WAVE OPTICS

Revise Most Important Questions to Crack NEET 2020

Q-1 - 16266976

If the amplitude ratio of two sources producing interference is 3 : 5, the ratio of intensities at maxima and minima is

(A) $25:16$

(B) $5:3$

(C) $16:1$

(D) $25:9$

CORRECT ANSWER: C

Q-2 - 16266992

Interference was observed in interference chamber when air was present, now the chamber is evacuated and if the same light is used, a careful observer will see

(A) No interference

(B) Interference with bright bands

(C) Interference with dark bands

(D) Interference in which width of the fringe will be slightly increased

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CORRECT ANSWER: D

Q-3 - 16267004

If two waves represented by $y_1 = 4\sin\omega t$ and $y_2 = 3\sin\left(\omega t + \frac{\pi}{3}\right)$ interfere at a point, the amplitude of the resulting wave will be about

(A) 7

(B) 6

(C) 5

(D) 3.5

CORRECT ANSWER: B

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Q-4 - 16267026

Huygen's priciple of secondary wavelets may be used to

(A) Find the velocity of light in vacuum

(B) Explain the particle behaviour of light

(C) Find the new position of the wavefront

(D) Explain photoelectric effect

CORRECT ANSWER: C

Q-5 - 16266977

Colours of thin films result from

Or

On a rainy day, a small oil film on water show brilliant colours.

This is due to

(A) Dispersion of light

(B) Interference of light

(C) Absorption of light

(D) Scattering of light

CORRECT ANSWER: B

Q-6 - 16267018

Two wave are represented by equation $y_1 = a \sin \omega t$ and $y_2 = a \cos \omega t$ the first wave :-

(A) Leads the second by π

(B) Lags the second by π

(C) Leads the second by $\frac{\pi}{2}$

(D) Lags the second by $\frac{\pi}{2}$

CORRECT ANSWER: D

Q-7 - 16267037

As a result of interference of two coherent sources of light, energy is

(A) Increased

(B) Redistributed and the distribution does not vary with time

(C) Decreased

(D) Redistributed and the distribution changes with time

CORRECT ANSWER: B

Q-8 - 16267044

The phase difference between incident wave and reflected wave is

180° when light ray

(A) Enters into glass from air

(B) Enters into air from glass

(C) Enters into glass from diamond

(D) Enters into water from glass

CORRECT ANSWER: A

Q-9 - 16267054

Monochromatic green light of wavelength $5 \times 10^{-7} m$ illuminates a pair of slits 1 mm apart. The separation of bright lines on the interference pattern formed on a screen 2 m away is

(A) $0.25 mm$

(B) $0.1mm$

(C) $1.2mm$

(D) $1.5mm$

CORRECT ANSWER: C

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Q-10 - 16267067

An oil flowing on water seems coloured due to interference. For observing this effect, the approximate thickness of the oil film should be

(A) 100 �

(B) 10000 �

(C) 1 mm

(D) 1 cm

CORRECT ANSWER: B

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Q-11 - 30559492

The idea of secondary wavelets for the propagation of a wave was first given by

(A) Newton

(B) Huygens

(C) Maxwell

(D) Fresnel

CORRECT ANSWER: B

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Q-12 - 30559499

The refractive index of glass is 1.5 for light waves of $\lambda = 6000$ in vacuum. Its wavelength in glass is

(A) 2000 Å

(B) 4000 Å

(C) 1000 Å

(D) 3000 Å

CORRECT ANSWER: B

SOLUTION:

$$\mu = \frac{c}{v} = \frac{\lambda_v}{\lambda_g}$$

$$\therefore \lambda_g = \frac{\lambda_v}{\mu} = \frac{6000}{1.5}$$

$$= 4000$$

Which of the following phenomenon is not explanined by Huygen's construction of wavefront ?

(A) reflection

(B) diffraction

(C) refraction

(D) origin of spectra

CORRECT ANSWER: D

SOLUTION:

The Huygen's construction of wavefront does not explain the phenomena of origin fo spectra.

Q-14 - 30559505

Earth is moving towards a fixed star with a velocity of $30kms^{-1}$. An observer on earth observes a shift of 0.58 in wavelength of light coming from star. What is the actual wavelength of light emitted by star ?

(A) 5800 Å

(B) 2400 Å

(C) 12000 Å

(D) 6000 Å

CORRECT ANSWER: A

SOLUTION:

Using , $\triangle\lambda = \frac{v}{c}\lambda$

Here,

$v = \; = 30kms^{-1} = 30$
$\times 10^3 ms^{-1}$

$c = 3 \times 10^8 ms^{-1} \triangle \lambda$
$= 0.58$

$$\therefore \lambda = \frac{c}{v}. \triangle \lambda$$
$$= \frac{3 \times 10^8}{30 \times 10^3} \times 0.58$$
$$= 5800$$

Q-15 - 30559508

With what speed should a galaxy move with respect to us to that the sodium line at $589.0nm$ is observed at $589.6nm$?

(A) 206 km s^{-1}

(B) 306 km s^{-1}

(C) 103 km s^{-1}

(D) 51 km s^{-1}

CORRECT ANSWER: B

SOLUTION:

The relation between v, c and λ are ,$v\lambda = c$

For small change in v and λ,

$$\frac{\triangle v}{v} = \frac{-\triangle \lambda}{\lambda}$$

As

$$\triangle \lambda = 589.6 - 589.0$$
$$= +0.6nm$$

Therefore, using doppler shift

$$\frac{\triangle v}{v} = \frac{-\triangle \lambda}{\lambda}$$
$$= \frac{-v_{\text{radial}}}{c}$$

or

$$- v_{\text{radial}} \cong + c\left(\frac{0.6}{589.0}\right) = + 3.06 \times 10^5 ms^{-1}$$

$$= 306 kms^{-1}$$

Therefore, the galaxy is moving away from us.

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Q-16 - 30559514

In the case of light waves from two coherent sources S_1 and S_2, there will be constructive interference at an arbitrary point P, the path difference $S_1P - S_2P$ is

(A) $\left(n + \frac{1}{2}\right)\lambda$

(B) $n\lambda$

(C) $\left(n - \frac{1}{2}\right)\lambda$

(D) $\frac{\lambda}{2}$

CORRECT ANSWER: B

SOLUTION:

Constructive interference occurs when the path

difference $(S_1P - S_2P)$ is an integral multiple of λ.

or $S_1P - S_2P = n\lambda$

where $n = 0, 1, 2, 3,$

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Q-17 - 30559516

Answer the following questions :

(a) When a low flying aircraft passes overhead, we sometimes notice a slight shaking of the piture on our TV screen. Suggest a possible expanation.

(b) As you have learnt in the text, the principle of linear superposition of wave displacement is basic to understanding intensity distributions in diffractions and interference patterns. What is the justification of this principle ?

(A) interference

(B) diffraction

(C) polarisation of direct signal

(D) Both (b) and (c)

CORRECT ANSWER: A

SOLUTION:

A low flying aircraft reflects the T.V signal. The slight shaking on the TV screen may be due to interference between the direct signal and the reflected signal.

Q-18 - 30559517

Two light waves superimposing at the mid-point of the screen are coming from coherent sources of light with phase difference 3p rad. Their amplitudes are 1 cm each. The resultant amplitude at the given point will be.

(A) 5 cm

(B) 3 cm

(C) 2 cm

(D) zero

CORRECT ANSWER: D

SOLUTION:

Resultant amplitude,

$$A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

Here,

$A_1 = A_2 = 1cm, \phi = 3\pi$ rad

$$\therefore A = \sqrt{I^2 + I^2 + 2 \times 1 \times 1 \times \cos 3\pi}$$

$$= \sqrt{2 + 2 \times (-1)} = 0$$

Q-19 - 30559518

Two beam of light having intensities I and 4I interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\frac{\pi}{2}$ at point A and π at point B. Then the difference between resultant intensities at A and B is : $(2001, 2M)$

(A) 2I

(B) 4I

(C) 5I

(D) 7I

CORRECT ANSWER: B

SOLUTION:

Here,

$$I_1 = I, I_2 = 4I, \phi_1 = \frac{\pi}{2}, \phi_2 = \pi$$

$$I_A = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi_1$$

$$= I + 4I + 2\sqrt{I \times 4I}\cos\frac{\pi}{2} = 5I$$

$$I_B = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi_2$$

$$= I + 4I + 2\sqrt{I \times 4I}\cos\pi = 5I - 4I = I$$

$$\therefore I_A - I_B = 5I - I = 4I$$

Q-20 - 30559519

Light from two coherent sources of the same amplitude A and wavelength λ illuminates the screen. The intensity of the central maximum is I_0. If the sources were incoherent, the intensity at the same point will be

(A) $4I_0$

(B) $2I_0$

(C) I_0

(D) $\frac{I_0}{2}$

CORRECT ANSWER: D

SOLUTION:

If sources are coherent,

$$I_R = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$$

$$\therefore I_0 = I + I + 2I\cos 0 = 4I$$

If sources are incoherent,

$$I_R = I_1 + I_2 = 2I = \frac{4I_0}{2} = \frac{I_0}{2}$$

Q-21 - 30559522

In Young's double slit experiment two disturbances arriving at a point P have phase difference fo $\frac{\pi}{3}$. The intensity of this point expressed as a fraction of maximum intensity I_0 is

(A) $\frac{3}{2} I_0$
(B) $\frac{1}{2} I_0$
(C) $\frac{4}{3} I_0$
(D) $\frac{3}{4} I_0$

CORRECT ANSWER: D

SOLUTION:

The resultant intensity, $I = I_0 \cos^2 \frac{\phi}{2}$

Here,I_0 is the maximum intensity and $\phi = \frac{\pi}{3}$

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

$$= I_0 \cos^2\left(\frac{\pi}{6}\right) = \frac{3}{4} I_0$$

Q-22 - 30559525

In young's double slit experiment using monochromatic light of wavelengths λ, the intensity of light at a point on the screen with path difference λ is M units. The intensity of light at a point where path difference is $\lambda/3$ is

(A) $\frac{M}{2}$

(B) $\frac{M}{4}$

(C) $\frac{M}{8}$

(D) $\frac{M}{16}$

CORRECT ANSWER: B

SOLUTION:

Resultant intensity

$$I_R = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\theta$$

If path difference $= \lambda$, phase difference 2π

$$I_R = I + I + 2\sqrt{I \times I}\cos 2\pi = 4I = M \quad (\because I_1 = I_2 = I)$$

If path difference $\frac{\lambda}{3}$, phase difference $\phi = \frac{2\pi}{3}$rad

$$I'_R = I + I + 2\sqrt{I \times I}\cos\frac{2\pi}{3} = I = \frac{M}{4}$$

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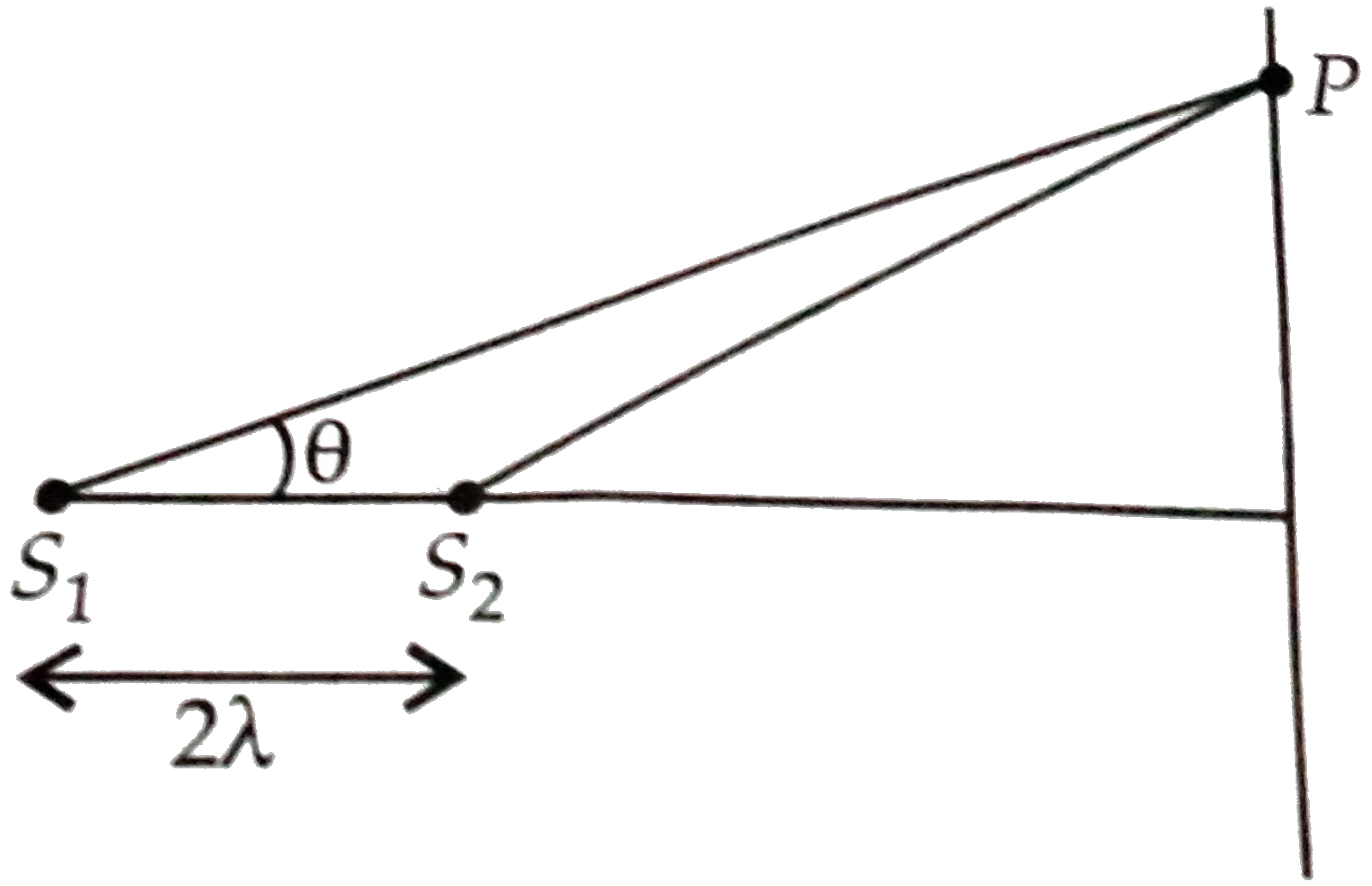
Q-23 - 30559528

In Young's double slit experiment, the slits are horizontal. The intensity at a point P as shown in figure is $\frac{3}{4}I_0$,whereI_0 is the maximum intensity.

