SURE SHOT QUESTIONS 2026

Chapter – 10 (Questions)

Wave Optics

➢ Questions

1. Two waves, each of amplitude 'a' and frequency 'ω' emanating from two coherent sources of light superpose at a point. If the phase difference between the two waves is ϕ, obtain an expression for the resultant intensity at that point.

2. Write two points of difference between interference and diffraction of light.

3. Define wavefront of a travelling wave. Using Huygens principle, obtain the law of refraction at a plane interface when light passes from a rarer to a denser medium.

4. In a single slit diffraction experiment, the width of the slit is decreased. How will the (i) size (ii) intensity of the central bright band be affected. Justify your answer.

5. Draw the intensity pattern for single slit diffraction and double slit interference. Hence, state two differences between interference and diffraction patterns.

6. A plane wavefront is propagating from a rarer into a denser medium. Use Huygens principle to show the refracted wavefront and verify Snell's law.

7. Define the term wavefront. Using Huygens wave theory, verify the law of reflection.

8. 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?

9. (a) 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,

(b) What kind of fringes do you expect to observe if white light is used instead of monochromatic light?

10. Answer the following questions:

(a) In a double slit experiment using light of wavelength 600 nm, the angular width of the fringe formed on a distant screen is 0.1^0. Find the spacing between the two slits.

(b) Light of wavelength 500 $\overset{0}{A}$ 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?

11. Why cannot two independent monochromatic sources produce sustained interference pattern?

12. What is a wavefront? How does it propagate? Using Huygens' principle, explain reflection of a plane wavefront from a surface and verify the laws of reflection.

OR

Define a wavefront. Using Huygen's principle verify the laws of reflection at a plane surface.

13. (a) Define a wavefront. How is it different from a ray?

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

(i) Light diverging from point source.

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

(iii) Using Huygen's construction of secondary wavelets, draw a diagram showing the passage of a plane wavefront from a denser into a rarer medium.

14. In Young's double slit experiment, deduce the condition for (a) constructive, and (b) destructive

interference at a point on the screen. Draw a graph showing variation of intensity in the interference pattern against position 'x' on the screen.

15. (a) 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.
(b) What king of fringes do you expect to observe if white light is used instead of monochromatic light?

16. (a) Why are coherent sources necessary to produce a sustained interference pattern?
(b) 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 $\lambda/3$.

17. A parallel beam of light of 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.

18. 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 3rd order maxima on one side of the screen. The distance between the slit and the screen is 1.5 m.

19. Use Huygen's principle to verify the laws of refraction.

20. (i) Define a wavefront. How it is 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 Huygens construction of secondary wavelets, draw a diagram showing the passage of a plane wavefront from a denser into a rarer medium.

21. Use Huygens' Principle to show how a plane wavefront propagates from a denser to a rarer medium. Hence, Verify Snell's law of refraction.

22. Define the term 'coherent sources' which are required to produce interference pattern in Young's double slit experiment.

23. Draw the intensity pattern for single slit diffraction and double slit interference. Hence, state two differences between interference and diffraction patterns.

24. Find the intensity at appoint on a screen in Young's double slit experiment where the interfering waves have a path difference of (i) $\lambda/6$, and (ii) $\lambda/2$.

25. Write the distinguishing features between a diffraction pattern due to a single slit and the interference fringes produced in Young's double slit experiment.

26. Yellow light ($\lambda = 6000$ Å) illuminates a single slit of width 1×10^{-4} m. Calculate : (i) the distance between the two dark lines on either side of central maximum, when the diffraction pattern is viewed on a screen kept 1.5 m away from the slit, (ii) The angular spread of the first diffraction minimum.

27. Give 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 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 the 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?

28. What is interference of light? Write two essential conditions for sustained interference pattern to be produced on the screen.
Draw a graph showing the variation of intensity versus the position on the screen in Young's experiment when (a) both the slits are opened and (b) one of the slits is closed.
What is the effect on the interference pattern in Young's double slit experiment when:

i. Screen is moved closer to the plane of slits?

ii. Separation between two slits is increased?

Explain your answer in each case.

29. In Young's double slit experiment using monochromatic light of wavelength λ, the intensity at a point on the screen where path difference is λ is K units. What is the intensity of light at a point where path difference is $\frac{\pi}{3}$?

30. Light of wavelength $6 \times 10^{-5}\ cm$ falls on a screen at a distance of 100 cm from a narrow slit. Find the width of the slit if the first minima lies 1 mm on either side of the central maximum.

31. In a single slit diffraction experiment first minimum for $\lambda_1 = 660\ nm$ coincides with first maxima for wavelength λ_2 Calculate λ_2.

