UNIT 10

WAVE OPTICS

SECTION – A

Questions 1 to 10 carry 1 mark each.

1. A ray of monochromatic light propagating in air, is incident on the surface of water. Which of the following will be the same for the reflected and refracted rays?
(a) Energy carried (b) Speed (c) Frequency (d) Wavelength
Ans. (c) Frequency

2. In a Young's double slit experiment, the path difference at a certain point on the screen between two interfering waves is 1/8 th of the wavelength. The ratio of intensity at this point to that at the centre of a bright fringe is close to:
(a) 0.80 (b) 0.74 (c) 0.94 (d) 0.85
Ans. (d) 0.85

3. The shape of the interference fringes in Young's double slit experiment when D (distance between slit and screen) is very large as compared to fringe width is nearly:
(a) straight line (b) parabolic (c) circular (d) hyperbolic
Ans. (a) straight line
The interference fringes produced by Young's double slit experiment are straight lines.

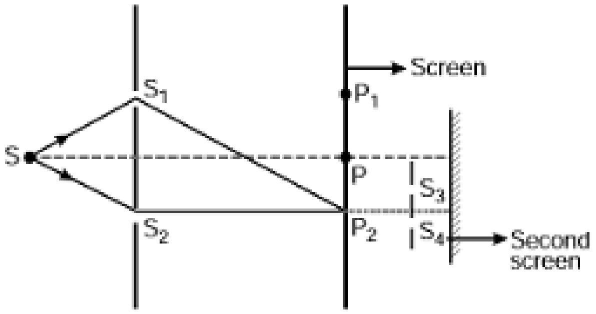
4. What happens, if the monochromatic light used in Young's double slit experiment is replaced by white light?
(a) No fringes are observed.
(b) All bright fringes become while.
(c) All bright fringes have colour between violet and red.
(d) Only the central fringe is white and all other fringes are coloured.
Ans. (d) Only the central fringe is white and all other fringes are coloured.
At central bright fringes of all wavelength overlap to produce white central fringe.

5. In Young's double-slit experiment, the intensity at the central maximum is I0 if one of the slit is covered, then the intensity at the central maximum become:
(a) $\frac{I_0}{2}$ (b) $\frac{I_0}{\sqrt{2}}$ (c) $\frac{I_0}{4}$ (d) I_0
Ans. (d) I_0

6. In a Young's double slit experiment, the source is white light. One of the holes is covered by a red filter and another by a blue filter. In this case
(a) there shall be alternate interference patterns of red and blue.
(b) there shall be an interference pattern for red distinct from that for blue.

(c) there shall be no interference fringes.
(d) there shall be an interference pattern for red mixing with one for blue.
Ans. (c) there shall be no interference fringes.

7. Figure shows a standard two slit arrangement with slits S_1, S_2. P_1, P_2 are the two minima points on either side of P (Figure). At P_2 on the screen, there is a hole and behind P_2 is a second 2- slit arrangement with slits S_3, S_4 and a second screen behind them.



(a) There would be no interference pattern on the second screen but it would be lighted.
(b) The second screen would be totally dark.
(c) There would be a single bright point on the second screen.
(d) There would be a regular two slit pattern on the second screen.
Ans. (d) There would be a regular two slit pattern on the second screen.

8. An interference pattern is observed by Young's double slit experiment. If now the separation between coherent sources is halved and the distance of screen from coherent sources is doubled, the new fringe width
(a) becomes double
(b) becomes one-fourth
(c) remains the same
(d) becomes four times
Ans. (d) becomes four times
Fringe width becomes four time.
As $\beta = \frac{D\lambda}{d}$, $\beta' = \frac{2 \times 2D\lambda}{d} = 4\beta$

In the following questions 9 and 10, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

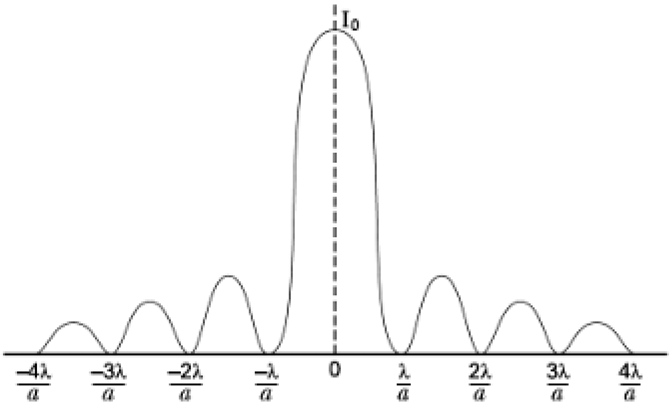
9. Assertion (A): In interference and diffraction of light, light energy reduces in one region producing a dark fringe. It increases in another region and produces a bright fringe.
Reason (R): This happens because energy is not conserved in the phenomena of interference and diffraction.
Ans. (c) Assertion is true and Reason is false.
In interference and diffraction energy disappearing from dark fringes reappears at bright fringes. Hence, there is no creation or destruction of energy in interference. It is only redistribution of energy. This means that interference and diffraction follow conservation of energy.