Then the value of θ is,

(Given the distance between the two slits S_1 and S_2 is 2λ)



(A) $\cos^{-1}\left(\frac{1}{12}\right)$

(B) $\sin^{-1}\left(\frac{1}{12}\right)$

(C) $\tan^{-1}\left(\frac{1}{12}\right)$

(D) $\sin^{-1}\left(\frac{3}{5}\right)$

CORRECT ANSWER: A

SOLUTION:

Here $\frac{I}{I_0} = \frac{3}{4}$(given)

$\Rightarrow \cos^2\left(\frac{\phi}{2}\right)$

$= \frac{3}{4} \quad \left(\because I\right.$

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

or $\cos\frac{\phi}{2} = \frac{\sqrt{3}}{2}$ or ϕ

$= 60 = \frac{\pi}{3}$

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

From the figure, pathe difference is

d

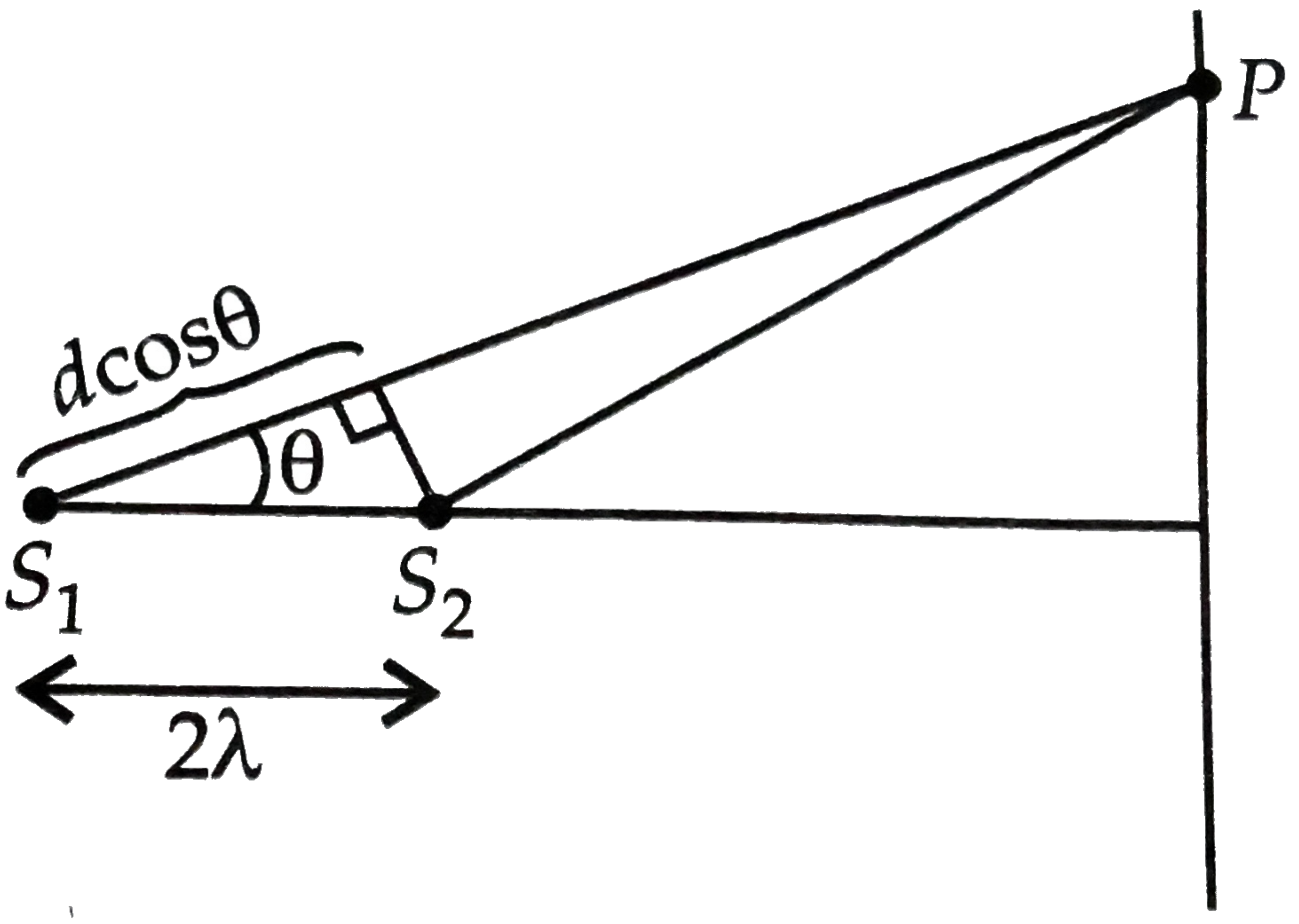
$\cos\theta = 2\lambda\cos\theta \quad ($

$\because d = 2\lambda)$

$$\therefore \frac{\pi}{3} = \frac{2\pi}{\lambda} 2\lambda\cos\theta$$

$$\therefore \cos\theta = \frac{1}{12}$$

$$\therefore \theta = \cos^{-1}\left(\frac{1}{12}\right)$$



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Two slits in Young's double slit experiment have widths in the ratio 81:1. What is the the ratio of amplitudes of light waves coming from them ?

(A) $3:1$

(B) $3:2$

(C) $9:1$

(D) $6:1$

CORRECT ANSWER: C

SOLUTION:

Width ratio, $\frac{\beta_1}{\beta_2} = \frac{I_1}{I_2} = \frac{81}{1}$

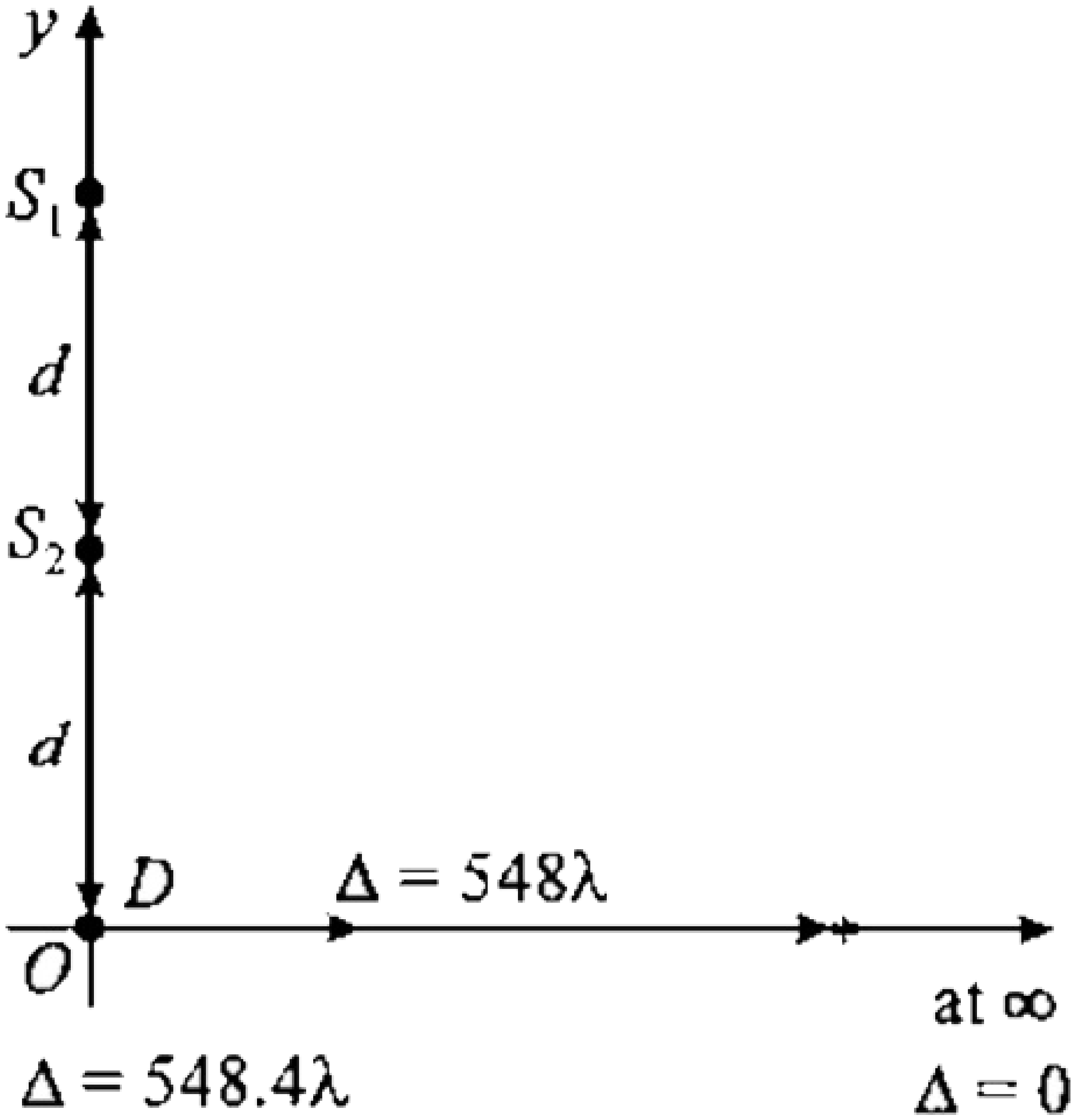
$\therefore$ Amplitude ratio,

$\frac{A_1}{A_2} = \sqrt{\frac{I_1}{I_2}} = \sqrt{\frac{81}{1}}$

$= 9:1$

Q-25 - 16798922

There are two coherent sources S_1 and S_2 which produce waves in same phase placed on Y axis at points (0, 2d) and (0, d) as shown in figure-6.23. A detector D is placed at origin which moves along X direction, find the number of maxima recorded by detector excluding points x = 0 and $x = \infty$. Given that wavelength of light produced is 6200 and separation between sources is 0.34 mm.