32. Yellow light ($\lambda = 6000\ \text{Å}$) illuminates a single slit of width 1×10^{-4} m. Calculate the distance between two dark lines on either side of the central maximum, when the diffraction pattern is viewed on a screen kept $1.5\ m$ away from the slit.

33. 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. (a) Find the distance of the second (i) bright fringe, (ii) dark fringe from the central maximum.

(b) How will the fringe pattern change if the screen is moved away from the slits?

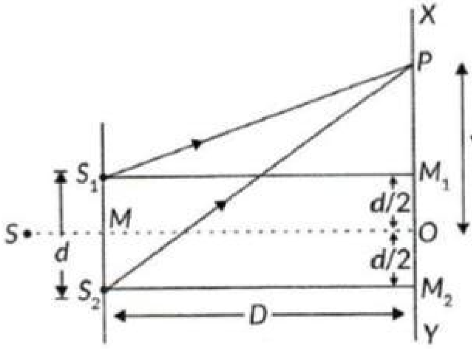
SURE SHOT QUESTIONS 2026

Chapter – 10 (Solutions)

Wave Optics

➢ Solutions

1. Ans. (a) Light waves each of amplitude "a" and frequency "ω", emanating from two coherent light sources superpose at a point. The displacements due to these waves is given by Y_1 = a cos ωt and. Y_2 = a cos (ωt +ϕ) where ϕ is the phase difference between the two



Resultant displacement at point *P* will be,

$$y = y_1 + y_2 = a\cos\omega t + a\cos(\omega t + \phi)$$
$$= a[\cos\omega t + \cos(\omega t + \phi)]$$
$$= a\left[2\cos\frac{(\omega t + \omega t + \phi)}{2}\cos\frac{(\omega t - \omega t - \phi)}{2}\right]$$

$$y = 2a\cos\left(\omega t + \frac{\phi}{2}\right)\cos\left(\frac{\phi}{2}\right) \quad \text{...(i)}$$

Let $2a\cos\left(\frac{\phi}{2}\right) = A$, then equation (i) becomes

$$y = A\cos\left(\omega t + \frac{\phi}{2}\right)$$

where *A* is amplitude of resultant wave,

Now, $A = 2a\cos\left(\frac{\phi}{2}\right)$

On squaring, $A^2 = 4a^2\cos^2\left(\frac{\phi}{2}\right)$

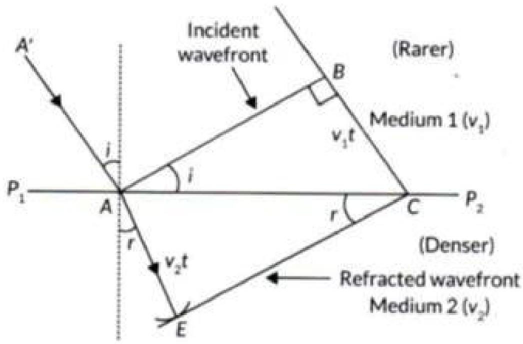
Hence, resultant intensity, $I = 4I_0\cos^2\left(\frac{\phi}{2}\right)$

2. Ans. Difference between interference and diffraction

	Interference	Diffraction
1.	Interference is caused by superposition of two waves starting from two coherent sources.	Diffraction is caused by superposition of a number of waves starting from the slit.
2.	All bright and dark fringes are of equal width.	Width of central bright fringe is double of all other maxima.
3.	All bright fringes are of same intensity.	Intensity of bright fringes decreases sharply as we move away from central bright fringe.
4.	Dark Fringes are perfectly dark.	Dark fringes are not perfectly dark.

3. Ans. A source of light sends the disturbance in all the directions and continuous locus of all the particles vibrating in same phase at any instant is called as wavefront.

Given figure shows the refraction of a plane wavefront at a rarer medium i.e., $v_1 > v_2$



The incident and refracted wavefronts are shown in figure.

Let the angles of incidence and refraction be i and r respectively.

From right ΔABC, we have,

$$\sin\angle BAC = \sin i = \frac{BC}{AC}$$

From right ΔAEC, we have,

$$\sin\angle ECA = \sin r = \frac{AE}{AC}$$

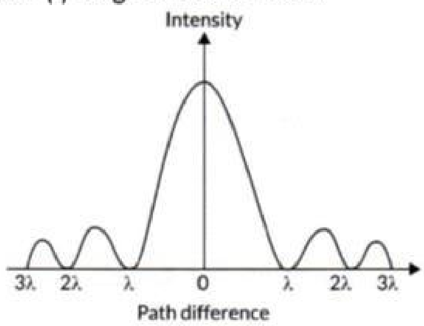
$$\therefore \frac{\sin i}{\sin r} = \frac{BC}{AE} = \frac{v_1 t}{v_2 t} \; or \; \frac{\sin i}{\sin r} = \frac{v_1}{v_2} = {}^1\mu_2 \quad \text{(a constant)}$$

This verifies Snell's law of refraction. The constant ${}^1\mu_2$ is called the refractive index of the second medium with respect to first medium.