10. Assertion (A): In Young's double slit experiment all fringes are of equal width.
Reason (R): The fringe width depends upon wavelength of light (λ) used, distance of screen from plane of slits (D) and slits separation (d).
Ans. (a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
In Young's double slit experiment, the fringes are of equal width. The width of the fringes depends upon the wavelength of light used, the distance of the screen from the plane of the slits and the separation between the slits.

SECTION – B

Questions 11 to 14 carry 2 marks each.

11. Draw the graph showing intensity distribution of fringes with phase angle due to diffraction through single slit.
Ans.



Intensity distribution of diffraction pattern.

12. What is the effect on the interference fringes in Young's double slit experiment due to each of the following operations? Justify your answers.
(a) The screen is moved away from the plane of the slits.
(b) The separation between slits is increased.
(c) The source slit is moved closer to the plane of double slit.

Ans. (a) Fringe width increases, $\beta = \frac{\lambda D}{d} \Rightarrow \beta \propto D$

(b) Fringe width decreases as $\beta \propto \frac{1}{d}$

(c) Since condition $\frac{s}{S} < \frac{\lambda}{d}$ is not satisfied, no interference will be obtained and frenges disappear.

OR

How will the interference pattern in Young's double-slit experiment be affected if:
(a) the screen is moved away from the plane of the slits.
(b) the source slit is moved away from the plane of the slits.
(c) the phase difference between the light waves emanating from the two slits S_1 and S_2 changes from 0 to π and remains constant.

Ans. (a) When the screen is moved away, 'D' increase, therefore, the width of the fringes increases.
(b) The fringe pattern becomes weaker and less distinct as the width of the source increases. When the source slit is too far the interference pattern disappears.
(c) Because the phase difference between the light waves from two slits is unexpected after shifting to π, the core fringe will turn black.

13. Two coherent monochromatic light beams of intensities I and 4I superpose each other. Find the ratio of maximum and minimum intensities in the resulting beam.
Ans.

$$\frac{I_{max}}{I_{min}} = \frac{(a_1+a_2)^2}{(a_1-a_2)^2} = \frac{(\sqrt{I}+2\sqrt{I})^2}{(\sqrt{I}-2\sqrt{I})^2} \qquad (\because a_1^2 = I, a_1 = \sqrt{I} \qquad a_2^2 = 4I, a_2 = 2\sqrt{I})$$

$$\therefore \frac{I_{max}}{I_{min}} = \frac{[\sqrt{I}(1+2)]^2}{[\sqrt{I}(1-2)]^2} = \frac{\mathbf{9}}{\mathbf{1}}$$

OR

Find the intensity at a point on a screen in Young's double slit experiment where the interfering waves of equal intensity have a path difference of (i) λ/4, and (ii) λ/3.

Ans. As we know, $I = 4I_0 \cos^2 \frac{\phi}{2}$

(i) If path difference $= \frac{\lambda}{4} \Rightarrow \phi = \frac{2\pi}{\lambda} \times \Delta = \frac{2\pi}{\lambda} \times \frac{\lambda}{4} = \frac{\pi}{2}$

Also, $\Rightarrow I = 4I_0 \cos^2 \frac{\phi}{2} = 4I_0 \cos^2 \frac{\pi}{4} = 2I_0$

(ii) If $\Delta = \frac{\lambda}{3} \Rightarrow \phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{3} = \frac{2\pi}{3}$

$\therefore I = 4I_0 \cos^2 \frac{\phi}{2} = 4I_0 \cos^2 \left(\frac{2\pi}{3 \times 2}\right) = I_0$

14. In a Young's double slit experiment, the separation between the two slits is d and distance of the screen from the slits is 1000 d. If the first minima falls at a distance d from the central maximum, obtain the relation between d and λ.

Ans. Given that: D = 1000d

$\frac{xd}{D} = \frac{\lambda}{2} \Rightarrow \frac{d \times d}{D} = \frac{\lambda}{2}$

$\Rightarrow \frac{d \times d}{1000d} = \frac{\lambda}{2} \Rightarrow d = 500\lambda$

OR

In Young's double-slit experiment, the two slits are separated by a distance equal to 100 times the wavelength of light that passes through the slits. Calculate:

(a) the angular separation in radians between the central maximum and the adjacent maximum.

