' wave theory). **(2)**

**3.** **Wavefront** Refer to text on page 300. **(1)**

**Law of reflection from Huygens' wave theory** Refer to text on page 301. **(2)**

**4.** **Law of refraction from Huygens' wave theory** Refer to text on pages 301 and 302. **(3)**

**5.** (i) Frequency is the characteristic of the sources while wavelength is the characteristic of the medium. When monochromatic light travels from one medium to another, its speed changes, so its wavelength changes but frequency remains same. Reflection and refraction arise through interaction of incident light with atomic constituents of matter which vibrate with the same frequency as that of the incident light. Hence, frequency remains unchanged. **(1)**

(ii) Refer to Sol. 1 on page 304. **(1)**

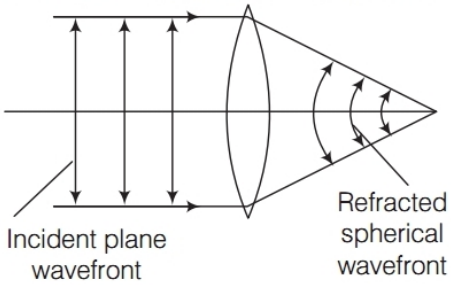
(iii) In the photon picture of light, intensity of a light is determined by the number of photons incident per unit area.

For a given frequency, intensity of light in the photon picture is determined by

$$I = \frac{\text{Energy of photons}}{\text{area} \times \text{time}} = \frac{n \times h\nu}{A \times t}$$ **(1)**

**6.** **Wavefront** Refer to text on page 300. **(1)**

**Huygens' principle** Refer to page 300.




When a plane wavefront (parallel rays) is incident on a thin convex lens, the emergent rays are focused on the focal point of the lens. Thus, the shape of emerging wavefront is spherical. **(2)**

**7.** According to Huygens' principle, each point on the given wavefront (called primary wavefront) is the source of a secondary disturbance (called

# Previous Years

## Examination Questions

### 1 Mark Questions

**1.** Write the conditions of path difference under which (a) constructive (b) and destructive interference occur in Young's double slit experiment. **Delhi 2020**

**2.** For a single slit of width $a$ the first minimum of the interference pattern of a monochromatic light of wavelength $\lambda$ occurs at an angle of $\lambda/a$. At the same angle of $\lambda/a$, we get a maximum for two narrow slits separated by a distance $a$. Explain. **Delhi 2014**

**3.** Define the term 'coherent sources' which are required to produce interference pattern in Young's double slit experiment. **Delhi 2014C**

**4.** How does the fringe width in Young's double slit experiment, change when the distance of separation between the slits and screen is doubled? **All India 2012**

**5.** How will the interference pattern in Young's double slit experiment get affected, when

(i) distance between the slits $S_1$ and $S_2$ reduced and

(ii) the entire set up is immersed in water? Justify your answer in each case. **Delhi 2011**

**6.** Laser light of wavelength 630 nm incident on a pair of slits produces an interference pattern in which the bright fringes are separated by 7.2 mm. Calculate the wavelength of another source of laser light which produce interference fringes separated by 8.1 mm using same pair of slits. **All India 2011**

### 2 Marks Questions

**7.** Why cannot two independent monochromatic sources produce sustained interference pattern? **Foreign 2015**

**8.** (i) Write the conditions under which light sources can be said to be coherent.

(ii) Why is it necessary to have coherent sources in order to produce an interference pattern? **All India 2013C**

### 3 Marks Questions

**9.** In a Young's double slit experiment using light of wavelength 600 nm, the slit separation is 0.8 mm and the screen is kept 1.6 m from the plane of the slits Calculate

(i) the fringe width

(ii) the distance of (a) third minimum and (b) fifth maximum, from the central maximum. **CBSE 2022 (Term-II)**

**10.** Two coherent light waves of intensity $5\times 10^{-2}$ $Wm^{-2}$ each superimpose and produce the interference pattern on a screen. At a point where the path difference between the waves is $\frac{\lambda}{6}$, $\lambda$ being wavelength of the wave. Find the

(i) phase difference between the waves,

(ii) resultant intensity at the point

(iii) and resultant intensity in terms of the intensity at the maximum.