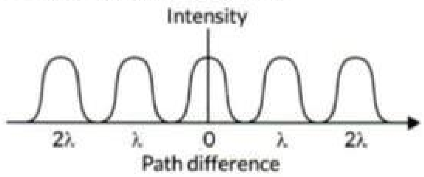
4. Ans. Width of central maximum is given by $\beta_0 = \frac{2D\lambda}{a}$

If width of slit is reduced then (i) size of central maxima will increase and (ii) intensity of central maximum will decrease.

5. Ans. (i) Single slit diffraction:



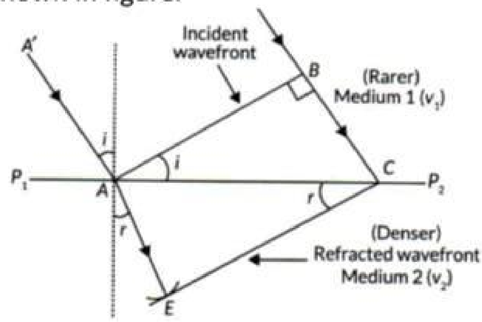
Double slit interference:



(ii) Difference between interference and diffraction

	Interference		Diffraction
1.	Interference is caused by superposition two waves starting from two coherent sources	1.	Diffraction is caused by superposition of a number of waves starting from the slit.
2.	All bright and dark fringes are of equal width.	2.	Width of central bright fringe is double of all other maxima.
3.	All bright fringes are of same intensity.	3.	Intensity of bright fringes decreases sharply as we move away from central bright fringe.
4.	Dark Fringes are perfectly dark.	4.	Dark fringes are not perfectly dark.

6. Ans. Snell's law of refraction : Let P_1P_2 represents the surface separating medium 1 and medium 2 as shown in figure.



Let v_1 and v_2 represents the speed of light in medium 1 and medium 2 respectively. We assume a plane wavefront AB propagating in the direction A'A incident on the interface at an angle i. Let t be the time taken by the wavefront to travel the distance BC.

$\therefore BC = v_1 t$ [∵ distance = speed x time]

In order to determine the shape of the refracted wavefront, we draw a sphere of radius v_2t from the point A in the second medium (the speed of the wave in second medium is v_2).

Let CE represents a tangent plane drawn from the point C. Then
AE = v_2t
∴ CE would represent the refracted wavefront.
In ΔABC and ΔAEC, we have

$$\sin i = \frac{BC}{AC} = \frac{v_1 t}{AC} \; and \; \sin r = \frac{AE}{AC} = \frac{v_2 t}{AC}$$

Where i and r are the angles of incident and refraction respectively.

$$\therefore \frac{\sin i}{\sin r} = \frac{v_1 t}{AC} \cdot \frac{AC}{v_2 t} \Rightarrow \frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$

If c represents the speed of light in vacuum, then

$$\mu_1 = \frac{c}{v_1} \; and \; \mu_2 = \frac{c}{v_2} \Rightarrow v_1 = \frac{c}{\mu_1} \; and \; v_2 = \frac{c}{\mu_2}$$

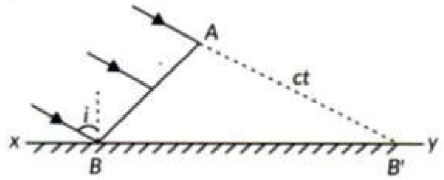
Where μ_1 and μ_2 are the refractive indices of medium 1 and medium 2.

$$\therefore \frac{\sin i}{\sin r} = \frac{c/\mu_1}{c/\mu_2} \Rightarrow \frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$$

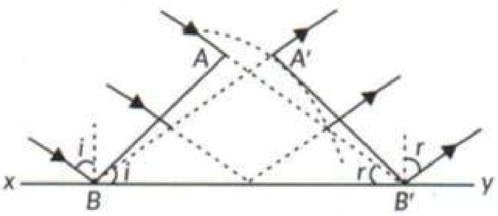
$$\Rightarrow \mu_1 \sin i = \mu_2 \sin r$$

This is the Snell's law of refraction

7. Ans. A source of light sends the disturbance in all the directions and continuous locus of all the particles vibrating in same phase at any instant is called as wavefront. Laws of reflection by Huygens' principle : Let us consider a plane wavefront AB incident on the plane reflecting surface xy. Incident rays are normal to the wavefront AB.