(b) the distance between these two maxima on a screen 50 cm from the slits.

Ans.

Here, $d = 100\,\lambda$ (given), $D = 50$ cm.

(*a*) Angular width, $\theta = \frac{\lambda}{d} = \frac{\lambda}{100\lambda} = \mathbf{0.01\ rad.}$

(*b*) Fringe width, $\beta = \frac{\lambda D}{d} = \frac{\lambda}{100\lambda} \times 50 = \frac{50}{100} = \mathbf{0.5\ cm}$

SECTION – C

Questions 15 to 17 carry 3 marks each.

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

(*b*) 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 a distance of 2.5 mm away from the centre. Find the width of the slit.

Ans:

Interference	Diffraction
(*i*) It is due to the superposition of two waves coming from two coherent sources.	(*i*) It is due to the superposition of secondary wavelets originating from different parts of the

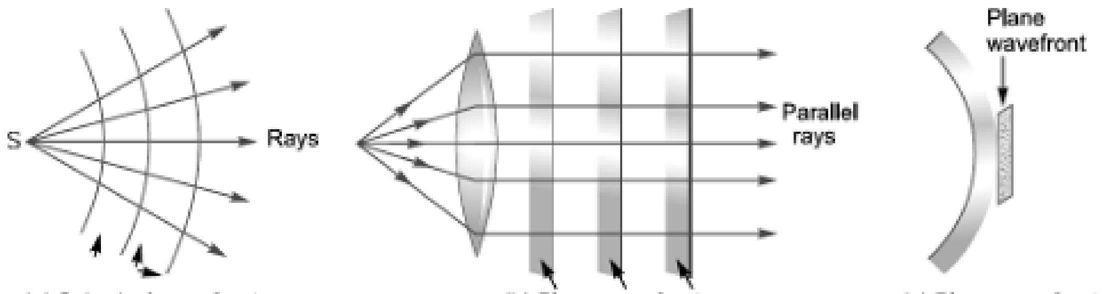
	same wavefront.
(*ii*) The width of the interference bands is equal.	(*ii*) The width of the diffraction bands is not the same.
(*iii*) The intensity of all maxima (fringes) is same.	(*iii*) The intensity of central maximum is maximum and goes on decreasing rapidly with increase of order of maxima.

(*b*) The distance of nth bright fringe from central fringe is, $y_n = \frac{n\lambda D}{d}$

Width, $d = \frac{n\lambda D}{y_n} = \frac{1\times 500\times 10^{-9}\times 1}{2.5\times 10^{-3}} = 2\times 10^{-4}$ m = 0.2 mm

OR

What is the shape of the wavefront in each of the following cases:
(a) light diverging from a point source.
(b) light emerging out of a convex lens when a point source is placed at its focus.
(c) the portion of a wavefront of light from a distant star intercepted by the earth.
Ans. (a) The wavefront will be spherical of increasing radius, fig. (a).
(b) The rays coming out of the convex lens, when point source is at focus, are parallel, so wavefront is plane, fig. (b).



(a) Spherical wavefront (b) Plane wavefront (c) Plane wavefront

(c) The wavefront starting from star is spherical. As star is very far from the earth, so the wavefront intercepted by earth is a very small portion of a sphere of large radius; which is plane (i.e., wavefront intercepted by earth is plane), fig. (c).

16. Derive an expression for the de-Broglie wavelength associated with an electron accelerated through a potential V. Draw a schematic diagram of a localised-wave describing the wave nature of the moving electron.
Ans: **Expression for de Broglie Wavelength associated with Accelerated Electrons**
The de Broglie wavelength associated with electrons of momentum p is given by

$$\lambda = \frac{h}{p} = \frac{h}{mv} \qquad \text{...............} \quad \text{(i)}$$

where m is mass and v is velocity of electron. If E_k is the kinetic energy of electron, then

$$E_k = \frac{1}{2}mv^2 \frac{1}{2}m\left(\frac{p}{m}\right)^2 = \frac{p^2}{2m} \qquad \left(\because p = mv \Rightarrow v = \frac{p}{m}\right)$$