**All India 2020**

**11.** (i) If one of two identical slits producing interference in Young's experiment is covered with glass, so that the light intensity passing through it is reduced to 50%, find the ratio of the maximum and minimum intensity of the fringe in the interference pattern.

(ii) What kind of fringes do you except to observe, if white light is used instead of monochromatic light? **CBSE 2018**

**12.** Answer the following questions

(i) In a double slit experiment using light of wavelength 600 nm, the angular width of the fringe formed on a distant screen is 0.1°. Find the spacing between the two slits.

(ii) Light of wavelength 500 Å propagating in air gets partly

reflected from the surface of water. How will the wavelengths and frequencies of the reflected and refracted light be affected? **Delhi 2015**

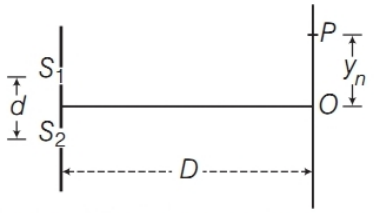
**13.** The ratio of the widths of two slits in Young's double slit experiment is 4:1. Evaluate the ratio of intensities at maxima and minima in the interference pattern. **Delhi 2015**

**14.** (i) Two monochromatic waves emanating from two coherent sources have the displacements represented by, $y_1 = a\ \cos\omega t$ and $y_2 = a\ \cos(\omega t + \phi)$, where, $\phi$ is the phase difference between the two waves. Show that the resultant intensity at a point due to their superposition is given by $I = 4I_0 \cos^2 \phi / 2$, where $I_0 = a^2$.

(ii) Hence, obtain the conditions for constructive and destructive interference. **All India 2014C**

**15.** The ratio of the intensities at minima to the maxima in the Young's double slit experiment is 9:25.Find the ratio of the widths of the two slits.**All India 2014**

**16.** The intensity at the central maxima ($O$) in a Young's double slit experiment is $I_0$ . If the distance $OP$ equals one-third of fringe width of the pattern, then show that the intensity at point $P$ would be $I_0/4$. **Foreign 2011**




**17.** In Young's double slit experiment, the two slits 0.15 mm apart are illuminated by monochromatic light of wavelength 450 nm. The screen is 1.0 m away from the slits.

(i) Find the distance of the second
- (a) bright fringe
- (b) dark fringe from the central maximum.

(ii) How will the fringe pattern change if the screen is moved away from the slits? **All India 2010**

**18.** A beam of light consisting of two wavelengths 560 nm and 420 nm is used to obtain interference fringes in a Young's double slit experiment.

Find the least distance from the central maximum, where the bright fringes, due to both the wavelengths coincide. The distance between the two slits is 4.0 mm and the screen is at a distance of 1.0 m from the slits. **Delhi 2010C**

## 5 Marks Questions

**19.** The British physicist Thomas Young explained the interference of light using the principle of superposition of waves. He observed the interference pattern on the screen, in his experimental set-up, known now as Young's double slit experiment. The two slits $S_1$ and $S_2$ were illuminated by light from a slit $S$. The interference pattern consists of dark and bright bands of light. Such bands are called fringes. The distance between two consecutive bright and dark fringes is called fringe width.**CBSE 2022 (Term-II)**

(i) If the screen is moved closer to the plane of slits $S_1$ and $S_2$, then the fringe width
- (a) will decrease, but the intensity of bright fringe remains the same
- (b) will increase but the intensity of bright fringe decreases
- (c) will decrease, but the intensity of bright fringe increases
- (d) and the intensity both remain the same

(ii) What will happen to the pattern on the screen, when the two slits $S_1$ and $S_2$ are replaced by two independent but identical sources?
- (a) The intensity of pattern will increase
- (b) The intensity of pattern will decrease

(c) The number of fringes will become double

(d) No pattern will be observed on the screen

(iii) Two sources of light are said to be coherent, when both emit light waves of

