Wave Optics

Question1

A beam of light of intensity I_0 falls on a system of three polaroids which are arranged in succession such that the pass (transmission) axis is turned through 60° with respect to preceding one. The fraction of the incident light intensity that passes through the system is $\left(\cos 60^\circ = \frac{1}{2}\right)$

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Options:

A.

$\frac{1}{8}$

B.

$\frac{1}{32}$

C.

$\frac{1}{16}$

D.

$\frac{1}{2}$

Answer: B

Solution:

According to Malus' law,

$I = I_0 \cos^2 \theta$

When beam passed through polaroid 1,

$I_1 = \frac{I_0}{2}$

When beam passed through polaroid 2,

$$I_2 = \frac{I_0}{2} \cos^2 60^\circ$$
$$\therefore\ I_2 = \frac{I_0}{8}$$

When beam passed through polaroid 3,

$I_3 = \frac{I_0}{8} \cos^2 60^\circ = \frac{I_0}{8} \times \left(\frac{1}{2}\right)^2 = \frac{I_0}{32}$

Question2

Resolving power of a telescope can be increased by increasing

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Options:

A.

the diameter of eyepiece.

B.

the wavelength of light.

C.

the focal length of eye-piece.

D.

the diameter of the objective.

Answer: D

Solution:

The resolving power R of a telescope depends mainly on the **objective lens/mirror** and is given (approximately) by the Rayleigh criterion:

$\theta \approx 1.22 \frac{\lambda}{D}$

where

- θ = minimum resolvable angle (smaller means better resolving power),
- λ = wavelength of light used,
- D = diameter of the objective lens or mirror.

Thus, increasing the **diameter of the objective** improves the resolving power.

✅ **Correct Answer: Option D — the diameter of the objective.**

Question3

In Young's double slit experiment, the intensity on screen at a point, where path difference is $\frac{\lambda}{4}$ is $\frac{K}{4}$. The intensity at a point when path difference is ' λ ' will be $\left[\cos \frac{\pi}{2}=0, \cos 2 \pi=1\right]$

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Options:

A.

4 K

B.

2 K

C.

K

D.

$\frac{K}{2}$

Answer: D

Solution:

The intensity is given by

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

When path difference is $\frac{\lambda}{4}$, i.e., $\phi=\frac{\pi}{2}$, intensity will be

$\frac{K}{4}=4I_0\cos^2\left(\frac{\pi}{4}\right) \qquad \ldots(i)$

When path difference is λ,i.e., $\phi=2\pi$, intensity will be

$\therefore \quad \mathrm{I}=4\mathrm{I}_0\cos^2(\pi) \qquad \ldots(ii)$

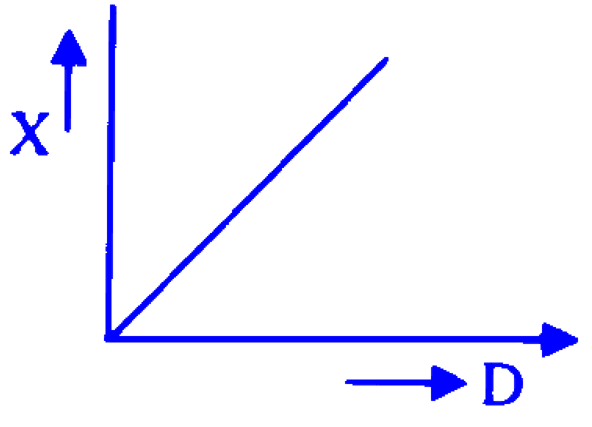
$\therefore$ From (i) and (ii), we get

$$\frac{K}{4I}=\frac{4I_0\cos^2\left(\frac{\pi}{4}\right)}{4I_0\cos^2(\pi)}=\frac{\cos^2\left(\frac{\pi}{4}\right)}{\cos^2(\pi)}=\frac{1}{2}$$

$$I=\frac{K}{2}$$

Question4

Graph shows the variation of fringe width (X) versus distance of the screen from the plane of the slits (D) in Young's double slit experiment. (keeping other parameters same, $d=$ distance between the slits). The wavelength of light used can be calculated as



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Options:

A.

slope $\times \mathrm{d}^2$

B.

$\frac{d}{\text{slope}}$

C.

$\frac{\text{slope}}{d}$

D.

slope $\times$d

Answer: D

Solution:

The formula for fringe width in Young's double slit experiment is:

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

Here, X is the fringe width, λ is the wavelength, D is the distance from the slits to the screen, and d is the distance between the two slits.

The graph shows how X (fringe width) changes with D (distance to the screen). This means the slope of the graph is $\frac{X}{D}$.

From the formula above, if we write it as $\frac{X}{D} = \frac{\lambda}{d}$, we see that the slope of the graph equals $\frac{\lambda}{d}$.

So, you can calculate λ (wavelength) using:

$\lambda = \text{slope} \times d$

Here, 'slope' means the value you get from the graph ($\frac{X}{D}$), and d is the distance between the slits.

Question5

In Young's double slit experiment, in an interference pattern second minimum is observed exactly in front of one slit. The distance between the two coherent sources is ' d ' and the distance between source and screen is ' D '. The wavelength of light source used is

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Options:

A.

$\frac{d^2}{4D}$

B.

$\frac{d^2}{3D}$

C.

$\frac{d^2}{2D}$

D.

$\frac{d^2}{D}$

Answer: B

Solution:

Step 1: Path difference at a point on screen

Suppose the slits are S_1 and S_2, separated by distance d. Consider the point P on the screen which is exactly in front of slit S_2. Then:

- Path from S_2 to $P = D$.
- Path from S_1 to P: slightly longer because it is displaced by d.

Using geometry, the path difference is approximately

$\Delta = \frac{d \cdot x}{D}$

where x is the distance of point P from the central axis (the midpoint between slits projected onto screen).

But here point P is directly in front of a slit (say slit S_2). The distance of that point on screen from the central axis is simply $x = \frac{d}{2}$.

(Reason: midpoint between slits is at $x = 0$; each slit is $\pm\frac{d}{2}$ from that axis; projecting forward keeps that offset).

Thus,

$\Delta = \frac{d \cdot (d/2)}{D} = \frac{d^2}{2D}$.

Step 2: Condition for minimum

Nth **minimum** condition in Young's setup:

$\Delta = \left(m + \frac{1}{2}\right)\lambda, \quad m = 0, 1, 2, \ldots$

The **second minimum** means $m = 1$ (since $m = 0$ is first minimum).

So:

$\Delta = \frac{3}{2}\lambda.$

Step 3: Equating path difference

$\frac{d^2}{2D} = \frac{3}{2}\lambda$

$\lambda = \frac{d^2}{3D}.$

✅ **Final Answer:**

$\boxed{\frac{d^2}{3D}}$

That corresponds to **Option B**.

Question6

The polarising angle of transparent medium is ' θ '. Let the speed of light in the medium be ' v '. Then the relation between ' θ ' and ' v ' is [c = velocity of light in air]

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Options:

A.

$\theta = \sin^{-1}\left(\frac{v}{c}\right)$

B.

$\theta = \tan^{-1}\left(\frac{v}{c}\right)$

C.

$\theta = \cot^{-1}\left(\frac{v}{c}\right)$

D.

$\theta = \cos^{-1}\left(\frac{v}{c}\right)$

Answer: C

Solution:

Step 1: Brewster's Law

The polarising angle (Brewster's angle) θ_p is defined by:

$\tan \theta_p = \mu$

where μ is the refractive index of the medium with respect to air.

Step 2: Relation between refractive index and velocity

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

where c = speed of light in vacuum (or air approximately),

v = speed of light in the medium.

Step 3: Substitute into Brewster's Law

$\tan \theta = \frac{c}{v}$

$\theta = \tan^{-1}\left(\frac{c}{v}\right)$

Step 4: Compare options

We want an expression involving $\frac{v}{c}$. Note:

$\theta = \tan^{-1}\left(\frac{c}{v}\right) = \cot^{-1}\left(\frac{v}{c}\right)$

✅ Correct option:

Option C

$\theta = \cot^{-1}\left(\frac{v}{c}\right)$

Question7

The ratio of the distance of n^{th} bright band and m^{th} dark band from the central bright band in an interference pattern is

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Options:

A. $n : m$

B. $m : n$

C. $n : \left(m - \frac{1}{2}\right)$

D. $\left(n - \frac{1}{2}\right) : m$

Answer: C

Solution:

Distance of n^{th} bright fringe from centre

$y_n = \frac{n\lambda D}{d} = nW \quad \left(\because W = \frac{\lambda D}{d}\right)$

Distance of m^{th} dark fringe from centre

$$y'_n = \left(m - \frac{1}{2}\right)\frac{\lambda D}{d} = \left(m - \frac{1}{2}\right)W$$

$$\therefore \quad \text{Ratio } = \frac{y_n}{y'_m} = \frac{nW}{\left(m - \frac{1}{2}\right)W} = \frac{n}{\left(m - \frac{1}{2}\right)}$$

$$\text{Ratio } = n : \left(m - \frac{1}{2}\right)$$

Question8

A single slit diffraction pattern is formed with white light. For what wavelength of light the 4^{th} secondary maximum in diffraction pattern coincides with the 3^{rd} secondary maximum in the pattern of light of wavelength ' λ '?

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Options:

A. $\frac{5\lambda}{7}$

B. $\frac{7\lambda}{9}$

C. $\frac{3\lambda}{4}$

D. $\frac{9\lambda}{13}$

Answer: B

Solution:

Position of n^{th} secondary maximum in a singleslit diffraction pattern is given by

$y_s = (2n+1)\frac{\lambda D}{2a}$

For 4^{th} secondary maximum,

$y_4 = \frac{9\lambda' D}{2a}$

For 3^{rd} secondary maximum,

$y_3 == \frac{7\lambda D}{2a}$

4^{th} and 3^{rd} secondary maximum coincides,

$$\therefore \quad y_4 = y_3$$
$$\frac{9\lambda' D}{2a} = \frac{7\lambda D}{2a}$$
$$\lambda' = \frac{7\lambda}{9}$$

Question9

In Young's double slit experiment, the distance between the slits is 2 mm and the slits are 1 m away, from the screen. Two interference patterns can be obtained on the screen due to light of wavelength ' λ_1 ' and ' λ_2 ' respectively. The separation on the screen between the 3^{rd} order bright fringes on the two interference patterns is ($\lambda_2 = 1.5\lambda_1$)

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Options:

A. $(0.75 \times 10^{+3})\lambda_1$

B. $(1.75 \times 10^{+3})\lambda_1$

C. $(2.00 \times 10^{+3})\lambda_1$

D. $(2.25 \times 10^{+3})\lambda_1$

Answer: A

Solution:

The fringe position of n^{th} order bright fringe is given by

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

For wavelength λ_1

$y_1 = \frac{3\lambda_1 D}{d}$

For wavelength $\lambda_2 = 1.5\lambda_1$

$y_2 = \frac{3(1.5\lambda_1)D}{d} = \frac{4.5\lambda_1 D}{d}$

So, the separation Δy between the two 3^{rd} order bright fringes is:

$$\Delta y = y_2 - y_1 = \frac{4.5\lambda_1 D}{d} - \frac{3\lambda_1 D}{d} = \frac{1.5\lambda_1 D}{d}$$
$$\therefore \quad \Delta y = \frac{1.5\lambda_1 \cdot 1}{2 \times 10^{-3}} = \frac{1.5\lambda_1}{2 \times 10^{-3}} = \left(0.75 \times 10^3\right)\lambda_1$$

Question10

In Young's double slit experiment, at two points P and Q on screen, waves from slits S_1 and S_2 have a path difference of 0 and $\frac{\lambda}{4}$ respectively. The ratio of intensities at point P to that at Q will be $\left(\cos 0^\circ = 1, \cos 45^\circ = \frac{1}{\sqrt{2}}\right)$

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Options:

A. 3 : 2

B. 2 : 1

C. $\sqrt{2}$: 1

D. 4 : 1

Answer: B

Solution:

If I_0 is the intensity of each wave and ϕ is the phase difference, then the resultant intensity is given by

$I = 4I_0 \cos^2 \frac{\phi}{2}$

When path difference $= 0$, phase difference $\phi = 0$, $I_1 = 4I_0 \cos^2 0 = 4I_0$

When path difference $= \frac{\lambda}{4}$, phase difference

$$\begin{aligned} & \phi = \frac{\pi}{2} \\ \therefore \quad & I_2 = 4I_0 \cos^2 \frac{\pi}{4} = 2I_0 \\ \therefore \quad & \frac{I_1}{I_2} = \frac{4I_0}{2I_0} = \frac{2}{1} \end{aligned}$$

Question11

In a biprism experiment a steady interference pattern is observed on the screen using a light of wavelength $5000\overset{o}{A}$. Without disturbing the set up of the experiment, the source of light is replaced by a source of wavelength $6400\overset{o}{A}$.

The fringe width will

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Options:

A. decrease by 48%

B. decrease by 28%

C. increase by 48%

D. increase by 28%

Answer: D

Solution:

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

$$\therefore \frac{W_1}{W_2} = \frac{\lambda_1}{\lambda_2}$$

$$\therefore \frac{W_2 - W_1}{W_1} = \frac{\lambda_2 - \lambda_1}{\lambda_1} = \frac{6400 - 5000}{5000} = \frac{1400}{5000}$$

$$= \frac{7}{25} = 0.28 = 28\%$$

Therefore, the fringe width will increase by 28%.

Question12

In a single slit diffraction experiment, slit of width ' a ' is illuminated by light of wavelength ' λ ' and the width of the central maxima in diffraction pattern is measured as ' y '. When half of the slit is covered and illuminated by light of wavelength (1.5) λ, the width of the central maximum in diffraction pattern becomes

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Options:

A. $\frac{3}{2}y$

B. $\frac{2}{3}y$

C. $3y$

D. $\frac{y}{3}$

Answer: C

Solution:

$$y = \frac{2\lambda D}{d}$$

When half the slit is covered, $d' = \frac{d}{2}, \lambda' = 1.5\lambda$

$$\therefore W' = \frac{2\lambda' D}{\frac{d}{2}}$$

$\therefore \quad \frac{y'}{y} = \frac{2\lambda'}{\lambda} = \frac{2\times1.5\lambda}{\lambda}$

$\therefore \quad \frac{y'}{y} = 3$

$\therefore \quad y' = 3y$

Question13

If the two sources of light emit waves of different amplitudes and interfere then

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Options:

A. there is some intensity of light in the region of destructive interference.

B. fringe width is less.

C. brightness of fringes is less.

D. fringes disappear after short time.

Answer: A

Solution:

If amplitudes are different, then in the region of destructive interference, the two waves do not cancel each other completely. Hence, there is some intensity of light.

Question14

In Fraunhofer diffraction pattern, slit width is 0.3 mm and screen is at 1.5 m away from the lens. If wavelength of light used is $4500\stackrel{o}{A}$, then the distance between the first minimum on either side of the central maximum is [θ is small and measured in radian.]

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Options:

A. 1.5 mm

B. 2.25 mm

C. 3.25 mm

D. 4.5 mm

Answer: D

Solution:

Distance of 1^{st} minima from central maxima

$y_{1d} = \frac{\lambda D}{a}$

Distance between two minima on either side of the central maxima is

$2y_{1d} = \frac{2\lambda D}{a} = \frac{2 \times 4500 \times 10^{-10} \times 1.5}{0.3 \times 10^{-3}} = 4.5 \text{ mm}$

Question15

A single slit diffraction pattern is formed with light of wavelength $6384\overset{o}{A}$. The second secondary maximum for this wavelength coincides with the third secondary maximum in the pattern for light of wavelength 'λ_0'. The value of 'λ_0' is

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Options:

A. $4242\overset{o}{A}$

B. $4560\overset{o}{A}$

C. $5474\overset{o}{A}$

D. $6384\overset{o}{A}$

Answer: B

Solution:

Step 1. Condition for secondary maxima

For a single slit of width a, the diffraction pattern has intensity minima at:

$a \sin\theta = m\lambda, \quad m = \pm1, \pm2, \pm3, \ldots$

Between two minima, there is a secondary maximum. The approximate positions of secondary maxima are given by:

$a \sin\theta \approx (m + \frac{1}{2})\lambda, \quad m = 1, 2, 3, \ldots$

Thus:

- 1st secondary max: $a \sin\theta \approx 1.5\lambda$
- 2nd secondary max: $a \sin\theta \approx 2.5\lambda$
- 3rd secondary max: $a \sin\theta \approx 3.5\lambda$

etc.

Step 2. Apply the given condition

For wavelength $\lambda_1 = 6384\,\text{Å}$:

- 2nd secondary maximum $\rightarrow a \sin\theta = 2.5\lambda_1$.

For wavelength λ_0:

- 3rd secondary maximum $\rightarrow a \sin\theta = 3.5\lambda_0$.

These coincide at the same angular position θ, so:

$2.5\lambda_1 = 3.5\lambda_0$

Step 3. Solve for λ_0

$\lambda_0 = \frac{2.5}{3.5}\lambda_1 = \frac{5}{7}\lambda_1$

$\lambda_0 = \frac{5}{7} \times 6384 \approx 4560\,\text{Å}$

✅ Final Answer:

$\lambda_0 = 4560\,\text{Å}$

Correct option: B.

Question16

In Young's double slit experiment, the intensity of light at a point on the screen where the path difference is λ is ' I '. The intensity at a point where the path difference is $\lambda/6$ is $\left[\cos\frac{\pi}{6}=\frac{\sqrt{3}}{2}\right][\lambda=$ **wavelength of light** $][\cos\pi=-1]$

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Options:

A. I

B. $\frac{3I}{4}$

C. $\frac{1}{2}$

D. $\frac{I}{4}$

Answer: B

Solution:

Young's Double Slit Experiment (YDSE):

We know the **intensity at a point** on the screen in YDSE is given by:

$I(\Delta\phi)=I_0\left[1+\cos(\Delta\phi)\right]$

where I_0 is the intensity due to each slit, and $\Delta\phi$ is the phase difference.

Equivalently, one can write:

$I(\Delta\phi)=4I_1\cos^2\left(\frac{\Delta\phi}{2}\right)$

where I_1 = intensity from each slit.

Step 1: Relation between path difference and phase difference

Phase difference:

$\Delta\phi=\frac{2\pi}{\lambda}\cdot(\text{path difference})$

Step 2: Given condition

At path difference = λ:

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

So intensity at this point is maximum:

$I_{\max} = 4I_1$

They have denoted this maximum intensity value as I.

So, $I = 4I_1$.

Step 3: Required condition

At path difference = $\lambda/6$:

$\Delta\phi = \frac{2\pi}{\lambda} \cdot \frac{\lambda}{6} = \frac{2\pi}{6} = \frac{\pi}{3}$

Now intensity is:

$I' = 4I_1 \cos^2\left(\frac{\Delta\phi}{2}\right) = 4I_1 \cos^2\left(\frac{\pi}{6}\right)$

$= 4I_1\left(\frac{\sqrt{3}}{2}\right)^2 = 4I_1 \cdot \frac{3}{4} = 3I_1.$

Step 4: Express in terms of given I

Since $I = 4I_1$,

$I' = \frac{3}{4}I$

✅ **Final Answer:**

The intensity at path difference $\lambda/6$ is:

$\boxed{\frac{3I}{4}}$

Correct Option: B

Question17

In Young's double slit experiment, the light of wavelength ' λ ' is used. The intensity at a point on the screen is ' T ' where the path difference is $\lambda\frac{-}{4}$. If ' I_0 ' denotes the maximum intensity then the ratio of ' I_0 ' to ' I ' is $\left(\cos 45^\circ = 1/\sqrt{2}\right)$

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Options:

A. 2 : 1

B. 4 : 1

C. 8 : 1

D. 12 : 1

Answer: A

Solution:

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

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

$$Q = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{\lambda} \times \frac{\lambda}{4} = \frac{\pi}{2}$$

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

$$\therefore \frac{I_0}{I} = \frac{I_0}{I_0/2} = 2$$

Question18

In Young's double slit experiment the wavelength of light used is $6000\overset{o}{A}$, the screen is 40 cm from the slits and the fringe width is 0.012 cm , the distance between two slits is

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Options:

A. 0.024 cm

B. 2.4 cm

C. 0.24 cm

D. 0.2 cm

Answer: D

Solution:

Given:

- Wavelength of light:

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

- Distance between slits and screen:

$D = 40\,\text{cm} = 0.40\,\text{m}$

- Fringe width:

$\beta = 0.012\,\text{cm} = 1.2 \times 10^{-4}\,\text{m}$

We need the distance between the two slits: d.

Formula:

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

Substitution:

$d = \frac{(6\times10^{-7})(0.40)}{1.2\times10^{-4}}$

$d = \frac{2.4\times10^{-7}}{1.2\times10^{-4}}$

$d = 2.0 \times 10^{-3}\,\text{m}$

Convert to cm:

$2.0 \times 10^{-3}\,\text{m} = 0.20\,\text{cm}$

Final Answer:

Option D: 0.2 cm ✅

Question19

Two polaroids are oriented with their planes perpendicular to incident light and transmission axis making an angle 30° with each other. What fraction of incident unpolarised light is transmitted?

$$\left(\cos 30^\circ = \sqrt{3}/2\right)$$

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Options:

A. 57.5%

B. 17.5%

C. 27.5%

D. 37.5%

Answer: D

Solution:

For unpolarised light passing through two polaroids at angle $\theta = 30^\circ$:

$I = I_0 \cos^2 \theta$

After passing through the first polaroid,

$\mathrm{I}_1 = \frac{\mathrm{I}_0}{2}$

After passing through the second polaroid,

$I_2 = I_1 \cos^2 30^\circ = \frac{I_0}{2} \cdot \left(\frac{\sqrt{3}}{2}\right)^2 = \frac{I_0}{2} \cdot \frac{3}{4} = \frac{3I_0}{8}$

$\therefore$ Transmitted fraction is 37.5%

Question20

In a single slit diffraction pattern, the distance between the plane of the slit and screen is 1.3 m . The width of the slit is 0.65 mm and the second maximum is formed at the distance of 2.6 mm from the centre of the screen. The wavelength of light used is

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Options:

A. $6500\overset{o}{A}$

B. $6000\overset{o}{A}$

C. $5200\overset{o}{A}$

D. $4600\overset{o}{A}$

Answer: C

Solution:

For n^{th} secondary maximum $a \sin \theta = \left(n + \frac{1}{2}\right)\lambda$

For second maximum, $n = 2$ a $\sin \theta = \frac{5}{2}\lambda$

For small angles, $\sin \theta \approx \tan \theta = \frac{y}{D}$

$$a \frac{y}{D} = \frac{5}{2}\lambda$$
$$\lambda = \frac{2ay}{5D}$$
$$\therefore \quad \lambda = \frac{2 \times 0.65 \times 10^{-3} \times 2.6 \times 10^{-3}}{5 \times 1.3}$$
$$= 0.52 \times 10^{-6}$$
$$= 5200\overset{o}{A}$$

Question21

A ray of light from a monochromatic point source of light is incident at a point on the screen. If a thin mica film of thickness ' t ' and refractive index ' n ' is introduced in its path, then the optical path

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Options:

A. is decreased by $(n - 1)t$.

B. is increased by $(n + 1)t$.

C. is not affected.

D. is increased by $(\mathrm{n}-1)\mathrm{t}$.

Answer: D

Solution:

Step 1: Concept of optical path length

The optical path length (OPL) is given by:

$\mathrm{OPL} = n \times$ geometrical length travelled in medium.

So, if a distance t in air is replaced by t in a medium of refractive index n:

- OPL in air: $= 1 \cdot t = t$.
- OPL in mica: $= n \cdot t$.

Step 2: Change in OPL

Difference due to insertion:

$\Delta(\mathrm{OPL}) = (nt - t) = (n-1)t$.

So the OPL is **increased** by $(n-1)t$.

Step 3: Correct option

- **Option D**: increased by $(n-1)t$. ✅

Final Answer:

$\boxed{\text{The optical path is increased by } (n-1)t.}$

Question22

Two polaroids are placed in the path of unpolarised beam of intensity ' I_0 ' such that no light is emitted from the second polaroid. If a third polaroid whose polarisation axis makes an angle ' θ ' with the polarisation axis of first polaroid is placed between these polaroids then the intensity of light emerging from the last polaroid will be

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Options:

A. $\frac{I_0}{4}(\sin 2\theta)^2$

B. $\frac{I_0}{8}(\sin 2\theta)^2$

C. $\frac{I_0}{4}\sin^2\theta$

D. $\frac{I_0}{8}\sin^2\theta$

Answer: B

Solution:

As no light passes through polaroid 2, polaroid 1 and polaroid 2 are at 90° to each other.