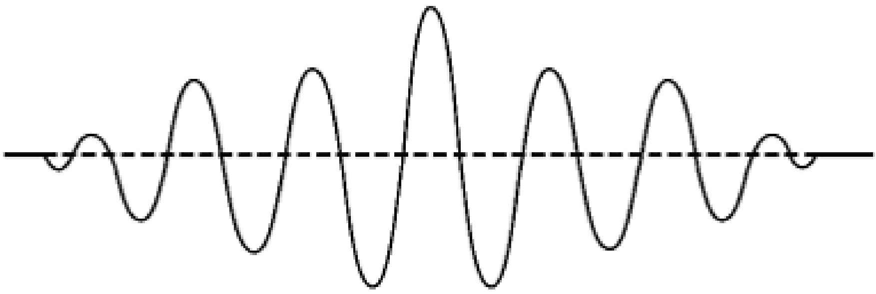
$$\Rightarrow p = \sqrt{2mE_k}$$

$\therefore$ Equation (*i*) gives $\lambda = \frac{h}{\sqrt{2mE_k}}$ .... (ii)

If V volt is accelerating potential of electron, then Kinetic energy, $E_K = eV$

$\therefore$ Equation (*ii*) gives $\lambda = \frac{h}{\sqrt{2meV}}$ .... (iii)

This is the required expression for de Broglie wavelength associated with electron accelerated to potential of V volt. The diagram of wave packet describing the motion of a moving electron is shown.

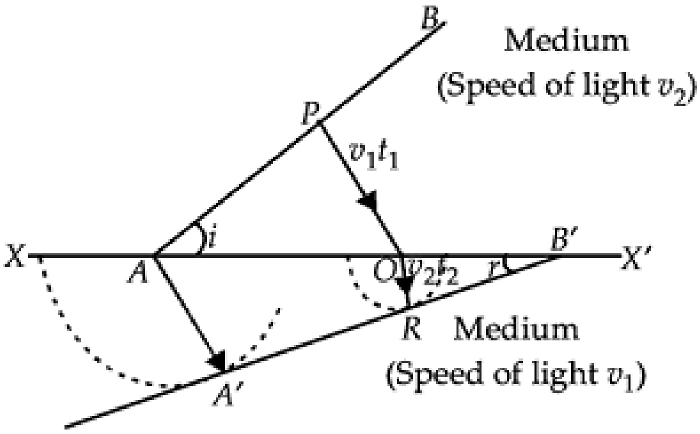


OR

Define the term wavefront. Using Huygen's wave theory, verify the law of refraction.

Ans: **Wavefront:** A wavefront is a locus of particles of medium all vibrating in the same phase.

Verification of Snell's law of refraction by using Huygen's principle.



We take a plane wavefront AB incident at a plane surface XX'. We use secondary wavelets starting at different times. We get refracted wavefront only when time taken by light to travel along different rays from one wavefront to another is same. We take any arbitrary ray starting from point P on incident wavefront to refracted wavefront at point R.

Let total time be t

$$t = \frac{PO}{v_1} + \frac{OR}{v_2} = \frac{AO\sin i}{v_1} + \frac{(AB' - AO)\sin r}{v_2}$$

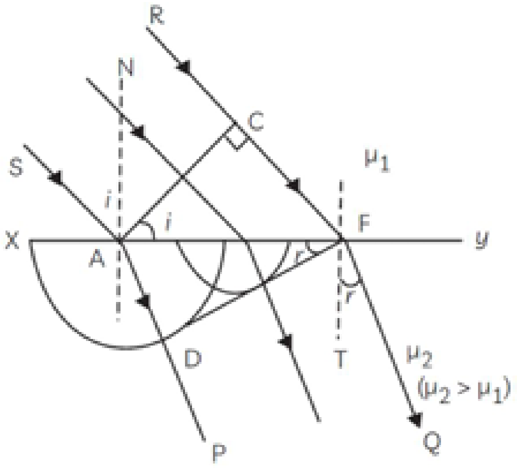
$$\Rightarrow t = \frac{AB'\sin r}{v_2} + AO\left(\frac{\sin i}{v_1} - \frac{\sin r}{v_2}\right)$$

As time should be independent of the ray to be considered, the coefficient of AO in the above equation should be zero.

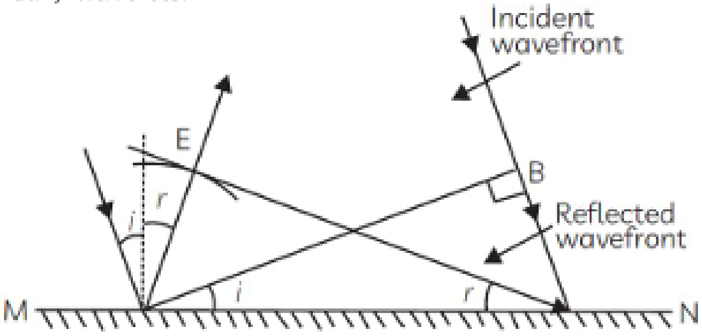
That is, $\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = {}^1\mu_2$, where ${}^1\mu_2$ is called refractive index of medium 2 w.r.t. medium 1. This is Snell's law of refraction.