Let in time t the secondary wavelets reaches B' covering a distance ct. Similarly from each point on primary wavefront AB. Secondary wavelets start growing with the speed c. To find reflected wavefront after time t, let us draw a sphere of radius ct taking B as center and now a tangent is drawn from B' on the sphere the tangent B'A' represents reflected wavefront after time t.



For every point on wavefront AB a corresponding point lie on the reflected wavefront A'B'.
So, comparing two triangle $\Delta BAB'$ and $\Delta B'A'B$
We find that

$AB' = A'B = ct$

$BB' = common$

$\angle A = \angle A' = 90^0$

Thus two triangles are congruent, hence $\angle i = \angle r$
This proves first law of reflection.
Also incident rays, reflected rays and normal to them all lie in the same plane. This gives second law of reflection.

8. 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) Energy carried by a wave depends on the frequency of the wave, not on the speed of wave propagation.

9. Ans. (a) We know, $\frac{I_{max}}{I_{min}} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2}$

According to question, $I_2 = 50\%\ of\ I_1$

$I_2 = 0.5 I_1;\ a_2^2 = 0.5 a_1^2\ (\because\ I \propto a^2)$

$a_2 = \frac{a_1}{\sqrt{2}}$

Hence,

$$\frac{I_{max}}{I_{min}} = \frac{(a_1 + a_1/\sqrt{2})^2}{(a_1 - a_1/\sqrt{2})^2} = \frac{(1+1/\sqrt{2})^2}{(1-1/\sqrt{2})^2} = \left(\frac{\sqrt{2}+1}{\sqrt{2}-1}\right)^2 \approx 34$$

(b) The central fringes are white. On the either side of the central white fringe the coloured bands (few coloured maxima and minima) will appear. This is because fringes of different colours overlap.

10. Ans. (a) Angular width, $\theta = \frac{\lambda}{d}\ or\ d = \frac{\lambda}{\theta}$

Here, $\lambda = 600\ nm = 6 \times 10^{-7} m$

$\theta = 0.1^0 = \frac{0.1 \times \pi}{180} rad = \frac{\pi}{1800} rad,\ d = ?$

$\therefore\ d = \frac{6 \times 10^{-7} \times 1800}{\pi} = 3.44 \times 10^{-4} m$

(b) Frequency of a light depends on its source only. So, the frequencies of reflected and refracted light will be same as that of incident light.
Reflected light is in the same medium (air) so its wavelength remains same as $500\overset{0}{A}$.

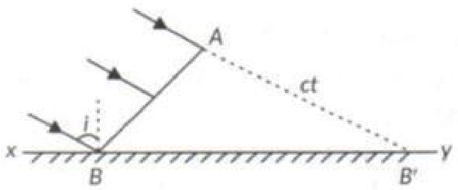
Wavelength of refracted light, $\lambda_r = \frac{\lambda}{\mu_w}$

μ_w = refractive index of water.
So, wavelength of refracted wave will be decreased.

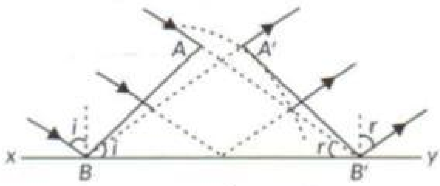
11. Ans. Two independent monochromatic sources cannot produce sustained interference pattern because the phase difference between the light waves from two independent sources keeps on changing continuously.

12. Ans. A source of light sends the disturbance in all the directions and continuous locus of all the particles vibrating in same phase at any instant is called as wavefront. Phase speed is the speed with which a wavefront moved outwards from the source.

Laws of reflection by Huygens' principle:
Let us consider a plane wavefront AB incident on the plane reflecting surface xy. Incident rays are normal to the wavefront AB.



Let in time t the secondary wavelets reaches B' covering a distance ct. Similarly from each point on primary wavefront AB. Secondary wavelets start growing with the speed c. To find reflected wavefront after time t, let us draw a sphere of radius ct taking B as center and now a tangent is drawn from B' on the sphere the tangent B'A' represents reflected wavefront after time t.



For every point on wavefront AB a corresponding point lie on the reflected wavefront A'B'.

So, comparing two triangle $\Delta BAB'$ and $\Delta B'A'B$

We find that

$AB' = A'B = ct$

$BB' = common$

$\angle A = \angle A' = 90^0$

Thus two triangles are congruent, hence $\angle i = \angle r$

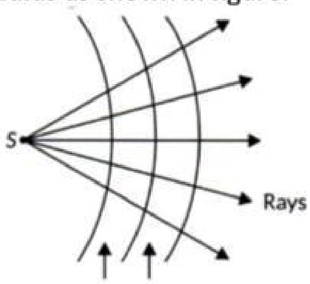
This proves first law of reflection.