Polaroid 3 is inserted between then at an angle θ to polaroid

After polaroid 1 : $I_1 = \frac{I_0}{2}$

After polaroid 3 : $I_2 = I_1 \cos^2\theta = \frac{I_0}{2}\cos^2\theta$

After polaroid 2 (angle $90^\circ - \theta$ to polaroid 3) :

$$I_3 = I_2 \sin^2\theta = \frac{I_0}{2}\cos^2\theta \sin^2\theta$$

$$\therefore I_3 = \frac{I_0}{8}(\sin 2\theta)^2$$

Question23

In a Young's double slit experiment wavelength of light used is $6000\stackrel{o}{A}$. The first order maxima and tenth order maxima fall at 14.50 mm and 16.75 mm from the particular reference point in the interference pattern respectively. If the wavelength is changed to $5500\stackrel{o}{A}$ then the position of zero order and tenth order maxima are respectively

[The other arrangements remaining same]

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Options:

A. 14.25 mm, 16.55 mm

B. 12.25 mm, 14.55 mm

C. 10.25 mm, 12.55 mm

D. 16.25 mm, 18.55 mmÅ

Answer: A

Solution:

Step 1: Recall the Young's double-slit fringe position formula

In Young's double slit experiment, the position of the m^{th} order maximum is given by:

$y_m = m\frac{\lambda D}{d}$

where

- m = order of the fringe,
- λ = wavelength,
- D = distance between slits and screen,
- d = slit separation.

Thus, **the fringe position is proportional to** $m\lambda$ for fixed D/d.

Step 2: Use the given information

We are told that:

- First order maximum ($m = 1$) at $\lambda = 6000\,\text{Å}$ lies at $y_1 = 14.50\,\text{mm}$.
- Tenth order maximum ($m = 10$) at same wavelength lies at $y_{10} = 16.75\,\text{mm}$.

So, fringe positions are not measured from the central fringe (zero-order maxima), but from some **reference point**.

Step 3: Find the difference

For wavelength 6000 Å:

$y_{10} - y_1 = 16.75 - 14.50 = 2.25\,\text{mm}$.

This distance corresponds to **9 fringes** (from $m = 1$ to $m = 10$).

So, fringe width is:

$\Delta y = \frac{2.25}{9} = 0.25\,\text{mm}.$

Step 4: Locate zero-order maximum with original wavelength

Since for $\lambda = 6000\,\text{Å}$, each fringe spacing is 0.25 mm:

- First order maximum is at 14.50 mm.
- Therefore, **zero-order maximum** is 1 fringe earlier:

$y_0 = 14.50 - 0.25 = 14.25\,\text{mm}.$

So the zero-order maximum lies at 14.25 mm.

Step 5: Check tenth order

From calculated zero position:

$y_{10} = y_0 + 10\Delta y = 14.25 + (10 \times 0.25) = 14.25 + 2.50 = 16.75\,\text{mm}.$

✓ Matches the given.

So reference point is consistent.

Step 6: For new wavelength $\lambda = 5500\,\text{Å}$

Fringe width (direct proportionality to wavelength):

$\Delta y' = \Delta y \times \frac{5500}{6000} = 0.25 \times \frac{5500}{6000}.$

$\Delta y' = 0.2292\,\text{mm (approx)}.$

Step 7: Zero-order position

The **zero order maximum position** does not depend on wavelength (it's central bright fringe), so it remains at:

$y'_0 = 14.25\,\text{mm}.$

Step 8: Tenth-order position with new wavelength

$y'_{10} = y'_0 + 10 \times \Delta y' = 14.25 + 10 \times 0.2292.$

$y'_{10} = 14.25 + 2.292 \approx 16.55\,\text{mm}.$

🔑 Final Answer:

Zero-order and tenth-order maxima positions are:

$\boxed{14.25\,\text{mm},\ 16.55\,\text{mm}}$

That corresponds to **Option A**. ✅

Question24

Assuming human pupil to have radius of 0.25 cm and comfortable viewing distance of 25 cm , the minimum separation between the two objects that human eye can resolve at 500 nm wavelength is nearly

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Options:

A. $330 \mu \mathrm{~m}$

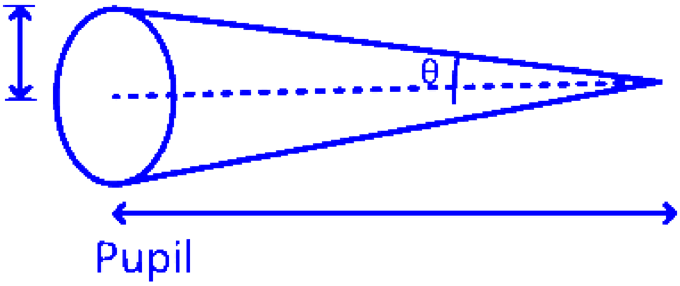
B. $30 \mu \mathrm{~m}$

C. $1 \mu \mathrm{~m}$

D. $100 \mu \mathrm{~m}$

Answer: B

Solution:



$$\begin{aligned} \text{R.P. } & =\frac{1.22 \lambda}{2 \mathrm{n} \sin \theta}=\frac{1.22 \times\left(500 \times 10^{-9} \mathrm{~m}\right)}{2 \times 1 \times\left(\frac{0.25}{25}\right)} \\ & =3.05 \times 10^{-5} \mathrm{~m} \approx 30 \mu \mathrm{~m}\end{aligned}$$

Question25

In a single slit diffraction pattern, identify the incorrect statement from the following.

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Options:

A. The fringes have unequal width.

B. The fringes have unequal intensity.

C. The fringes have unequal width and unequal intensity.

D. The fringes have equal width and equal intensity.

Answer: D

Solution:

We are dealing with a **single slit diffraction pattern** (Fraunhofer diffraction of a single slit).

Key facts:

- In **single slit diffraction**, we do not really get "fringes" like in interference; instead we get a **central maximum** and successive secondary maxima with decreasing intensity on either side.
- The **central maximum** is the widest (twice the width of the others). The subsequent secondary maxima are narrower, and their intensities decrease.
- Therefore:
- Widths of maxima are **not equal** (central maximum is twice as wide as others).
- Intensities are **not equal** (the central maximum is brightest, others are weaker).
- Hence maxima have **unequal widths and unequal intensities**.

Check options:

- **A. The fringes have unequal width.** ✅ Correct (central maximum is wider).
- **B. The fringes have unequal intensity.** ✅ Correct (central is brightest).
- **C. The fringes have unequal width and unequal intensity.** ✅ Correct (both vary).
- **D. The fringes have equal width and equal intensity.** ❌ Incorrect.

✅ **Answer: Option D is incorrect.**

Question26

The two coherent sources produce interference with intensity ratio ' b '. In the interference pattern, the ratio $\frac{I_{\max} \quad +I_{\min}}{I_{\max} \quad -I_{\min}}$ will be

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Options:

A. $\frac{1+b}{\sqrt{b}}$

B. $\frac{1+b}{2\sqrt{b}}$

C. $\frac{2\sqrt{b}}{1+b}$

D. $\frac{2\sqrt{b}}{(1+b)^2}$

Answer: B

Solution:

We're asked:

Two coherent sources interfere. Intensity ratio = b. Then compute

$\frac{I_{\max}+I_{\min}}{I_{\max}-I_{\min}}$.

Step 1. Express intensities of sources

Let the two sources have intensities I_1 and I_2.

Their ratio:

$\frac{I_1}{I_2} = b.$

Assume $I_1 = bI_2$.

Let $I_2 = I_0$. Then $I_1 = bI_0$.

Step 2. Amplitudes

Amplitude is proportional to $\sqrt{I}$.

So,

$A_1 = \sqrt{I_1} = \sqrt{bI_0} = \sqrt{b}\sqrt{I_0},$

$A_2 = \sqrt{I_2} = \sqrt{I_0}.$

Step 3. Constructive and destructive interference

- Maximum amplitude: $A_{max} = A_1 + A_2 = (\sqrt{b}+1)\sqrt{I_0}.$

So maximum intensity:

$I_{max} = (A_{max})^2 = (\sqrt{b}+1)^2 I_0.$

- Minimum amplitude: $A_{min} = |A_1 - A_2| = |\sqrt{b}-1|\sqrt{I_0}.$

So minimum intensity:

$I_{min} = (A_{min})^2 = (\sqrt{b}-1)^2 I_0.$

Step 4. Compute the required ratio

$\frac{I_{max}+I_{min}}{I_{max}-I_{min}} = \frac{(\sqrt{b}+1)^2 I_0 + (\sqrt{b}-1)^2 I_0}{(\sqrt{b}+1)^2 I_0 - (\sqrt{b}-1)^2 I_0}.$

Cancel I_0:

$= \frac{(\sqrt{b}+1)^2 + (\sqrt{b}-1)^2}{(\sqrt{b}+1)^2 - (\sqrt{b}-1)^2}.$

Expand:

- Numerator: $(b+1+2\sqrt{b}) + (b+1-2\sqrt{b}) = 2b+2.$
- Denominator: $(b+1+2\sqrt{b}) - (b+1-2\sqrt{b}) = 4\sqrt{b}.$

So ratio:

$= \frac{2(b+1)}{4\sqrt{b}} = \frac{1+b}{2\sqrt{b}}.$

✅ **Final Answer:**

Option **B**:

$$\boxed{\frac{1+b}{2\sqrt{b}}}$$

Question27

According to Huygen's wave theory of light, which one of the following statements is not correct?

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Options:

A. Different colours of light are due to different wavelengths of waves.

B. Different colours of light are due to different sizes of the corpuscles.

C. Speed of light in denser medium is less than that in rarer medium.

D. It can explain laws of reflection and refraction.

Answer: B

Solution:

We are asked:

According to Huygen's wave theory of light, which one of the following statements is *not correct*?

Option A:

Different colours of light are due to different wavelengths of waves.

✅ Correct according to wave theory.

Option B:

Different colours of light are due to different sizes of the corpuscles.

❌ This belongs to Newton's corpuscular theory, **not** Huygen's wave theory.

Option C:

Speed of light in denser medium is less than that in rarer medium.

✅ Correct prediction of Huygens' wave theory.

Option D:

It can explain laws of reflection and refraction.

✅ Correct.

✅ Correct Answer: Option B

"Different colours of light are due to different sizes of the corpuscles."

Question28

Interference fringes are produced on the screen by using two light sources of intensities I and 9I. The phase difference between the beams is $\pi/2$ at point P and π at point Q on the screen. The difference between the resultant intensities at points P and Q is $(\cos 90^\circ = 0, \cos \pi = -1)$

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Options:

A. 2 I

B. 4 I

C. 6 I

D. 8 I

Answer: C

Solution:

Given:

- The intensities of the two sources are $I_1 = I$ and $I_2 = 9I$.
- Phase difference at point P is $\frac{\pi}{2}$.
- Phase difference at point Q is π.
- $\cos 90^\circ = 0, \cos \pi = -1$.

Step 1: Resultant Intensity Formula

For two sources with intensities I_1 and I_2, and phase difference ϕ, the resultant intensity is:

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

Step 2: Intensity at P ($\phi_P = \frac{\pi}{2}$)

$I_P = I + 9I + 2\sqrt{I \cdot 9I} \cos\left(\frac{\pi}{2}\right)$

$I_P = 10I + 2 \times 3I \times 0$

$I_P = 10I + 0 = 10I$

Step 3: Intensity at Q ($\phi_Q = \pi$)

$I_Q = I + 9I + 2\sqrt{I \cdot 9I} \cos \pi$

$I_Q = 10I + 2 \times 3I \times (-1)$

$I_Q = 10I - 6I = 4I$

Step 4: Difference in Intensities

$I_P - I_Q = 10I - 4I = 6I$

Final Answer:

$\boxed{6I}$

Correct Option:

Option C

Question29

In Young's double slit experiment, in an interference pattern, a minimum is observed exactly in front of one slit. The distance between the two coherent sources is d and D is the distance between source and screen. The possible wavelengths used are proportional to

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Options:

A. $\frac{1}{\mathrm{D}}, \frac{1}{5\mathrm{D}}, \frac{1}{7\mathrm{D}},$

B. $\frac{1}{\mathrm{D}}, \frac{1}{3\mathrm{D}}, \frac{1}{5\mathrm{D}},$

C. $\frac{1}{\mathrm{D}}, \frac{1}{2\mathrm{D}}, \frac{1}{3\mathrm{D}},$

D. $\frac{1}{\mathrm{D}^2}, \frac{1}{2\mathrm{D}^2}, \frac{1}{3\mathrm{D}^2},$

Answer: B

Solution:

Let the distance between the two slits (sources) be d and the distance between the sources and the screen be D.

Let A and B be the positions of the two slits.

Let O be a point on the screen exactly in front of slit B.

We know, in Young's double slit experiment, the path difference at a point y from the central maximum (midway between A and B) is:

$\Delta = \frac{d\,y}{D}$

If we focus on the point exactly in front of slit B, the distance from slit A to the point is more than the distance from slit B to the point by exactly d (since the slits are separated by d).

So, the path difference at the point right in front of slit B is:

$\Delta = d$

For a minimum (destructive interference), path difference,

$\Delta = (2n+1)\frac{\lambda}{2} \quad (n = 0, 1, 2, \ldots)$

Set $\Delta = d$:

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

$\Rightarrow \lambda = \frac{2d}{2n+1}$

Here $(2n+1)$ can take values $1, 3, 5, 7, \ldots$

So, possible values of wavelength are:

$\lambda \propto \frac{1}{1}, \frac{1}{3}, \frac{1}{5}, \ldots$

Because the actual wavelength depends only on d, so

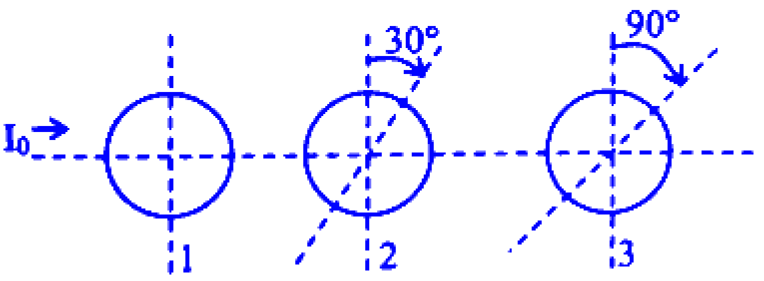
The correct pattern is

$\frac{1}{D}, \frac{1}{3D}, \frac{1}{5D}, \ldots$

So, the correct answer is **Option B**.

Question30

Three polarised sheets are co-axially placed. Pass axis of polaroids 2 and 3 make 30° and 90° with pass axis of polaroid sheet. If I_0 is the intensity of unpolarised light entering sheet 1 , the intensity of the emergent light through sheet 3 is



$\left(\cos 30^{\circ}=\sqrt{3}/2, \cos 90^{\circ}=0, \cos 60^{\circ}=1/2\right)$

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Options:

A. zero

B. $\frac{3I_0}{32}$

C. $\frac{3I_0}{8}$

D. $\frac{3I_0}{16}$

Answer: B

Solution:

According to Malus' law,

$I=I_0 \cos^2 \theta$

When beam passed through polaroid 1 ,

$I=\frac{I_0}{2}$

When beam passed through polaroid 2,

$$I_2=\frac{I_0}{2}\cos^2 60^{\circ}$$
$$\therefore I_2=\frac{I_0}{8}$$

When beam passed through polaroid 3,

$I_3=\frac{I_0}{8}\cos^2 30^{\circ}=\frac{I_0}{8}\times\left(\frac{\sqrt{3}}{2}\right)^2=\frac{3I_0}{32}$

Question31

Four polaroids are placed such that the optic axis of each is inclined at an angle of 30° the optic axis of the preceding one. If unpolarised light of intensity ' I_0 ' falls on the first polaroid, the intensity of light transmitted from the fourth polaroid is $\left[\cos 30^{\circ}=\frac{\sqrt{3}}{2}\right]$

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Options:

A. $\frac{9 \mathrm{I}_0}{32}$

B. $\frac{27 \mathrm{I}_0}{128}$

C. $\frac{35 \mathrm{I}_0}{128}$

D. $\frac{27 \mathrm{I}_0}{32}$

Answer: B

Solution:

According to Malus' law,

$I=I_0 \cos ^2 \theta$

When beam passed through first polaroid,

$\mathrm{I}=\frac{\mathrm{I}_0}{2}$

When beam passed through second polaroid,

$$\begin{aligned} & \mathrm{I}_2=\frac{\mathrm{I}_0}{2} \cos ^2 30^{\circ} \\ \therefore \quad & \mathrm{I}_2=\frac{3 \mathrm{I}_0}{8} \end{aligned}$$

When beam passed through third polaroid,

$I_3=\frac{3 I_0}{8} \cos ^2 30^{\circ}=\frac{3 I_0}{8} \times\left(\frac{\sqrt{3}}{2}\right)^2=\frac{9 I_0}{32}$

When beam passed through fourth polaroid,

$I_4=\frac{9 I_0}{32} \cos ^2 30^{\circ}=\frac{9 I_0}{32} \times\left(\frac{\sqrt{3}}{2}\right)^2=\frac{27 I_0}{128}$

Question32

The apparent wavelength of light from a star moving away from the earth is 0.02% more than the actual wavelength. The velocity of star is $[\mathrm{c} = \text{velocity of light} = 3 \times 10^8 \mathrm{~m/s}]$

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Options:

A. $30 \mathrm{~km/s}$

B. $60 \mathrm{~km/s}$

C. $90 \mathrm{~km/s}$

D. $120 \mathrm{~km/s}$

Answer: B

Solution:

When a star moves away from the Earth, the observed wavelength (λ') becomes longer than the actual wavelength (λ). This phenomenon is known as the **redshift** due to the **Doppler effect**.

According to the Doppler effect for light (for velocities much less than c):

$\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$

where

$\Delta\lambda = \lambda' - \lambda$ is the **change in wavelength**,

v is the **velocity of the star away from the Earth**,

c is the **speed of light**.

Given:

The apparent wavelength is 0.02% more than the actual wavelength.

So,

$\frac{\Delta\lambda}{\lambda} = 0.02\% = \frac{0.02}{100} = 0.0002$

Substitute in the Doppler formula:

$0.0002 = \frac{v}{3 \times 10^8}$

Solving for v:

$v = 0.0002 \times 3 \times 10^8$

$v = 6 \times 10^4 \text{ m/s}$

$v = 60 \text{ km/s}$

Correct option:

Option B 60 km/s

Question33

In Young's double slit experiment with monochromatic light of wavelength 600 nm , the distance between the slits is 10^{-3} m. For changing the fringe width by 3×10^{-5} m

a. the screen is moved away from the slit by 5 cm .

b. the screen is moved 5 cm towards the slits.

c. the screen is moved 3 cm towards the slits.

d. the screen is moved away from the slits by 3 cm .

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Options:

A.

both (c) and (d)

B. both (a) and (b)

C. only (a)

D. only (c)

Answer: B

Solution:

In Young's double slit experiment, the fringe width (β) is given by:

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

where

- $\lambda =$ wavelength of light $= 600 \text{ nm} = 600 \times 10^{-9} \text{ m}$
- $D =$ distance between slits and screen
- $d =$ separation between the slits $= 10^{-3} \text{ m}$

Let the initial fringe width be β_1 at distance D_1, and the new fringe width be β_2 at distance D_2.

Given,

$\beta_2 - \beta_1 = 3 \times 10^{-5} \text{ m}$

So,

$\beta_2 = \frac{\lambda D_2}{d}$

$\beta_1 = \frac{\lambda D_1}{d}$

Therefore,

$\beta_2 - \beta_1 = \frac{\lambda}{d}(D_2 - D_1) = 3 \times 10^{-5} \text{ m}$

Substituting the values:

$\lambda = 600 \times 10^{-9} \text{ m}$

$d = 10^{-3} \text{ m}$

So,

$\frac{600 \times 10^{-9}}{10^{-3}}(D_2 - D_1) = 3 \times 10^{-5}$

Simplifying:

$(600 \times 10^{-6})(D_2 - D_1) = 3 \times 10^{-5}$

$D_2 - D_1 = \frac{3 \times 10^{-5}}{600 \times 10^{-6}}$

$D_2 - D_1 = \frac{3 \times 10^{-5}}{6 \times 10^{-4}}$

$D_2 - D_1 = \frac{3}{6} \times \frac{10^{-5}}{10^{-4}}$

$D_2 - D_1 = \frac{1}{2} \times 0.1$

$D_2 - D_1 = 0.05 \text{ m}$

$D_2 - D_1 = 5 \text{ cm}$

This means the **distance between the screen and slits must change by** 5 **cm** to change the fringe width by 3×10^{-5} m.

If $D_2 > D_1$, the screen is moved **away** from the slits by 5 cm.

If $D_2 < D_1$, the screen is moved **towards** the slits by 5 cm.

Correct options according to the question:

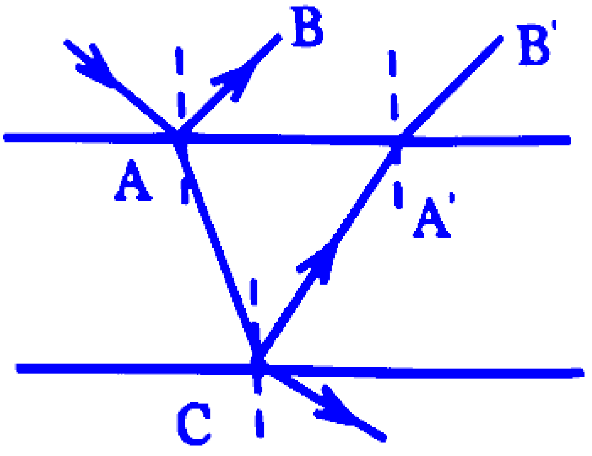
- The screen is moved away by 5 cm (*option a*).
- The screen is moved 5 cm towards the slits (*option b*).

So, the correct answer is:

Option B: both (a) and (b)

Question34

A ray of light of intensity ' I ' is incident on a parallel glass slab at a point ' A ' as shown in figure. It undergoes partial reflection and refraction. At each reflection 25% of incident energy is reflected. The rays AB and AB undergo interference. The ratio $\frac{I_{max}}{I_{min}}$ is



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Options:

A. 7:1

B. 49 : 1

C. 4:1

D. 8 : 1

Answer: B

Solution:

Given that, 25% of the incident light is reflected at the upper surface.

If incident intensity is I_0, then

Reflected at A (upper surface) $I_1 = 25I$

Transmitted $= 0.75I$

At lower surface:

25% of this is reflected back:

$I_2 = \frac{1}{4} \times \frac{3}{4} I_0 = \frac{3}{16} I$

Again at upper surface:

$$\text{Reflected } = \frac{1}{4} \times \frac{3}{16} I = \frac{3}{64} I$$
$$\text{Trasmitted } = \frac{3}{16} I - \frac{3}{64} I = \frac{9}{64} I$$

$$\because \quad \text{Intensity } \propto \text{ (Amplitude) }^2$$
$$\Rightarrow \quad A_1 = \sqrt{\frac{I}{4}} = \frac{\sqrt{I}}{2}, A_2 = \sqrt{\frac{9}{64} I} = \frac{3}{8}\sqrt{I}$$
$$\frac{I_{\max}}{I_{\min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2$$
$$= \left(\frac{\frac{\sqrt{I}}{2} + \frac{3}{8}\sqrt{I}}{\frac{\sqrt{I}}{2} - \frac{3}{8}\sqrt{I}}\right)^2 = \left(\frac{\frac{7}{8}\sqrt{I}}{\frac{1}{8}\sqrt{I}}\right)^2 = \frac{49}{1}$$

Question35

In Young's double slit experiment, the distance between screen and aperture is 1 m . The slit width is 2 mm . Light of $6000 \mathring{A}$ is used. If a thin glass plate ($\mu = 1.5$) of thickness 0.04 mm is placed over one of the slits, then there will be a lateral displacement of the fringes by

Options:

A. 0.5 cm

B. 1 cm

C. 1.5 cm

D. 2 cm

Answer: B

Solution:

We are given a glass plate with thickness $t = 0.04$ mm.

When this glass plate is placed on one slit, the fringe pattern shifts. The amount the pattern shifts (lateral displacement) is found using:

$d' = \frac{t(\mu-1)D}{d}$

Here's what the variables mean:

- t = Thickness of glass plate (0.04 mm)
- μ = Refractive index of glass (1.5)
- D = Distance from slits to screen (1 m)
- d = Distance between the slits (2 mm)

Let's put in the numbers. First, change all measurements to meters:

- $t = 0.04 \text{ mm} = 0.04 \times 10^{-3} \text{ m}$
- $d = 2 \text{ mm} = 2 \times 10^{-3} \text{ m}$

Now substitute the values into the formula:

$d' = \frac{0.04 \times 10^{-3} \times (1.5-1) \times 1}{2 \times 10^{-3}}$

Calculate $1.5 - 1 = 0.5$.