17. State Huygen's principle. With the help of a diagram, show how a plane wave is reflected from a surface. Hence verify the law of reflection.

Ans. Huygen's principle states that each point on a wavefront can be considered as a source of secondary wavelets that spread out in all directions with a speed equal to the speed of propagation of the wave. The wavefront at a later time is the envelope of all these secondary wavelets. When a plane wave is incident on a reflecting surface, each point on the wavefront can be considered as a source of secondary wavelets. These secondary wavelets propagate in all directions, including back towards the reflecting surface. The reflected wavefront is then formed by the envelope of all these reflected secondary wavelets. Here is a diagram showing the reflection of a plane wave from a surface:



In this diagram, the incident plane wave is shown propagating towards the surface. Each point on the wavefront is considered as a source of secondary wavelets, which spread out in all directions, including back towards the surface. The reflected wavefront is formed by the envelope of all these reflected secondary wavelets.



To verify the law of reflection, we can draw a line perpendicular to the reflecting surface at the point of incidence, which is called the normal. The angle of incidence, i, is the angle between the incident wave and the normal, and the angle of reflection, r, is the angle between the reflected wave and the normal. According to the law of reflection, the angle of incidence is equal to the angle of reflection, i.e., i = r.

In the diagram above, the incident wave is shown at an angle of incidence i with respect to the normal, and the reflected wave is shown at an angle of reflection r with respect to the normal. The angle of incidence is equal to the angle of reflection, i.e., i = r, which verifies the law of reflection.

OR

Explain the following, giving reasons:

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

(ii) When light travels from a rarer to a denser medium, the 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?

Ans. (i) 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.

(ii) No; when light travels from a rarer to a denser media, its frequency remains unchanged. According to quantum theory of light, the energy of light photon depends on frequency and not on speed.

(iii) For a given frequency, intensity of light in the photon picture is determined by the number of photon incident normally on a crossing an unit area per unit time.

SECTION – D

Questions 18 carry 5 marks.

18. 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.

Ans: Diffraction of light at a single slit : When monochromatic light is made incident on a single slit, we get diffraction pattern on a screen placed behind the slit. The diffraction pattern contains bright and dark bands, the intensity of central band is maximum and goes on decreasing on both sides.

Explanation : Let AB be a slit of width 'a' and a parallel beam of monochromatic light is incident on it. According to Fresnel the diffraction pattern is the result of superposition of a large number of waves, starting from different points of illuminated slit.

Let θ be the angle of diffraction for waves reaching at point P of screen and AN the perpendicular dropped from A on wave diffracted from B.

The path difference between rays diffracted at points A and B,

$$\Delta = BP - AP = BN$$

In $\Delta\, ANB$, $\angle ANB = 90^\circ$ $\therefore$ and $\angle BAN = \theta$

As AB = width of slit = a

$\therefore$ Path difference, $\Delta = a \sin\theta$ .... (i)

To find the effect of all coherent waves at P, we have to sum up their contribution, each with a different phase. This was done by Fresnel by rigorous calculations, but the main features may be explained by simple arguments given below :

At the central point C of the screen, the angle θ is zero. Hence the waves starting from all points of slit arrive in the same phase. This gives maximum intensity at the central point C.

If point P on screen is such that the path difference between rays starting from edges A and B is λ, then path difference

$a\sin\theta = \lambda \Rightarrow \sin\theta = \dfrac{\lambda}{a}$

If angle θ is small, $\sin\theta = \theta = \dfrac{\lambda}{a}$ ....(ii)

Minima : Now we divide the slit into two equal halves AO and OB, each of width $\dfrac{a}{2}$. Now for every point, M_1 in AO, there is a corresponding point M_2 in OB, such that $M_1M_2 = \dfrac{a}{2}$; Then path difference between waves arriving at P and starting from M_1 and M_2 will be $\dfrac{a}{2}\sin\theta = \dfrac{\lambda}{2}$. This means that the contributions from the two halves of slit AO and OB are opposite in phase and so cancel each other. Thus equation (2) gives the angle of diffraction at which intensity falls to zero.

Similarly it may be shown that the intensity is zero for $\sin\theta = \dfrac{n\lambda}{a}$, with n as integer.