CORRECT ANSWER: N/A

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Q-26 - 30559534

The two coherent sources with intensity ratio β produce interference. The fringe visibility will be

(A) $\frac{2\sqrt{\beta}}{1+\beta}$

(B) 2β

(C) $\frac{2}{1+\beta}$

(D) $\frac{\sqrt{\beta}}{1+\beta}$

CORRECT ANSWER: A

SOLUTION:

$$\frac{I_1}{I_2}=\frac{a^2}{b^2}=\beta\therefore\frac{a}{b}$$
$$=\sqrt{\beta}$$

Fringe visibility is given by

$$V=\frac{I_{\max}-I_{\min}}{I_{\max}+I_{\min}}$$
$$=\frac{(a+b)^2-(a-b)^2}{(a+b)^2+(a-b)^2}$$

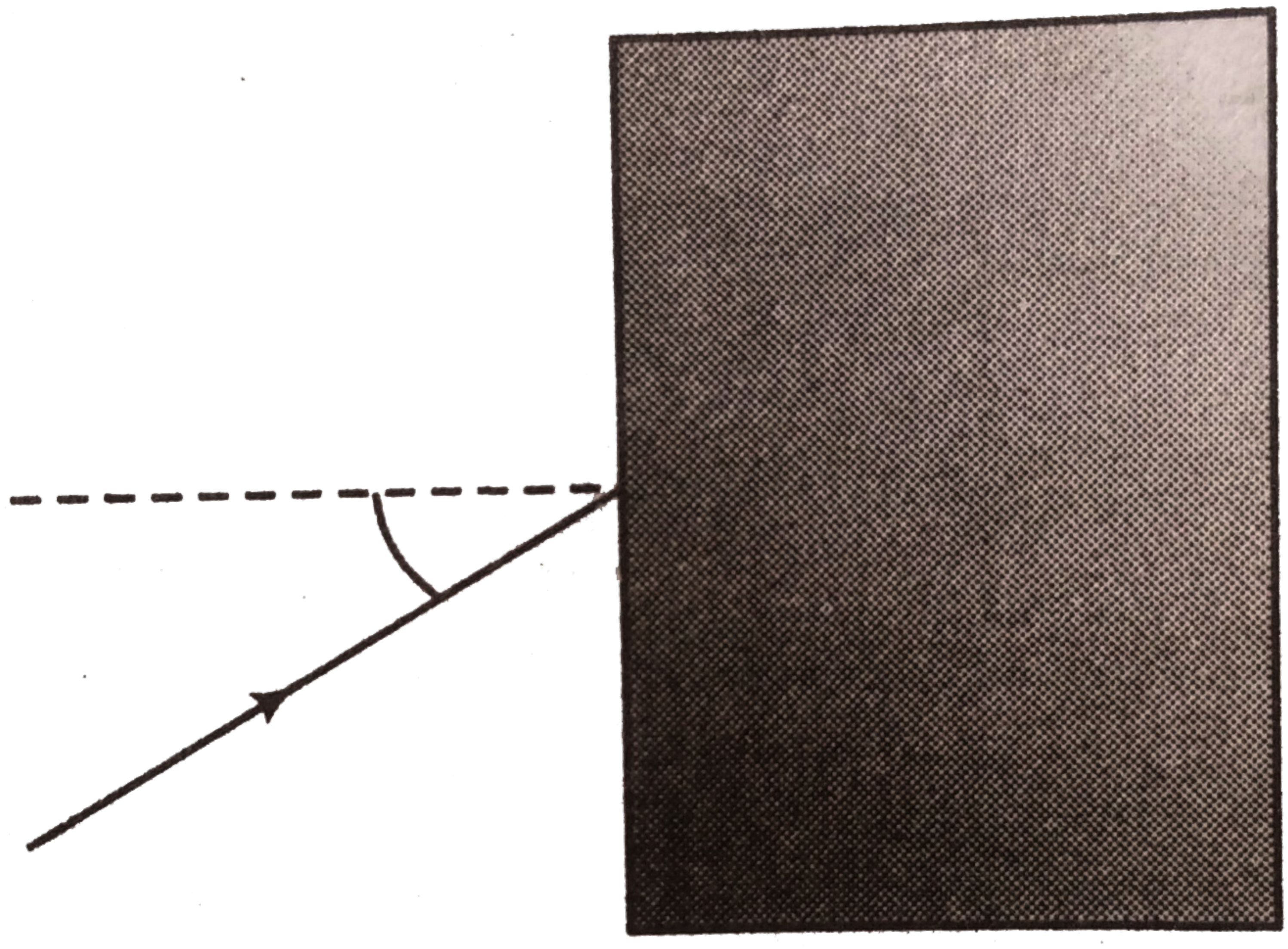
$$= \frac{4ab}{2(a^2 + b^2)}$$

$$= \frac{2(a/b)}{\left(\frac{a^2}{b^2} + 1\right)}$$

$$= \frac{2\sqrt{\beta}}{\beta + 1}$$

Q-27 - 10968760

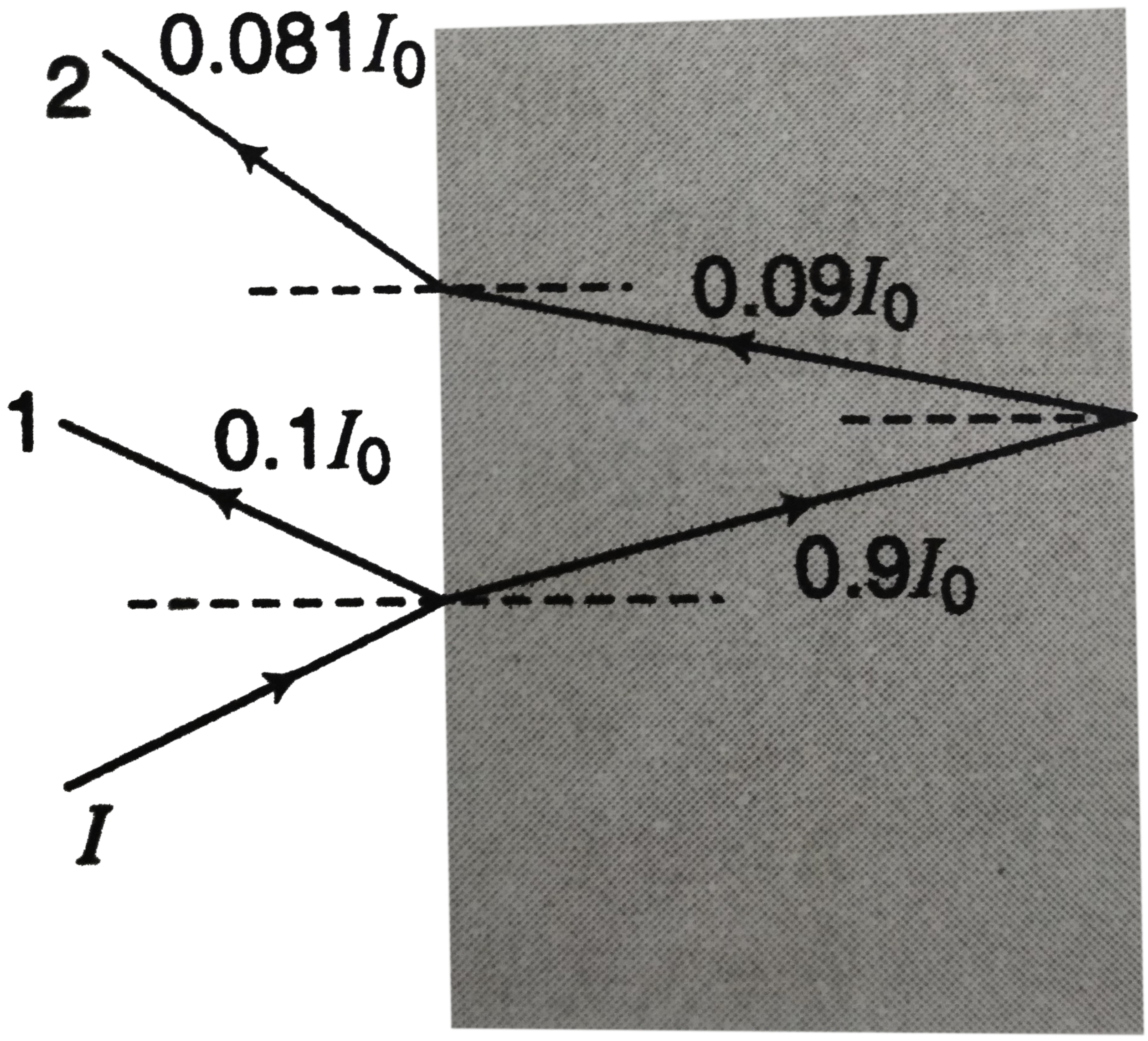
A ray of light is incident on the left vertical face of the glass slab. If the incident light has an intensity I and on each reflection the intensity decreases by 90% and on each refraction the intensity decreases by 10%, find the ratio of the intensities of maximum to minimum in reflected pattern.



CORRECT ANSWER: A::C

SOLUTION:

$I_1 = 0.1 I_0, I_2 = 0.081 I_0$



$$\therefore \sqrt{\frac{I_1}{I_2}} = \frac{10}{9}$$

$$\therefore \frac{I_{\max}}{I_{\min}}$$

$$= \left(\frac{\sqrt{I_1/I_2} + 1}{\sqrt{\frac{I_1}{I_2}} - 1}\right)^2$$

$$= (19)^2$$

= 361.

Q-28 - 30559536

In Young's double slit experiment, one of the slit is wider than other, so that amplitude of the light from one slit is double of that from other slit. If I_m be the maximum intensity, the resultant intensity I when they interfere at phase difference ϕ is given by:

(A) $\frac{I_m}{3}\left(1+2\cos^2\frac{\phi}{2}\right)$

(B) $\frac{I_m}{5}\left(1+4\cos^2\frac{\phi}{2}\right)$

(C) $\frac{I_m}{9}\left(1+8\cos^2\frac{\phi}{2}\right)$

(D) $\frac{I_m}{9}\left(8+\cos^2\frac{\phi}{2}\right)$

CORRECT ANSWER: C

SOLUTION:

Here, $A_2 = 2A_1$

$\because$ Intensity $\propto (\text{Amplitude})^2$

$$\therefore \frac{I_2}{I_1} = \left(\frac{A_2}{A_1}\right)^2$$

$$= \left(\frac{2A_1}{A_1}\right)^2$$

$$= 4 \quad \text{or} \quad I_2 = 4I_1$$

Maximum intensity, $I_m = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

$$I_m = \left(\sqrt{I_1} + \sqrt{4I_1}\right)^2$$

$$= \left(3\sqrt{I_1}\right)^2$$

$$= 9I_1 \quad \text{or} \quad I_1$$

$$= \frac{I_m}{9} \quad ...(i)$$

Resultant intensity,

$$I = I_1 + I_2$$

$$+ 2\sqrt{I_1 I_2}\cos\phi = I_1$$

$$+ 4I_1$$

$$+ 2\sqrt{I_1(4I_1)}\cos\phi$$

$$= 5I_1 + 4I_1 \cos\phi$$

$$= I_1 + 4I_1 + 4I_1 \cos\phi$$

$$= I_1 + 4I_1(1 + \cos\phi)$$

$$= I_1\left(1 + 8\cos^2\frac{\phi}{2}\right)$$

$$\left(\because 1 + \cos\phi\right.$$

$$\left. = 2\cos^2\frac{\phi}{2}\right)$$

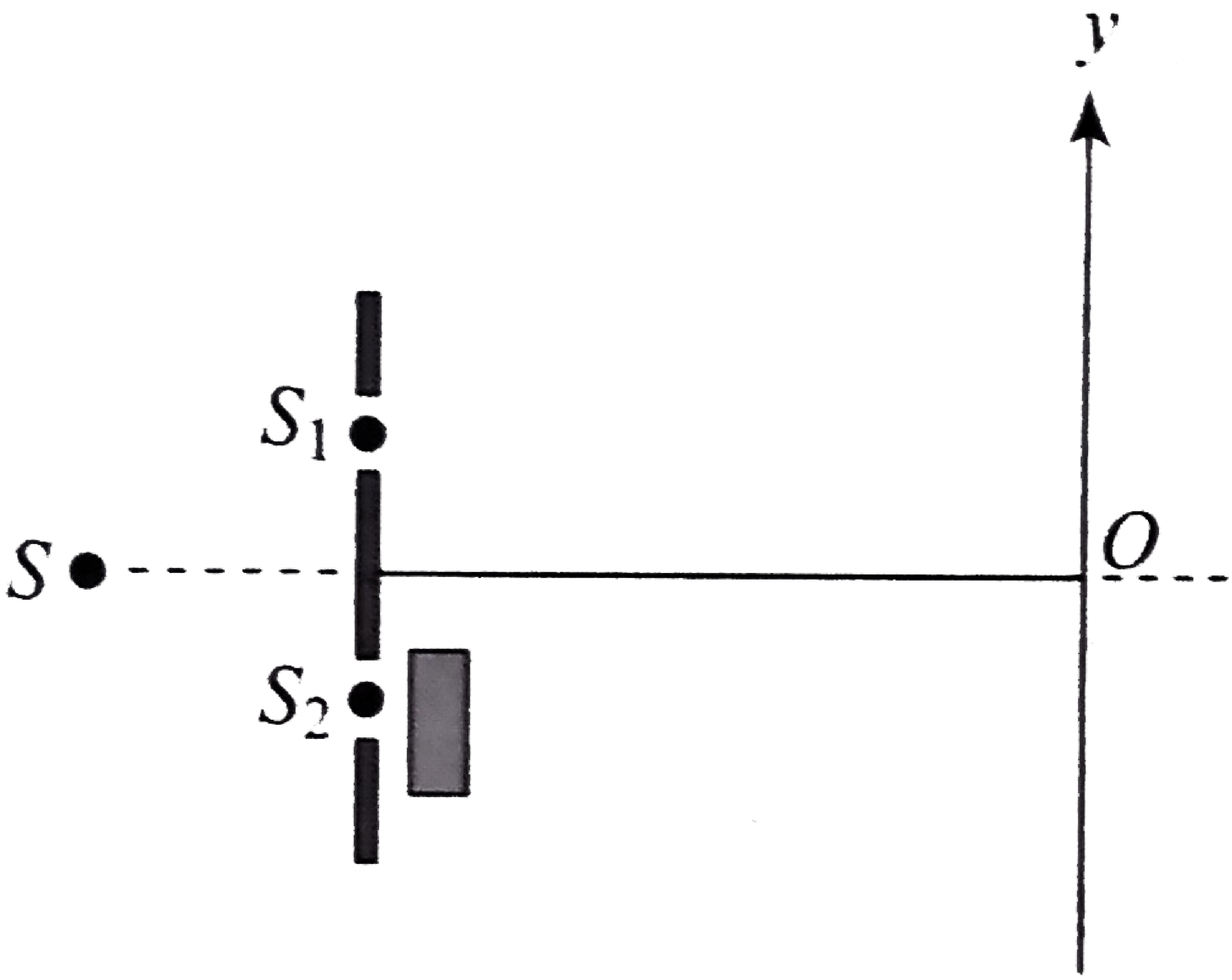
Putting the value of I_1 from eqn. (i),we get

$$I = \frac{I_m}{9}\left(1\right.$$

$$\left. + 8\cos^2\frac{\phi}{2}\right)$$

Q-29 - 11312088

A YDSE is performed in a medium of refractive index $4/3$, A light of 600 nm wavelength is falling on the slits having 0.45 nm separation . The lower slit S_2 is covered b a thin glass plate of thickness 10.4 mm and refractive index 1.5. The interference pattern is observed on a screen placed 1.5 m from the slits as shown in figure. (All the wavelengths in this problem are for the given medium of refractive index $4/3$, ignore absorption.)