Also incident rays, reflected rays and normal to them all lie in the same plane. This gives second law of reflection.

13. Ans. (a) A wavefront is defined as the locus of all the particles vibrating in same phase at any instant.

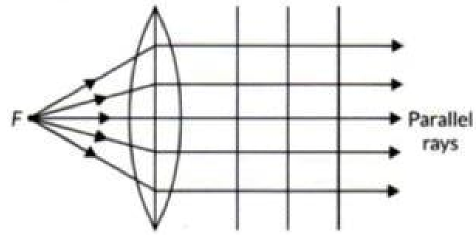
A line perpendicular to the wavefront in the direction of propagation of light wave is called a ray.

(b) (i) The wavefront will be spherical of increasing radius as shown in figure.



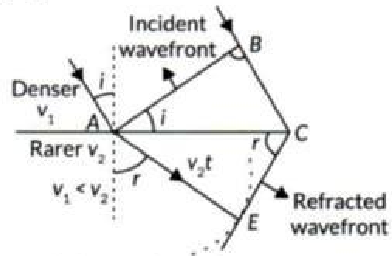
Spherical wavefront

(ii) When source is at the focus, the rays coming out of the convex lens are parallel, so wavefront is plane as shown in figure.



Plane wavefront

(iii)



14. Ans. (a) Condition for constructive interference,

$\cos\Delta\phi = +1$

$2\pi \dfrac{\Delta x}{\lambda} = 0, 2\pi, 4\pi......$

$or\ \ \Delta x = n\lambda;\ n = 0, 1, 2, 3, ...$

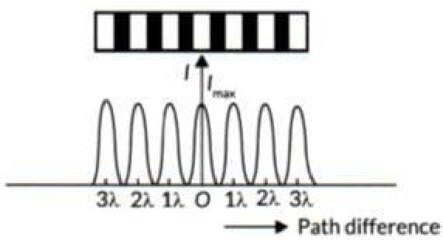
(b) Condition for destructive interference,

$\cos\Delta\phi = -1$

$2\pi \dfrac{\Delta x}{\lambda} = \pi, 3\pi, 5\pi....$

$or\ \ \Delta x = (2n-1)\lambda/2$

Where n = 1, 2, 3.....



15. Soln. (a) We know, $\dfrac{I_{max}}{I_{min}} = \dfrac{(a_1 + a_2)^2}{(a_1 - a_2)^2}$

According to question, $I_2 = 50\%$ of I_1

$I_2 = 0.5 I_1; \qquad a_2^2 = 0.5 a_1^2 \qquad (\because I \propto a^2)$

$a_2 = \dfrac{a_1}{\sqrt{2}}$

Hence,

$\dfrac{I_{max}}{I_{min}} = \dfrac{(a_1 + a_1/\sqrt{2})^2}{(a_1 - a_1/\sqrt{2})^2} = \dfrac{(1 + 1/\sqrt{2})^2}{(1 - 1/\sqrt{2})^2}$

$= \left(\dfrac{\sqrt{2}+1}{\sqrt{2}-1}\right)^2 \approx 34$

(b) The central fringes are white. On the either side of the central white fringe the coloured bands (few coloured maxima and minima) will appear. This is because fringes of different colours overlap.

16. Soln. (a) Coherent sources are necessary to produce a sustained interference pattern otherwise the phase difference changes very rapidly with time and hence no interference will be observed.

(b) Intensity at a point, $I = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$

Phase difference = $\frac{2\pi}{\lambda} \times$ Path difference

At path difference λ,

Phase difference, $\phi = \frac{2\pi}{\lambda} \times \lambda = 2\pi$

$\therefore$ Intensity, $K = 4I_0 \cos^2\left(\frac{2\pi}{2}\right)$

[$\because$ Given $I = K,$ at path difference λ]

$K = 4I_0$ ....(i)

If path difference is $\frac{\lambda}{3}$, then phase difference will be

$$\phi' = \frac{2\pi}{\lambda} \times \frac{\lambda}{3} = \frac{2\pi}{3}$$

$\therefore$ Intensity,

$$I' = 4I_0 \cos^2\left(\frac{2\pi}{6}\right) = \frac{K}{4} \text{ (Using (i))}$$