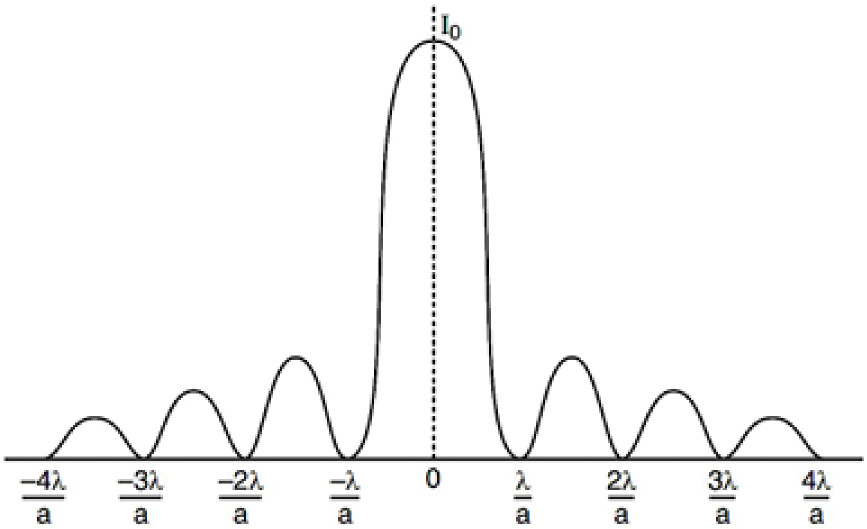
Thus the general condition of **minima** is

$a \sin\theta = n\lambda$ ....(iii)

Secondary Maxima : Let us now consider angle θ such that $\sin\theta = \theta = \dfrac{3\lambda}{2a}$

which is midway between two dark bands given by

$\sin\theta = \theta = \dfrac{\lambda}{a}$ *and* $\sin\theta = \theta = \dfrac{2\lambda}{a}$



Let us now divide the slit into three parts. If we take the first two of parts of slit, the path difference between rays diffracted from the extreme ends of the first two parts

$$\frac{2}{3}a\sin\theta = \frac{2}{3}a \times \frac{3\lambda}{2a} = \lambda$$

Then the first two parts will have a path difference of $\frac{\lambda}{2}$ and cancel the effect of each other. The remaining third part will contribute to the intensity at a point between two minima. Clearly there will be a maxima between first two minima, but this maxima will be of much weaker intensity than central maximum. This is called *first secondary maxima*. In a similar manner we can show that there are secondary maxima between any two consecutive minima; and the intensity of maxima will go on decreasing with increase of order of maxima. In general the position of *n*th maxima will be given by

$$a\sin\theta = \left(n + \frac{1}{2}\right)\lambda, \ [n = 1, 2, 3, 4, \ldots] \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(iv)$$

The intensity of secondary maxima decrease with increase of order n because with increasing n, the contribution of slit decreases.

For $n = 2$, it is one-fifth, for $n = 3$, it is one-seventh and so on.

(*b*) Angular width of secondary maxima

$$a.\theta = \left(n + \frac{1}{2}\right)\lambda$$

$$\Rightarrow \theta = \left(n + \frac{1}{2}\right)\frac{\lambda}{a}$$

and Linear width $\theta = \frac{y}{D}$

$$\Rightarrow y = D.\theta = \left(n + \frac{1}{2}\right)\frac{\lambda D}{a}$$

If $n = 1$, and $\lambda_1 = 590$ nm,

$$y_1 = \left(1 + \frac{1}{2}\right)\frac{\lambda_1 D}{a} = \frac{3\lambda_1 D}{2a}$$

If $n = 1$ $\lambda_2 = 596$ nm

$$y_2 = \left(1 + \frac{1}{2}\right)\frac{\lambda_2 D}{a} = \frac{3\lambda_2 D}{2a}$$

Linear separation $= y_2 - y_1 = \frac{3(\lambda_2 - \lambda_1)D}{2a}$

$$= \frac{3(596-590)\times10^{-9}\times1.5}{2\times2\times10^{-6}} = \frac{3\times6\times10^{-3}\times1.5}{4}$$