The location of the central maximum (bright fringe with zero path difference) on the y-axis will be

(A) 2.33 mm

(B) 4.33 mm

(C) 6.33 mm

(D) 4.43 mm

CORRECT ANSWER: D

SOLUTION:

Path difference at point P on the screen, $\Delta x = \frac{yd}{D}$

At the position of central maxima, the optical path length

S_2P and S_1P and equal.

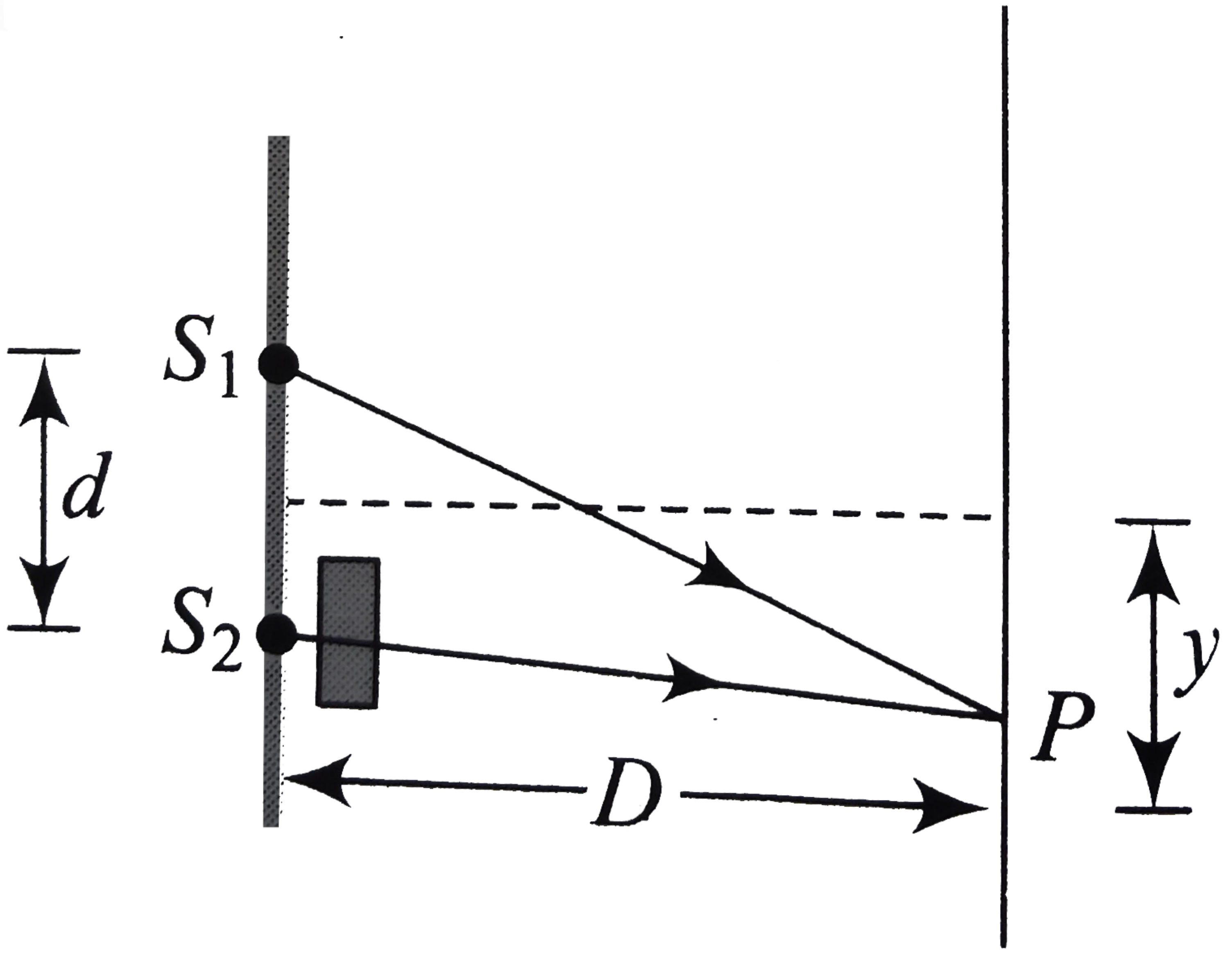
$$\frac{(S_2P - t)}{c/\mu_1} = \frac{1}{c/\mu_2}$$

$$= \frac{S_1P}{c/\mu_1}$$

where $\mu_1 = 4/3$, $\mu_2 = 3/2$.

$$\mu_1(S_1P - S_2P)$$
$$= (\mu_2 - \mu)t$$

$$\mu_1\left(\frac{yd}{D}\right) = (\mu_2 - \mu_1)t$$
$$y = \frac{(\mu_2 - \mu_1)tD}{\mu_1 d}$$
$$= \frac{[(3/2) - (4/3)] \times 10.4 \times 1.5}{(4.3) \times 0.45 \times 10^{-3}}$$
$$= 4.33mm$$



b. At point O, net path difference.

$$\Delta x = \left(\frac{\mu_2}{\mu_1} - 1\right)t$$

Net phase difference,

$$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$$

$$= \frac{2\pi}{6 \times 10^{-7}}\left(\frac{1.5}{4/3}\right.$$

$$\left. - 1\right)\left(10.4 \times 10^{-6}\right)$$

$$= \left(\frac{13}{3}\right)\pi$$

Thus, intensity

$$I = I_{\max} \cos^2(\phi/2)$$
$$= I_{\max} \cos^2\left(\frac{13\pi}{6}\right)$$
$$= \frac{3}{4} I_{\max}$$

c. For maximum intensity at point O,

$$\Delta x = n\lambda$$

Path difference at point O,

$$\Delta x = \left(\frac{1.5}{4/3} - 1\right)\left(10.4 \times 10^{-6}\right)$$
$$= 1300 nm$$

Thus, maximum intensity will correspond to $\frac{1300}{2} nm$, $\frac{1300}{3} nm$,...

In the given range, required values are 650 nm and

433.33 nm.

Q-30 - 30559658

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.

CORRECT ANSWER: C

SOLUTION:

The light from two slits of Young's double slit experiment is of different colours/wavelengths/frequencies. Hence, there shall be no interference fringes.

Q-31 - 30559655

Consider sunlight incident on a slit of width 10^4 . The image seen through the slit shall

(A) be a fine sharp slit white in colour at the centre

(B) a bright slit white at the centre diffusing to zero intensities at the edges

(C) a bright slit white at the centre diffusing to regions of different colours

(D) only be a diffused slit white in colour

CORRECT ANSWER: A

Q-32 - 30559638

Light is incident on a glass surface at polarizing angle of 57.5 .

Then the angle between the incident ray and the refracted ray is

(A) 57.5°

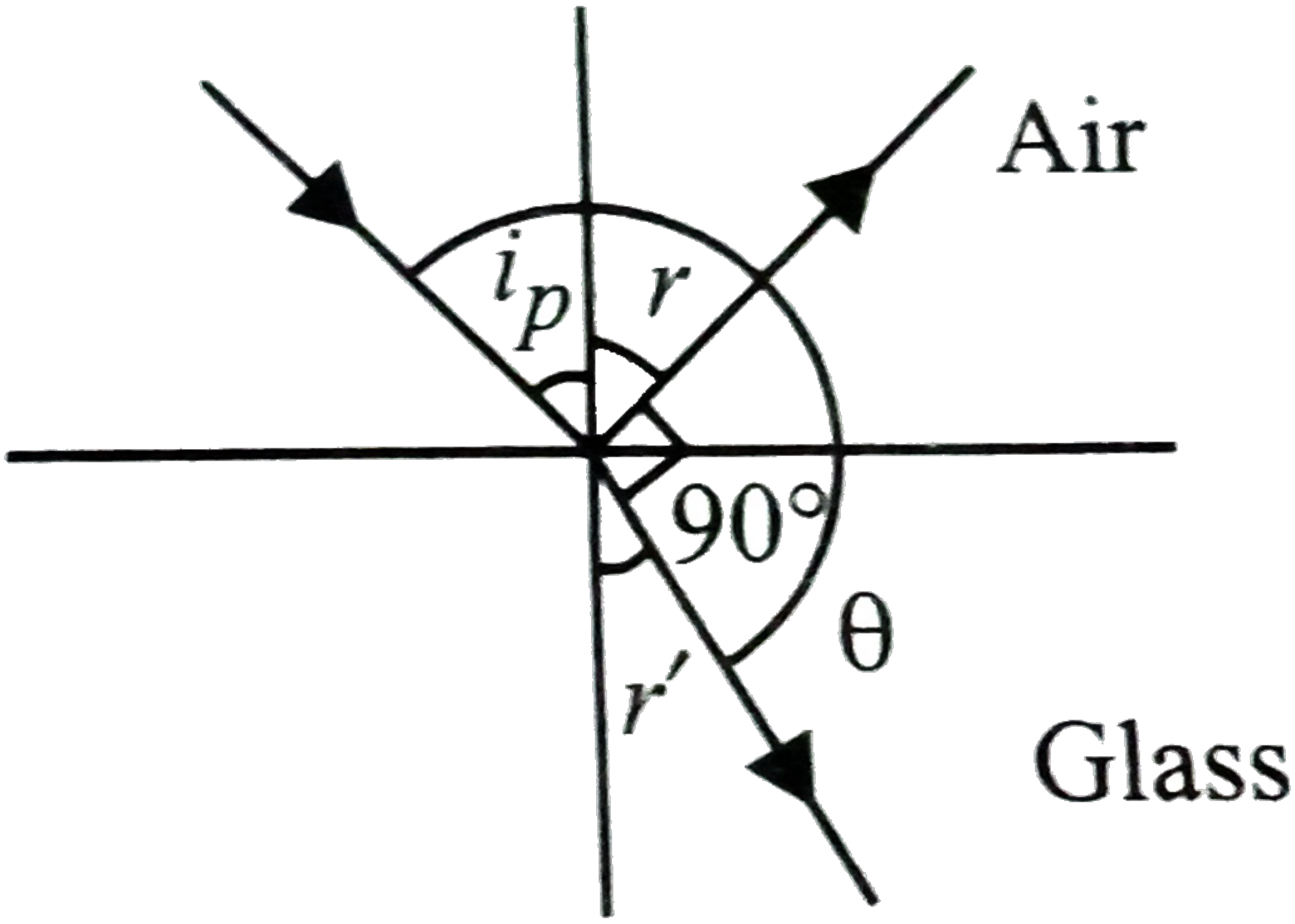
(B) 115°

(C) 205°

(D) 145°

CORRECT ANSWER: C

SOLUTION:



When a light is incident at polarising angle, the reflected and refracted rays are perpendicular to each other as shown in the figure. where i_p is the angle of incidence and r is the angle of reflection, r' is the angle of refraction. Given, $i_p = 57.5$

Let θ be the angle between the incident ray and the refracted ray.