(a) same amplitude and have a varying phase difference

(b) same wavelength and a constant phase difference

(c) different wavelengths and same intensity

(d) different wavelengths and a constant phase difference

(iv) The fringe width in a Young's double slit experiment is β. If the whole set-up is immersed in a liquid of refractive index μ, then the new fringe width will be

(a) β (b) βμ (c) $\frac{\beta}{\mu}$ (d) $\frac{\beta}{\mu^2}$

(v) The total path difference between two waves meeting at points $P_1$ and $P_2$ on the screen are $\left(\frac{3\lambda}{2}\right)$ and $2\lambda$ respectively, Then

(a) bright fringes are formed at both points

(b) dark fringes are formed at both points

(c) a bright fringe is formed at $P_1$ and a dark fringe is formed at $P_2$

(d) a bright fringe is formed at $P_2$ and a dark fringe is formed at $P_1$

**20.** (i) Consider two coherent sources $S_1$ and $S_2$ producing monochromatic waves to produce interference pattern. Let, the displacement of the wave produced by $S_1$ be given by $y_1 = a\cos\omega t$ and the displacement by $S_2$ be $y_2 = a\cos(\omega t + \phi)$

Find out the expression for the amplitude of the resultant displacement at a point and show that the intensity at that point will be $I = 4a^2\cos^2\frac{\phi}{2}$

Hence, establish the conditions for constructive and destructive interference.

(ii) What is the effect on the interference fringes in Young's double slit experiment when (a) the width of the source slit is increased; (b) the monochromatic source is replaced by a source of white light? **All India 2015**

**21.** (i) (a) 'Two independent monochromatic sources of light cannot produce a sustained interference pattern'. Give reason.

(b) Light waves each of amplitude $a$ and frequency ω emanating from two coherent light sources superpose at a point. If the displacements due to these waves is given by $y_1 = a\cos\omega t$ and $y_2 = a\cos(\omega t + \phi)$ where $\phi$ is the phase difference between the two, obtain the expression for the resultant intensity at the point.

(ii) In Young's double slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ, is $K$ units. Find out the intensity of light at a point where path difference is λ/3. **Delhi 2014,2012**

**22.** (i) In Young's double slit experiment, derive the condition for

(a) constructive interference and

(b) destructive interference at a point on the screen.

(ii) A beam of light consisting of two wavelengths, 800 nm and 600 nm is used to obtain the interference fringes on a screen placed 1.4 m away in a Young's double slit experiment. If the two slits are separated by 0.28 mm, calculate the least distance from the central bright maximum where the bright fringes of the two wavelengths coincide. **All India 2012**

**23.** (i) What is the effect on the interference fringes to a Young's double slit experiment when

(a) the separation between the two slits is decreased?

(b) the width of the source slit is increased?

(c) the monochromatic source is replaced by a source of white light? Justify your answer in each case.

(ii) The intensity at the central maxima in Young's double slit experimental set up is $I_0$.

Show that the intensity at a point where the path difference is $\lambda / 3$ is $I_0/4$. **Foreign 2012**

**24.** (i) What are coherent sources? Why are they necessary for observing a sustained interference pattern? How are the two coherent sources obtained in the Young's double slit experiment?

(ii) Show that the superposition of the waves originating from the two coherent sources, $S_1$ and $S_2$ having displacement, $y_1 = a \cos \omega t$ and $y_2 = a \cos(\omega t + \phi)$ at a point produce a resultant intensity,

$$I = 4a^2 \cos^2 \phi/2$$

Hence, write the conditions for the appearance of dark and bright fringes.