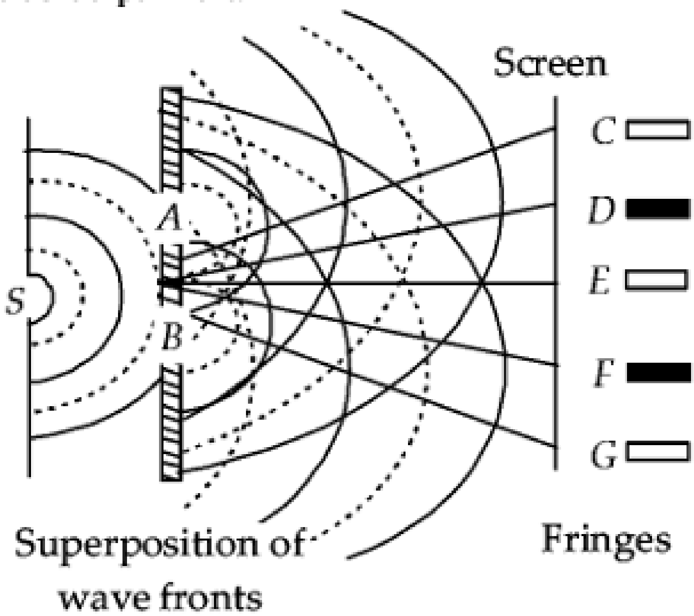
$= 4.5 \times 1.5 \times 10^{-3}$

$= 6.75 \times 10^{-3} = 6.75$ mm

OR

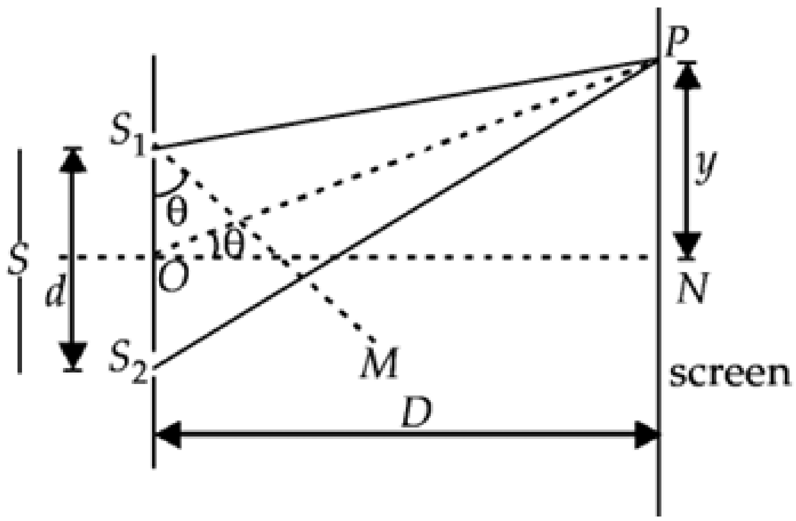
Describe Young's double slit experiment to produce interference pattern due to a monochromatic source of light. Deduce the expression for the fringe width.

Ans: **Young's double slit experiment:**



S is a narrow slit (of width about 1 mm) illuminated by a monochromatic source of light, S. At a suitable distance (about 10 cm) from S, there are two fine slits A and B about 0.5 mm apart placed symmetrically parallel to S. When a screen is placed at a large distance (about 2 m) from the slits A and B, alternate bright and dark fringes running parallel to the lengths of slits appear on the screen. These are the interference fringes. The fringes disappear when one of the slits A or B is covered.

Expression for fringe width : In Young's double slit experiment we obtain two sources from a single source.



Here S_1P and S_2P are nearly parallel since the distance $S_1S_2 = d$ is much less than D. The angle that these two lines make with the normal to the screen is taken as θ.

Path difference between the waves reaching the point P on screen is

$\Delta P = S_2P - S_1P = S_2P - MP = S_2M = d\sin\theta$

As angle is very small

$d\sin\theta \approx d\tan\theta$

i.e. $\Delta P = \frac{yd}{D} \left(\because in\ \Delta NOP, \tan\theta = \frac{y}{D} \right)$ ……………....(i)

We know, that for maxima

$\Delta P = n\lambda$ ……………………..(ii)

where, $n = 1, 2, 3, ...$

From equation (i) and (ii), we get

$$y_n = \frac{n\lambda D}{d}$$

Similarly for minima

$$y_n = \frac{(2n-1)\lambda D}{2d}$$

The fringe width is the separation between two consecutive maxima or minima,

$$\Delta y == \frac{\lambda D}{d}(n+1-n) = \frac{\lambda D}{d}$$

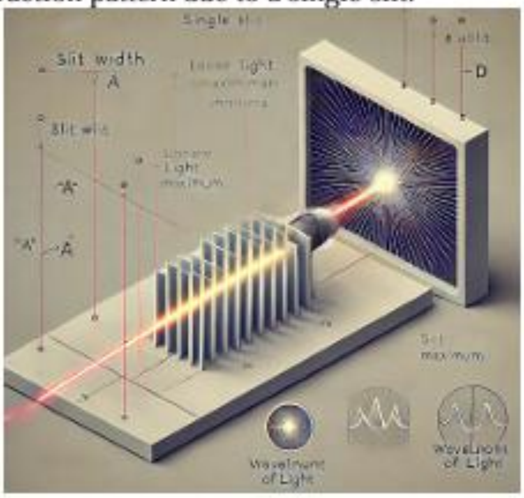
It is denoted by β

$$\beta == \frac{\lambda D}{d}$$

SECTION – E (Case Study Based Questions)

Questions 19 to 20 carry 4 marks each.