From figure,

$\theta = i_p + r + 90 = 2i_p$
$+ 90$

$$= 2 \times 57.5 + 90$$

$$= 205 \quad [\because i_p = r]$$

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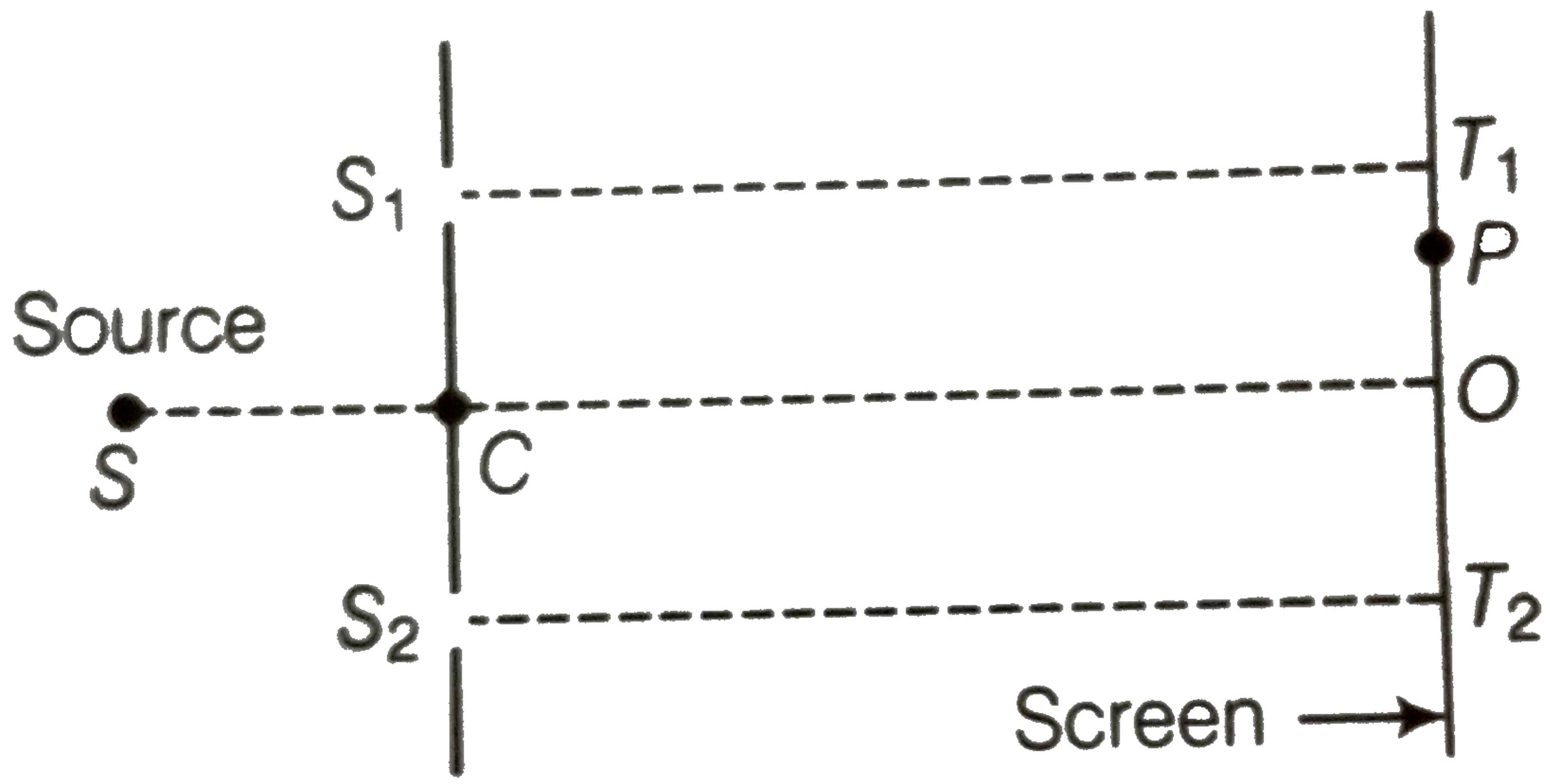
Q-33 - 30559651

Consider a two slit interference arrangements (figure) such that the distance of the screen from the slits is half the distance between the slits. Obtain the value of D in terms of λ such that the first minima on the screen falls at a distance D from the centre O.



(A) $\dfrac{\lambda}{2.472}$

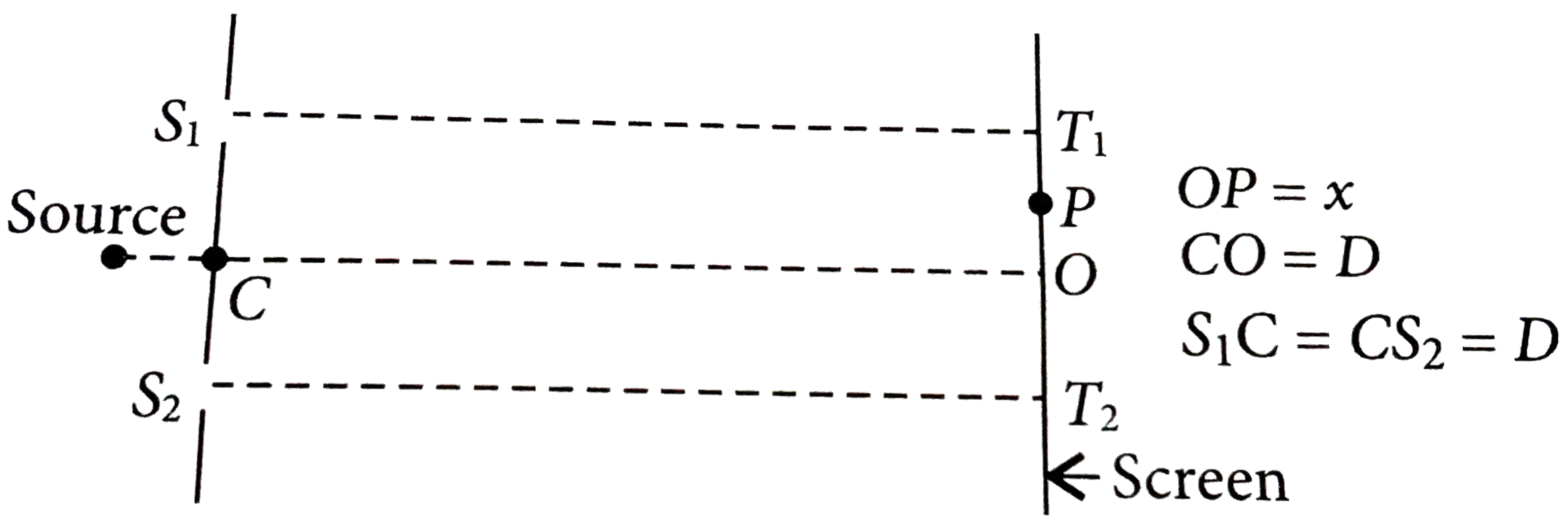
(B) $\dfrac{\lambda}{2.236}$

(C) $\dfrac{\lambda}{1.227}$

(D) $\dfrac{\lambda}{3.412}$

CORRECT ANSWER: A

SOLUTION:



From diagram

$$T_1P = T_1O - OP$$
$$= (D - x)$$

$$T_2P = T_2O - OP$$
$$= (D + x)$$

Now

S_1P
$$= \sqrt{(S_1T_1)^2 + (T_1P)^2}$$
$$= \sqrt{D^2 + (D - x)^2}$$

S_2P
$$= \sqrt{(S_2T_2)^2 + (T_2P)^2}$$
$$= \sqrt{D^2 + (D + x)^2}$$

Path difference $S_2P - S_1P = \frac{\lambda}{2}$, for first minimum to occur

$$\sqrt{D^2 + (D + x)^2} - \sqrt{D^2 + (D - x)^2} = \frac{\lambda}{2}$$

The first minimum falls at a distance D from the center,

i.e., $x = D$.

$$\left[D^2 + 4D^2\right]^{1/2} - D = \frac{\lambda}{2}$$

$$D(\sqrt{5} - 1) = \frac{\lambda}{2}$$

$$D(2.236 - 1) = \frac{\lambda}{2}, \quad D = \frac{\lambda}{2.472}$$

Q-34 - 13166967

In double slit experiment fringes are obtained using light of wavelength 4800 One slit is covered with a thin glass film of refractive index. 1.4 and another slit is covered by a film of same thickness but refractive index 1.7. By doing so, the central fringe is shifted to fifth bright fringe in the original pattern. The thickness of glass film is

(A) $2 \times 10^{-3} mm$

(B) $4 \times 10^{-3} mm$

(C) $6 \times 10^{-3} mm$

(D) $8 \times 10^{-3} mm$

CORRECT ANSWER: D

SOLUTION:

$$n\lambda = (\mu_2 - \mu_1)t, 5\beta$$
$$= (\mu_2 - \mu_1)t\frac{\beta}{\lambda}$$

Q-35 - 30559649

To ensure almost 100 % transmittivity, photographic lenses are often coated with a thin layer of dielectric material, like $MgF_2(\mu = 1.38)$. The minimum thickness of the film to be used so that at the centre of visible spectrum $(\lambda = 5500)$ there is maximum transmission.

(A) 5000 Å

(B) 2000 Å

(C) 1000 Å

(D) 3000 Å

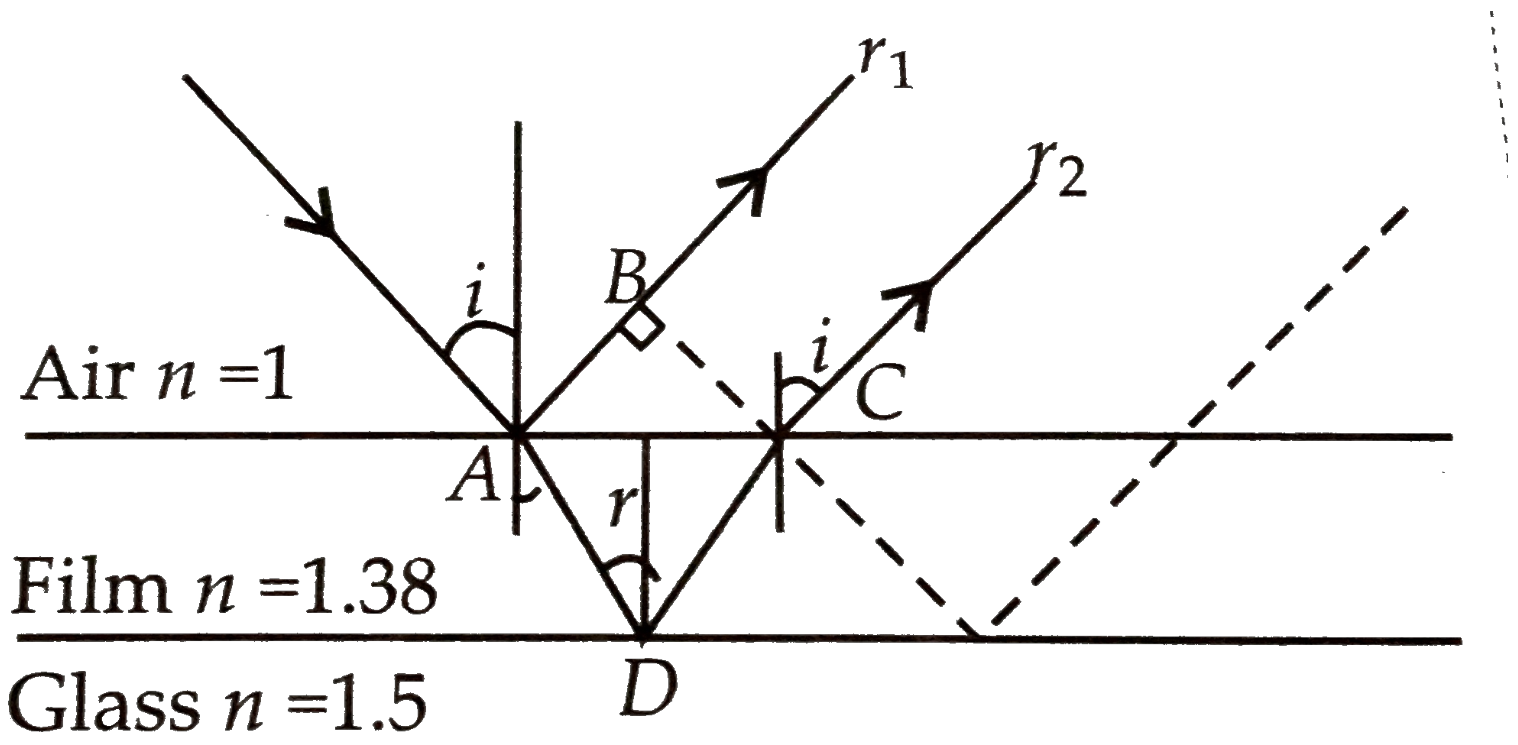
CORRECT ANSWER: C

SOLUTION:

Consider a ray incident at angle i. A part of this ray is reflected from the air-film interface and a part refracted inside. This is partly reflected at the film-glass interface and a part transmitted. A part of the reflected ray is reflected at the film - air interface and a part transmitted as r_2 parallel to r_1. Of course successive reflections and transmissions will keep on decreasing the amplitude fo the wave. Hence rays r_1 and r_2 shall dominate the behavior. If incident light is to be transmitted through the lens, r_1 and r_2 should interfere destructively. Both the reflections at A and D are from lower to higher refractive index and hence there is no phase change on reflection. The optical path difference between r_2 and r_1 is

$$n(AD + CD) - AB.$$

If d is the thickness of the film, then



$$AD = CD = \frac{d}{\cos r}$$

$$AB = AC \sin i$$

$$\frac{AC}{2} = d \tan r$$

$\therefore AC = 2d \tan r$

Hence, $AB = 2d \tan r \sin i$

Thus the optical path difference is

$$2n\frac{d}{\cos r} - 2d \tan r \sin i$$
$$= 2 . \frac{\sin i}{\sin r}\frac{d}{\cos r}$$
$$- 2d\frac{\sin r}{\cos r}\sin i$$

$$= 2d \sin i\left[\frac{1 - \sin^2 r}{\sin r \cos r}\right]$$
$$= 2nd \cos r$$

For these waves to interfere destructively this must be

$\lambda / 2.$

$$2nd \cos r = \frac{\lambda}{2} \text{ or}$$
$$nd \cos r = \frac{\lambda}{4}$$

For a camera lens, the sources are in the vertical plane and hence

$$i \cong r \cong 0$$

$$\therefore nd \cong \frac{\lambda}{4}$$

$$\Rightarrow d = \frac{5500}{1.38 \times 4}$$

$$\cong 1000$$

Q-36 - 14528326

A thin oil film of refractive index 1.2 floats on the surface of water $\left(\mu = \frac{4}{3}\right)$. When a light of wavelength $\lambda = 9.6 \times 10^{-7} m$ falls normally on the film from air, then it appears dark when seen normally. The minimum change in its thickness for which it will appear bright in normally reflected light by the same light is:

(A) 10^{-7}m

(B) $2 \times 10^{-7} m$

(C) $3 \times 10^{-7} m$

(D) $5 \times 10^{-7} m$

CORRECT ANSWER: B

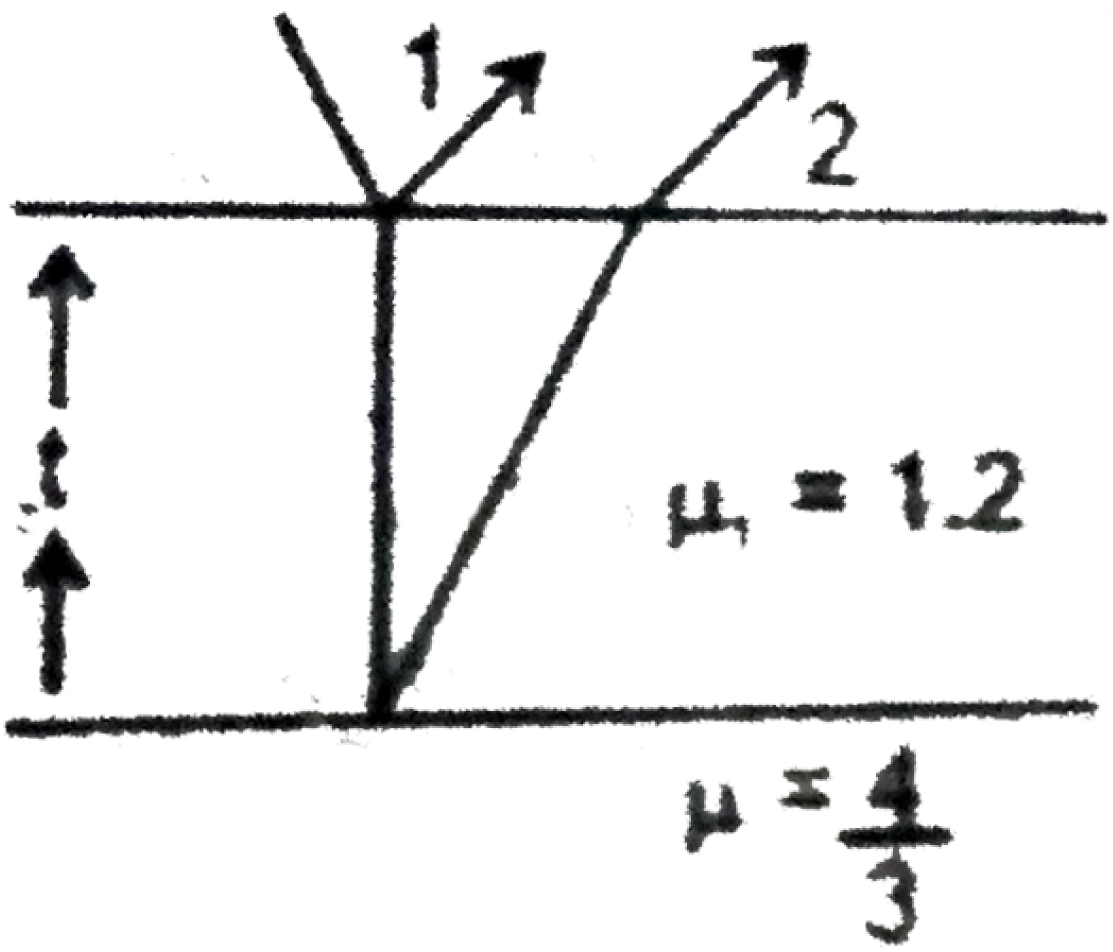
SOLUTION:

For normal incidence path difference between ray 1 and ray 2 is $2\mu_1 t$

For minima thickness increment $2\mu_1 \Delta t = \frac{\lambda}{2}$

$$\Rightarrow (t_2 - t_1) = \frac{\lambda}{4\mu_1}$$

$$= \frac{9.6 \times 10^{-7}}{4 \times 1.2} = 2 \times 10^{-7} m$$



Q-37 - 30559642

A beam of light consisting of two wavelengths $650nm$ and $520nm$ is used to obtain interference fringes in a Young's double slit experiment.

(a) Find the distance of the third bright fringe on the screen from the central maximum for the wavelength $650nm$.

(b) What is the least distance from the central maximum where the bright fringes due to both the wavelengths coincide? The distance between the slits is $2mm$ and the distance between the plane of the slits and screen is $120cm$.

(A) 1.17 mm

(B) 2.52 mm

(C) 1.56 mm

(D) 3.14 mm

CORRECT ANSWER: C

SOLUTION:

Let at linear distance 'y' from center of screen the bright fringes due to both wavelength coincides. Let n_1 number of bright fringe with wavelength λ_1 coincides with n_2 number of bright fringe with wavelength λ_2.

We can write

$y = n_1\beta_1 = n_2\beta_2$

$$n_1 \frac{\lambda_1 D}{d} = n_2 \frac{D\lambda_2}{d} \quad \text{or}$$

$$n_1\lambda_1 = n_2\lambda_2$$

...(i)

Also at first position of coincide, the n^{th} bright fringe of one will coincide with $(n+1)^{th}$ bright fringe of other.

If $\lambda_2 < \lambda_1$,

So, then $n_2 > n_1$ and $n_2 = n_1 + 1$ ...(ii)

Using equation (ii) in equation (i)

$$n_1\lambda_1 = (n_1 + 1)\lambda_2$$

$$n_1(650) \times 10^{-9}$$
$$= (n_1 + 1)520$$
$$\times 10^{-9}$$

$$65n_1 = 52n_1 + 52 \quad \text{or}$$
$$13n_1 = 52 \quad \text{or} \quad n_1$$
$$= 4$$

Thus,

$y = n_1 \beta_1$

$= 4 \left[\frac{(6.5 \times 10^{-7})(1.2)}{2 \times 10^{-3}} \right]$

$= 1.56 \times 10^{-3} m$

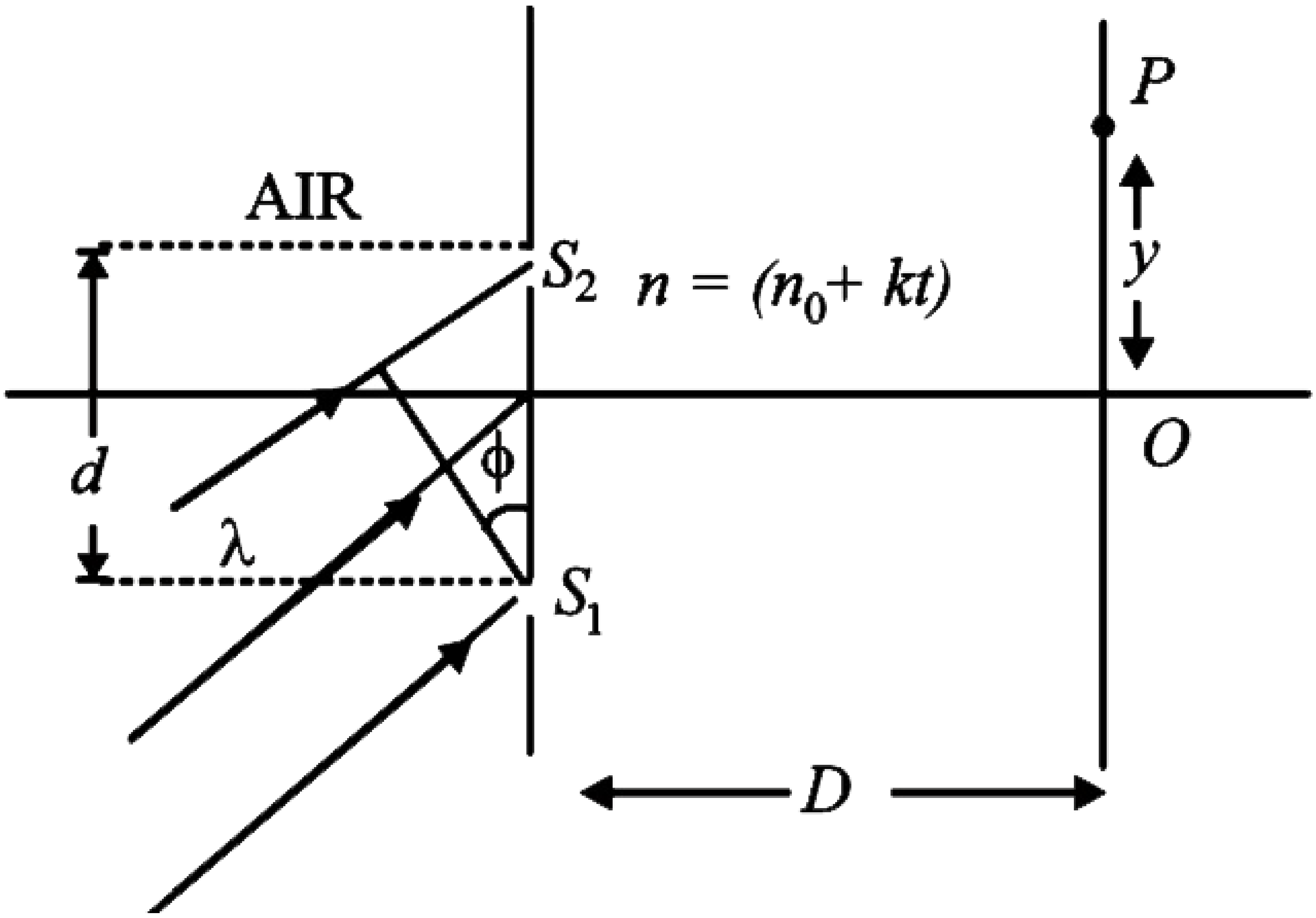
$= 1.56 mm$

So, the fourth bright fringe of wavelength 520 nm

coincides with 5^{th} bright fringe of wavelength 650 nm.

Q-38 - 14797394

In a Youngs double slit experiment a monochromatic light whose wavelength is l strikes on the slits, separated by distance d, as shown in the figure. Refractive index of the medium between slits and screen varies with time t as n = n0 + kt. Here n0 and k are positive constants. Position of any point P on screen is measure by its y-coordinate as shown.



The velocity of central maxima at any time t as a function of time t is

(A) $\dfrac{-2kD\sin\phi}{(n_0 + kt)^2}$

(B) $\dfrac{-kD\sin\phi}{(n_0 + kt)^2}$

(C) $\dfrac{-2kD\sin\phi}{(n_0 + kt)}$

(D) $\dfrac{-kD\sin\phi}{(n_0 + kt)}$

Q-39 - 30559639

An optically active compound

(A) rotates the plane of polarised light

(B) changes the direction of polarised light

(C) does not allow plane polarised light to pass through

(D) none of these.

CORRECT ANSWER: A

SOLUTION:

An optically active compound rotates the plane of polarized light.