So,$d' = \frac{0.04 \times 10^{-3} \times 0.5 \times 1}{2 \times 10^{-3}}$

Multiply the top: $0.04 \times 0.5 = 0.02$. So the top becomes 0.02×10^{-3}.

Now divide:$d' = \frac{0.02 \times 10^{-3}}{2 \times 10^{-3}}$

Divide 0.02 by 2 to get 0.01.

So,$d' = 0.01 \text{ m}$

$0.01 \text{ m} = 1 \text{ cm}$

Therefore, the fringe pattern shifts by 1 cm.

Question36

In Young's double slit experiment, when light of wavelength 600 nm is used, 18 fringes are observed on the screen. If the wavelength of light is changed to 400 nm , the number of fringes observed on the screen is

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Options:

A. 12

B. 27

C. 22

D. 24

Answer: B

Solution:

Let the distance between the slits and the screen be D and slit separation be d. The width of the screen that is illuminated and on which fringes are observed is L.

The fringe width (distance between two consecutive bright or dark fringes) is given by:

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

The **total number of fringes (n)** that can be seen on the screen (of length L) is:

$n = \frac{L}{\beta}$

So,

$n = \frac{L}{\frac{\lambda D}{d}} = \frac{Ld}{\lambda D}$

This shows that $n \propto \frac{1}{\lambda}$ if L, d, and D are unchanged.

Let n_1 be the initial number of fringes for wavelength λ_1 and n_2 the number for wavelength λ_2:

$\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1}$

Given:

- $n_1 = 18$ for $\lambda_1 = 600\,\text{nm}$
- $\lambda_2 = 400\,\text{nm}$
- $n_2 = ?$

Substitute the values:

$\frac{18}{n_2} = \frac{400}{600}$

$\frac{18}{n_2} = \frac{2}{3}$

$n_2 = \frac{18 \times 3}{2} = 27$

Correct answer:

$\boxed{27}$

So, the correct option is **Option B: 27**.

Question37

In Young's double slit experiment, for the nth dark fringe ($\mathrm{n} = 1, 2, 3 \ldots$) the phase difference of the interfering waves in radian will be

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Options:

A. $\mathrm{n}\frac{\pi}{2}$

B. $(2n + 1)\pi$

C. $(2n - 1)\pi$

D. $(2n - 1)\frac{\pi}{2}$

Answer: C

Solution:

For the nth dark fringe in Young's double slit experiment, the condition for darkness is:

$$\text{Path difference} = \left(n - \frac{1}{2}\right)\lambda, \quad \text{where } n = 1, 2, 3, \ldots$$

The corresponding phase difference $(\Delta\phi)$ is given by:

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

Substituting the value of path difference:

$\Delta\phi = \frac{2\pi}{\lambda}\left(n - \frac{1}{2}\right)\lambda$

$= 2\pi\left(n - \frac{1}{2}\right)$

$= 2n\pi - \pi$

$= (2n - 1)\pi$

Correct answer:

$\boxed{(2n-1)\pi}$

So, the correct option is **Option C**.

Question38

In Young's double slit experiment, the intensity on screen at a point where path difference is $\frac{\lambda}{4}$ is $\frac{K}{2}$. The intensity at a point when path difference is ' λ ' will be

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Options:

A. 4 K

B. 2 K

C. K

D. $\frac{\mathrm{K}}{4}$

Answer: C

Solution:

Given:

- Intensity at path difference $\frac{\lambda}{4}$ is $\frac{K}{2}$.
- We are to find the intensity at path difference λ.

Step 1: Write the general formula for intensity

In Young's Double Slit Experiment, the intensity at a point on the screen is:

$I = I_0\left[1 + \cos\phi\right]$

Here,

- I_0: intensity due to each slit (if both slits have equal amplitude).
- ϕ: phase difference at that point.

The phase difference ϕ is related to path difference x as:

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

Step 2: Use the condition at path difference $= \frac{\lambda}{4}$

At path difference $= \frac{\lambda}{4}$:

- $\phi_1 = \frac{2\pi}{\lambda} \cdot \frac{\lambda}{4} = \frac{\pi}{2}$

The intensity at this point is:

$I_1 = I_0\left[1 + \cos\left(\frac{\pi}{2}\right)\right]$

Since $\cos\left(\frac{\pi}{2}\right) = 0$,

$I_1 = I_0[1 + 0] = I_0$

But it is given that this intensity is $\frac{K}{2}$.

So,

$I_0 = \frac{K}{2}$

Step 3: Find intensity at path difference $= \lambda$

Now,

- $\phi_2 = \frac{2\pi}{\lambda} \times \lambda = 2\pi$

So, the intensity at this point:

$I_2 = I_0\left[1 + \cos(2\pi)\right]$

Since $\cos(2\pi) = 1$,

$I_2 = I_0(1 + 1) = 2I_0$

Substitute $I_0 = \frac{K}{2}$:

$I_2 = 2 \times \frac{K}{2} = K$

Step 4: Check answer options

The correct answer is

Option C: K

Question39

In Fraunhofer diffraction pattern, slit width is 0.2 mm and screen is at 2 m away from the lens. If the distance between the first minimum on either side of the central maximum is 1 cm , the wavelength of light used is

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Options:

A. $2000\mathring{A}$

B. $4000\mathring{A}$

C. $5000\mathring{A}$

D. $10000\mathring{A}$

Answer: C

Solution:

Given:

Slit width, $a = 0.2\,\text{mm} = 2 \times 10^{-4}\,\text{m}$

Distance from slit to screen, $D = 2\,\text{m}$

Distance between the first minima on both sides $= 1\,\text{cm} = 0.01\,\text{m}$

Let the wavelength of light be λ.

Step 1: Condition for minima in single-slit Fraunhofer diffraction

For the first minimum (on either side), the angular position θ satisfies:

$a \sin\theta = m\lambda, \quad \text{where } m = \pm 1$

Step 2: Small angle approximation

For small θ, $\sin\theta \approx \tan\theta \approx \theta$.

The linear distance from the center to the first minimum on the screen,

$y_1 = D\tan\theta \approx D\sin\theta \approx D\theta$

So,

$\sin\theta = \frac{y_1}{D}$

Step 3: Distance between first minima on both sides

First minimum appears at y_1 above and $-y_1$ below the central maximum, so the total distance is

$Y = 2y_1$

Given $Y = 0.01\,\text{m}$,

$y_1 = \frac{Y}{2} = \frac{0.01}{2} = 0.005\,\text{m}$

Step 4: Substitute and solve

Using $a\sin\theta = \lambda$,

$a\sin\theta = \lambda$

$\lambda = a\sin\theta = a\frac{y_1}{D}$

Substitute the values:

- $a = 2 \times 10^{-4}$ m
- $y_1 = 0.005$ m
- $D = 2\,\text{m}$

So,

$\lambda = 2 \times 10^{-4} \times \frac{0.005}{2}$

$\lambda = 2 \times 10^{-4} \times 0.0025$

$\lambda = 5 \times 10^{-7}$ m

Step 5: Convert to Angstrom

$1\ \text{Å} = 10^{-10}$ m

$\lambda = 5 \times 10^{-7}\ \text{m} = 5 \times 10^{-7}\ \text{m} \times \frac{1\ \text{Å}}{10^{-10}\ \text{m}} = 5 \times 10^{3}\ \text{Å} = 5000\ \text{Å}$

Final Answer

Option **C**: 5000 $\mathring{A}$

Question40

In Young's double slit experiment let 'd' be the distance between two slits and 'D' be the distance between the slits and the screen. Using a monochromatic source of wavelength ' λ ', in an interference pattern, third minimum is observed exactly in front of one of the slits. If at the same point on the screen first minimum is to be obtained, the required change in the wavelength is [$\mathrm{d} \& \mathrm{D}$ are not changed].

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Options:

A. 2λ

B. 3λ

C. 4λ

D. 5λ

Answer: C

Solution:

Let the **distance between slits** be d,

Distance from slits to screen be D,

Wavelength is λ.

Let **point P** on screen be directly in front of the **second slit, S_2**.

1. Path difference at point P

At point P (just in front of S_2):

- Distance from S_1 to P = d farther compared to S_2 to P
- So, **Path difference** $= d$.

2. Condition for n^{th} Minimum in YDSE

The position of the n^{th} **minimum** from the central bright is given by:

Path difference for n^{th} minimum $= (2n-1)\frac{\lambda}{2}$

3. For third minimum ($n=3$) at P :

Set path difference $= d$:

$d = (2 \times 3 - 1)\frac{\lambda}{2}$

$d = (6-1)\frac{\lambda}{2}$

$d = \frac{5\lambda}{2}$

4. For first minimum at the same point P with new wavelength (λ'):

$d = (2 \times 1 - 1)\frac{\lambda'}{2}$

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

$d = \frac{\lambda'}{2}$

5. Equate both values of d (slit separation not changed):

$\frac{5\lambda}{2} = \frac{\lambda'}{2}$

$5\lambda = \lambda'$

6. Required Change in Wavelength

Change in wavelength:

$\Delta\lambda = \lambda' - \lambda = 5\lambda - \lambda = 4\lambda$

Final Answer

$\boxed{4\lambda}$

(Correct option: **C**)

Question41

In Young's double slit interference experiment, using two coherent sources of different amplitudes, the intensity ratio between bright to dark fringes is $5:1$. The value of the ratio of resultant amplitudes of bright fringe to dark fringe is

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Options:

A. $\left(\frac{\sqrt{5}+1}{\sqrt{5}-1}\right)$

B. $\sqrt{5} : 1$

C. $\left(\frac{\sqrt{5}-1}{\sqrt{5}+1}\right)$

D. $1 : \sqrt{5}$

Answer: B

Solution:

Given:

- In Young's double slit experiment, two coherent sources have different amplitudes.
- The intensity ratio between **bright** and **dark** fringes is $5 : 1$.

Let the amplitudes of the two sources be a_1 and a_2.

Step 1: Write the formulas

Maximum intensity (bright fringe):

$$I_{\text{max}} = (a_1 + a_2)^2$$

Minimum intensity (dark fringe):

$$I_{\text{min}} = (a_1 - a_2)^2$$

Step 2: Use the given intensity ratio

$$\frac{I_{\text{max}}}{I_{\text{min}}} = \frac{(a_1+a_2)^2}{(a_1-a_2)^2} = \frac{5}{1}$$

Step 3: Take square root on both sides

$$\frac{a_1+a_2}{a_1-a_2} = \sqrt{5}$$

Step 4: Find the required ratio

The **ratio of amplitudes at bright fringe to dark fringe** is:

$$\frac{A_{\text{bright}}}{A_{\text{dark}}} = \frac{a_1+a_2}{|a_1-a_2|}$$

But from the above,

$\frac{a_1+a_2}{a_1-a_2}=\sqrt{5}$

So,

$\frac{A_{\text{bright}}}{A_{\text{dark}}}=\sqrt{5}:1$

Final Answer

$\boxed{\text{Option B: } \sqrt{5}:1}$

Question42

In a Fraunhoffer diffraction, light of wavelength ' λ ' is incident on slit of width ' d '. The diffraction pattern is observed on a screen placed at a distance ' D '. The linear width of central maximum is equal to two times the width of the slit, then 'D' has value

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Options:

A. $\frac{\mathrm{d}^2}{\lambda}$

B. $\frac{\mathrm{d}^2}{2\lambda}$

C. $\frac{\mathrm{d}^2}{3\lambda}$

D. $\frac{\mathrm{d}^2}{4\lambda}$

Answer: A

Solution:

Given:

- Wavelength of light = λ
- Width of slit = d
- Distance to screen = D
- **Linear width of central maximum** = $2d$

Let's solve step by step:

1. Position of first minima in single-slit Fraunhofer diffraction

The angular position of first minima is given by:

$d \sin\theta = \pm\lambda$

For small angles, $\sin\theta \approx \theta$ (in radians).

So,

$d\theta = \lambda \implies \theta = \frac{\lambda}{d}$

2. Linear width of central maximum

Central maximum is between first minima on both sides:

- Angular width: $2\theta = 2\left(\frac{\lambda}{d}\right)$
- Linear (on screen):

  Linear width $= 2D\theta = 2D\left(\frac{\lambda}{d}\right) = \frac{2D\lambda}{d}$

3. Given condition:

Linear width of central maximum $= 2d$

So,

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

4. Solve for D:

Divide both sides by 2:

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

$D\lambda = d^2$

$D = \frac{d^2}{\lambda}$

5. Final Answer:

Option A:

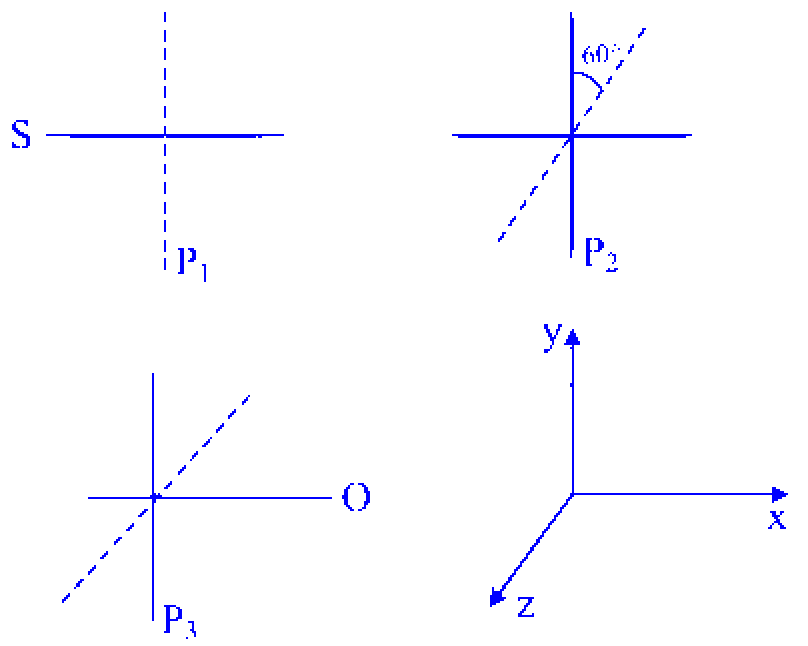
$$\boxed{\frac{d^2}{\lambda}}$$

This is the correct value of D.

Question43

Three identical polaroids P_1, P_2 and P_3 are placed one after another. The pass axis of P_2 and P_3 are inclined at an angle of 60° and 90° with respect to axis of P_1. The source has an intensity $256 \mathrm{~W} / \mathrm{m}^2$. The intensity of light at point ' O ' is

$\left(\cos 30^{\circ}=\sqrt{3} / 2, \cos 60^{\circ}=0.5\right)$



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Options:

A. $24 \mathrm{~W} / \mathrm{m}^2$

B. $20 \mathrm{~W} / \mathrm{m}^2$

C. $16 \mathrm{~W} / \mathrm{m}^2$

D. $8 \mathrm{~W} / \mathrm{m}^2$

Answer: A

Solution:

The polaroids are arranged in order $\mathrm{P}_1, \mathrm{P}_3$ and P_2 Using law of Malus',

Intensity of light transmitted from P_1 will be reduced by half

$I_1=\frac{I_0}{2}$

$\therefore$ Intensity of emergent light from P_2,

$I_2 = I_1 \cos^2 60^\circ = \frac{I_0}{2} \times \frac{1}{4} = \frac{I_0}{8}$

$\therefore$ Intensity of emergent light from P_3,

$I_3 = I_2 \cos^2 \theta$ ...... (i)

$\because$ P_1 and P_3 are perpendicular to each other,

$\therefore$ Angle between P_2 and $P_3, \theta = 90^\circ - 60^\circ = 30^\circ$

Substituting in equation (i),

$I_3 = I_2 \cos^2 30^\circ = \frac{I_0}{8} \times \frac{3}{4} = \frac{3I_0}{32}$

Substituting the value of I_0 in the equation above,

$I_3 = \frac{3\times256}{32} = 24 = 24\ \mathrm{W/m^2}$

Question44

In a single slit diffraction experiment, for a wavelength of light ' λ ', half-angular width of the principle maxima is ' θ '. Also for wavelength of light $p\lambda$, the half angular width of the principle maxima is $q\theta$. The ratio of the halfangular widths of the first secondary maxima in the first case to second case will be

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Options:

A. p : 1

B. q : 1

C. p : q

D. q : p

Answer: B

Solution:

Let the slit width be a.

1. Principal maximum

For single–slit diffraction, the first minimum is at

$$a \sin\theta = \lambda \quad (\text{for small } \theta,\ \sin\theta \approx \theta)$$

So the **half–angular width of the central (principal) maximum** is

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

Given: for wavelength $p\lambda$ this half–angular width is $q\theta$:

$$q\theta = \frac{p\lambda}{a}$$

Using $\theta = \frac{\lambda}{a}$,

$$q\left(\frac{\lambda}{a}\right) = \frac{p\lambda}{a} \Rightarrow q = p$$

So p and q are equal.

---

2. First secondary maximum

The first secondary maximum lies between the first and second minima (at $a \sin\theta = \lambda$ and 2λ).
The **half–angular width** of this secondary maximum is proportional to the distance between these two minima:

$$\Delta\theta_{\text{sec}} \propto (2\lambda/a - \lambda/a) = \lambda/a$$

So it is again **proportional to** λ.

Therefore, ratio of half–angular widths of the first secondary maxima:

$$\frac{\Delta\theta_{\text{sec, 1st case}}}{\Delta\theta_{\text{sec, 2nd case}}} = \frac{\lambda}{p\lambda} = \frac{1}{p} = \frac{1}{q}$$

So the second case has q times the half–angular width of the first case, i.e.

$$\Delta\theta_{\text{sec, 2nd}} : \Delta\theta_{\text{sec, 1st}} = q : 1$$

which corresponds to **option B (q : 1)** as given in the key.

Question45

In a double slit experiment, the distance between slits is increased 10 times, whereas their distance from screen is halved, the fringe width

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Options:

A. remain the same.

B. becomes $\frac{1}{10}$ times.

C. becomes $\frac{1}{20}$ times.

D. becomes $\frac{1}{90}$ times.

Answer: C

Solution:

In a double-slit experiment, the fringe width is determined by the formula:

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

where β is the fringe width, D is the distance from the slits to the screen, λ is the wavelength of light, and d is the distance between the slits.

If the distance between the slits, d, is increased by 10 times and the distance from the slits to the screen, D, is halved, then the new fringe width, β_2, can be calculated as follows:

$\beta_2 = \frac{\frac{D}{2}\lambda}{10d} = \frac{D\lambda}{20d}$

Therefore, β_2 becomes $\frac{1}{20}$ of the original fringe width β_1.

Question46

The angular separation of the central maximum in the Fraunhofer diffraction pattern is measured. The slit is illuminated by the light of wavelength $6000\overset{o}{A}$. If the slit is illuminated by light of another wavelength, the angular separation decreases by 20%. The wavelength of light used is

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Options:

A. $6400\overset{o}{A}$

B. $5600\overset{o}{A}$

C. $4800\overset{o}{A}$

D. $4400\overset{o}{A}$

Answer: C

Solution:

The angular width of the central maximum in a Fraunhofer diffraction pattern is given by:

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

This implies that:

$\theta \propto \lambda$

Therefore, if the angle changes when a different wavelength is used, we get:

$\frac{\theta_2}{\theta_1} = \frac{\lambda_2}{\lambda_1}$

Given that the angular separation decreases by 20% when a new wavelength is used, we have:

$\theta_2 = \theta_1 - \frac{20}{100}\theta_1 = 0.8\theta_1$

Thus:

$\lambda_2 = 0.8\lambda_1 = 0.8 \times 6000 = 4800\overset{o}{A}$

Therefore, the wavelength of the light used is $4800\overset{o}{A}$.

Question47

In Young's double slit experiment, intensity at a point is $\left(\frac{1}{4}\right)$ of the maximum intensity. The angular position of this point is

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Options:

A. $\sin^{-1}\left(\frac{\lambda}{D}\right)$

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

C. $\sin^{-1}\left(\frac{\lambda}{3\text{ d}}\right)$

D. $\sin^{-1}\left(\frac{\lambda}{4d}\right)$

Answer: C

Solution:

For any point in interference pattern,

$$
\begin{aligned}
& \mathrm{I}=\mathrm{I}_{\max} \cos^2 \frac{\phi}{2} \\
\therefore \quad & \frac{\mathrm{I}_{\max}}{4}=\mathrm{I}_{\max} \cos^2 \frac{\phi}{2} \\
\therefore \quad & \cos^2 \frac{\phi}{2}=\frac{1}{4} \\
\therefore \quad & \cos \frac{\phi}{2}=\frac{1}{2} \\
\therefore \quad & \frac{\phi}{2}=60^{\circ}=\frac{\pi}{3} \\
\therefore \quad & \phi=\frac{2\pi}{3}
\end{aligned}
$$

We know that,

$\phi=\left(\frac{2\pi}{\lambda}\right)\Delta x$, where Δx is path difference.

$$
\begin{aligned}
& \text{and } \Delta x=d \sin \theta \\
\therefore \quad & \frac{2\pi}{3}=\frac{2\pi}{\lambda}(\mathrm{d} \sin \theta) \\
\therefore \quad & \frac{\lambda}{3\mathrm{~d}}=\sin \theta \\
\therefore \quad & \theta=\sin^{-1}\left(\frac{\lambda}{3\mathrm{~d}}\right)
\end{aligned}
$$

Question48

Two sound waves each of wavelength ' λ ' and having the same amplitude ' A ' from two source ' S_1 ' and ' S_2 ' interfere at a point P . If the path difference, $\mathrm{S}_2\mathrm{P}-\mathrm{S}_1\mathrm{P}=\lambda/3$ then the amplitude of resultant wave at point ' P ' will be $[\cos(120^{\circ})=-0.5]$

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Options:

A. A

B. 2A

C. $\frac{A}{2}$

D. $\frac{3A}{2}$

Answer: A

Solution:

Path difference $= \frac{\lambda}{3}$

$\therefore$ Phase difference $= \frac{2\pi}{\lambda} \times \frac{\lambda}{3} = \frac{2\pi}{3} = 120^{\circ}$

Resultant amplitude

$$R = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\theta}$$

Since, $A_1 = A_2$

$$\therefore \quad R = \sqrt{A^2 + A^2 + 2A^2\cos 120^{\circ}}$$

$$R = \sqrt{A^2 + A^2 + 2A^2 \times \left(-\frac{1}{2}\right)}$$

$$\therefore \quad R = A$$

Question49

Sodium light $\left(\lambda = 6 \times 10^{-7}\text{ m}\right)$ is used to produce interference pattern. The observed fringe width is 0.12 mm . The angle between the two wave trains is

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Options:

A. 5×10^{-1}rad

B. 5×10^{-3}rad

C. 1×10^{-2}rad

D. 1×10^{-3}rad

Answer: B

Solution:

To determine the angle between the two wave trains when sodium light is used, we can start with the formula for fringe width in an interference pattern:

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

Here, $\lambda = 6 \times 10^{-7}$ m is the wavelength of sodium light, and $W = 0.12\,\text{mm} = 0.12 \times 10^{-3}$ m is the observed fringe width.

To find the angle between the two wave trains, we use the relationship:

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

The calculations are as follows:

$\frac{d}{D} = \frac{6 \times 10^{-7}}{0.12 \times 10^{-3}}$

$\frac{d}{D} = 5 \times 10^{-3}$ rad

Thus, the angle between the two wave trains is 5×10^{-3} rad.

Question50

A plate of refractive index 1.6 is introduced in the path of light from one of the slits in Young's double slit experiment then

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Options:

A. the fringe width towards the side of the plate will decrease.

B. the central maximum will shift towards this side

C. number of fringes seen will decrease.

D. interference pattern will disappear.

Answer: B

Solution:

When a thin plate of refractive index n is introduced in front of one of the slits in Young's double-slit experiment, it adds an extra optical path (and hence a phase difference) to the light coming from that slit. This shifts the entire interference pattern on the screen but does not change the fringe spacing or make the pattern disappear.

Fringe width does not change because it depends on the slit separation and the wavelength in air, not on a uniform phase shift introduced in one path.

Number of visible fringes does not necessarily decrease (as long as the plate is not too thick to cause excessive absorption or other effects).

The interference pattern does not vanish unless coherence is destroyed (e.g., by scattering or large thickness variations).

The net effect of introducing a uniform optical path difference in one slit is a lateral shift of the central maximum (and all fringes) **toward the slit with the plate**.

Hence the correct statement is :

(B) The central maximum will shift towards the side on which the plate is introduced.