**All India 2010C**

# Previous Years

## Examination Questions

### 1 Mark Questions

1. How does the angular separation between fringes in single slit diffraction experiment change when the distance of separation between the slit and screen is doubled? **All India 2012**
2. State Huygens' principle of diffraction of light? **All India 2011**
3. For a given single slit, the diffraction pattern is obtained on a fixed screen, first by using red light and then with blue light. In which case, will the central maxima, in the observed diffraction pattern, have a larger angular width? **Delhi 2010 C**

### 2 Marks Questions

4. In a single slit diffraction experiment, the width of the slit is decreased. How will the (i) size (ii) and intensity of the central bright band be affected?
   Justify your answer. **Delhi 2020**
5. Draw the intensity pattern for single slit diffraction and double slit interference. Hence, state two differences between interference and diffraction patterns.
   **All India 2017**
6. For a single slit of width $a$, the first minimum of the interference pattern of a monochromatic light of wavelength $\lambda$ occurs at an angle of $\lambda / a$. At the same angle of $\lambda / a$, we get a maximum for two narrow slits separated by a distance $a$. Explain. **Delhi 2014**
7. A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1 m away. It is observed that the first minimum is at a distance of 2.5 mm from the centre of the screen. Calculate the width of the slit. **All India 2013**
8. Compare the interference pattern observed in Young's double slit experiment with single slit diffraction pattern, pointing out two distinguishing features.
   **Delhi 2012, All India 2011C**
9. Yellow light ($\lambda$ = 6000 Å) illuminates a single slit of width $1 \times 10^{-4}$ m. Calculate the distance between two dark lines on either side to the central maximum, when the diffraction pattern is viewed on a screen kept 1.5 m away from the slit.
   **All India 2011C**

## 3 Marks Questions

**10.** (i) State two conditions for two light sources to be coherent.

(ii) Give two points of difference between an interference pattern due to a double slit and a diffraction pattern due to a single slit. **CBSE 2022 (Term-II)**

**11.** A plane wavefront of light of wavelength $\lambda$ is incident normally on a narrow slit of width $a$ and a diffraction pattern is observed on a screen at a distance $D$ from the slit.

(i) Depict the intensity distribution in the pattern observed.

(ii) Obtain the expression for the first maximum from the central maximum. **CBSE 2022 (Term-II)**

**12.** In a diffraction pattern due to a single slit, how will the angular width of central maximum change, if

(i) orange light is used in place of green light,

(ii) the screen is moved closer to the slit,

(iii) the slit width is decreased?

Justify your answer in each case. **CBSE 2022 (Term-II)**

**13.** (i) Using Huygens' construction of secondary wavelets, explain how a diffraction pattern is obtained on a screen due to a narrow slit on which a monochromatic beam of light is incident normally ?

(ii) Show that the angular width of the first diffraction fringe is half that of the central fringe.

(iii) Explain why the maxima at $\theta = \left(n + \frac{1}{2}\right)\frac{\lambda}{d}$ become weaker and weaker with increasing $n$ ? **All India 2015**

**14.** A parallel beam of monochromatic light falls normally on a narrow slit of width '$a$' to produce a diffraction pattern on the screen placed parallel to the plane of the slit.Use Huygens' principle to explain that

(i) the central bright maxima is twice as wide as the other maxima.

(ii) the intensity falls as we move to successive maxima away from the centre on either side. **Delhi 2014C**

**15.** (i) In what way is diffraction from each slit related to the interference pattern in a double slit experiment ?

(ii) Two wavelengths of sodium light 590 nm and 596 nm are used, in turn to study the diffraction taking place at single slit of aperture $2 \times 10^{-4}$m. The distance between the slit and the screen is 1.5 m. Calculate the separation between the positions of the first maxima of the diffraction pattern obtained in the two cases. **Delhi 2013**

## 5 Marks Questions

**16.** (i) Why cannot the phenomenon of interference be observed by illuminating two pin holes with two sodium lamps?

(ii) Two monochromatic waves having displacements $y_1 = a\cos\omega t$ and $y_2 = a\cos(\omega t + \phi)$ from two coherent sources interfere to produce an interference pattern. Derive the expression for the resultant intensity and obtain the conditions for constructive and destructive interference.