Q-40 - 10968647

White light is used to illuminate the two slits in a Young's

double slit experiment. The separation between the slits is b and the

screen is at

a distance $d(>>b)$ from the slits. At a point on the screen

directly in front of

one of the slits, certain wavelengths are missing. Some of these

missing

wavelength are

$(a)\lambda = b^2/d(b)\lambda = 2b^2$
$/d(c)\lambda = b^2/3d(d)\lambda = 2b^2$
$/3d$

.

(A) $\lambda = b^2/d$

(B) $\lambda = 2b^2/d$

(C) $\lambda = b^2/3d$

(D) $\lambda = 2b^2 / 3d$

CORRECT ANSWER: A::C

SOLUTION:

At P (directly in front of S_1)y = b/2

:. Path difference,

$$\Delta x = S_2P - S_1P$$
$$= \left(y.\frac{b}{d}\right)$$
$$= \left(\frac{\left(\frac{b}{2}\right)(b)}{d}\right) = \frac{b^2}{2}d$$

Those wavelengths will be missing for which

$$\Delta x = \frac{\lambda_1}{2}, \frac{3\lambda_2}{2}, \frac{5\lambda_3}{2}$$
$$\lambda_1 = 2\Delta x = \frac{b^2}{d}$$
$$\lambda_2 = \frac{2\Delta x}{3} = \frac{b^2}{3d}$$
$$\lambda_3 = \frac{2\Delta x}{5} = \frac{b^2}{5d}$$

Therefore, the correct options are (a) and (c).

Q-41 - 30559636

The critical angle of a certain medium is $\sin^{-1}\left(\frac{3}{5}\right)$. The polarizing angle of the medium is :

(A) $\sin^{-1}\left(\frac{4}{5}\right)$

(B) $\tan^{-1}\left(\frac{5}{3}\right)$

(C) $\tan^{-1}\left(\frac{3}{4}\right)$

(D) $\tan^{-1}\left(\frac{4}{3}\right)$

CORRECT ANSWER: B

SOLUTION:

Here, critical angle, $i_c = \sin^{-1}\left(\frac{3}{5}\right)$

$\therefore \sin i_c = \frac{3}{5}$

As $\mu = \frac{1}{\sin i_c} = \frac{5}{3}$

According to Brewster's law

$\tan i_p = \mu$

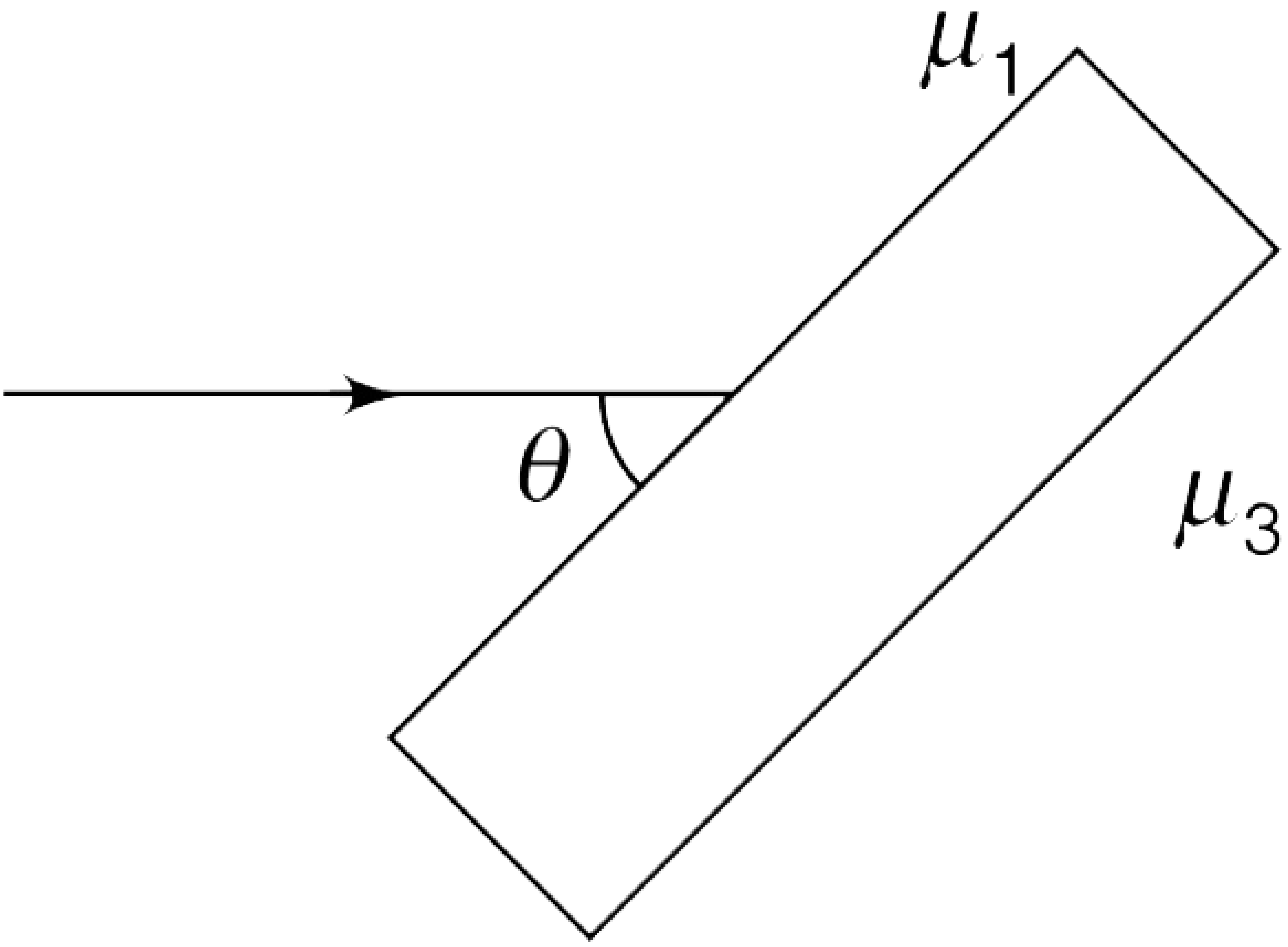
where i_p is the polarising angle

$\therefore \tan i_p = \frac{5}{3} \Rightarrow i_p$

$= \tan^{-1}\left(\frac{5}{3}\right)$

Q-42 - 15282524

A light ray travelling in a medium of refractive index μ_1 is incident on a parallel faced glass slab making an angle of θ with the glass surface. The refractive index of the medium on the other side of the glass slab is $\mu_3(> \mu_1)$. Find the angular deviation suffered by the light ray.



CORRECT ANSWER:

$$DELTA = \frac{PI}{2} - THETA - SIN^{-1}\left(\frac{MU_1}{MU_3} COSTHETA\right)$$

Q-43 - 30559649

To ensure almost 100 $\%$ transmittivity, photographic lenses are often coated with a thin layer of dielectric material, like $MgF_2(\mu = 1.38)$. The minimum thickness of the film to be used so that at the centre of visible spectrum $(\lambda = 5500)$ there is maximum transmission.

(A) 5000 Å

(B) 2000 Å

(C) 1000 Å

(D) 3000 Å

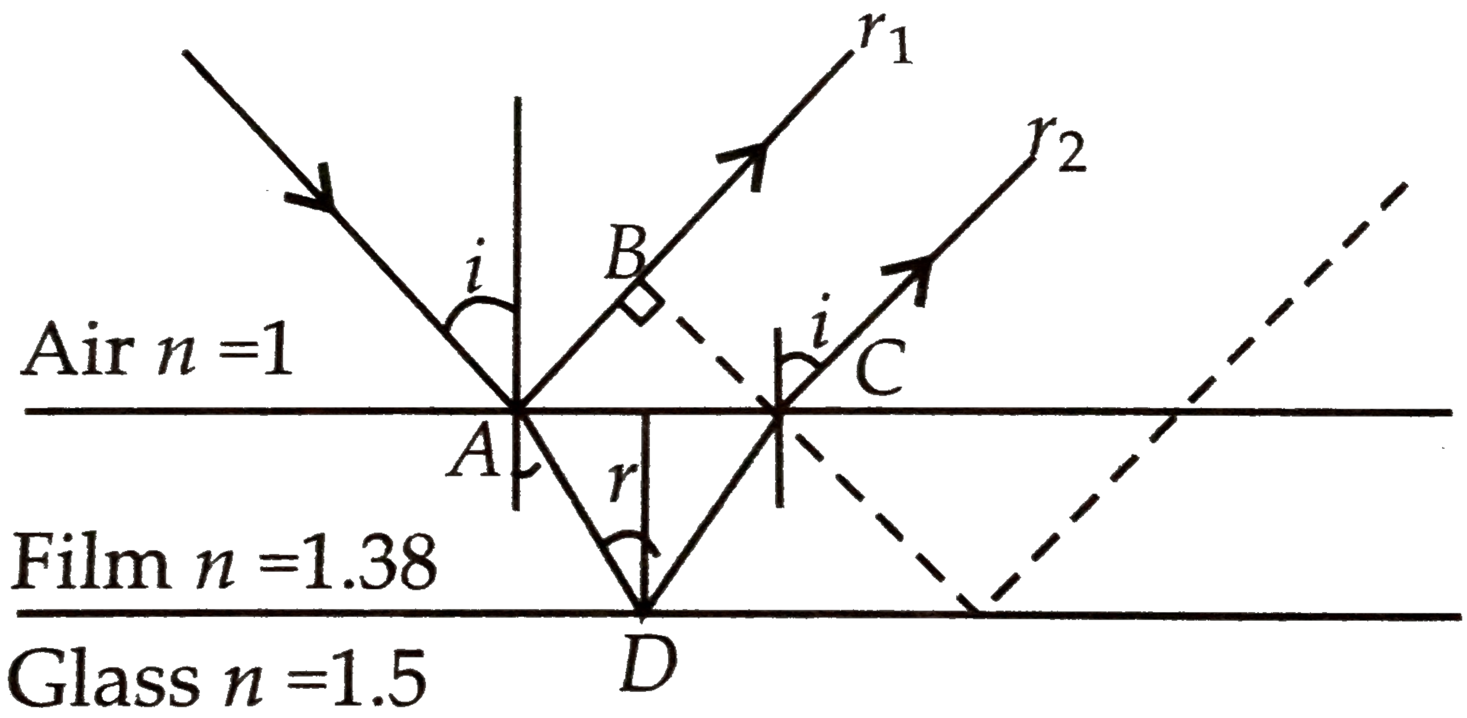
CORRECT ANSWER: C

SOLUTION:

Consider a ray incident at angle i. A part of this ray is reflected from the air-film interface and a part refracted inside. This is partly reflected at the film-glass interface and a part transmitted. A part of the reflected ray is reflected at the film - air interface and a part transmitted as r_2 parallel to r_1. Of course successive reflections and transmissions will keep on decreasing the amplitude fo the wave. Hence rays r_1 and r_2 shall dominate the behavior. If incident light is to be transmitted through the lens, r_1 and r_2 should interfere destructively. Both the reflections at A and D are from lower to higher refractive index and hence there is no phase change on reflection. The optical path difference between r_2 and r_1 is

$n(AD + CD) - AB.$

If d is the thickness of the film, then



$$AD = CD = \frac{d}{\cos r}$$

$$AB = AC \sin i$$

$$\frac{AC}{2} = d \tan r$$

$$\therefore AC = 2d \tan r$$

Hence, $AB = 2d \tan r \sin i$

Thus the optical path difference is

$$2n\frac{d}{\cos r} - 2d \ \tan r \sin i$$

$$= 2. \frac{\sin i}{\sin r}\frac{d}{\cos r}$$

$$- 2d\frac{\sin r}{\cos r}\sin i$$

$$= 2d \ \sin i\left[\frac{1 - \sin^2 r}{\sin r \cos r}\right]$$

$$= 2nd \ \cos r$$

For these waves to interfere destructively this must be

$\lambda/2$.

$$2nd \quad \cos r = \frac{\lambda}{2} \quad \text{or}$$

$$nd \quad \cos r = \frac{\lambda}{4}$$

For a camera lens, the sources are in the vertical plane

and hence

$i \cong r \cong 0$

$$\therefore nd \cong \frac{\lambda}{4}$$

$$\Rightarrow d = \frac{5500}{1.38 \times 4}$$

$$\cong 1000$$

Q-44 - 11969249

If we observe the single slit Fraunhofer diffraction with wavelength

λ and slit width d, the width of the central maxima is 2θ. On decreasing the slit width for the same λ

(A) (a) θ increases

(B) (b) θ remains unchanged

(C) (c) θ decreases

(D) (d) θ increases or decreases depending on the intensity of light

---

CORRECT ANSWER: A

SOLUTION:

$2\theta = \frac{2\lambda}{d}$ (where d=slit width)

As d decreases, θ increases.