Question51

In Young's double slit experiment, the intensity of light at a point on the screen where the path difference is λ is x units, λ being the wavelength of light used. The intensity at a point where the path difference is $\frac{\lambda}{4}$ will be $\left(\cos 2\pi = 1, \cos \frac{\pi}{2} = 0\right)$

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Options:

A. $\frac{x}{4}$

B. $\frac{x}{2}$

C. x

D. zero

Answer: B

Solution:

When path difference $= \lambda$

Phase difference

$$\begin{aligned} &\Delta\phi = \frac{2\pi}{\lambda} \times \lambda = 2\pi \\ &I = 4\mathrm{I}_0 \cos^2\left(\frac{\phi}{2}\right) \\ &x = 4\mathrm{I}_0 \cos^2\left(\frac{2\pi}{2}\right) = 4\mathrm{I}_0 \\ \therefore \quad &x = 4\mathrm{I}_0 \end{aligned}$$

When path difference $= \frac{\lambda}{4}$

Phase difference

$$\Delta\delta = \frac{2\pi}{\lambda} \times \frac{\lambda}{4} = \frac{\pi}{2}$$

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

Intensity, $\mathrm{x}' = \frac{\mathrm{x}}{2}$

Question52

In double slit experiment, instead of taking slits of equal widths, one slit is made twice as wide as the other. Then in interference pattern

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Options:

A. the intensity of the maxima decreases and the minima has zero intensity.

B. the intensity of maxima decreases and that of the minima increases.

C. the intensity of the maxima increases and the minima has zero intensity.

D. the intensities of both the maxima and the minima increase.

Answer: D

Solution:

When both slits have equal widths, they produce waves of equal intensity. If each slit provides an intensity I, the total resultant intensity at a point on the screen due to constructive interference (maxima) is:

$I_{\text{max}} = (\sqrt{I} + \sqrt{I})^2 = (2\sqrt{I})^2 = 4I.$

For destructive interference (minima):

$I_{\text{min}} = (\sqrt{I} - \sqrt{I})^2 = 0.$

So, with equal slit widths, we have:

Maxima intensity: $4I$

Minima intensity: 0

Modified Scenario (One Slit Twice as Wide):

If one slit is made twice as wide as the other, the intensity from that slit will be greater. Intensity is proportional to the square of the amplitude and amplitude is proportional to the slit width.

Let's say the narrower slit still produces an intensity I. The wider slit, being twice as wide, will have twice the amplitude, hence:

Amplitude from narrower slit $= A \implies$ Intensity $= A^2 = I.$

For the wider slit (double width):

Amplitude $= 2A \implies$ Intensity $= (2A)^2 = 4A^2 = 4I.$

Now we have two slit intensities: $I_1 = I$ (narrow slit) and $I_2 = 4I$ (wide slit).

Resultant Intensity in the Modified Case:

The resultant intensity at any point is:

$I_{\text{res}} = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi.$

Substituting $I_1 = I$ and $I_2 = 4I$:

$I_{\text{res}} = I + 4I + 2\sqrt{I \cdot 4I}\cos\phi = 5I + 2 \cdot 2I\cos\phi = 5I + 4I\cos\phi.$

Maximum and Minimum Intensities Now:

For maximum intensity ($\phi = 0^\circ, \cos\phi = 1$):

$I_{\text{max}} = 5I + 4I = 9I.$

For minimum intensity ($\phi = 180^\circ, \cos\phi = -1$):

$I_{\text{min}} = 5I - 4I = I.$

Previously, for equal slit widths:

Maxima = $4I$

Minima = 0.

Now, after making one slit twice as wide:

Maxima = $9I$ (which is greater than the old maxima of $4I$)

Minima = I (which is greater than the old minima of 0).

Conclusion:

By making one slit wider, you unbalance the amplitudes. This causes:

Maxima intensity to increase (from $4I$ to $9I$).

Minima intensity to no longer be zero; it actually increases (from 0 to I).

Answer:

The intensities of both the maxima and the minima increase.

Correct Option:

D) the intensities of both the maxima and the minima increase.

Question53

In biprism experiment, the fringe width is 0.6 mm . The distance between 6^{th} dark fringe and 8^{th} bright fringe on the same side of central bright fringe is

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Options:

A. 6 mm

B. 4 mm

C. 1.5 mm

D. 0.9 mm

Answer: C

Solution:

In the biprism experiment, we are given that the fringe width is 0.6 mm. We need to determine the distance between the 6th dark fringe and the 8th bright fringe on the same side of the central bright fringe.

To find this distance, let's consider:

Position of the 8th Bright Fringe:

$x_8 = 8X$

Position of the 6th Dark Fringe:

$x_6 = \left(6 - \frac{1}{2}\right)X = 5.5X$

Calculating the Distance Between the 6th Dark Fringe and the 8th Bright Fringe:

$x_8 - x_6 = 8X - 5.5X = 2.5X$

Since the fringe width (X) is 0.6 mm, substitute this value to find the distance:

$x_8 - x_6 = 2.5 \times 0.6 = 1.5\,\mathrm{mm}$

Therefore, the distance between the 6th dark fringe and the 8th bright fringe is 1.5 mm.

Question54

In Young's double slit experiment, 'I' is the minimum intensity and ' I_1 ' is the intensity at a point where the path difference is $\frac{\lambda}{4}$ where ' λ ' is the wavelength of light used. The ratio $I_1 \mathrm{I}_1$ is (Intensities of the two interfering waves are same) $\left(\cos 0^{\circ} = 1, \cos 90^{\circ} = 0\right)$

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Options:

A. 0

B. 4

C. 3

D. 2

Answer: A

Solution:

As $I_{\min} = I = 0$, the ratio $\frac{I}{I_1} = 0$.

Question55

Considering interference between two sources of intensities ' I ' and ' 4 I ', the intensity at a point where the phase difference is π is $(\cos \pi = -1)$

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Options:

A. I

B. 4I

C. 5I

D. 3I

Answer: A

Solution:

The intensity at a point due to interference between two sources can be found using the formula for resultant intensity:

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

where:

I_1 and I_2 are the intensities of the two sources.

ϕ is the phase difference between the waves.

In this case:

$I_1 = I$

$I_2 = 4I$

$\phi = \pi$ (thus, $\cos \pi = -1$)

Substituting these values into the formula:

$$I_{\text{resultant}} = I + 4I + 2\sqrt{I \cdot 4I} \cdot (-1)$$

Calculating each term:

$I + 4I = 5I$

$2\sqrt{I \cdot 4I} = 2\sqrt{4I^2} = 2 \times 2I = 4I$

Plug these results back into the equation:

$I_{\text{resultant}} \quad = 5I - 4I$

Thus, the resultant intensity at the point where the phase difference is π is:

$I_{\text{resultant}} \quad = I$

Therefore, the correct answer is:

Option A: I

Question56

The phase difference between two waves giving rise to dark fringe in Young's double slit experiment is (n is the integer)

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Options:

A. zero

B. $(4\mathrm{n}+1)\frac{\pi}{2}$

C. $(2n-1)\pi$

D. $(2n+1)\frac{\pi}{2}$

Answer: C

Solution:

In Young's double-slit experiment, the phase difference between the two waves is related to the path difference by

$\Delta\phi = \frac{2\pi}{\lambda}\Delta r.$

For a dark fringe (destructive interference), the path difference must be

$\Delta r = \left(n + \frac{1}{2}\right)\lambda,$

where n is an integer (starting from 0). Substituting this into the phase difference formula gives

$\Delta\phi = \frac{2\pi}{\lambda}(n + \frac{1}{2})\lambda = 2\pi\left(n + \frac{1}{2}\right) = (2n+1)\pi.$

Notice that writing $(2n+1)\pi$ or $(2n-1)\pi$ essentially represents the odd multiples of π; the difference lies only in the indexing of n (whether you start counting from 0 or 1). In this problem, Option C is written as

$(2n-1)\pi,$

which is equivalent to the dark fringe condition if we assume n starts from 1.

Thus, the correct answer is Option C: $(2n-1)\pi$.

Question57

How is the interference pattern affected when violet light replaces sodium light?

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Options:

A. The fringes become brighter.

B. The fringes become faint.

C. Fringewidth decreases.

D. Fringewidth increases.

Answer: C

Solution:

In a two-slit interference experiment, the fringe width (the distance between adjacent bright fringes) is given by:

$\Delta y = \frac{\lambda D}{d}$

where:

λ is the wavelength of light,

D is the distance to the screen, and

d is the distance between the slits.

Since violet light has a shorter wavelength than sodium light (typically, sodium light is around 589 nm while violet light is closer to 400 nm), replacing sodium light with violet light will reduce the value of λ.

Pausing the formula:

A smaller λ means that Δy decreases.

Hence, the fringes move closer together.

Therefore, the correct answer is:

Option C: Fringewidth decreases.

Question58

In Fraunhofer diffraction pattern, slitwidth is 0.5 mm and screen is at 2 m away from the lens. If wavelength of light used is $5500 \overset{o}{A}$, then the distance between the first minimum on either side of the central maximum is (θ is small and measured in radian)

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Options:

A. 1.1 mm

B. 2.2 mm

C. 4.4 mm

D. 5.5 mm

Answer: C

Solution:

In a Fraunhofer diffraction pattern, the slit width is 0.5 mm, and the screen is placed 2 meters away from the lens. The light used has a wavelength of 5500 Å. To find the distance between the first minima on either side of the central maximum, we use the following formulas (assuming θ is small and measured in radians):

The distance of the first minimum from the central maximum is given by:

$y_{1d} = \frac{\lambda D}{a}$

Where:

$\lambda = 5500 \times 10^{-10}$ m (wavelength converted from angstroms to meters)

$D = 2\,\text{m}$ (distance to the screen)

$a = 0.5 \times 10^{-3}\,\text{m}$ (slit width converted from millimeters to meters)

The distance between the first minima on either side of the central maximum is:

$2y_{1d} = \frac{2\lambda D}{a} = \frac{2 \times 5500 \times 10^{-10} \times 2}{0.5 \times 10^{-3}} = 4.4\,\text{mm}$

Therefore, the distance between the first minima on either side of the central maximum is 4.4 mm.

Question59

Two identical light waves having phase difference ϕ propagate in same direction. When they superpose, the intensity of resultant wave is proportional to

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Options:

A. $\cos^2\left(\frac{\phi}{4}\right)$

B. $\cos^2\left(\frac{\phi}{3}\right)$

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

D. $\cos^2\phi$

Answer: C

Solution:

To determine the intensity of the resultant wave formed by two identical light waves with a phase difference ϕ propagating in the same direction, we start with the formula for the amplitude A of the resultant wave:

$A^2 = a_1^2 + a_2^2 + 2a_1a_2\cos\phi$

Given that the amplitudes of the individual waves are equal, $a_1 = a_2 = a$, we can substitute to find:

$A^2 = 2a^2(1 + \cos\phi)$

Using the trigonometric identity, $\cos\phi = 2\cos^2\left(\frac{\phi}{2}\right) - 1$, the equation becomes:

$A^2 = 2a^2\left(1 + 2\cos^2\frac{\phi}{2} - 1\right)$

Simplifying this, we obtain:

$A^2 = 2a^2 \cdot 2\cos^2\frac{\phi}{2} = 4a^2\cos^2\frac{\phi}{2}$

Thus,

$A^2 \propto \cos^2\frac{\phi}{2}$

Since intensity I is proportional to the square of the amplitude ($I \propto A^2$), we conclude:

$I \propto \cos^2\frac{\phi}{2}$

This shows that the intensity of the resultant wave is proportional to $\cos^2\frac{\phi}{2}$.

Question60

In Young's double slit experiment, the distance between the two coherent sources is ' d ' and the distance between the source and screen is ' D '. When the wavelength (λ) of light source used is $\frac{d^2}{3D}$, then n^{th} dark fringe is observed on the screen, exactly in front of one of the slits. The value of ' n ' is

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Options:

A. 1

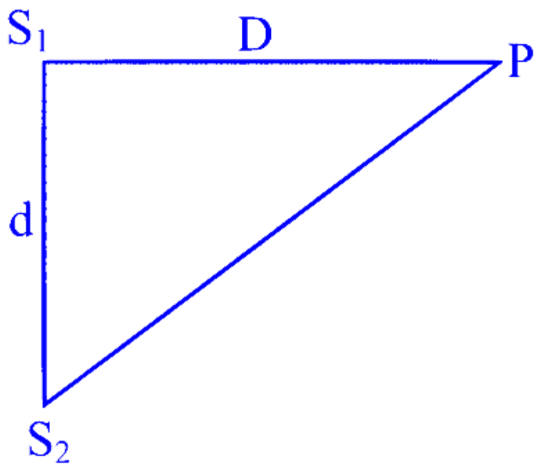
B. 2

C. 3

D. 4

Answer: B

Solution:



$$S_2P = \left(D^2 + d^2\right)^{1/2}$$
$$= D\left[1 + \frac{d^2}{D^2}\right]^{1/2}$$

$$\mathrm{S_2P} = \mathrm{D}\left[1 + \frac{1}{2}\frac{\mathrm{d}^2}{\mathrm{D}^2}\right]^{1/2} = \mathrm{D} + \frac{\mathrm{d}^2}{2\mathrm{D}}$$

$\Rightarrow$ Path difference $= \frac{\mathrm{d}^2}{2\mathrm{D}}$

For dark fringe, $\frac{\mathrm{d}^2}{2\mathrm{D}} = (2\mathrm{n} - 1)\frac{\lambda}{2}$

$\therefore \quad \frac{d^2}{2D} = (2n - 1)\frac{d^2}{6D}$

$\therefore \quad 2n - 1 = 3$

$\therefore \quad n = 2$

Question61

Two light rays having the same wavelength ' λ ' in vacuum are in phase initially. Then, the first ray travels a path ' L_1 ' through a medium of refractive index ' μ_1 ' while the second ray travels a path of length ' L_2 ' through a medium of refractive index ' μ_2 '. The two waves are then combined to observe interference. The phase difference between the two waves is

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Options:

A. $\frac{2\pi}{\lambda}(\mu_1 L_1 - \mu_2 L_2)$

B. $\frac{2\pi}{\lambda}(L_2 - L_1)$

C. $\frac{2\pi}{\lambda}\left(\frac{L_1}{\mu_1} - \frac{L_2}{\mu_2}\right)$

D. $\frac{2\pi}{\lambda}(\mu_2 L_1 - \mu_1 L_2)$

Answer: A

Solution:

To understand how the phase difference between two light waves is determined, consider the following:

Initial Conditions: Two light rays with the same wavelength, denoted as 'λ', are initially in phase.

Traveling through Different Media:

The first ray travels a distance 'L_1' through a medium with a refractive index 'μ_1'.

The second ray travels a distance 'L_2' through a medium with a refractive index 'μ_2'.

Optical Path Difference: When light travels through a medium, the distance is effectively multiplied by the medium's refractive index to obtain the optical path length. Hence, the optical path for the first ray is '$\mu_1 L_1$', and for the second ray, it is '$\mu_2 L_2$'.

Phase Difference Formula:

Optical Path Difference $= \mu_1 L_1 - \mu_2 L_2$

The phase difference ($\Delta\varphi$) between the two waves is directly related to their optical path difference and is given by:

$\Delta\phi = \frac{2\pi}{\lambda} \times (\text{Optical Path Difference})$

Simplifying, we have:

$\Delta\phi = \frac{2\pi}{\lambda}[\mu_1 L_1 - \mu_2 L_2]$

This formula helps determine how the difference in paths affects the phase relationship of the two waves when they recombine, thus influencing interference patterns.

Question62

In Young's double slit experiment, the slits are separated by 0.6 mm and screen is placed at a distance of 1.2 m from slit. It is observed that the tenth bright fringe is at a distance of 8.85 mm from the third dark fringe on the same side. The wavelength of light used is

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Options:

A. 5440 $\stackrel{o}{A}$

B. 5890 $\stackrel{o}{A}$

C. 5900 $\stackrel{o}{A}$

D. 6630 $\stackrel{o}{A}$

Answer: C

Solution:

In Young's double slit experiment, the separation between the slits is 0.6 mm, and the screen is positioned 1.2 m away from the slits. The observed distance from the third dark fringe to the tenth bright fringe on the same side is 8.85 mm. We need to determine the wavelength of the light used.

Explanation

Formula for nth Bright Fringe:

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

For the 10th bright fringe:

$y_{10} = \frac{10\times\lambda\times1.2}{0.6\times10^{-3}} = (20 \times 10^3)\lambda \quad \text{(Equation i)}$

Formula for nth Dark Fringe:

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

For the 3rd dark fringe:

$y'_3 = \frac{5\lambda\times1.2}{2\times(0.6\times10^{-3})} = (5 \times 10^3)\lambda \quad \text{(Equation ii)}$

Given:

$y_{10} - y'_3 = 8.85 \times 10^{-3}$

Substituting from Equations (i) and (ii):

$(20 \times 10^3)\lambda - (5 \times 10^3)\lambda = 8.85 \times 10^{-3}$

Simplifying:

$15 \times 10^3 \lambda = 8.85 \times 10^{-3}$

Solving for λ:

$\lambda = \frac{8.85 \times 10^{-3}}{15 \times 10^3} = 5.9 \times 10^{-7} \text{ m}$

When expressed in Angstroms:

$\lambda = 5900 \text{ Å}$

Question63

In a diffraction pattern due to single slit of width ' a ', the first minimum is observed at an angle 30° when light of wavelength $5000 \overset{o}{A}$ is incident on the slit. The first secondary maximum is observed at an angle $\left[\sin 30 = \frac{1}{2}\right]$

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Options:

A. $\sin^{-1}\left(\frac{1}{2}\right)$

B. $\sin^{-1}\left(\frac{3}{4}\right)$

C. $\sin^{-1}\left(\frac{1}{4}\right)$

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

Answer: B

Solution:

In the context of a single-slit diffraction pattern, the first minimum occurs when the light of wavelength 5000 Å is diffracted at an angle of 30°. This scenario arises from the relationship for minima in single-slit diffraction as described by:

$a \sin \theta_n = n\lambda$

For the first minimum ($n = 1$), we can express it as:

$a \sin 30^\circ = \lambda \quad \text{(Equation i)}$

Given the value of $\sin 30^\circ = \frac{1}{2}$, we substitute to get:

$a \cdot \frac{1}{2} = \lambda$

Next, to find the angle for the first secondary maximum, we consider:

$a \sin \theta_n = (2n+1)\frac{\lambda}{2}$

For the second secondary maximum ($n = 1$), the equation becomes:

$a \sin \theta_n = (2 \cdot 1 + 1)\frac{\lambda}{2} = \frac{3\lambda}{2} \quad \text{(Equation ii)}$

By dividing Equation i by Equation ii, we get:

$\frac{\frac{1}{2}}{\sin \theta_n} = \frac{2}{3}$

Solving for $\sin \theta_n$, we find:

$\sin \theta_n = \frac{3}{4}$

Thus, the angle θ_n for the first secondary maximum is:

$\theta_n = \sin^{-1}\left(\frac{3}{4}\right)$

Question64

In biprism experiment, if 5^{th} bright band with wavelength λ_1 coincides with 6^{th} dark band with wavelength λ_2 then the ratio (λ_1/λ_2) is

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Options:

A. $\frac{7}{9}$

B. $\frac{10}{11}$

C. $\frac{11}{10}$

D. $\frac{9}{7}$

Answer: C

Solution:

In the biprism experiment, if the 5th bright band with wavelength λ_1 coincides with the 6th dark band with wavelength λ_2, we can find the ratio $\frac{\lambda_1}{\lambda_2}$ using the following equations:

Given that the position of the 5th bright band for λ_1 is the same as the position of the 6th dark band for λ_2:

$y_5 = y_6'$

The position of the bright band is given by:

$\left(\frac{n\lambda D}{d}\right)_5 = \left[\frac{(2n-1)\lambda D}{2d}\right]_6$

Substituting the values for the 5th bright band and 6th dark band:

$\frac{5\lambda_1 D}{d} = \frac{11\lambda_2 D}{2d}$

By solving this equation, we find:

$\frac{\lambda_1}{\lambda_2} = \frac{11}{10}$

Question65

In young's double slit experiment, the n^{th} maximum of wavelength λ_1 is at a distance of y_1 from the central maximum. When the wavelength of the source is changed to λ_2, $\left(\frac{\mathrm{n}}{3}\right)^{\text{th}}$ maximum is at a distance of y_2 from its central maximum. The ratio $\frac{y_1}{y_2}$ is

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Options:

A. $\frac{3\lambda_1}{\lambda_2}$

B. $\frac{3\lambda_2}{\lambda_1}$

C. $\frac{\lambda_1}{3\lambda_2}$

D. $\frac{\lambda_2}{3\lambda_1}$

Answer: A

Solution:

In Young's double-slit experiment, the position of the nth maximum for a wavelength λ_1 is given by:

$y_1 = \frac{n\lambda_1 D}{d}$ (Equation 1)

where D is the distance from the slits to the screen, and d is the separation between the slits.

When the wavelength is changed to λ_2, the position of the $\left(\frac{n}{3}\right)^{\text{th}}$ maximum is given by:

$y_2 = \frac{\frac{n}{3}\lambda_2 D}{d}$ (Equation 2)

To find the ratio $\frac{y_1}{y_2}$, substitute the expressions for y_1 and y_2 from Equations 1 and 2:

$$\frac{y_1}{y_2} = \frac{\frac{n\lambda_1 D}{d}}{\frac{\frac{n}{3}\lambda_2 D}{d}}$$

Simplifying this expression:

$$\frac{y_1}{y_2} = \frac{3\lambda_1}{\lambda_2}$$

Thus, the ratio $\frac{y_1}{y_2}$ is $\frac{3\lambda_1}{\lambda_2}$.

Question66

In the Young's double slit experiment, the intensity at a point on the screen, where the path difference is $\lambda(\lambda =$ wavelength $)$ is β. The intensity at a point where the path difference is $\lambda/3$, will be $\cos\frac{\pi}{3} = 1/2]$

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Options:

A. β

B. $\beta/2$

C. $\frac{\beta}{4}$

D. $\beta/8$

Answer: C

Solution:

In Young's double slit experiment, the intensity at a point on the screen is determined by the path difference between the light waves. When the path difference is equal to the wavelength λ, the intensity is given as β. We want to find the intensity at a point where the path difference is $\lambda/3$.

The intensity I can be calculated using the formula:

$$I = 4I_0 \cos^2 \frac{\phi}{2}$$

Here, I_0 is the intensity of each slit and ϕ is the phase difference between the two waves. Maximum intensity $\beta = 4I_0$ occurs when the phase difference $\phi = 0$.

For a path difference of $\lambda/3$, the phase difference ϕ is:

$$\phi = \frac{2\pi}{3}$$

Now, calculate the intensity using:

$$I = \beta \cos^2 \frac{2\pi}{3}$$

Since

$$\cos \frac{2\pi}{3} = -\frac{1}{2}$$

we have:

$$I = \beta\left(-\frac{1}{2}\right)^2 = \frac{\beta}{4}$$

Therefore, the intensity at the point where the path difference is $\lambda/3$ is $\frac{\beta}{4}$.

Question67

The fringe width in an interference pattern is ' X '. The distance between the sixth dark fringe from one side of central bright band to the fourth bright fringe on other side is

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Options:

A. 1.5 X

B. 2 X

C. 5.5 X

D. 9.5 X

Answer: D

Solution:

The fringe width in an interference pattern is denoted by X.

Explanation:

The fringe width is defined as:

$W = \frac{\lambda D}{d} = X$

Here, λ is the wavelength, D is the distance to the screen, and d is the slit separation.

Position of the 4th Bright Fringe:

The position of the n-th bright fringe is given by:

$n\frac{\lambda D}{d} = 4X$

In this case, for the 4th bright fringe, $n = 4$. Thus, the position is $4X$.

Position of the 6th Dark Fringe:

The position of the n-th dark fringe is given by:

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

For the 6th dark fringe, $n = 6$:

$(2 \times 6 - 1)\frac{X}{2} = 5.5X$

Total Distance:

The total distance from the 6th dark fringe on one side of the central bright band to the 4th bright fringe on the other side is:

$(4 + 5.5)X = 9.5X$

Therefore, the total distance between the specified fringes is $9.5X$.

Question68

In Young's double slit experiment using monochromatic light of wavelength ' λ ', the maximum intensity of light at a point on the screen is ' K ' units. The intensity of light at a point where the path

difference is $\frac{\lambda}{6}$ ' is

$$\left(\cos 60^{\circ}=\sin 30^{\circ}=0.5, \sin 60^{\circ}=\cos 30^{\circ}=\sqrt{3}/2\right)$$

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Options:

A. $\frac{3\text{ K}}{4}$

B. $\frac{\text{K}}{4}$

C. $\frac{\text{K}}{2}$

D. K

Answer: A

Solution:

In Young's double-slit experiment with monochromatic light of wavelength λ, the maximum intensity of light at a given point on the screen is represented as K units. We aim to find the intensity at a point where the path difference is $\frac{\lambda}{6}$.