(iii) Two wavelengths of sodium light of 590 nm and 596 nm are used in turn to study the diffraction taking place at a single slit of aperture $2 \times 10^{-6}$m. If the distance between the slit and the screen is 1.5 m, calculate the separation between the positions of the second maxima of diffraction pattern obtained in the two cases. **CBSE 2019**

**17.** (i) Describe any two characteristic features which distinguish between interference and diffraction phenomena.

(ii) In the diffraction due to a single slit experiment, the aperture of the slit is 3 mm. If monochromatic light of wavelength 620 nm is incident normally on the slit, calculate the separation between the first order minima and the third order maxima on one side of the screen. The distance between the slit and the screen is 1.5 m. **CBSE 2019**

**18.** (i) Define a wavefront. Using Huygens' principle, verify the laws of reflection at a plane surface.

(ii) In a single slit diffraction experiment, the width of the slit is made double the original width. How does this affect the size and intensity of the central diffraction band? Explain.

(iii) 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 obstacle. Explain, why? **CBSE 2018**

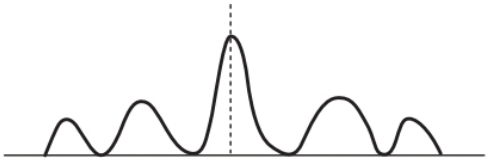
**19.** (i) Explain two features to distinguish between the interference pattern in Young's double slit experiment with the diffraction pattern obtained due to a single slit.

(ii) A monochromatic light of wavelength 500 nm is incident normally on a single slit of width 0.2 mm to produce a diffraction pattern. Find the angular width of the central maximum obtained on the screen.

Estimate the number of fringes obtained in Young's double slit experiment with fringe width 0.5 mm, which can be accommodated within the region of total angular spread of the central maximum due to single slit. **Delhi 2017**

**20.** When a plane wavefront of light of wavelength $\lambda$, is incident on a narrow slit, an intensity distribution pattern, of the form shown is observed on a screen, suitably kept behind the slit.

Name the phenomenon observed.



(i) Obtain the conditions for the formation of central maximum and secondary maxima and the minima.

(ii) Why is there significant fall in intensity of the secondary maxima compared to the central maximum, whereas in double slit experiment all the bright fringes are of the same intensity ?

(iii) When the width of the slit is made double the original width, how is the size of the central band affected?

**Delhi 2016C**

**21.** (i) Describe briefly how a diffraction pattern is obtained on a screen due to a single narrow slit illuminated by a monochromatic source of light ? Hence, obtain the conditions for the angular width of secondary maxima and secondary minima.

(ii) Two wavelengths of sodium light of 590 nm and 596 nm are used in turn to study the diffraction taking place at a single slit of aperture $2 \times 10^{-6}$ m. The distance between the slit and the screen is 1.5m. Calculate the separation between the positions of first maxima of the diffraction pattern obtained in the two cases. **All India 2014**

**22.** (i) Write three characteristic features to distinguish between the interference fringe in Young's double slit experiment and the diffraction pattern obtained due to a narrow single slit.

(ii) A parallel beam of light of wavelength 500nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1 m away. It is observed at the first minimum is distance of 2.5 mm away from the centre.

Find the width of the slit. **Foreign 2014**

**23.** (i) Obtain the conditions for the bright and dark fringes in diffraction pattern due to a single narrow slit illuminated by a monochromatic source.

Explain clearly, why the secondary maxima go on becoming weaker with increasing?

(ii) When the width of the slit is made double, how would this affect the size and intensity of the central diffraction band? Justify your answer. **Foreign 2012**

**24.** (i) State Huygens' principle. Using this principle explain how a diffraction pattern is obtained on a screen due to a narrow slit on which a narrow beam coming from a monochromatic source of light is incident normally.

(ii) Show that the angular width of the first diffraction fringe is half of that of the central fringe.

(iii) If a monochromatic source of light is replaced by white light, what change would you observe in the diffraction pattern? **All India 2011**

**25.** (i) In a single narrow slit (illuminated by a monochromatic source) diffraction experiment, deduce the conditions for the central maximum and secondary maxima and minima observed in the diffraction pattern. Also explain why the secondary maxima go on becoming weaker in intensity as the order increases.

(ii) How does the width of the slit affect the size of the central diffraction band? **All India 2010**