17. Soln. Position of first minimum in diffraction pattern

$$y = \frac{D\lambda}{a}$$

So, slit width $a = \frac{D\lambda}{y} = \frac{1 \times 500 \times 10^{-9}}{2.5 \times 10^{-3}} = 2 \times 10^{-4}\, m$

18. Soln. Here, $\lambda = 620\, nm = 620 \times 10^{-9} m$

$a = 3 \times 10^{-3} m, \quad D = 1.5 m$

Distance of first order minima from the centre,

$$y_1 = \frac{D\lambda}{a} = \frac{1.5 \times 620 \times 10^{-9}}{3 \times 10^{-3}}$$
$$= 3.1 \times 10^{-4} m$$

Distance of third order maxima on the same side,

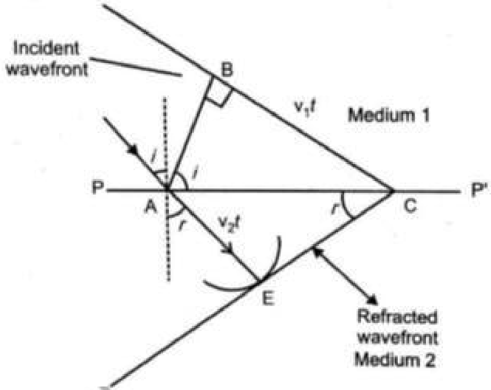
$$y_2 = \frac{7D\lambda}{2a} = \frac{7 \times 1.5 \times 620 \times 10^{-9}}{2 \times 3 \times 10^{-3}}$$
$$= 10.85 \times 10^{-4}\, m$$

Separation between them.

$$y = y_2 - y_1$$
$$= 10.85 \times 10^{-4} - 3.1 \times 10^{-4}$$
$$= 7.75 \times 10^{-4}\, m$$

19. Soln. Wavefront: The continuous locus of all the particles of a medium, which are vibrating in the same phase is called wavefront.

Laws of refraction: Let PP' represent the surface separating medium 1 and medium 2 as shown in fig.



From ΔABC,

$$\sin i = \frac{BC}{AC} = \frac{v_1 t}{AC}$$

From ΔAEC,

$$\sin r = \frac{AE}{AC} = \frac{v_2 t}{AC}$$

$$\therefore \quad \frac{\sin i}{\sin r} = \frac{v_1 t}{AC} \times \frac{AC}{v_2 t} = \frac{v_1}{v_2} = \mu$$

$$\therefore \quad \frac{\sin i}{\sin r} = \mu$$

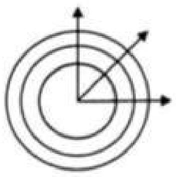
Which is Snell's law of refraction of light (first law).
Second law: Incident wavefront, refracted wavefront, normal all lie in the same plane.

20. Soln. (i) A wavefront is defined as a surface of constant phase.

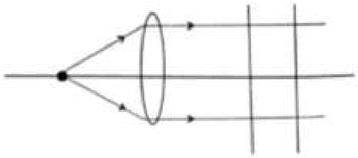
[Alternatively, A wavefront is the locus of all points in the medium that have the same phase.]
Difference from a ray:

(a) The ray, at each point of a wavefront, is normal to the wavefront at that point.
(b) The ray indicates the direction of propagation of wave while the wavefront is the surface of constant phase.
(c) The shape of the wavefront, in the three cases, are as shown.

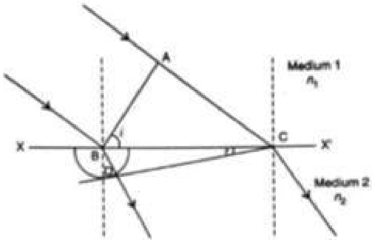
(ii) (a)



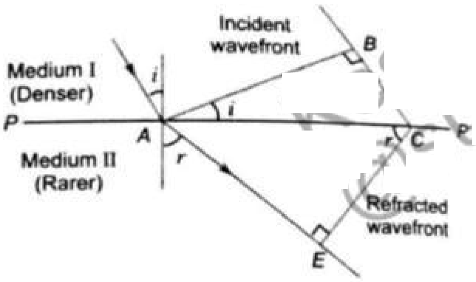
(b)



(c)



21. Soln. We assume a plane wavefront AB propagating in denser medium incident on the interface PP' at angle $\hat{i}$ as shown in fig. Let τ be the time taken by the wave front to travel a distance BC. If v_1 is the speed of the light in medium I.