The intensity I is given by:

$I=4 I_0 \cos^2 \frac{\phi}{2}$ ... (i)

The maximum intensity, $K=4 I_0$, occurs when the phase difference $\phi=0$.

For a path difference of $\frac{\lambda}{6}$, the phase difference is calculated as:

$\phi=\frac{2\pi}{\lambda} \times \text{path difference}=\frac{\pi}{3}$

Substituting this into our intensity equation, we get:

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

Therefore, the intensity at this point is:

$I=\frac{3K}{4}$

Question69

A wavefront is a surface

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Options:

A. perpendicular to the direction of propagation of light.

B. parallel to the direction of propagation of light.

C. without any specific orientation with direction of propagation of light.

D. which has nothing to do with intensity of light.

Answer: A

Solution:

A **wavefront** is defined as the locus of points that have the **same phase** of vibration. In an isotropic medium (where light travels uniformly in all directions), these wavefronts are surfaces **perpendicular** to the direction of propagation of light rays.

Hence, the correct choice is:

(A) perpendicular to the direction of propagation of light.

Question70

Two wavelength 590 nm and 596 nm of sodium light are used one after other, to study the diffraction taking place at a single slit of aperture 2.4 mm . The distance between the slit and screen is 2 m . The separation between the positions of first secondary maximum of the diffraction pattern obtained in the two cases is

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Options:

A. 7.5×10^{-6} m

B. 7.5×10^{-9} m

C. 2.5×10^{-6} m

D. 5.0×10^{-6} m

Answer: A

Solution:

To calculate the separation between the first secondary maxima for two different wavelengths of sodium light in a diffraction pattern, we use the formula for the position of the first secondary maximum in a single slit diffraction setup:

$\sin\theta = (2n+1)\frac{\lambda}{2a} = \frac{3\lambda}{2a}$

For small angles, we can approximate $\sin\theta \approx \tan\theta = \theta$. Therefore, the position x of the first secondary maximum on the screen is given by:

$x = \frac{3\lambda D}{2a}$

Here, λ is the wavelength of light, D is the distance from the slit to the screen, and a is the aperture of the slit.

To find the separation Δx between the positions of the first secondary maxima for two different wavelengths, $\lambda_1 = 590\,\text{nm}$ and $\lambda_2 = 596\,\text{nm}$, use:

$\Delta x = \frac{3D(\lambda_2 - \lambda_1)}{2a}$

Substituting the given values:

$D = 2\,\text{m}$

$\lambda_1 = 590 \times 10^{-9}\,\text{m}$

$\lambda_2 = 596 \times 10^{-9}\,\text{m}$

$a = 2.4 \times 10^{-3}\,\text{m}$

we get:

$\Delta x = \frac{3 \times 2 \times (596 - 590) \times 10^{-9}}{2 \times 2.4 \times 10^{-3}}$

Simplifying this:

$\Delta x = \frac{3 \times 2 \times 6 \times 10^{-9}}{4.8 \times 10^{-3}} = 7.5 \times 10^{-6}\,\text{m}$

Thus, the separation between the positions of the first secondary maximum for the two wavelengths is 7.5×10^{-6} m.

Question71

A parallel beam of light of intensity I_0 is incident on a glass plate, 25% of light is reflected by upper surface and 50% of light is reflected from lower surface. The ratio of maximum to minimum intensity in interference region of reflected rays is

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Options:

A. $\left[\frac{\frac{1}{2}+\sqrt{\frac{3}{8}}}{\frac{1}{2}-\sqrt{\frac{3}{8}}}\right]^2$

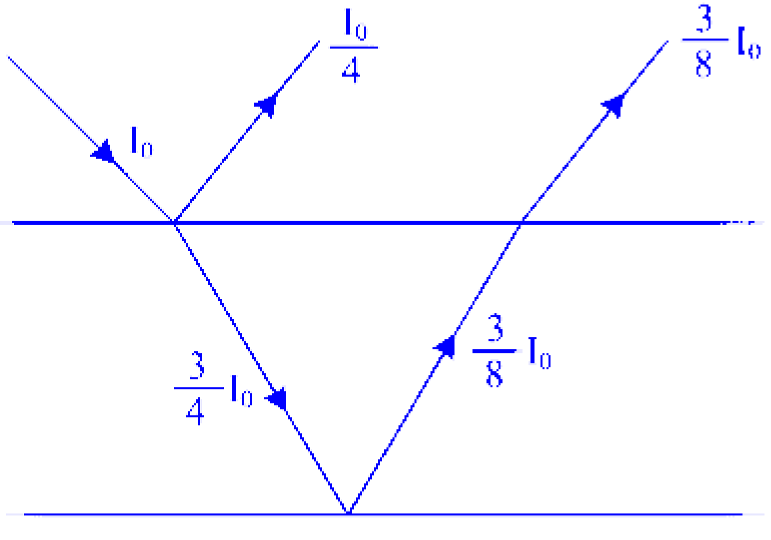
B. $\left[\frac{\frac{1}{4}+\sqrt{\frac{3}{8}}}{\frac{1}{2}-\sqrt{\frac{3}{8}}}\right]^2$

C. $\frac{5}{8}$

D. $\frac{8}{5}$

Answer: A

Solution:



Given that, 25% of total intensity of incident light is reflected from upper surface. This implies, if intensity of incident light is I_0, the intensity of light reaching the lower surface of plate will be $\frac{3}{4} I_0$.

As 50% of this intensity is reflected, the final intensity of light emerging from glass plate will be $\frac{3}{8} I_0$.

$$\therefore \quad I_1 = \frac{I_0}{4}$$

$$I_2 = \frac{3}{8} I_0$$

Now, $\frac{I_{\max}}{I_{\min}} = \frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2} = \left(\frac{\frac{1}{2}+\sqrt{\frac{3}{8}}}{\frac{1}{2}-\sqrt{\frac{3}{8}}}\right)^2$

Question72

A single slit of width d is illuminated by violet light of wavelength 400 nm and the width of the diffraction pattern is measured as ' Y '. When half of the slit width is covered and illuminated by yellow light of wavelength 600 nm , the width of the diffraction pattern is

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Options:

A. zero

B. $\frac{Y}{3}$

C. 3 Y

D. 4 Y

Answer: C

Solution:

To find the width of the diffraction pattern when the slit is partially covered, we start with the formula for the width of the diffraction pattern:

$W = \frac{2 \lambda D}{d} \quad$ (i)

Given:

The initial wavelength, $\lambda = 400 \, \mathrm{nm}$

The initial slit width, d

The initial width of the diffraction pattern is Y

Now, when half of the slit is covered, the effective width of the slit becomes:

$d' = \frac{d}{2}$

The new wavelength is $\lambda' = 600\,\mathrm{nm}$.

Substituting these values into our formula, the new width of the diffraction pattern is:

$$\begin{aligned} W' &= \frac{2\lambda' D}{d'} \\ &= \frac{2 \cdot 600\,\mathrm{nm} \cdot D}{d/2} \quad \text{(ii)} \end{aligned}$$

So, comparing the new width to the original:

$$\begin{aligned} \frac{W'}{W} &= \frac{2\lambda' D}{\lambda D} \\ &= \frac{2 \times 600}{400} \\ &= 3 \end{aligned}$$

Thus, the new width of the diffraction pattern, W', is:

$W' = 3W = 3Y$

Therefore, the width of the diffraction pattern, when half the slit is covered and illuminated by yellow light, becomes three times the initial width, or $3Y$.

Question73

In a biprism experiment, monochromatic light of wavelength ' γ ' is used. The distance between the two coherent sources ' d ' is kept constant. If the distance between slit and eyepiece ' D ' is varied as D_1, D_2, D_3, D_4 and corresponding measured fringe widths are W_1, W_2, W_3, W_4 then

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Options:

A. $W_1 D_1 = W_2 D_2 = W_3 D_3 = W_4 D_4$

B. $\frac{W_1}{D_1} = \frac{W_2}{D_2} = \frac{W_3}{D_3} = \frac{W_4}{D_4}$

C. $W_1 \sqrt{D_1} = W_2 \sqrt{D_2} = W_3 \sqrt{D_3} = W_3 \sqrt{D_3}$

D. $D_1\sqrt{W_1} = D_2\sqrt{W_2} = D_3\sqrt{W_3} = D_4\sqrt{W_4}$

Answer: B

Solution:

In a biprism experiment using monochromatic light with wavelength ' λ ', the distance ' d ' between the two coherent sources remains constant. As you change the distance between the slit and the eyepiece to D_1, D_2, D_3, D_4, the corresponding fringe widths are measured as W_1, W_2, W_3, W_4.

The formula for the fringe width W is:

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

From this equation, we can derive:

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

Since λ and d are constants, $\frac{W}{D}$ is also a constant. Therefore, this relationship holds for all the measured pairs:

$\frac{W_1}{D_1} = \frac{W_2}{D_2} = \frac{W_3}{D_3} = \frac{W_4}{D_4}$

Question74

Three identical polaroids P_1, P_2 and P_3 are placed one after another. The pass axis of P_2 and P_3 are inclined at an angle 60° and 90° with respect to axis of P_1. The source has an intensity I_0. The intensity of transmitted light through P_3 is $\left(\cos 60^\circ = 0.5, \cos 30^\circ = \frac{\sqrt{3}}{2}\right)$

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Options:

A. $\frac{I_0}{8}$

B. $\frac{3I_0}{16}$

C. $\frac{3I_0}{32}$

D. $\frac{I_0}{32}$

Answer: C

Solution:

The source intensity is I_0.

The pass axis of P_2 is at an angle of 60° with respect to the axis of P_1.

The pass axis of P_3 is at an angle of 90° with respect to the axis of P_1.

Transmission through P_1:

The light intensity after passing through P_1 is reduced to half, according to the properties of a polaroid.

Therefore, $I = \frac{I_0}{2}$.

Transmission through P_2:

Use Malus' Law: $I = I_0 \cos^2 \theta$.

At $P_2, \theta = 60^\circ$.

Hence, $I_2 = \frac{I_0}{2} \cos^2 60^\circ = \frac{I_0}{2} \times (0.5)^2 = \frac{I_0}{8}$.

Transmission through P_3:

Between P_2 and P_3, the angle is effectively 30° due to the relative orientations.

Use Malus' law again: $I_3 = \frac{I_0}{8} \cos^2 30^\circ$.

With $\cos 30^\circ = \frac{\sqrt{3}}{2}$, the calculation becomes:

$$I_3 = \frac{I_0}{8} \times \left(\frac{\sqrt{3}}{2}\right)^2 = \frac{I_0}{8} \times \frac{3}{4} = \frac{3I_0}{32}$$

This calculation shows how the intensity I_3 of the transmitted light through P_3 is reduced to $\frac{3I_0}{32}$.

Question75

In Young's double slit experiment, in an interference pattern, second minimum is observed exactly in front of one slit. The distance between the two coherent sources is ' d ' and the distance between the source and screen is ' D '. The wave length of light (λ) used is

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Options:

A. $\frac{\mathrm{d}^2}{\mathrm{D}}$

B. $\frac{\mathrm{d}^2}{2\mathrm{D}}$

C. $\frac{\mathrm{d}^2}{3\mathrm{D}}$

D. $\frac{d^2}{4D}$

Answer: C

Solution:

In Young's double-slit experiment, the path difference for the minima in the interference pattern is given by:

$d\sin(\theta) = (m + \frac{1}{2})\lambda$

where m is the order of the minimum (with consecutive minima being $m = 0, 1, 2, \ldots$) and θ is the angle of the fringe with respect to the central line.

Given that the second minimum is observed exactly in front of one slit, the second minimum corresponds to $m = 1$. Here, the minima can be assumed symmetrical, and thus directly in front of one slit at $m = 1$.

For small angles where $\sin(\theta) \approx \tan(\theta) \approx \frac{x_m}{D}$, the path difference can be rewritten considering the distance on the screen. Thus:

$x_m = \frac{(m+\frac{1}{2})\lambda D}{d}$

Given that the minimum occurs directly in front of one slit ($x_m = \frac{d}{2}$), we plug it in and solve for the wavelength λ:

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

Solving for λ:

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

$\lambda = \frac{2d^2}{3D}$

This means the correct option is:

Option C

$\frac{d^2}{3D}$

Question76

A screen is placed at 50 cm from a single slit, which is illuminated with light of wavelength 600 nm . If separation between the 1^{st} and

3^{rd} minima in the diffraction pattern is 3 mm then slit width is

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Options:

A. 0.2 mm

B. 0.02 mm

C. 2 mm

D. 20 mm

Answer: A

Solution:

To find the width of the slit, we use the formula for the position of the nth minima in a diffraction pattern:

$x_n = \frac{nD\lambda}{d}$

The distance between the first and third minima is given by:

$x_3 - x_1 = (3-1)\frac{D\lambda}{d} = \frac{2D\lambda}{d}$

Rearranging to solve for the slit width d, we have:

$d = \frac{2D\lambda}{x_3 - x_1}$

Substitute the known values:

$D = 50\,\text{cm} = 0.5\,\text{m}$

$\lambda = 600\,\text{nm} = 600 \times 10^{-9}\,\text{m}$

$x_3 - x_1 = 3\,\text{mm} = 3 \times 10^{-3}\,\text{m}$

Now, calculate d:

$d = \frac{2 \times 0.5 \times 600 \times 10^{-9}}{3 \times 10^{-3}}$

$d = 0.2\,\text{mm}$

So, the slit width is 0.2 mm.

Question77

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 ' λ ' is K units. The intensity of light at a point where the path difference is $\frac{\lambda}{6}$ is $\left[\cos \frac{\pi}{6}=\sin \frac{\pi}{3}=\frac{\sqrt{3}}{2}\right]$

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Options:

A. K

B. $\frac{3\text{ K}}{4}$

C. $\frac{\text{K}}{2}$

D. $\frac{\text{K}}{4}$

Answer: B

Solution:

In Young's double slit experiment, the intensity of the light at a point on the screen depends on the path difference and can be found using the relation:

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

where I_0 is the maximum intensity, and $\Delta \phi$ is the phase difference related to the path difference Δx by:

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

For the path difference $\Delta x=\lambda$, the phase difference is:

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

The intensity at this point is given by:

$I=I_0 \cos^2\left(\frac{2 \pi}{2}\right)=I_0 \cdot 1=I_0$

This intensity is stated as K units.

Now, for the path difference $\Delta x=\frac{\lambda}{6}$, the phase difference becomes:

$\Delta \phi=\frac{2 \pi}{\lambda} \cdot \frac{\lambda}{6}=\frac{\pi}{3}$

The intensity at this point is:

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

Given that $\cos\frac{\pi}{6}=\frac{\sqrt{3}}{2}$, we have:

$I=I_0\left(\frac{\sqrt{3}}{2}\right)^2=I_0\cdot\frac{3}{4}$

Since $I_0=K$, the intensity becomes:

$I=\frac{3K}{4}$

Therefore, the correct answer is:

Option B: $\frac{3\mathrm{~K}}{4}$

Question78

In an interference experiment, the n^{th} bright fringe for light of wavelength $\lambda_1(\mathrm{n}=0,1,2,3\ldots)$ coincides with the m^{th} dark fringe for light of wavelength $\lambda_2(\mathrm{~m}=1,2,3\ldots)$. The ratio $\frac{\lambda_1}{\lambda_2}$ is

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Options:

A. $\frac{\mathrm{m}-1}{\mathrm{n}}$

B. $\frac{2\mathrm{~m}-1}{\mathrm{n}}$

C. $\frac{2m-1}{2n}$

D. $\frac{2\mathrm{~m}+1}{2\mathrm{n}}$

Answer: C

Solution:

In an interference experiment, the condition for a bright fringe due to a light of wavelength λ_1 is given by the equation:

$d\sin\theta=n\lambda_1,$

where d is the slit separation, θ is the angle of diffraction, and n is the order of the bright fringe ($n=0,1,2,\ldots$).

For a dark fringe due to a light of wavelength λ_2, the condition is:

$$d \sin\theta = \left(m - \frac{1}{2}\right)\lambda_2,$$

where m is the order of the dark fringe ($m = 1, 2, 3, \ldots$).

If both these fringes coincide, their path differences must be equal. Therefore:

$$n\lambda_1 = \left(m - \frac{1}{2}\right)\lambda_2.$$

Solving for the ratio $\frac{\lambda_1}{\lambda_2}$, we have:

$$\frac{\lambda_1}{\lambda_2} = \frac{m - \frac{1}{2}}{n}.$$

Multiplying the numerator and the denominator by 2 to clear the fraction, we obtain:

$$\frac{\lambda_1}{\lambda_2} = \frac{2m-1}{2n}.$$

So, the correct option is **Option C**: $\frac{2m-1}{2n}$.

Question79

A single slit diffraction pattern is formed with light of wavelength $6195 \stackrel{o}{A}$. The second secondary maximum for this wavelength coincides with the third secondary maximum in the pattern for light of wavelength ' λ_0 '. The value of ' λ_0 ' is

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Options:

A. $4180 \stackrel{o}{A}$

B. $4425 \stackrel{o}{A}$

C. $5330 \stackrel{o}{A}$

D. $6235 \stackrel{o}{A}$

Answer: B

Solution:

In a single slit diffraction pattern, the position of secondary maxima can be determined using the angular position equation:

$a \sin \theta = (m + \frac{1}{2})\lambda$

where:

a is the width of the slit,

θ is the angle of diffraction,

m is the order number of the secondary maximum,

λ is the wavelength of light.

For the second secondary maximum (m = 2) of the light with wavelength $\lambda = 6195\overset{o}{A}$:

$a \sin \theta = \left(2 + \frac{1}{2}\right)\lambda = \frac{5}{2} \times 6195$

For the third secondary maximum (m = 3) with the unknown wavelength λ_0:

$a \sin \theta = \left(3 + \frac{1}{2}\right)\lambda_0 = \frac{7}{2}\lambda_0$

Since both maxima coincide, their angular positions are equal:

$\frac{5}{2} \times 6195 = \frac{7}{2}\lambda_0$

Solving for λ_0:

$\lambda_0 = \frac{\frac{5}{2} \times 6195}{\frac{7}{2}} = \frac{5 \times 6195}{7}$

$\lambda_0 = \frac{30975}{7} = 4425\overset{o}{A}$

Therefore, the value of λ_0 is $4425\overset{o}{A}$.

Correct Option:

Option B: $4425\overset{o}{A}$

Question80

When wavefronts pass from denser medium to rarer medium, the width of the wavefront

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Options:

A. increases.

B. may increase or decrease.

C. decreases.

D. remains unchanged.

Answer: A

Solution:

When wavefronts pass from a denser medium to a rarer medium, their behavior can be analyzed using the principles of wave optics, particularly refraction and Huygens' principle.

Understanding Refraction and Wavefront Behavior:

Speed and Wavelength Increase:

In a rarer medium, the speed of the wave increases because the optical density is lower.

Since the frequency of the wave remains constant (as it is determined by the source), an increase in speed results in an increase in wavelength ($v = f\lambda$).

Wavefront Bending:

According to Snell's Law, when a wave passes from a denser to a rarer medium at an angle, it bends **away from the normal**.

This bending causes the wavefront to spread out more in the lateral direction.

Width of the Wavefront:

The "width of the wavefront" refers to the lateral extent of the wavefront perpendicular to the direction of propagation.

As the wavefront bends away from the normal, the lateral spread increases, effectively **increasing the width of the wavefront**.

Visual Explanation:

Imagine a beam of light (or any wave) passing obliquely from water (denser medium) into air (rarer medium). Upon entering the air:

The wavefronts move faster.

The beam spreads out because each point on the wavefront moves away from the normal at a greater angle.

The overall width of the beam (wavefront) increases due to this spreading.

Conclusion:

Given the above analysis, when wavefronts transition from a denser to a rarer medium, the width of the wavefront **increases**.

Answer: Option A: increases.

Question81

A diffraction pattern is obtained using a beam of red light. If red light is replaced by blue light then

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Options:

A. no change in diffraction pattern.

B. diffraction bands become narrow and crowded together.

C. diffraction bands become broader and farther apart.

D. bands disappear.

Answer: B

Solution:

In the context of diffraction, when a beam of red light, which has a longer wavelength (λ_{red}), is replaced by blue light, which has a shorter wavelength (λ_{blue}), the effect on the diffraction pattern can be understood through the formula for the distance between successive maxima:

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

Here, β represents the distance between successive maxima, λ is the wavelength of the light used, D is the distance to the screen, and a is the slit width. From the equation, it is clear that β is directly proportional to the wavelength λ.

Since $\lambda_{\text{blue}} < \lambda_{\text{red}}$, when blue light is used, the value of β decreases compared to when red light is used. Hence, the diffraction bands become narrower and more closely spaced together.

Question82

The intensity ratio of the maxima and minima in an interference pattern produced by two coherent sources of light is $9 : 1$. The intensities of the light sources used are in the ratio

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Options:

A. 3 : 1

B. 4 : 1

C. 9 : 1

D. 10 : 1

Answer: B

Solution:

To determine the intensity ratio of the light sources in an interference pattern, we start with the given intensity ratio of maxima to minima, which is 9:1. This relationship is expressed as:

$$\frac{I_{\text{max}}}{I_{\text{min}}} = \frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2}$$

Plugging the given ratio into the equation:

$$\frac{9}{1} = \frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2}$$

Taking the square root on both sides of the equation gives:

$$\frac{3}{1} = \frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}$$

Cross-multiplying to solve for the intensity terms:

$$3\left(\sqrt{I_1}-\sqrt{I_2}\right) = 1\left(\sqrt{I_1}+\sqrt{I_2}\right)$$

Expanding and rearranging terms, we have:

$$3\sqrt{I_1} - 3\sqrt{I_2} = \sqrt{I_1} + \sqrt{I_2}$$

Rearranging terms gives:

$$2\sqrt{I_1} = 4\sqrt{I_2}$$

Solving for the square root ratio, we find:

$$\sqrt{\frac{I_1}{I_2}} = \frac{2}{1}$$

Squaring both sides provides the ratio of intensities:

$$\frac{I_1}{I_2} = \frac{4}{1}$$

Therefore, the ratio of the intensities of the light sources is 4 : 1.

Question83

Two points separated by a distance of 0.1 mm can just be seen in microscope when light of wavelength $6000\overset{o}{A}$ is used. If the light of wavelength $4800\overset{o}{A}$ is used, the limit of resolution will become

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Options:

A. 0.8 mm

B. 0.12 mm

C. 0.10 mm

D. 0.08 mm

Answer: D

Solution:

Original distance that can just be resolved: $d_1 = 0.1$ mm (using light with wavelength $\lambda_1 = 6000$ Å)

New wavelength $\lambda_2 = 4800$ Å

Using the proportionality relationship:

$\frac{d_1}{d_2} = \frac{\lambda_1}{\lambda_2}$

Substitute the values:

$\frac{0.1}{d_2} = \frac{6000}{4800}$

Solving for d_2:

$d_2 = \frac{0.1 \times 4800}{6000} = 0.08\,\text{mm}$

Thus, when using light with a wavelength of 4800 Å, the limit of resolution becomes 0.08 mm.

Question84

The intensity of light coming from one of the slits in Young's double slit experiment is double the intensity from the other slit. The ratio of the maximum intensity to the minimum intensity in the interference fringe pattern observed is

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Options:

A. 9 : 1

B. 34 : 1

C. 4 : 1

D. 16 : 1

Answer: B

Solution:

Two coherent sources of intensities I_1 and I_2 produce,

maximum intensity, $I_{max} \quad = (\sqrt{I_1} + \sqrt{I_2})^2$ and

minimum intensity, $I_{min} \quad = (\sqrt{I_1} - \sqrt{I_2})^2$ in an interference pattern.

$$\frac{I_{max}}{I_{min}} = \frac{(\sqrt{I_1} + \sqrt{I_2})^2}{(\sqrt{I_1} - \sqrt{I_2})^2} = \frac{I_1 + I_2 + 2\sqrt{I_{I_2}}}{I_1 + I_2 - 2\sqrt{I_1 I_2}}$$

Given $I_1 = 2I_2$

$$\therefore \quad \frac{I_{max}}{I_{min}} = \frac{3I_2 + 2\sqrt{2}I_2}{3I_2 - 2\sqrt{2}I_2} = \frac{3 + 2\sqrt{2}}{3 - 2\sqrt{2}} = 34$$

Question85

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

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Options:

A. there shall be alternative interference fringes of red and blue.

B. there shall be interference fringes for red distinct from that for blue.

C. there shall be no interference fringes.

D. there shall be interference fringes for red mixing with one for blue.

Answer: C

Solution:

In a Young's double slit experiment where one slit is covered by a red filter and the other slit by a blue filter, the interference pattern will not form. This is because the two slits are illuminated with light of different wavelengths (red and blue), and for a meaningful interference pattern, coherent sources of the same wavelength (or nearly the same) are necessary.