Q-45 - 30559602

The angular resolution of a $10cm$ diameter telescope at a wavelength 5000 is of the order

(A) 10^{6} rad

(B) 10^{-2} rad

(C) 10^{-4} rad

(D) 10^{-6} rad

CORRECT ANSWER: D

SOLUTION:

Using ,

$$d\theta = \frac{1.22\lambda}{D}$$

$$= \frac{1.22 \times 5000 \times 10^{-10}}{0.10}$$

$$= 6.1 \times 10^{-6}\text{rad}$$

$$= 10^{-6}$$

rad

Q-46 - 10968649

In YDSE, bichromatic light of wavelengths 400 nm and 560 nm

are used. The distance between the slits is 0.1 mm and the distance

between the

plane of the slits and the screen is 1m. The minimum distance

between two

successive regions of complete darkness is

(a) 4mm (b) 5.6mm (c) 14 mm (d)28 mm .

(A) $4mm$

(B) $5.6mm$

(C) $14mm$

(D) $28mm$

CORRECT ANSWER: D

SOLUTION:

Let nth minima of 400nm coincides with mth minima of

560nm, then

$$\frac{(2n-1)\lambda_1 D}{2d} = \frac{(2n-1)\lambda_2 D}{2d}$$

or

$$(2n-1)\left(\frac{400}{2}\right) = (2m-1)\left(\frac{560}{2}\right)$$

$$\frac{2n-1}{2m-1} = \frac{7}{5} = \frac{14}{10} = \frac{21}{15}$$

If we take the first ratio, then n = 4 and m=3.

If we take the second ratio, then n =7.5 and m=5.5

This is not acceptable. If we take the ratio, then n= 11 and m=8

i.e. 4th minima of 400nm coincides with 3rd minima of 560nm.

Location of this minima is

$$y_1 = \frac{(2 \times 11 - 1)(1000)\left(400 \times 10^{-6}\right)}{2 \times 0.1} = 14mm$$

.

Next 11 th minima of 400nm will coincide with 8th minima of 560nm.

Location of this minima is

y_2

$$= \frac{(2 \times 11 - 1)(1000)\left(400 \times 10^{-6}\right)}{2 \times 0.1}$$

$= 42mm.$

$\therefore$ Required distance = $y_2 - y_1 = 28mm$

$\therefore$ The correct option is (d) .

Q-47 - 30559599

A diffraction pattern is obtained using a beam of redlight. What happens if the red light is replaced by blue light

(A) No change.

(B) Diffraction bands become narrower and crowded together.

(C) Band become broader and farther apart.

(D) Bands disappear altogether.

CORRECT ANSWER: B

SOLUTION:

As $\lambda_{\text{blue}} < \lambda_{\text{red}}$, and width of diffraction bands is directly proportional to λ, therefore diffraction bands become narrower and crowded.

Q-48 - 16799121

The distance between two slits in a YDSE apparatus is 3mm. The distance of the screen from the slits is 1m. Microwaves of wavelength 1 mm are incident on the plane of the slits normally. Find the distance of the first maxima on the screen from the central maxima.

CORRECT ANSWER: [35.35CM APP.,5]

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Q-49 - 16798921

A YDSE setup is immersed in water $(\mu = 1.33)$. If has slit separation 1 mm and distance between slits and screen is 1.33m. Incident light on slits have wavelength 6300. Find the fringe width on screen.

CORRECT ANSWER: N/A

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Q-50 - 30559604

For the same objective, what is the ratio of the least separation between two points to be distinguished by a microscope for light of

5000 and electrons accelerated through 100 V used as an illuminating substance?

(A) 3075

(B) 3575

(C) 4075

(D) 5075

CORRECT ANSWER: C

SOLUTION:

The limit of resolution of a microscope is

$$d = \frac{\lambda}{2\sin\theta}$$

where 2θ is the angle of cone of light rays entering the objective of the microscope.

Here, $\lambda_1 = 5000$

For electrons accelerated through 100 V, de Broglie wavelength,

$$\lambda_2 = \frac{12.27}{\sqrt{100}} = 1.227$$

As $(2\sin\theta)$ is same in the two cases, therefore,

$$\frac{d_1}{d_2} = \frac{\lambda_1}{\lambda_2} = \frac{5000}{1.227}$$
$$= 4075$$

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Q-51 - 30559594

A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is observe on 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. Find the width of the slit.

(A) 0.2 mm

(B) 1 mm

(C) 2 mm

(D) 1.5 mm

CORRECT ANSWER: A

SOLUTION:

Width of slit, $d = \frac{n\lambda D}{x}$

Here,

$n = 1, D = 1m, x = 2.5mm = 2.5 \times 10^{-3}m$

$\lambda = 500nm = 500 \times 10^{-9}m$

$\therefore d = \frac{1 \times 500 \times 10^{-9} \times 1}{2.5 \times 10^{-3}} = 2 \times 10^{-4}m = 0.2mm$

Q-52 - 30559589

In Young's double slit experiment, the distance d between the slits S_1 and S_2 is 1 mm. What should the width of each slit be so as to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern ?

(A) 0.9 mm

(B) 0.8 mm

(C) 0.2 mm

(D) 0.6 mm

CORRECT ANSWER: C

SOLUTION:

The angular separation between n bright fringes,

$$\theta_n = \frac{x_n}{D} = \frac{n\lambda}{d} \quad \left(\because x_n = \frac{n\lambda D}{d} \right)$$

For 10 bright fringes, $\theta_{10} = \frac{10\lambda}{d}$

The angular width of the central maximum in the diffraction pattern due to slit of width a is

$$2\theta_1 = \frac{2\lambda}{a}$$

Now

$$\frac{10\lambda}{d} \leq \frac{2\lambda}{a} \quad \text{or} \quad a \leq \frac{d}{5} = \frac{1}{5}mm = 0.2mm$$

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Q-53 - 11969209

In Young's double slit experiment the y-coordinates of central maxima and 10th maxima are $2cm$ and $5cm$ respectively. When the YDSE apparatus is immersed in a liquid of refractive index 1.5 the corresponding y-coordintates will be

(A) (a) $2cm$, $7.5cm$

(B) (b) $3cm$, $6cm$

(C) (c) $2cm$, $4cm$

(D) (d) $4/3cm$, $10/3cm$

CORRECT ANSWER: C

SOLUTION:

Fringe with $\beta \propto \lambda$. Therefore, λ and hence β decreases 1.5 times when immersed in liquid. The distance between central maxima and 10^{th} maxima is 3cm in vacuum. When immersed in liquid it will reduce to $2cm$.

Position of central maxima will not chagne while 10th maxima will be obtained at $y = 4cm$.

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Q-54 - 30559585

A parallel beam of light of wavelength 6000 gets diffracted by a single slit of width 0.3 mm. The angular position of the first minima of diffracted light is :

(A) 2×10^{-3}rad

(B) 3×10^{-3}rad

(C) 1.8×10^{-3}rad

(D) 6×10^{-3}rad

CORRECT ANSWER: A

SOLUTION:

Here,

$\lambda = 6000 = 6000$
$\times 10^{-10} m = 6$
$\times 10^{-7} m$

$a = 0.3 mm = 0.3$
$\times 10^{-3} m = 3$
$\times 10^{-4} m$

For first minima, $a \sin \theta = \lambda$ where a is the slit width

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

$= \frac{6 \times 10^{-7} m}{3 \times 10^{-4} m} = 2$
$\times 10^{-3}$

As $\sin \theta$ is very small

$\therefore \theta \cong \sin \theta = 2$
$\times 10^{-3}$
rad

Q-55 - 13166998

Two identical narrow slits S_1 and S_2 are illuminated by light of wavelength λ from a point source P. If, as shown in the diagtam above the light is then allowed to fall on a scree, and if n is a positive integer, the condition for destructive interference at Q is that

(A)
$(l_1 - l_2) = (2n + 1)\lambda / 2$

(B)
$(l_3 - l_4) = (2n + 1)\lambda / 2$

(C)
$(l_3 + l_3) - (l_2 + l_4) = n\lambda$

(D)
$(l_1 + l_3) - (l_2 + l_4) = (2n + 1)\lambda / 2$

CORRECT ANSWER: D

Q-56 - 30559561

In a two slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the plane of slits.

If the screen is moved by 5×10^{-2}m. towards the slits, the change in fringe width is 3×10^{-5}m. If the distance between slits is 10^{-3} m, the wavelength fo light will be

(A) 3000 Å

(B) 4000 Å

(C) 6000 Å

(D) 7000 Å

CORRECT ANSWER: C

SOLUTION:

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

where $\lambda$is the wavelength of light, D is the distance between screen and the slits and d is the distance between two slits

$$\therefore \triangle \beta = \frac{\lambda}{d}$$

$$\triangle D \quad \text{or} \quad \lambda = \frac{\triangle \beta d}{\triangle D}$$

(As λ and d are constants)

Substituting the given values, we get

$$\lambda = \frac{(3 \times 10^{-5} m)(10^{-3} m)}{(5 \times 10^{-2} m)}$$

$$= 6 \times 10^{-7} m = 6000$$

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Q-57 - 30559607

The diameter of the pupil of human eye is about $2mm$. Human eye is most sensitive to the wavelength $555nm$. Find the limit of resolution of human eye.

(A) 1.2 min

(B) 2.4 min

(C) 0.6 min

(D) 0.3 min

CORRECT ANSWER: A

SOLUTION:

Limit of resolution,

$$d\theta = \frac{1.22\lambda}{D}$$

$$= \frac{1.22 \times 555 \times 10^{-9}}{2 \times 10^{-3}}$$

$$= 3.39 \times 10^{-4} \text{rad}$$

$$d\theta = 3.39 \times 10^{-4} \times \left(\frac{180}{\pi}\right)$$

$$= 0.0194 = 0.0194 \times 60' = 1.2'$$

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Q-58 - 30559570

In a Young's double slit experiment, (slit distance d) monochromatic light of wavelength λ is used and the fringe pattern observed at a distance D from the slits. The angular position of the bright fringes are

(A) $\sin^{-1}\left(\frac{N\lambda}{d}\right)$

(B) $\sin^{-1}\left(\frac{(N+\frac{1}{2})\lambda}{d}\right)$

(C) $\sin^{-1}\left(\frac{N\lambda}{D}\right)$

(D) $\sin^{-1}\left(\frac{(N+\frac{1}{2})\lambda}{D}\right)$

CORRECT ANSWER: A

SOLUTION:

Condition for bright fringes:

Path difference, $\delta = d\sin\theta_{\text{bright}} = N\lambda$, where

$N = 0, \pm 1, \pm 2,$

$\therefore \theta_{\text{bright}}$

$$= \sin^{-1}\left(\frac{N\lambda}{d}\right)$$

Q-59 - 30559620

Upolarised light of intensity 32 W m^{-2} passes through three polarisers such that transmission axis of first is crossed with third. If intensity of emerging light is 2 W m^{-2}, what is the angle of transmission axis between the first two polarisers?

(A) 30°

(B) 45°

(C) 22.5°

(D) 60°

CORRECT ANSWER: C

SOLUTION:

Let θ be angle between the axis of the first two polarisers then obviously $(90-\theta)$ is the angle between 2^{nd} and 3^{rd} polarisers.

$$\therefore I=\frac{I_0}{2}\cos^2\theta\cos^2(90-\theta)$$

or

$$2=\frac{32}{2}\cos^2\theta\cos^2(90-\theta)=16\cos^2\theta\sin^2\theta$$

$(2\sin\theta\cos\theta)^2$

$= \frac{1}{2}$ or $\sin^2 2\theta$

$= \frac{1}{2} \therefore \sin 2\theta = \frac{1}{\sqrt{2}}$

$\therefore 2\theta = 45$ or θ

$= 22.5$

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Q-60 - 30559560

Interference fringes were produced in Young's double slit experiment using light of wavelength 5000 . When a film of material $2.5 \times 10^{-3} cm$ thick was placed over one of the slits, the fringe pattern shifted by a distance equal to 20 fringe widths. The refractive index of the material of the film is

(A) 1.25

(B) 1.33

(C) 1.4

(D) 1.5

CORRECT ANSWER: C

SOLUTION:

Fringe width, $\beta = \dfrac{\lambda D}{d}$ (i)

where D is the distance between the screen and slit and

d is the distance between two slits.

When a film of thickness t and refractive index μ is

placed over one of the slit, the fringe pattern is shifted by

distance S and is given by

$$S = \frac{(\mu - 1)tD}{d} \quad \text{... (ii)}$$

Given : $S = 20\beta$ ... (iii)

From equations (i), (ii) and (iii) we get,

$(\mu - 1)t = 20\lambda$

or

$$(\mu - 1) = \frac{20\lambda}{t}$$

$$= \frac{20 \times 5000 \times 10^{-8} cm}{2.5 \times 10^{-3} cm}$$

$$\mu - 1 = 0.4 \quad \text{or} \quad \mu = 1.4$$


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Illustration 4.32 If $\sqrt{x}+\sqrt{y}=4$, then find $\frac{dx}{dy}$ at $y=1$.
Sol. Differentiating both sides of the given equation w.r.t. we get
doubtnut