So, $BC = v_1 \tau$

In order to find the shape of the refracted wavefront, we draw a sphere of radius AE = $v_2 \tau$, where v_2 is the speed of light in medium II (rarer medium). The tangent plane CE represents the refracted wave front

In ΔABC, $\sin i = \dfrac{BC}{AC} = \dfrac{v_1 t}{AC}$

And in ΔACE, $\sin r = \dfrac{AE}{AC} = \dfrac{v_2 t}{AC}$

$$\therefore \quad \frac{\sin i}{\sin r}\frac{BC}{AE} = \frac{v_1 t}{v_2 t} = \frac{v_1}{v_2} \qquad \text{............(1)}$$

Let c be the speed of light in vacuum

So, $\mu_1 = \dfrac{C}{v_1}$ and $\mu_2 = \dfrac{C}{v_2}$

$$\frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} \qquad \text{...........(2)}$$

From equations (1) and (2), we have

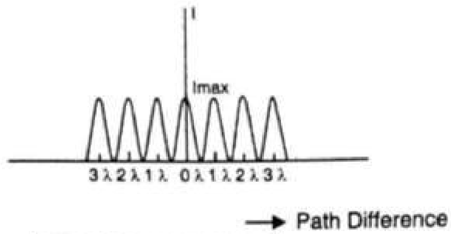
$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$$

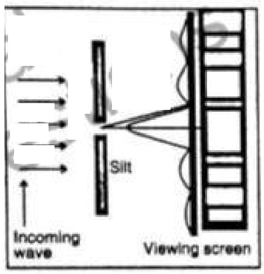
$$\mu_1 \sin i = \mu_2 \sin r$$

It is known as Snell's law.

22. Soln. Two monochromatic sources, which produce light waves, having a constant phase difference, are known as coherent sources.

23. Soln.





Interference	Diffraction
Fringe width is constant.	Fringe width is varied.
Fringes are obtained with the coherent light coming from two slits.	Fringes are obtained with the monochromatic light coming from single slit.
It is superposition of fewer waves.	It is superposition of many waves.
It depends upon the distance between two openings.	It depends upon the aperture of single slit opening.
Many fringes are visible.	Fewer fringes are visible.
All fringes are of same brightness.	Central fringe has maximum brightness, then it reduces gradually.

24. Soln. Phase difference = $\frac{2\pi}{\lambda} \times$ Path difference

Path difference = $\frac{\lambda}{6} \Rightarrow$ Phase difference = $\frac{\pi}{3}$

Path difference $\frac{\lambda}{2} \Rightarrow$ Phase difference = π

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

(i) $I_1 = 4I_0 \times \frac{3}{4} = 3I_0$

(ii) $I_2 = 4I_0 \times 0 = 0$

25. Soln. Diffraction due to a Single Slit:

(i) It is produced due to different parts of same wavefronts.
(ii) Central fringe is twice as wide as other fringes.
(iii) Intensity of fringes decreases as we go to successive maxima away from the centre.
(iv) At an angle 1/a, first minima is obtained.

Interference Fringe Young's Double Slit:

(i) It is produced due to two different wavefronts.
(ii) Fringe width is of same size.
(iii) Fringes have same intensity.
(iv) At an angle λ / a, maxima is obtained.

26. Soln. Separation between two dark bands on each side of central bright fringe = width of bright fringe,

We know width of the central fringe

$$= \frac{2D\lambda}{a}$$

Where, D = distance of slit from screen,
λ = wavelength of the light,.
a = width of the slit.
According to question

Width of central fringe = $\frac{1.5 \times 2 \times 6000 \times 10^{-10}}{1 \times 10^{-4}}$

So the distance between the two dark lines on either side of the central maximum
= 18 mm

Angular spread of the first diffraction minimum = $\frac{\lambda}{a}$

$$= \frac{6000 \times 10^{-10}}{1 \times 10^{-4}}$$
$$= 6 \times 10^{-3} rad$$

27. Soln. (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. [Energy carried by a wave depends on the amplitude of the wave, not on the speed of wave propagation].

(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.

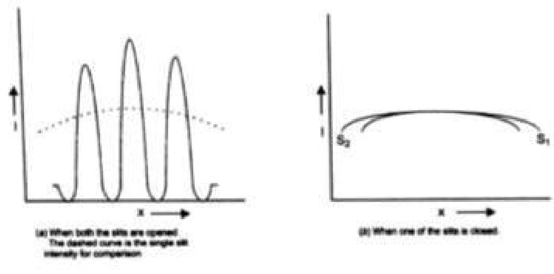
28. Soln. Interference of light: When two waves of same frequency and constant initial phase difference travel in the same direction along a straight line simultaneously, They superpose in such a way that the intensity of the resultant wave is maximum at certain points and minimum at certain other points. This phenomenon of redistribution of energy due to superposition of two waves of same frequency and constant initial phase difference is called interference.