Thus, the correct option is:

Option C: there shall be no interference fringes.

Interference occurs when waves overlap and superimpose to create a pattern; however, this requires the waves to have a constant phase relationship. This condition cannot be met when using light of different colors, or wavelengths, because they will not have the necessary coherent phase relationship across the slits. Therefore, the result is no visible interference pattern of fringes on the observing screen.

Question86

On replacing a thin film of mica of thickness 12×10^{-5} cm in the path of one of the interfering beams in Young's double slit experiment using monochromatic light, the fringe pattern shifts through a distance equal to the width of bright fringe. If $\lambda = 6 \times 10^{-5}$ cm, the refractive index of mica is

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Options:

A. 1.1

B. 1.3

C. 1.5

D. 1.4

Answer: C

Solution:

The equation for the shift in the fringe pattern is given as,

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

$\therefore$ Refractive index of mica is:

$$\mu = \frac{n\lambda}{t} + 1$$

$$\therefore \quad \mu = \frac{1 \times 6 \times 10^{-5}}{12 \times 10^{-5}} + 1 = 0.5 + 1$$

$$\therefore \quad \mu = 1.5$$

Question87

When two light waves each of amplitude 'A' and having a phase difference of $\frac{\pi}{2}$ superimposed then the amplitude of resultant wave is

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Options:

A. $\frac{A}{\sqrt{2}}$

B. 2 A

C. $\sqrt{2}$ A

D. $\frac{A}{2}$

Answer: C

Solution:

The formula for resultant amplitude is,

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

Here, $A_1=A_2=A$ and $\phi=90^{\circ}$

$\therefore \quad R=\sqrt{A^2+A^2+2 A^2 \cos 90^{\circ}}=\sqrt{2 A^2}=\sqrt{2} A$

Question88

Two wavelengths of sodium light $590 \mathrm{~nm}$ and $596 \mathrm{~nm}$ are used one after another to study diffraction due to single slit of aperture $2 \times 10^{-6} \mathrm{~m}$. The distance between the slit and the screen is $1.5 \mathrm{~m}$. The separation between the positions of first maximum of the diffraction pattern obtained in the two cases is

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Options:

A. 5.5 mm

B. 5.75 mm

C. 6.25 mm

D. 6.75 mm

Answer: D

Solution:

First maximum in single slit diffraction pattern is obtained at, $x=\frac{3 \lambda D}{2 d}$

$\therefore \quad \Delta x = \frac{3D \times \Delta\lambda}{2\ d} = \frac{3 \times 1.5}{2 \times 2 \times 10^{-6}}(596 - 590)$

$\therefore \quad \Delta x = 6.75\ mm$

Question89

The diffraction fringes obtained by a single slit are of

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Options:

A. equal width

B. equal width and unequal intensity

C. unequal width but equal intensity

D. unequal width and unequal intensity

Answer: D

Solution:

When a wave encounters an obstacle, such as a slit, that is comparable in size to its wavelength, diffraction occurs. This phenomenon can result in the formation of a pattern of bright and dark regions called fringes on the other side of the slit. In the case of a single-slit diffraction, both the width and the intensity of the fringes vary.

The central maximum is the brightest and the widest. As one moves away from the center towards the edges, the intensity of the fringes decreases and their width becomes narrower. Thus, the width and the intensity of the fringes are not constant. The intensity falls off more slowly than the width, but both are functions of the angle from the central maximum.

The diffraction pattern for a single-slit can be explained using the Huygens-Fresnel principle, where each point on a wavefront within the slit is considered as a source of secondary spherical wavelets, and the wavelets interfere with each other to produce the diffraction pattern.

The width of the diffraction fringes can be described mathematically by the formula that gives the position of the minima:$d \sin\theta = m\lambda$where:d is the width of the slit,θ is the diffraction angle,m is the order of the minimum (with $m = \pm1, \pm2, \pm3, \ldots$),and λ is the wavelength of the light.

As m increases, the value of $\sin\theta$ for the minima also increases, but not linearly, and thus the spacing between fringes changes. The intensity distribution of the single-slit diffraction pattern is governed by the intensity function, which shows that the intensity of the fringes falls off as a function of the angle θ.

The correct answer is : Option D - unequal width and unequal intensity.

Question90

In Young's double slit experiment, 8^{th} maximum with wavelength 'λ_1' is at a distance 'd_1' from the central maximum and 6^{th} maximum with wavelength 'λ_2' is at a distance 'd_2'. Then $\frac{\mathrm{d}_2}{\mathrm{d}_1}$ is

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Options:

A. $\frac{3\lambda_1}{4\lambda_2}$

B. $\frac{3\lambda_2}{4\lambda_1}$

C. $\frac{4\lambda_1}{3\lambda_2}$

D. $\frac{4\lambda_2}{3\lambda_1}$

Answer: B

Solution:

$$\mathrm{d} \propto \mathrm{n}\lambda$$

$$\therefore \quad \frac{\mathrm{d}_2}{\mathrm{d}_1} = \frac{\mathrm{n}_2\lambda_2}{\mathrm{n}_1\lambda_1} = \frac{6\lambda_2}{8\lambda_1}$$

$$\therefore \quad \frac{\mathrm{d}_2}{\mathrm{d}_1} = \frac{3\lambda_2}{4\lambda_1}$$

Question91

If I_0 is the intensity of the principal maximum in the single slit diffraction pattern, then what will be the intensity when the slit width is doubled?

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Options:

A. $\frac{I_0}{2}$

B. I_0

C. $4I_0$

D. $2I_0$

Answer: B

Solution:

The slit width has no effect on the intensity of the principal maximum in the single-slit diffraction pattern.

$\therefore$ The intensity will be same, I_0.

Question92

Light of wavelength $5000\overset{o}{A}$ is incident normally on a slit. The first minimum of the diffraction pattern is observed to lie at a distance of $5\ \mathrm{mm}$ from the central maximum on a screen placed at a distance of $2\ \mathrm{m}$ from the slit. The width of the slit is

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Options:

A. 2 cm

B. 0.2 cm

C. 0.02 cm

D. 0.01 cm

Answer: C

Solution:

Position of the nth minima is

$x_n = \frac{n\lambda D}{a}$ .... (i)

where, $a =$ slit width

$D =$ Distance between screen

and slit$\lambda =$ wavelength

Given, $\lambda = 5000\overset{o}{A} = 5000 \times 10^{-10}$ m

$$\begin{aligned} & x = 5 \text{ mm} = 5 \times 10^{-3} \text{ m} \\ & D = 2 \text{ m} \\ \Rightarrow \quad & n = 1 \end{aligned}$$

Put all these values in Eq. (i), we get

$$\begin{aligned} & 5 \times 10^{-3} = \frac{1 \times 5000 \times 10^{-10} \times 2}{a} \\ \Rightarrow \quad & a = \frac{5 \times 10^{-7} \times 2}{5 \times 10^{-3}} \\ \Rightarrow \quad & a = 2 \times 10^{-4} \text{ m} \\ & = 0.02 \text{ cm} \end{aligned}$$

Therefore, the slit width is 0.02 cm.

Question93

The path difference between two identical light waves at a point Q on the screen is $3\mu\text{m}$. If wavelength of the waves is $5000\overset{o}{A}$, then at point Q there is

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Options:

A. 3rd dark band

B. 4th bright band

C. 5th dark band

D. 6 th bright band

Answer: D

Solution:

Given, path difference $(\Delta x) = 3\mu\text{m} = 3 \times 10^{-6}$ m

Wavelength of length, $\lambda = 5000\overset{o}{A} = 5 \times 10^{-7}$ m

angular position is given by

$\theta = \frac{\Delta x}{\lambda} = \frac{3 \times 10^{-6}}{5 \times 10^{-7}} = 6$

Since, $n =$ integer (6) is even, therefore, we will have 6th order maxima.

Question94

Of the two slits producing interference in Young's experiment, one is covered with glass so that light intensity passing is reduced to 50%. Which of the following is correct?

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Options:

A. Intensity of fringes remains unaltered.

B. Intensity of bright fringe decreases and that of dark fringe increases.

C. Intensity of bright fringe increases and that of dark fringe decreases.

D. Intensity of both bright and dark fringes decreases.

Answer: B

Solution:

Initial intensity of bright fringes, $(\sqrt{I} + \sqrt{I})^2$

Final intensity of bright fringes after covering one slit with glass sheet $= \left(\sqrt{I} + \sqrt{\frac{I}{2}}\right)^2$

Clearly, the intensity of bright fringes has decreased. For dark fringes initial intensity $= (\sqrt{I} - \sqrt{I})^2$

But, new intensity $= \left(\sqrt{I} - \frac{\sqrt{I}}{2}\right)^2 \neq 0$

Hence, intensity of dark fringes increases.

Question95

In a biprism experiment, monochromatic light of wavelength 'λ' is used. The distance between two coherent sources 'd' is kept constant. If the distance between slit and eyepiece 'D' is varied as $D_1, D_2, D_3 \& D_4$ and corresponding measured fringe widths are Z_1, Z_2, Z_3 and Z_4 then

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Options:

A. $\mathrm{Z_1D_1 = Z_2D_2 = Z_3D_3 = Z_4D_4}$

B. $\frac{Z_1}{D_1} = \frac{Z_2}{D_2} = \frac{Z_3}{D_3} = \frac{Z_4}{D_4}$

C. $\mathrm{D_1\sqrt{Z_1} = D_2\sqrt{Z_2} = D_3\sqrt{Z_3} = D_4\sqrt{Z_4}}$

D. $Z_1\sqrt{D_1} = Z_2\sqrt{D_2} = Z_3\sqrt{D_3} = Z_4\sqrt{D_4}$

Answer: B

Solution:

Fringe width $Z = \frac{\lambda D}{d}$

$\therefore \quad \frac{Z}{D} = \frac{\lambda}{d} =$ constant, as λ and d are constant

$\therefore \quad \frac{Z_1}{D_1} = \frac{Z_2}{D_2} = \frac{Z_3}{D_3} = \frac{Z_4}{D_4}$

Question96

A and B are two interfering sources where A is ahead in phase by 54° relative to B. The observation is taken from point P such that PB − PA = 2.5 λ. Then the phase difference between the waves from A and B reaching point P is (in rad)

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Options:

A. 3.5π

B. 5.3π

C. 4.3π

D. 5.8π

Answer: B

Solution:

$$
\begin{aligned}
&\text{Total phase difference } = \phi_1 + \phi_2 \\
&\phi_1 = 54 \times \frac{\pi}{180} = 0.3\pi \\
&\phi_2 = \frac{2\pi}{\lambda} \times (\text{PB} - \text{PA}) \\
&\quad = \frac{2\pi}{\lambda} \times 2.5\lambda = 5\pi \\
\therefore \quad &\phi_1 + \phi_2 = 5\pi + 0.3\pi = 5.3\pi
\end{aligned}
$$

Question97

The ratio of intensities of two points on a screen in Young's double slit experiment when waves from the two slits have a path difference of $\frac{\lambda}{4}$ and $\frac{\lambda}{6}$ is

$(\cos 90^{\circ} = 0, \cos 60^{\circ} = 0.5)$

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Options:

A. 2 : 1

B. 2 : 3

C. 3 : 4

D. 3 : 5

Answer: B

Solution:

The intensity at the point due to interference is given as $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$ ..... (i)

For path difference $\frac{\lambda}{4}$, the phase difference is

$\phi_1 = \frac{2\pi}{\lambda} \times \frac{\lambda}{4} = \frac{\pi}{2}$

For path difference $\frac{\lambda}{6}$, the phase difference is

$\phi_2 = \frac{2\pi}{\lambda} \times \frac{\lambda}{6} = \frac{\pi}{3}$

Assuming equal intensity of the interfering waves i.e., $I_1 = I_2 = I_0$

Equation (i) becomes,

$$\mathrm{I} = \mathrm{I}_0 + \mathrm{I}_0 + 2\mathrm{I}_0\cos\phi$$
$$\mathrm{I} = 2\mathrm{I}_0(1 + \cos\phi)$$

For the given path difference, $I_1 = 2I_0\left(1 + \cos\frac{\pi}{2}\right)$, and $I_2 = 2I_0\left(1 + \cos\frac{\pi}{3}\right)$

$\therefore \quad \frac{I_1}{I_2} = \frac{1+\cos\frac{\pi}{2}}{1+\cos\frac{\pi}{3}}$

$$\frac{\mathrm{I}_1}{\mathrm{I}_2} = \frac{1+0}{1+0.5}$$
$$\therefore \quad \frac{\mathrm{I}_1}{\mathrm{I}_2} = \frac{1}{1.5} = \frac{2}{3}$$

Question98

In Young's double slit experiment when a glass plate of refractive index 1.44 is introduced in the path of one of the interfering beams, the fringes are displaced by a distance 'y'. If this plate is replaced by

another plate of same thickness but of refractive index 1.66, the fringes will be displaced by a distance

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Options:

A. $\frac{3y}{2}$

B. $\frac{2y}{3}$

C. $\frac{5y}{4}$

D. $\frac{4y}{5}$

Answer: A

Solution:

As a glass plate is used in one of the paths,

$$y_1 = \frac{\beta}{\lambda}(1.44 - 1)t$$
$$y_1 = 0.44t \times \frac{\beta}{\lambda}$$

New displacement is:

$$y_2 = \frac{\beta}{\lambda}(1.66 - 1)t$$
$$y_2 = 0.66t \times \frac{\beta}{\lambda}$$
$$\frac{y_2}{y_1} = \frac{0.66}{0.44}$$
$$\therefore \quad y_2 = \frac{3y}{2}$$

Question99

One of the slits in Young's double slit experiment is covered with a transparent sheet of thickness 2.9×10^{-3} cm. The central fringe

shifts to a position originally occupied by the 25^{th} bright fringe. If $\lambda = 5800\ \overset{o}{A}$, the refractive index of the sheet is

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Options:

A. 1.65

B. 1.60

C. 1.55

D. 1.50

Answer: D

Solution:

As it is given that a transparent sheet of certain thickness is inserted, we use

$$(\mu - 1) \times t = N\lambda$$
$$25\lambda = (\mu - 1)t$$
$$\mu - 1 = \frac{25\lambda}{t}$$

$\therefore$ The refractive index of the sheet is:

$$\mu = \frac{25 \times 5800 \times 10^{-10}}{2.9 \times 10^{-5}} + 1$$
$$\mu = 1.50$$

Question100

In Young's double slit experiment the intensities at two points, for the path difference $\frac{\lambda}{4}$ and $\frac{\lambda}{3}$ ($\lambda =$ wavelength of light used) are I_1 and I_2 respectively. If I_0 denotes the intensity produced by each one of the individual slits then $\frac{\mathrm{I}_1 + \mathrm{I}_2}{\mathrm{I}_0}$ is equal to

$$\left(\cos 60^\circ = 0.5, \cos 45^\circ = \frac{1}{\sqrt{2}}\right)$$

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Options:

A. 1

B. 2

C. 3

D. 4

Answer: C

Solution:

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

For first point, $\phi_1 = \frac{2\pi}{\lambda}\left(\frac{\lambda}{4}\right)$

$$\therefore \quad \phi_1 = \frac{\pi^c}{2}$$
$$I_1 = 2I_0\left(1 + \cos\phi_1\right)$$
$$\therefore \quad I_1 = 2I_0 \quad \ldots[\because \cos\phi_1 = \cos(\pi/2) = 0]$$

Similarly, for second point, $\phi_2 = \frac{2\pi^c}{3}$

$$\therefore \quad I_2 = 2I_0\left(1 + \cos\phi_2\right)$$
$$\therefore \quad I_2 = 2I_0\left(1 - \frac{1}{2}\right) \quad \ldots\left[\because \cos\left(\frac{2\pi}{3}\right) = \frac{-1}{2}\right]$$
$$\therefore \quad I_2 = I_0$$

Hence, $\frac{I_1+I_2}{I_0} = \frac{2I_0+I_0}{I_0} = 3$

Question101

In two separate setups for Biprism experiment using same wavelength, fringes of equal width are obtained. If ratio of slit separation is 2 : 3 then the ratio of the distance between the slit and screen in the two setups is

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Options:

A. 2 : 3

B. 1 : 2

C. 4 : 9

D. 9 : 4

Answer: A

Solution:

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

For constant W and λ

$D \propto d$

$\therefore \quad \frac{D_1}{D_2}=\frac{d_1}{d_2}=\frac{2}{3}$

Question102

A beam of light is incident on a glass plate at an angle of 60°. The reflected ray is polarized. If angle of incidence is 45° then angle of refraction is

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Options:

A. $\sin^{-1}\left(\frac{1}{\sqrt{6}}\right)$

B. $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$

C. $\sin^{-1}\left(\sqrt{\frac{3}{2}}\right)$

D. $\cos^{-1}\left(\sqrt{\frac{3}{2}}\right)$

Answer: A

Solution:

According to Brewster's law,

$$
\begin{aligned}
& \tan \theta_{\mathrm{B}}=\mathrm{n} \\
\therefore \quad & \tan 60^{\circ}=\mathrm{n} \\
\therefore \quad & \mathrm{n}=\sqrt{3} \\
& \text{Now, } \frac{\sin \mathrm{i}}{\sin \mathrm{r}}=\mathrm{n} \\
\therefore \quad & \sin \mathrm{r}=\frac{\sin \mathrm{i}}{\mathrm{n}} \\
\therefore \quad & \sin \mathrm{r}=\frac{\sin 45^{\circ}}{\sqrt{3}} \\
\therefore \quad & \sin \mathrm{r}=\frac{1}{\sqrt{6}} \quad \ldots .\left(\because \sin 45^{\circ}=\frac{1}{\sqrt{2}}\right) \\
\therefore \quad & \mathrm{r}=\sin^{-1}\left(\frac{1}{\sqrt{6}}\right)
\end{aligned}
$$

Question103

A beam of light of wavelength $600 \mathrm{~nm}$ from a distant source falls on a single slit $1 \mathrm{~mm}$ wide and the resulting diffraction pattern is observed on a screen $2 \mathrm{~m}$ away. The distance between the first dark fringe on either side of the central bright fringe is

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Options:

A. 1.2 mm

B. 2.4 mm

C. 1.2 cm

D. 2.4 cm

Answer: B

Solution:

The distance between the central bright fringe and the first dark fringe is given as:

$$y_{n_d} = \frac{n\lambda D}{d}$$
$$y_{1_d} = \frac{1 \times 600 \times 10^{-9} \times 2}{10^{-3}}$$
$$= 1.2 \times 10^{-3} = 1.2 \text{ mm}$$

$\therefore$ The distance between the first dark fringe on either side of the central bright fringe is $2\mathrm{y}_{\mathrm{n}} = 2 \times 1.2 = 2.4 \text{ mm}$

Question104

In Young's double slit experiment, the fifth maximum with wavelength 'λ_1' is at a distance 'y_1' and the same maximum with wavelength 'λ_2' is at a distance 'y_2' measured from the central bright band. Then $\frac{y_1}{y_2}$ is equal to [D and d are constant]

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Options:

A. $\frac{\lambda_1}{\lambda_2}$

B. $\frac{\lambda_2}{\lambda_1}$

C. $\frac{\lambda_1^2}{\lambda_2^2}$

D. $\frac{\lambda_2^2}{\lambda_1^2}$

Answer: A

Solution:

The equations for the position of the fringe from the central maxima are given as

$$y_1 = \frac{5\lambda_1 D}{d}$$
$$y_2 = \frac{5\lambda_2 D}{d}$$
$$\therefore \quad \frac{y_1}{y_2} = \frac{\lambda_1}{\lambda_2}$$

Question105

In Young's double slit experiment, green light is incident on two slits. The interference pattern is observed on a screen. Which one of the following changes would cause the observed fringes to be more closely spaced?

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Options:

A. Reducing the separation between the slits

B. Using blue light instead of green light

C. Using red light instead of green light

D. Moving the screen away from the slits

Answer: B

Solution:

The formula for fringe width is $W = \frac{\lambda D}{d}$

$\therefore \quad W \propto \lambda, W \propto D$ and $W \propto \frac{1}{\lambda}$

If the distance from the screen is increased, the width will increase.

If the distance between the slit is decreased, the width will increase.

As the wavelength will decrease the distance between the fringes will decrease.

$\lambda_{\text{red}} > \lambda_{\text{green}} > \lambda_{\text{blue}}$

$\therefore \quad$ Blue light should be used.

Question106

A double slit experiment is immersed in water of refractive index 1.33. The slit separation is $1 \mathrm{~mm}$, distance between slit and screen is $1.33 \mathrm{~m}$ The slits are illuminated by a light of wavelength $6300 \stackrel{o}{A}$. The fringe width is

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Options:

A. $4.9 \times 10^{-4} \mathrm{~m}$

B. $5.8 \times 10^{-4} \mathrm{~m}$

C. $6.3 \times 10^{-4} \mathrm{~m}$

D. $8.6 \times 10^{-4} \mathrm{~m}$

Answer: C

Solution:

$$\lambda_{\text{liquid}} = \frac{\lambda_{\text{air}}}{\mu}$$

$$\lambda_{\text{liquid}} = \frac{6300 \times 10^{-10}}{1.33}$$

Fringe width,

$$\mathrm{W} = \frac{\lambda_{\text{liquid}} \times \mathrm{D}}{\mathrm{d}} = \frac{6300 \times 10^{-10} \times 1.33}{1.33 \times 0.001} = 6.3 \times 10^{-4} \mathrm{~m}$$

Question107

In the experiment of diffraction due to a single slit, if the slit width is decreased, the width of the central maximum

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Options:

A. becomes zero.

B. does not change.

C. increases.

D. decreases.

Answer: C

Solution:

Width of the central maxima $= W = \frac{\lambda\theta}{d}$

Thus, the slit width is inversely proportional to the width of the central maximum.

Hence, when the slit width is decreased, the width of the central maxima increases.

Question108

In biprism experiment, if 5^{th} bright band with wavelength λ_1' coincides with 6^{th} dark band with wavelength λ_2' then the ratio $\left(\frac{\lambda_2}{\lambda_1}\right)$ is

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Options:

A. $\frac{9}{7}$

B. $\frac{7}{9}$

C. $\frac{10}{11}$

D. $\frac{11}{10}$

Answer: C

Solution:

The fifth bright band will be:

$y_5 = \frac{5\lambda_1 D}{d}$

$\therefore$ The sixth dark band will be:

$$y_6{}' = \frac{11\lambda_2 D}{2\,d}$$

Given: $y_5 = y_6'$

$$\therefore \quad \frac{5\lambda_1 D}{d} = \frac{11\lambda_2 D}{2\,d}$$

$$5\lambda_1 = \frac{11\lambda_2}{2}$$

$$\frac{\lambda_2}{\lambda_1} = \frac{10}{11}$$

Question109

In Young's double slit experiment, the two slits are 'd' distance apart. Interference pattern is observed on a screen at a distance 'D' from the slits. A dark fringe is observed on a screen directly opposite to one of the slits. The wavelength of light is

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Options:

A. $\frac{D^2}{2\,d}$

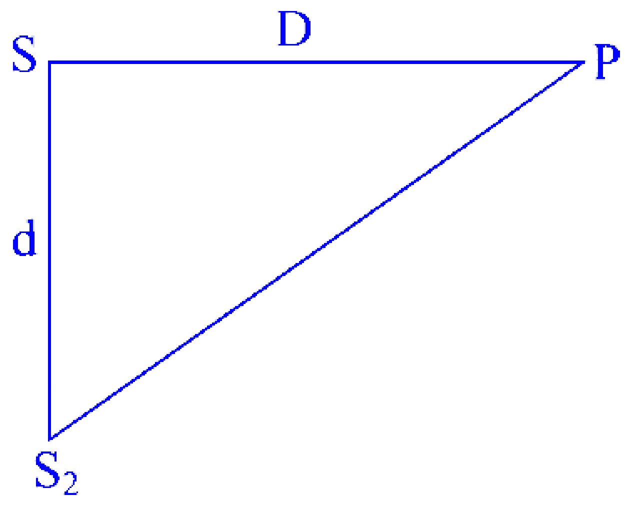
B. $\frac{d^2}{2D}$

C. $\frac{D^2}{d}$

D. $\frac{d^2}{D}$

Answer: D

Solution:



$$S_2P = \left(D^2 + d^2\right)^{1/2}$$
$$= D\left[1 + \frac{d^2}{D^2}\right]^{1/2}$$

Using binomial equation,

$$S_2P = D\left[1 + \frac{1}{2}\frac{d^2}{D^2}\right]^{1/2} = D + \frac{d^2}{2D}$$

$\Rightarrow$ Path difference $= \frac{d^2}{2D}$

For dark fringe, $\frac{d^2}{2D} = \frac{\lambda}{2}$

$\therefore \quad \lambda = \frac{d^2}{D}$

Question110

A parallel beam of monochromatic light falls normally on a single narrow slit. The angular width of the central maximum in the resulting diffraction pattern

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Options:

A. increases with increase of slit width.

B. decreases with increase of slit width.

C. decreases with decrease of slit width.

D. may increase or decrease with decrease of slit width.

Answer: B

Solution:

Width of central maximum $\mathrm{W_c} = 2\left[\frac{\lambda \mathrm{D}}{\mathrm{a}}\right]$

$\Rightarrow \mathrm{W_c} \propto \frac{1}{\mathrm{a}}$

$\therefore$ Angular width of principal maximum decreases with increase in width of the slit.