19. Diffraction: Diffraction of light is bending of light around the corners of an object whose size is comparable with the wavelength of light. Diffraction actually defines the limits of ray optics. This limit for optical instruments is set by the wavelength of light. An experimental arrangement is set up to observe the diffraction pattern due to a single slit.



(i) The penetration of light into the region of geometrical shadow is called

(a) polarisation (b) interference (c) diffraction (d) refraction

(ii) To observe diffraction, the size of an obstacle

(a) should be of the same order as wavelength

(b) should be much larger than the wavelength

(c) have no relation to wavelength

(d) should be exactly $l/2$

(iii) Both, light and sound waves produce diffraction. It is more difficult to observe diffraction with light waves because

(a) light waves do not require medium (b) wavelength of light waves is too small

(c) light waves are transverse in nature (d) speed of light is far greater

(iv) Angular width of central maximum of a diffraction pattern of a single slit does not depend upon
(a) distance between slit and source (b) wavelength of light used
(c) width of the slit (d) frequency of light used

OR

The diffraction effect can be observed in
(a) only sound waves (b) only light waves
(c) only ultrasonic waves (d) sound as well as light waves

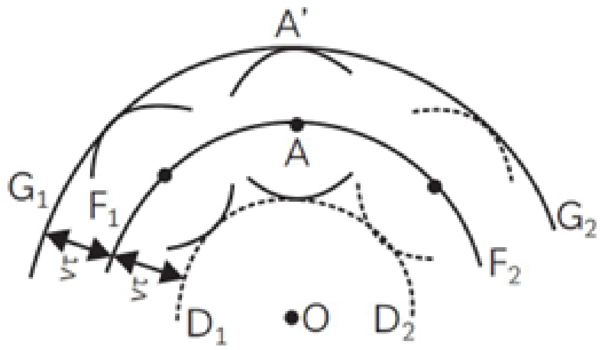
Ans. (i) (c) The bending of light around the corners is known as diffraction of light. So, the light penetrates into the region of geometrical shadow.
(ii) (a) To observe diffraction, the size of obstacle should be of the same order as that of the wavelength.
(iii) (b) It is more difficult to observe diffraction with light waves because wavelength of light waves is far too smaller compared to that of sound waves.
(iv) (a) Angular width, $\theta = \frac{\lambda}{d} = \frac{c}{\nu d}$
Hence, angular width depend upon wavelength of light used, width of slit and frequency of light used.

OR

(d) The diffraction effect can be observed in sound as well as in light waves.

20. Huygen's principle:

According to Huygen's principle, each point of the wavefront is the source of a secondary disturbance and the wavelets emanating from these points spread out in all directions with the speed of the wave. These wavelets emanating from the wavefront are usually referred to as secondary wavelets and if we draw a common tangent to all these spheres, we obtain the new position of the wavefront at a later time.



(i) According to the Huygen's principle, light is a form of:
(a) particle
(b) rays
(c) wave
(d) particle and wave both

(ii) Huygen's wave theory allows us to know:
(a) the wavelength of the wave
(b) the velocity of the wave
(c) the amplitude of the wave
(d) the propagation of wavefronts

(ii) A 'wavefront' is the surface of constant:
(a) phase (b) frequency
(c) wavelength (d) amplitude

(iv) The wavefront due to a source situated at infinity is:
(a) spherical (b) cylindrical
(c) planar (d) rectilinear

Ans. (i) (c) wave
Huygen's suggested that light travels in a form of longitudinal waves just as sound propagates through air. He proposed that light waves propagate through an all-pervading hypothetical medium, called luminiferous ether.
(ii) (d) the propagation of wavefronts
Huygen's wave theory explain the propagation of wavefronts and secondary wavelets.
(iii) (a) phase
A wavefront is the continuous locus of all such particles of the medium which are vibrating in the same phase at any instant.
(iv) (c) planer
As a spherical or cylindrical wavefront advances, its curvature decreases progressively. So a small portion of such a wavefront at a large distance from the source will be a plane wavefront.