Conditions for Sustained Interference of Light Waves

To obtain sustained (well-defined and observable) interference pattern, the intensity must be maximum and zero at points corresponding to constructive and destructive interference. For the purpose following conditions must be fulfilled:

(i) *The two interfering sources must be coherent and of same frequency, i.e., the sources should emit light of the same wavelength or frequency and their initial phase should remain constant.* If this condition is not satisfied the phase difference between the interfering wave will vary continuously. As a result the resultant intensity at any point will vary with time being alternately maximum and minimum, just like the phenomenon of beats in sound.

(ii) *The interfering waves must have equal amplitudes.* Otherwise the minimum intensity will not be zero and there will be general illumination.



The variation of intensity I versus the position x on the screen in Young's experiment.

Fringe width, $\beta = \frac{D\lambda}{d}$.

(i) $\beta \propto D$, therefore with the decrease of separation between the plane of slits and screen, the fringe width decreases.

(ii) On increasing the separation between two slits (d), the fringe separation decreases as β is inversely proportional to d $\left(i.e., \beta \propto \frac{1}{d}\right)$

29. Soln. Resultant intensity at any point having a phase difference ϕ is given by $I = 4I_0 \cos^2 \frac{\phi}{2}$

When path difference is λ, phase difference is 2π

$\therefore \quad I = 4I_0 \cos^2 \pi = 4I_0 = K$

(given) ....(i)

When path difference, $\Delta = \frac{\lambda}{3}$, the phase difference

$$\phi' = \frac{2\pi}{\lambda}\Delta = \frac{2\pi}{\lambda} \times \frac{\lambda}{3} = \frac{2\pi}{3}$$

$$I' = 4I_0 \cos^2 \frac{2\pi}{3} \qquad (\text{since } K = 4I_0)$$

$$= K \cos^2 \frac{2\pi}{3} = K \times \left(-\frac{1}{2}\right)^2 = \frac{1}{4}K$$

30. Soln. Here, $n = 1, \lambda = 6 \times 10^{-5} cm$

Distance of screen from slit = 100 cm

Distance of first minimum from central maxima = 0.1 cm

$$\sin\theta = \frac{\text{Distance of } 1^{st} \text{ minima from the central maxima}}{\text{Distance of the screen from the slit}}$$

$$\theta_1 = \frac{0.1}{100} = \frac{1}{1000}$$

We know that

$$a\sin\theta = n\lambda \Rightarrow a = \frac{\lambda}{\theta_1} = 0.06 cm$$

31. Soln. For minima in diffraction pattern, $d\sin\theta = n\lambda$

For first minima, $d\sin\theta_1 = (1)\lambda_1 \Rightarrow \sin\theta_1 = \frac{\lambda_1}{d}$

For first maxima, $d\sin\theta_2 = \frac{3}{2}\lambda_2 \Rightarrow \sin\theta_2 = \frac{3\lambda_2}{2d}$

The two will coincide if, $\theta_1 = \theta_2$ or $\sin\theta_1 = \sin\theta_2$

$$\therefore \frac{\lambda_1}{d} = \frac{3\lambda_2}{2d} \Rightarrow \lambda_2 = \frac{2}{3}\lambda_1 = \frac{2}{3} \times 660 nm = 440 nm$$

32. Soln. (i) Here $a = 1 \times 10^{-4} m, D = 1.5m$

$\lambda = 6000 \overset{0}{A} = 6000 \times 10^{-10} m$

The distance between the two dark bands on each side of central band is equal to width of the central bright band,

i.e., $\frac{2D\lambda}{a} = \frac{2 \times 1.5 \times 6000 \times 10^{-10}}{1 \times 10^{-4}} = 18mm$

33. Soln. Given that distance between the two slits, d = 0.15 mm

Wavelength of monochromatic light, $\lambda = 450 nm$

Distance between the screen and slits, D = 1 m

(a) (i) Distance of nth bright fringe from central maximum $= \frac{n\lambda D}{d}$

$$= 2 \times \frac{450 \times 10^{-9} \times 1}{0.15 \times 10^{-3}} \qquad [\because n = 2]$$

$= 6 \times 10^{-3}$ m = 6 mm

(ii) Distance of n^{th} dark fringe from central maximum

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

$$= (2 \times 2 - 1) \times \frac{450 \times 10^{-9} \times 1}{2 \times 0.15 \times 10^{-3}} \quad [\because n = 2]$$

$$= \frac{3}{2} \times 3 \times 10^{-3} = 4.5 nm$$

(b) Since, width of bright or dark fringes is given by $\beta = \frac{\lambda D}{d}$,

Thus when screen is moved away, D increases and hence fringe width increases.