Question111

Light waves from two coherent sources arrive at two points on a screen with path difference of zero and $\frac{\lambda'}{2}$. The ratio of intensities at the points is $(\cos 0^\circ = 1, \cos \pi = -1)$

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Options:

A. 2 : 1

B. 1 : 1

C. 1 : 2

D. ∞ : 1

Answer: D

Solution:

Given: Wave length $= \frac{\lambda}{2}$

Path difference of first wave $\Delta x_1 = 0$

Path difference of second wave $\Delta x_2 = \frac{\lambda}{2}$

$\therefore \quad \Delta\phi_1 = \frac{2\pi}{\lambda} \cdot \Delta x_1 = 0$

Similarly,

$\Delta\phi_2 = \frac{2\pi}{\lambda} \cdot \Delta x_2 = \pi$

$\therefore$ Intensity of first wave $I_1 = 4I_0 \cos^2(0) = 4I_0$

Similarly,

Intensity of second wave $I_2 = 4I_0 \cos^2\left(\frac{\pi}{2}\right) = 0$

$\therefore \quad \frac{I_1}{I_2} = \frac{4I_0}{0} = \infty$

$\Rightarrow \infty : 1$

Question112

A person is observing a bacteria through a compound microscope. For better observation and to improve its resolving power he should

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Options:

A. increase the wavelength of light.

B. increase the refractive index of the medium between the object and objective lens.

C. decrease the focal length of the eyepiece.

D. decrease the diameter of the objective lens.

Answer: B

Solution:

Resolving Power $R = \frac{N.A}{0.61\lambda}$

$N.A = 2n \sin\alpha$

$\therefore$ By increasing the refractive index of the medium between the subject and the objective lens, the resolving power can be increased.

Question113

In Young's double slit experiment the separation between the slits is doubled without changing other setting of the experiment to obtain same fringe width, the distance 'D' of the screen from slit should be made

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Options:

A. $\frac{D}{2}$

B. $\frac{D}{\sqrt{2}}$

C. 2D

D. 4D

Answer: C

Solution:

Fringe width,

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

Given: $d = 2\,d$

$\Rightarrow W' = \frac{\lambda D'}{2\,d}$

Since given,

$W = W'$

$$\therefore \quad \frac{\lambda D}{d} = \frac{\lambda D'}{2\,d}$$
$$\therefore \quad D' = 2D$$

Question114

Two sources of light $0.6 \mathrm{~mm}$ apart and screen is placed at a distance of $1.2 \mathrm{~m}$ from them. A light of wavelength $6000 \stackrel{o}{A}$ used. Then the phase difference between the two light waves interfering on the screen at a point at a distance $3 \mathrm{~mm}$ from central bright band is

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Options:

A. 6π radian

B. 3π radian

C. 4π radian

D. 5π radian

Answer: D

Solution:

Fringe width, $\mathrm{W}=\frac{\lambda \mathrm{D}}{\mathrm{d}}=\frac{6000 \times 10^{-10} \times 1.2}{0.6 \times 10^{-3}}=1.2 \mathrm{~mm}$

$\therefore$ Number of fringes $(\mathrm{n})=\frac{3}{1.2}=2.5$

$\therefore$ Phase difference,

$\Delta \phi=2 \mathrm{n} \pi=2 \times 2.5 \pi=5 \pi$

Question115

Light of wavelength ',λ' is incident on a slit of width 'd'. The resulting diffraction pattern is observed on a screen at a distance 'D'. The linear width of the principal maximum is then equal to the width of the slit if D equals

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Options:

A. $\frac{d}{\lambda}$

B. $\frac{\mathrm{d}^2}{2\lambda}$

C. $\frac{2\lambda}{\mathrm{d}}$

D. $\frac{2\lambda^2}{d}$

Answer: B

Solution:

In diffraction of light by single slit, the width of central maximum is given as

$\mathrm{W_c} = \frac{2\lambda \mathrm{D}}{\mathrm{d}}$

Given: $\mathrm{W_c} = \mathrm{d}$

$$\therefore \quad d = \frac{2\lambda D}{d}$$
$$\Rightarrow D = \frac{d^2}{2\lambda}$$

Question116

In Young's double slit experiment, the wavelength of light used is 'λ'. The intensity at a point is 'I' where path difference is $\left(\frac{\lambda}{4}\right)$. If I_0 denotes the maximum intensity, then the ratio $\left(\frac{\mathrm{I}}{\mathrm{I_0}}\right)$ is

$$\left(\sin\frac{\pi}{4} = \cos\frac{\pi}{4} = \frac{1}{\sqrt{2}}\right)$$

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Options:

A. $\frac{1}{\sqrt{2}}$

B. $\frac{1}{2}$

C. $\frac{3}{4}$

D. $\frac{\sqrt{3}}{2}$

Answer: B

Solution:

Phase difference, $\Delta\phi = \left(\frac{2\pi}{\lambda}\right)\Delta l$

For path difference $\frac{\lambda}{4}$,

Phase difference $\Delta\phi = \frac{\pi}{2}$

Using, $\mathrm{I} = \mathrm{I}_0 \cos^2 \frac{\phi}{2}$

$\therefore \quad \frac{\mathrm{I}}{\mathrm{I}_0} = \cos^2 \frac{\phi}{2} = \cos^2\left(\frac{\pi}{4}\right)$

$\therefore \quad \frac{\mathrm{I}}{\mathrm{I}_0} = \frac{1}{2}$

Question117

In Young's double slit experiment, the fringe width is 2 mm. The separation between the 13^{th} bright fringe and the 4^{th} dark fringe from the centre of the screen on same side will be

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Options:

A. 13 mm.

B. 17 mm.

C. 19 mm.

D. 23 mm.

Answer: C

Solution:

Given: Fringe width W = 2 mm

The distance of the n^{th} bright fringe from centre of the screen $y_n = \frac{n\lambda D}{d}$ ...... (i)

The distance of the n^{th} dark fringe from centre of the screen $y'_n = (2n-1)\frac{\lambda D}{2d}$ ..... (ii)

Substituting, n = 13 in (i) and n = 4 in (ii) we get $y_{13} = \frac{13\lambda D}{d}$ and $y'_4 = \frac{7}{2}\frac{\lambda D}{d}$

∴ The separation between the 13^{th} bright fringe and the 7^{th} dark fringe is

$$
\begin{aligned}
& y_{13} - y'_4 \\
& = \frac{13\lambda D}{d} - \frac{7}{2}\frac{\lambda D}{d} \\
& = \left(13 - \frac{7}{2}\right)\frac{\lambda D}{d} \\
& = \frac{19}{2}\frac{\lambda D}{d} = \frac{19}{2} W
\end{aligned}
$$

but W = 2 mm

$$\therefore \quad y_{13} - y'_4 = \frac{19}{2} \times 2 = 19 \text{ mm}$$

Question118

A beam of unpolarized light passes through a tourmaline crystal A and then it passes through a second tourmaline crystal B oriented so that its principal plane is parallel to that of A. The intensity of emergent light is I_0. Now B is rotated by 45° about the ray. The emergent light will have intensity $\left(\cos 45^\circ = \frac{1}{\sqrt{2}}\right)$

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Options:

A. $\frac{I_0}{2}$

B. $\frac{I_0}{\sqrt{2}}$

C. $\frac{\sqrt{2}}{I_0}$

D. $\frac{2}{I_0}$

Answer: A

Solution:

Using law of Malus,

$$\begin{aligned} I &= I_0 \cos^2 \theta \\ &= I_0 \left(\cos^2 45\right) \\ &= I_0 \left(\frac{1}{\sqrt{2}}\right)^2 \\ &= \frac{I_0}{2} \end{aligned}$$

Question119

In a diffraction pattern due to single slit of width 'a', the first minimum is observed at an angle of 30° when the light of wavelength $5400 \overset{o}{A}$ is incident on the slit. The first secondary maximum is observed at an angle of $\left(\sin 30^{\circ} = \frac{1}{2}\right)$

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Options:

A. $\sin^{-1}\left(\frac{3}{4}\right)$

B. $\sin^{-1}\left(\frac{2}{3}\right)$

C. $\sin^{-1}\left(\frac{1}{2}\right)$

D. $\sin^{-1}\left(\frac{1}{4}\right)$

Answer: A

Solution:

For n^{th} secondary minimum,

path difference $= a \sin \theta_n = n\lambda$

For n^{th} secondary maximum,

path difference $= a \sin \theta_n = (2n+1)\frac{\lambda}{2}$

$\therefore$ For 1^{st} minimum, $a \sin 30^\circ = \lambda$ ..... (i)

For 2^{nd} maximum, $a \sin \theta_n = (2+1)\frac{\lambda}{2} = \frac{3\lambda}{2}$ ..... (ii)

$\therefore$ Dividing equation (i) by equation (ii),

$\frac{\left(\frac{1}{2}\right)}{\sin \theta_n} = \frac{2}{3} \Rightarrow \theta_n = \sin^{-1}\left(\frac{3}{4}\right)$

Question120

In a single slit experiment, the width of the slit is doubled. Which one of the following statements is correct?

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Options:

A. The intensity and width of the central maximum are unaffected.

B. The intensity remains same and angular width becomes half.

C. The intensity and angular width both are doubled.

D. The intensity increases by a factor 4 and the angular width decreases by a factor of $\frac{1}{2}$.

Answer: D

Solution:

For single slit diffraction,

Fringe width $W = \frac{\lambda D}{d}$

Also, $I \propto D^2$

$I \propto D^2$ This means I will be 4 times the original value of I. As only 1 option mentions this, the correct answer is D.

Question121

The rays of different colours fail to converge at a point after passing through a thick converging lens. This defect is called

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Options:

A. spherical aberration

B. distortion

C. coma

D. chromatic aberration

Answer: D

Solution:

✅ Correct Answer: **D. Chromatic aberration**

✔ **Explanation**

When light of different colours (different wavelengths) passes through a lens:

- **Each colour refracts by a different amount**
- **They do not converge at the same point**

This is because the **refractive index of the lens material depends on wavelength** (shorter wavelengths like blue bend more, longer wavelengths like red bend less).

This defect is called:

⭐ **Chromatic Aberration**

It causes coloured fringes around images.

Question122

A parallel beam of monochromatic light falls normally on a single narrow slit. The angular width of the central maximum in the resulting diffraction pattern

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Options:

A. decreases with increase of slitwidth

B. may increase or decrease

C. decreases with decrease of slitwidth

D. increases with increase in slitwidth

Answer: A

Solution:

The angular width of the central maximum is

$2\theta = \frac{2\lambda}{a}$ where a is the slit width.

$\therefore$ If a is increased, the angular width is decreased.

Question123

In a Fraunhofer diffraction at a single slit of width 'd' and incident light of wavelength $5500\overset{o}{A}$, the first minimum is observed at an angle 30°. The first secondary maxima is observed at an angle θ, equal to

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Options:

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

B. $\sin^{-1}\left(\frac{3}{4}\right)$

C. $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$

D. $\sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$

Answer: B

Solution:

The first minimum in a Fraunhofer diffraction pattern occurs when the path difference between the light from the two edges of the slit is equal to the wavelength of the light, λ. The condition for the first minimum can be written as:

$d \sin\theta = m\lambda$

For the first minimum, $m = 1$ and we know that the angle is 30°. Using the given wavelength $\lambda = 5500\overset{o}{A} = 550 \times 10^{-9}$ meters (since $1\overset{o}{A} = 10^{-10}$ meters), we can write:

$d \sin 30^\circ = 1 \times 550 \times 10^{-9}$ m

$d \times \frac{1}{2} = 550 \times 10^{-9}$ m

$d = 2 \times 550 \times 10^{-9}$ m

$d = 1100 \times 10^{-9}$ m

$d = 1100\overset{o}{A}$

The secondary maxima occur in between the primary minima. The first secondary maxima (also known as the first 'bright' fringe other than the central maximum) occurs when the path difference is $3/2$ times the wavelength (this is the condition for the maximum that lies between the first and second minima, $m = 1$ and $m = 2$, respectively). This results in the following condition:

$d \sin\theta = \left(m + \frac{1}{2}\right)\lambda$

For the first secondary maxima $m = 1$:

$d \sin\theta = \left(1 + \frac{1}{2}\right)550 \times 10^{-9}$ m

$d \sin\theta = \frac{3}{2} \times 550 \times 10^{-9}$ m

$1100 \sin\theta = 3 \times 550 \times 10^{-9}$ m

$\sin\theta = \frac{3}{2} \times \frac{550 \times 10^{-9}}{1100 \times 10^{-9}}$

$\sin\theta = \frac{3}{2} \times \frac{1}{2}$

$\sin\theta = \frac{3}{4}$

Therefore, the correct answer is:

Option B

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

Question124

Two monochromatic beams of intensities I and 4 I respectively are superposed to form a steady interference pattern. The maximum and minimum intensities in the pattern are

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Options:

A. 4I and I

B. 9 I and 3I

C. 5 I and 3 I

D. 9 I and I

Answer: D

Solution:

$\frac{I_1}{I_2} = \frac{I}{4I} = \frac{1}{4} = \frac{a_1^2}{a_2^2}$

where a_1 and a_2 are the amplitudes

$$\therefore \frac{a_1}{a_2} = \frac{1}{2} \quad \therefore \frac{a_{max}}{a_{min}} = \frac{a_1 + a_2}{a_1 - a_2} = \frac{1.2}{1-2} = \frac{3}{-1}$$
$$\therefore \frac{I_{max}}{I_{min}} = \frac{a_{max}^2}{a_{min}^2} = \frac{9}{1}$$

Question125

The path difference between two interfering light waves meeting at a point on the screen is $\left(\frac{57}{2}\right)\lambda$. The bond obtained at that point is

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Options:

A. 29^{th} bright band

B. 57^{th} dark band

C. 57^{th} bright band

D. 29^{th} dark band

Answer: D

Solution:

The interference pattern formed by light waves is characterized by alternating bright and dark bands (fringes). The path difference between two interfering waves determines whether we get a bright or dark band at a specific point. The criterion for these bands based on the path difference can be stated as follows:

For the bright band (constructive interference):

$\Delta x = m\lambda$

where Δx is the path difference, m is any integer (0, 1, 2, 3, ...), and λ is the wavelength of light.

For the dark band (destructive interference):

$\Delta x = (m + \frac{1}{2})\lambda$

where m is any integer (0, 1, 2, 3, ...).

Given that the path difference is:

$\Delta x = \frac{57}{2}\lambda$

We observe that:

$\frac{57}{2} = 28.5$

This suggests that the path difference is equal to $(28.5)\lambda$. Hence, this can be expressed in terms of the dark band condition:

$\Delta x = (28 + \frac{1}{2})\lambda$

This matches the formula for the dark band, with $m = 28$. Therefore, the point corresponds to the 29^{th} dark band (since we start counting from m = 0).

Hence, the correct answer is:

Option D: 29th dark band

Question126

In Young's double slit experiment, in an interference pattern, a minimum is observed exactly in front of one slit. The distance between the two coherent sources is 'd' and 'D' is the distance between the source and screen. The possible wavelengths used are inversely proportional to

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Options:

A. D, 5D, 9D, ...

B. $\mathrm{D}, 3 \mathrm{D}, 5 \mathrm{D}, \ldots$

C. $3 \mathrm{D}, 4 \mathrm{D}, 5 \mathrm{D}, \ldots$

D. $3 \mathrm{D}, 7 \mathrm{D}, 10 \mathrm{D}, \ldots$

Answer: B

Solution:

If x is the fringe width, then there will be a minimum in front of the slit if

$\frac{\mathrm{d}}{2}=\frac{x}{2}, \frac{3 \mathrm{x}}{2}, \frac{5 \mathrm{x}}{2}, \ldots \ldots$

or $d=x, 3 x, 5 x, \ldots \ldots$

$\therefore x=d, \frac{d}{3}, \frac{d}{5}, \ldots \ldots$

$\lambda=\frac{\mathrm{xd}}{\mathrm{D}}$

$\therefore \lambda=\frac{\mathrm{d}^2}{\mathrm{D}}, \frac{\mathrm{d}^2}{3 \mathrm{D}}, \frac{\mathrm{d}^2}{5 \mathrm{D}}$

$\therefore \lambda$ is inversely proportional to $\mathrm{D}, 3 \mathrm{D}, 5 \mathrm{D}, \ldots$..

Question127

A beam of light having wavelength $5400 \mathrm{~A}$ from a distant source falls on a single slit $0.96 \mathrm{~mm}$ wide and the resultant diffraction pattern is observed on a screen $2 \mathrm{~m}$ away. What is the distance between the first dark fringe on either side of central bright fringe?

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Options:

A. 4.8 mm

B. 1.2 mm

C. 2.4 mm

D. 3.6 mm

Answer: C

Solution:

Distance between the two dark fringes on either side of the central bright fringe is given by

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

Putting $\lambda=5.4 \times 10^{-7} \mathrm{~m}, \mathrm{D}=2 \mathrm{~m}$ and $\mathrm{a}=0.9 \times 10^{-3} \mathrm{~m}$ we get $2 x=2.4 \mathrm{~mm}$

Question128

Two beams of light having intensities I and 4I interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\pi / 2$ at point A and π at point B. Then the difference between the resultant intensities at A and B is

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Options:

A. 4I

B. 5I

C. 2I

D. 3I

Answer: A

Solution:

$$\mathrm{IA} = \mathrm{I} + 4\mathrm{I} + 2\sqrt{I} \cdot \sqrt{4I} \cdot \cos\frac{\pi}{2}$$
$$= 5I$$
$$\mathrm{I}_8 = I + 4I + 2\sqrt{I} \cdot \sqrt{4I} \cdot \cos\pi$$
$$= I$$
$$\therefore I_A - I_B = 5I - I = 4I$$

Question129

In Young's double slit experiment, the intensity at a point where path difference is $\frac{\lambda}{6}$ (λ being the wavelength of light used) is I'. If 'I_0' denotes the maximum intensity, then $\frac{I}{I_0}$ is equal to
$\left(\cos 0^\circ = 1, \cos 60^\circ = \frac{1}{\lambda}\right)$

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Options:

A. $\frac{\sqrt{3}}{2}$

B. $\frac{4}{3}$

C. $\frac{1}{\sqrt{2}}$

D. $\frac{1}{2}$

Answer: B

Solution:

If I_0 is the intensity of each wave, then the resultant intensity at a point is given by

$I = 4I_0 \cos^2 \frac{\phi}{2}$

At point P, path difference is zero, hence phase difference $\phi = 0$

$\therefore I_p = 4I_0 \cos^2 0 = 4I_0$

At point Q, path difference is $\frac{\lambda}{6}$, hence phase differences is $\frac{2\pi}{6}$ or $\frac{\pi}{3}$.

$$\therefore I_Q = 4I_0 \cos^2 \frac{\pi}{6} \quad = 4I_0 \frac{3}{4}$$
$$\therefore \frac{I_p}{I_Q} = \frac{4}{3}$$

Question130

In Young's double slit experiment, the distance of n^{th} dark band from the central bright band in terms of bandwidth 'β' is

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Options:

A. $n\beta$

B. $(n-1)\beta$

C. $(n-0.5)\beta$

D. $(n+0.5)\beta$

Answer: C

Solution:

In Young's double slit experiment, the position of dark and bright fringes on the screen is a result of constructive and destructive interference of light waves coming from the two slits.

The distance between two consecutive bright or dark fringes is called the fringe width, denoted by β. The fringe width is given by:

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

where:

- λ is the wavelength of light used.
- D is the distance between the slits and the screen.
- d is the separation between the two slits.

The position of the nth dark band from the central bright band is given by the condition for destructive interference, which occurs at:

$$y_n = \left(n - \frac{1}{2}\right)\beta$$

where n is the order of the dark fringe.

Therefore, the distance of the n^{th} dark band from the central bright band is:

Option C: $(\mathrm{n} - 0.5)\beta$

Question131

In biprism experiment, 6^{th} bright band with wavelength 'λ_1' coincides with 7^{th} dark band with wavelength 'λ_2' then the ratio $\lambda_1 : \lambda_2$ is (other setting remains the same)

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Options:

A. $7 : 6$

B. $13 : 12$

C. $12 : 13$

D. $6 : 7$

Answer: B

Solution:

Distance of 6^{th} bright band $= \frac{6\lambda_1 \mathrm{D}}{\mathrm{d}}$

Distance of 7^{th} dark band $= \frac{6.5\lambda_2 D}{d}$

$\therefore \frac{3\lambda_1 D}{d} = \frac{6.5\lambda_2 D}{d}, \quad \therefore \frac{\lambda_1}{\lambda_2} = \frac{6.5}{6} = \frac{13}{12}$

Question132

In Young's experiment with a monochromatic source and two slits, one of the slits is covered with black opaque paper, the fringes will

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Options:

A. be darker

B. be narrower

C. be broader

D. not be observed

Answer: D

Solution:

Young's double-slit experiment relies on the interference of light waves from two slits to produce fringes—a pattern of dark and bright bands. The basic principle behind this phenomenon is the constructive and destructive interference of coherent light waves emanating from the two slits. When these waves superimpose, they create alternating bright (constructive interference) and dark (destructive interference) fringes on a screen placed behind the slits.

If one of the slits is covered with black opaque paper, there won't be any interference because only one light source will be contributing to the pattern. The process of interference requires two coherent sources of light. Without the second slit, there is no second wave to interfere with the first wave, and therefore, the interference pattern of fringes cannot be formed.

Hence, the fringes will:

Option D: not be observed

Question133

In the interference experiment using a biprism, the distance of the slits from the screen is increased by 25% and the separation between the slits is halved. If 'W' represents the original fringewidth, the new fringewidth is

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Options:

A. 2 W

B. 2.5 W

C. 4 W

D. 1.5 W

Answer: B

Solution:

To determine how the fringe width changes when the distance between the slits and the screen is increased by 25% and the separation between the slits is halved, we need to understand the formula for fringe width in a double-slit interference pattern:

The fringe width W is given by:

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

where:

- λ is the wavelength of the light
- D is the distance between the slits and the screen
- d is the separation between the slits

Originally, the fringe width is:

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

Now let's consider the new conditions:

1. The distance between the slits and the screen is increased by 25%, so the new distance D' is:

   $D' = D + 0.25D = 1.25D$

2. The separation between the slits is halved, so the new separation d' is:

   $d' = \frac{d}{2}$

The new fringe width W' is then:

$W' = \frac{\lambda D'}{d'}$

Substituting the new values:

$W' = \frac{\lambda \cdot 1.25 D}{\frac{d}{2}}$

This simplifies to:

$W' = \frac{1.25 \cdot 2 \cdot \lambda D}{d}$

$W' = 2.5 \cdot \frac{\lambda D}{d}$

Since $\frac{\lambda D}{d} = W$, we have:

$W' = 2.5W$

Therefore, the new fringe width is $2.5W$, corresponding to Option B:

Option B: 2.5 W

Question134

In biprims experiment, the 4^{th} dark band is formed opposite to one of the slits. The wavelength of light used is $(\mathrm{d} =$ distance between the slits, $\mathrm{D} =$ distance between scource and the screen)

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Options:

A. $\frac{\mathrm{d}^2}{14\mathrm{D}}$

B. $\frac{\mathrm{d}^2}{7\mathrm{D}}$

C. $\frac{d^2}{9\mathrm{D}}$

D. $\frac{d^2}{11\mathrm{D}}$

Answer: B

Solution:

In the biprism experiment, the formula for the position of dark bands in an interference pattern is given by the equation:

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

where:

y_{dark} : Position of the nth dark band

λ: Wavelength of light

D: Distance between the source and the screen

d: Distance between the slits

n: Order of the dark band

According to the problem, the 4th dark band is formed opposite to one of the slits. For constructive interference to form right at a slit, the position can be approximated as:

$y = \frac{d}{2}$

Since we are considering the 4th dark band, $n = 4$. Substituting into the formula:

$y_{\text{dark}}(4) = (2 \times 4 - 1)\frac{\lambda D}{2d}$

Therefore:

$\frac{d}{2} = (7)\frac{\lambda D}{2d}$

Now, solve for λ:

$\lambda = \frac{d^2}{7D}$

Thus, the wavelength of the light used in the experiment is:

Option B: $\frac{d^2}{7D}$

Question135

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

$$\left[\cos 60^\circ = \sin 30^\circ = \frac{1}{2}\right]$$

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Options:

A. $\frac{K}{4}$

B. $\frac{3K}{4}$

C. K

D. $\frac{\mathrm{K}}{2}$

Answer: A

Solution:

The intensity is given by

$\mathrm{I}=4 \mathrm{I}_0 \cos ^2 \frac{\phi}{2}$

Maximum intensity $\mathrm{K}=4 \mathrm{I}_0$ when $\phi=0$ when path difference is $\frac{\lambda}{3}, \phi=\frac{2 \pi}{3}$

$\therefore \quad \mathrm{I}=\mathrm{k} \cos ^2 \frac{2 \pi}{3}=\mathrm{k}\left(-\frac{1}{2}\right)^2=\frac{\mathrm{k}}{4}$

Question136

If two sources emit light waves of different amplitudes then

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Options:

A. brightness of fringes is less.

B. fringes disappear after short time.

C. fringe width is less.

D. there is some intensity of light in the region of destructive interference.

Answer: D

Solution:

When considering the interference pattern produced by two sources of light waves, the effect of having different amplitudes from each source is significant on the pattern's overall intensity but not directly on the fringe width. Interference patterns are typically characterized by regions of constructive interference (where the waves add up to produce a brighter region, or fringe) and destructive interference (where the waves cancel each other out, leading to darker regions or fringes).

Option A, "brightness of fringes is less," might seem like a potential effect of having different amplitudes. Indeed, if one wave has a significantly lower amplitude than the other, it might lead to a general reduction in the maximum brightness of the fringes, but this statement is somewhat vague and doesn't specifically describe the effect of amplitude difference on the interference pattern.

Option B, "fringes disappear after short time," is not accurate. The presence of fringes in an interference pattern is a result of the coherent phase relationship between the waves and does not directly depend on their amplitudes. The fringes will not "disappear" over time solely because of differences in amplitude.

Option C, "fringe width is less," is incorrect regarding what we're discussing. The fringe width in an interference pattern is determined by the wavelength of the light and the geometry of the setup (for example, the distance between the slits in a double-slit experiment and the distance from the slits to the observation screen). It does not depend on the amplitude of the waves.

Option D, "there is some intensity of light in the region of destructive interference," directly addresses the impact of having light waves of different amplitudes. In ideal conditions where two waves have exactly the same amplitude, the regions of perfect destructive interference would result in completely dark fringes, as the waves cancel each other out perfectly. However, if the waves have different amplitudes, even in regions of destructive interference, the cancellation will not be complete, leading to a nonzero intensity in what would ideally be a dark fringe. This is because the wave with the larger amplitude is not fully canceled out by the wave with the smaller amplitude.

Therefore, the most accurate statement related to the effect of having light waves of different amplitudes on an interference pattern is **Option D**: there is some intensity of light in the region of destructive interference.

Question137

In Young's double slit experiment, the 10^{th} maximum of wavelength 'λ_1' is at a distance of 'Y_1' from the central maximum. When the wavelength of the source is changed to 'λ_2', 5^{th} maximum is at a distance 'Y_2' from the central maximum. The ratio $\frac{Y_1}{Y_2}$ is

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Options:

A. $\frac{2\lambda_1}{\lambda_2}$

B. $\frac{\lambda_2}{2\lambda_1}$

C. $\frac{2\lambda_2}{\lambda_1}$

D. $\frac{\lambda_1}{2\lambda_2}$

Answer: A

Solution:

In Young's double slit experiment, the position of the n^{th} maximum for a given wavelength can be calculated using the formula:

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

where:

- Y is the distance from the central maximum,
- n is the order of the maximum,
- λ is the wavelength of the light,
- D is the distance between the slits and the screen,
- d is the distance between the two slits.

According to the given problem:

1. The 10^{th} maximum for wavelength λ_1 is at a distance Y_1 from the central maximum:

   $Y_1 = \frac{10\lambda_1 D}{d}$

2. The 5^{th} maximum for wavelength λ_2 is at a distance Y_2 from the central maximum:

   $Y_2 = \frac{5\lambda_2 D}{d}$

We need to find the ratio $\frac{Y_1}{Y_2}$:

$\frac{Y_1}{Y_2} = \frac{\frac{10\lambda_1 D}{d}}{\frac{5\lambda_2 D}{d}} = \frac{10\lambda_1}{5\lambda_2} = \frac{2\lambda_1}{\lambda_2}$

Therefore, the correct answer is:

Option A

$\frac{2\lambda_1}{\lambda_2}$

Question138

A single slit diffraction pattern is formed with white light. For what wavelength of light the 3^{rd} secondary maximum in diffraction

pattern coincides with the 2^{nd} secondary maximum in the pattern of red light of wavelength 6000 $\overset{o}{A}$?

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Options:

A. 4500 $\overset{o}{A}$

B. 3500 $\overset{o}{A}$

C. 4000 $\overset{o}{A}$

D. 5000 $\overset{o}{A}$

Answer: A

Solution:

Distance of nth maximum $y_n = \left(n + \frac{1}{2}\right)\frac{\lambda D}{a}$

$$\therefore \quad y_2 = \left(2 + \frac{1}{2}\right)\frac{\lambda_1 D}{a} \text{ and } y_3 = \left(3 + \frac{1}{2}\right)\frac{\lambda_2 D}{a}$$

$$\therefore \quad 2.5\lambda_1 = 3.5\lambda_2$$

$$\therefore \quad 2.5 \times 6000 = 3.5\lambda_2$$

$$\therefore \quad \lambda_2 = \frac{2.5 \times 6000}{3.5} \approx 4300\overset{o}{A}$$

Question139

The width of central maximum of a diffraction pattern on a single slit does not depend upon

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Options:

A. frequency of light used

B. width of the slit

C. distance between slit and source

D. wavelength of light used

Answer: A

Solution:

✅ Correct Answer: A. frequency of light used

✔ **Explanation**

For a single–slit diffraction pattern, the **angular width of the central maximum** is:

$$\text{Width} = \frac{2\lambda}{a}$$

Where:

- λ = wavelength of light
- a = slit width

So the width of the central maximum **depends on:**

- ✔ wavelength of light (λ)
- ✔ slit width (a)
- ✔ distance to the screen (if linear width is asked)

But it **does NOT depend on:**

❌ **frequency of light**

Because:

$$\lambda = \frac{c}{f}$$

Width depends directly on **wavelength**, not frequency.

Even though λ and f are related, the question asks which parameter the width is **independent of.**

Thus:

👉 **Central maximum width ∝ wavelength**

👉 **NOT directly dependent on frequency**

Question140

Two coherent sources of wavelength 'λ' produce steady interference pattern. The path difference corresponding to 10^{th} order maximum will be

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Options:

A. 9.5 λ

B. 10.5 λ

C. 9 λ

D. 10 λ

Answer: D

Solution:

Path difference for nth maximum in nλ.

Question141

In Young's experiment, fringes are obtained on a screen placed at a distance $75 \mathrm{~cm}$ from the slits. When the separation between two narrow slits is doubled, then the fringe width is decreased. In order to obtain the initial fringe width, the screen should be moved through.

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Options:

A. 150 cm away from the slits.

B. 75 cm towards the slits.

C. 75 cm away from slits.

D. 150 cm towards the slits.

Answer: C

Solution:

Fringe width $X = \frac{\lambda D_1}{d_1} = \frac{\lambda D_2}{d_2}$

$$\therefore \quad \frac{d_2}{d_1} = \frac{D_2}{D_1} \quad \therefore 2 = \frac{D_2}{D_1}$$
$$\therefore \quad D_2 = 2D_1 = 2 \times 75 = 150 \text{ cm}$$

Question142

Two coherent sources 'P' and 'Q' produce interference at point 'A' on the screen, where there is a dark band which is formed between 4^{th} and 5^{th} bright band. Wavelength of light used is 6000 $\overset{o}{A}$. The path difference PA and QA is

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Options:

A. 3.6×10^{-4} cm

B. 3.2×10^{-4} cm

C. 2.4×10^{-4} cm

D. 2.7×10^{-4} cm

Answer: D

Solution:

The dark band between the 4^{th} and 5^{th} bright band in the 5^{th} dark band. For 5^{th} dark band, the path difference is

$\left(5 - \frac{1}{2}\right)\lambda = 4.5\lambda = 4.5 \times 6000 = 2.7 \times 10^{-4}$ cm

---

Question143

In diffraction experiment, from a single slit, the angular width of central maximum does NOT depend upon

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Options:

A. ratio of wavelength and slit width

B. distance of the slit from the screen

C. wavelength of light used

D. width of the slit

Answer: B

Solution:

Angular width of central maximum $\theta = \frac{2\lambda}{a}$

Where a is slit width

Question144

In biprism experiment, 21 fringes are observed in a given region using light of wavelength 4800 $\overset{o}{A}$. If light of wavelength 5600 $\overset{o}{A}$ is used, the number of fringes in the same region will be

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Options:

A. 18

B. 24

C. 14

D. 21

Answer: A

Solution:

$$21 \times \frac{\lambda_1 D}{d} = N \times \frac{\lambda_2 D}{d}$$
$$\therefore N = 21 \frac{\lambda_1}{\lambda_2} = \frac{21 \times 4800}{5600} = 18$$

Question145

A double slit experiment is immersed in water of refractive index 1.33. The slit separationis 1 mm and the distance between slit and screen is $1.33 \mathrm{~m}$. The slits are illuminated by a light of wavelength $6300 \stackrel{o}{A}$. The fringewidth is

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Options:

A. $4.9 \times 10^{-4} \mathrm{~m}$

B. $6.3 \times 10^{-4} \mathrm{~m}$

C. $8.6 \times 10^{-4} \mathrm{~m}$

D. $5.8 \times 10^{-4} \mathrm{~m}$

Answer: B

Solution:

$\mathrm{d} = 1\ \mathrm{mm} = 10^{-3}\ \mathrm{m}, \mathrm{D} = 1.33\ \mathrm{m}$

$\lambda = 6300\overset{o}{A} = 6.3 \times 10^{-7}\ \mathrm{m}$

$\lambda_w = \text{ wavelength in water } = \frac{6.3 \times 10^{-7}}{1.33}\ \mathrm{m}$

$\text{Fringe width X} = \frac{\lambda_w \mathrm{D}}{\mathrm{d}} = \frac{6.3 \times 10^{-7} \times 1.33}{1.33 \times 10^{-3}} = 6.3 \times 10^{-4}\ \mathrm{m}$

Question146

In a single slit diffraction pattern, the distance between the first minimum on the left and the first minimum on the right is 5 mm. The screen on which the diffraction pattern is obtained is at a distance of 80 cm from the slit. The wavelength used is 6000 $\overset{o}{A}$. The width of the silt is

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Options:

A. 0.096 mm

B. 0.576 mm

C. 0.192 mm

D. 0.384 mm

Answer: C

Solution:

$\text{Distance between the first minima } = \frac{2\lambda \mathrm{D}}{\mathrm{a}} = 5\ \mathrm{mm} = 5 \times 10^{-3}\ \mathrm{m}$

$\lambda = 6000\overset{o}{A} = 6 \times 10^{-7}\ \mathrm{m}, \mathrm{D} = 80\ \mathrm{cm} = 0.8\ \mathrm{m}$

$\therefore \frac{2 \times 6 \times 10^{-7} \times 0.8}{\mathrm{a}} = 5 \times 10^{-3}$

$\therefore \mathrm{a} = \frac{2 \times 6 \times 10^{-7} \times 0.8}{5 \times 10^{-3}} = 0.192 \times 10^{-3}\ \mathrm{m}$

$= 0.192\ \mathrm{mm}$

Question147

In Young's double slit experiment, with a source of light having wavelength $6300\overset{o}{A}$, the first maxima will occur when the

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Options:

A. path difference is $9200\overset{o}{A}$

B. phase difference is π radian

C. phase difference is $\frac{\pi}{2}$ radian.

D. path difference is $6300\overset{o}{A}$

Answer: D

Solution:

For maxima, path difference = $n\lambda$

For first maximum, n = 1

$\therefore$ Path difference, $\lambda = 6300\ \overset{o}{A}$

Question148

In Young's double slit experiment, the intensity at a point where the path difference is $\frac{\lambda}{4}$ [λ is wavelength of light used] is 'I'. If 'I_0' is the maximum intensity then $\frac{I}{I_0}$ is equal to $\left[\cos\frac{\pi}{4} = \sin\frac{\pi}{4} = \frac{1}{\sqrt{2}}\right]$

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Options:

A. 3 : 2

B. 2 : 3

C. 3 : 4

D. 1 : 2

Answer: D

Solution:

If I' is the intensity of each wave, then resultant intensity is given by

$I = 4I' \cos^2 \frac{\phi}{2}$

I will have maximum value when $\cos^2 \frac{\phi}{2} = 1$

$\therefore$ maximum intensity, $\mathrm{I}_0 = 4\mathrm{I}'$

When path difference is $\frac{\lambda}{4}$, the phase difference, $\phi = \frac{\pi}{2}$

The resultant intensity, $I = 4I' \cos^2 \frac{\pi}{4} \quad = 4I' \times \frac{1}{2} = 2I'$

$\therefore \frac{\mathrm{I}}{\mathrm{I}_0} = \frac{1}{2}$

Question149

In Young's double slit experiment, the 'n^{th}' maximum of wavelength 'λ_1' is at a distance 'y_1' from the central maximum. When the wavelength of the source is changed to 'λ_2', $\left(\frac{\mathrm{n}}{2}\right)^{\text{th}}$ maximum is at a distance of 'y_2' from its central maximum. The ratio $\frac{y_1}{y_2}$ is

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Options:

A. $\frac{\lambda_2}{2\lambda_1}$

B. $\frac{2\lambda_1}{\lambda_2}$

C. $\frac{2\lambda_2}{\lambda_1}$

D. $\frac{\lambda_1}{2\lambda_2}$

Answer: B

Solution:

$$Y_1 = \frac{\mathrm{n}\lambda_1 D}{\mathrm{d}}, \quad Y_2 = \frac{\mathrm{n}\lambda_2 \mathrm{D}}{\mathrm{d}}$$
$$\therefore \frac{\mathrm{Y}_1}{\mathrm{Y}_2} = \frac{2\lambda_1}{\lambda_2}$$

Question150

Light of wavelength 'λ' is incident on a single slit of width 'a' and the distance between slit and screen is 'D'. In diffraction pattern, if slit width is equal to the width of the central maximum then $\mathrm{D} =$

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Options:

A. $\frac{a^2}{\lambda}$

B. $\frac{\mathrm{a}}{\lambda}$

C. $\frac{a^2}{2\lambda}$

D. $\frac{\mathrm{a}}{2\lambda}$

Answer: C

Solution:

Width of central maximum $= \frac{2\lambda D}{a}$

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

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

Question151

In Fraunhofer diffraction pattern, slit width is 0.2 mm and screen is at 2m away from the lens. If wavelength of light used is 5000 $\overset{o}{A}$ then the distance between the first minimum on either side of the central maximum is (θ is small and measured in radian)

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Options:

A. 2×10^{-2} m

B. 10^{-1} m

C. 10^{-2} m

D. 10^{-3} m

Answer: D

Solution:

Distance between the first minima $= \frac{2\lambda D}{a} = \frac{2\times5\times10^{-7}\times2}{0.2\times10^{-3}} = 10^{-3}$ m

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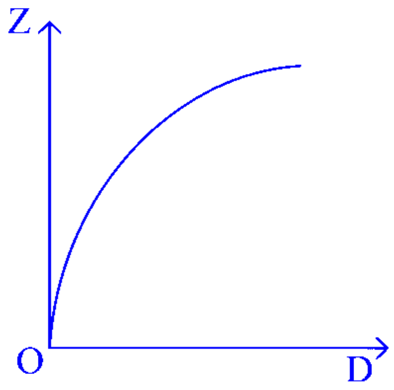
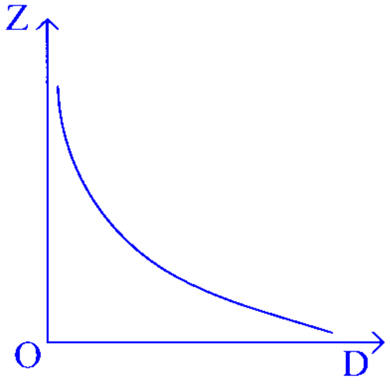
Question152

A graph is plotted between the fringe-width Z and the distance D between the slit and eye-piece, keeping other adjustment same. The correct graph is

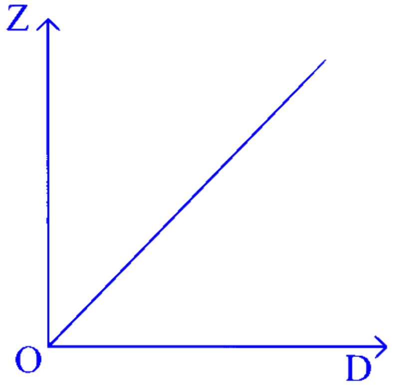
(A)



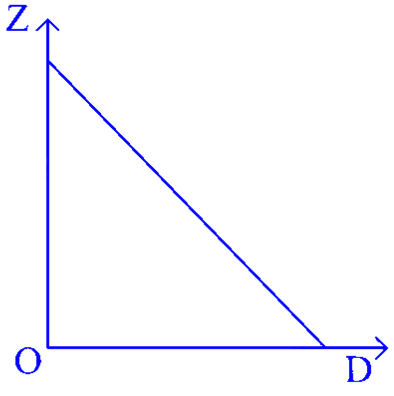
(B)



(C)



(D)



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Options:

A. A

B. B

C. D

D. C

Answer: D

Solution:

The fringe width is given by

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

As, λ and d are constants.

$\therefore \quad Z \propto D$

So, the graph between Z and D will be a straight line inclined to D-axis, as shown in graph (C).

Question153

The Brewster's angle for the glass-air interface is $(54.74)^{\circ}$. If a ray of light passing from air to glass strickes at an angle of incidence 45°, then the angle of refraction is

$$\left[\tan(54.74)^{\circ}=\sqrt{2}, \sin 45=\frac{1}{\sqrt{2}}\right]$$

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Options:

A. $\sin^{-1}(\sqrt{2})$

B. $\sin^{-1}(1)$

C. $\sin^{-1}(05)$

D. $\sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$

Answer: C

Solution:

According to Brewster's law, the refractive index of glass μ_2 can be determined using the Brewster's angle:

$\mu_2 = \tan(i_p) = \tan(54.74^\circ) = \sqrt{2}$

Using Snell's law, we relate the angles and refractive indices:

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

Given that $\mu_1 = 1$ (for air), $i = 45^\circ$, and $\mu_2 = \sqrt{2}$:

$1 \times \sin(45^\circ) = \sqrt{2} \sin r$

Substituting for $\sin(45^\circ)$:

$\frac{1}{\sqrt{2}} = \sqrt{2} \sin r$

Simplifying:

$\frac{1}{\sqrt{2} \times \sqrt{2}} = \sin r$

$\sin r = 0.5$

Thus, the angle of refraction r is:

$r = \sin^{-1}(0.5)$

Question154

A light wave of wavelength λ is incident on a slit of width d. The resulting diffraction pattern is observed on a screen at a distance D. If linear width of the principal maxima is equal to the width of the slit, then the distance D is

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Options:

A. $\frac{2\lambda}{d}$

B. $\frac{d^2}{2\lambda}$

C. $\frac{2\lambda^2}{d}$

D. $\frac{d}{\lambda}$

Answer: B

Solution:

The linear width of the principal maxima in a diffraction pattern is given by:

$\beta = \frac{2D\lambda}{d}$

It is stated that the linear width of the principal maxima is equal to the width of the slit. Therefore, we have:

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

Solving for D, we can rearrange the equation to find:

$D = \frac{d^2}{2\lambda}$

Question155

When wavelength of light used in optical instruments A and B are $4500\overset{o}{A}$ and $6000\overset{o}{A}$ respectively, the ratio of resolving power of A to B will be

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Options:

A. 9 : 16

B. 16 : 9

C. 7 : 1

D. 4 : 3

Answer: D

Solution:

The resolving power of optical instruments is inversely proportional to the wavelength of light used, as represented by the formula:

Resolving Power $\propto \frac{1}{\lambda}$

Given that the wavelengths for optical instruments A and B are $\lambda_A = 4500$ Å and $\lambda_B = 6000$ Å, the ratio of their resolving powers can be calculated as follows:

$\frac{(\text{Resolving Power}\quad)_A}{(\text{Resolving Power}\quad)_B} = \frac{\lambda_B}{\lambda_A} = \frac{6000}{4500} = \frac{4}{3}$

Therefore, the ratio of resolving power for instrument A to B is 4 : 3.

Question156

In diffraction experiment, from a single slit, the angular width of the central maxima does not depend upon

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Options:

A. ratio of wavelength and slit width

B. distance of the slit from the screen

C. wavelength of light used

D. width of the slit

Answer: B

Solution:

In diffraction from a single slit, the angular width of central maxima,

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

where, $\lambda =$ wavelength of light used,

and $\quad a =$ width of the slit.

$\therefore$ Angular width does not depend upon the distance of the slit from the screen.

Question157

In Young's double slit experiment green light is incident on the two slits. The interference pattern is observed on a screen. Which one of the following changes would cause the observed fringes to be more closely spaced?

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Options:

A. Moving the screen away from the slits

B. Using blue light instead of green light

C. Using red light instead of green light

D. Reducing the separation between the slits

Answer: B

Solution:

The spacing of the interference fringes in Young's double slit experiment can be calculated using the formula:

$\Delta y = \frac{\lambda L}{d}$

where:

- Δy is the fringe spacing, i.e., the distance between adjacent bright or dark fringes on the screen,
- λ is the wavelength of the light used,
- L is the distance from the slits to the screen, and
- d is the separation between the two slits.

Given this formula, let's discuss how each option affects the fringe spacing:

Option A: Moving the screen away from the slits

If we increase L, the distance from the slits to the screen, according to the formula, Δy would also increase, causing the fringes to be more widely spaced, not more closely spaced.

Option B: Using blue light instead of green light

The wavelength of light (λ) is a key factor in determining fringe spacing. Blue light has a shorter wavelength than green light. Decreasing λ (by switching from green to blue light) would cause Δy to decrease, according to the formula. This means the fringes will be more closely spaced, making this option a potentially correct answer.

Option C: Using red light instead of green light

Since red light has a longer wavelength than green light, switching to red light would increase λ, leading to an increase in Δy, according to the formula. This would make the fringes more widely spaced, not more closely spaced.

Option D: Reducing the separation between the slits

Reducing the separation between the slits (d) while keeping the wavelength and the screen distance constant would cause Δy to increase, according to the formula, thereby spacing the fringes further apart, not closer together.

Based on this analysis, **Option B: Using blue light instead of green light** is the correct choice, as it would cause the observed fringes to be more closely spaced due to the shorter wavelength of blue light.

Question158

When a photon enters glass from air, which one of the following quantity does not change?

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Options:

A. Velocity

B. Wavelength

C. Momentum

D. Energy

Answer: D

Solution:

When a photon transitions from air to glass, its velocity, wavelength, and momentum do experience changes due to the optical density and refractive index of the glass, which are different from those of air. However, the energy of the photon does not change upon entering the glass from air. The energy of a photon is given by the equation:

$E = hf = \frac{hc}{\lambda}$,

where E is the energy of the photon, h is the Planck constant, f is the frequency of the photon, c is the speed of light in a vacuum, and λ is the wavelength of the photon in a vacuum. When the photon enters glass from air, its speed and wavelength change, but its frequency, f, remains constant, since frequency is determined by the source of the light and is not affected by the medium through which the light is traveling. Since the energy of the photon depends directly on its frequency (and not on its speed or wavelength within the medium), the energy of the photon remains unchanged during the transition. Therefore, the correct option is:

Option D: Energy

Question159

In Young's double slit experiment fifth dark fringe is formed opposite to one of the slit. IID is the distance between the slits and the screen and d is the separation between the slits, then the wavelength of light used is

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Options:

A. $\frac{d^2}{5D}$

B. $\frac{d^2}{9D}$

C. $\frac{d^2}{6D}$

D. $\frac{d^2}{15D}$

Answer: B

Solution:

In Young's double slit experiment, the position of the nth dark fringe is determined by the formula:

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

From this, the wavelength λ can be expressed as:

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

Given that the fifth dark fringe is formed directly across one of the slits, we have:

$2x_5 = d$

Substituting $n = 5$ into Eq. (i), we find:

$\lambda = \frac{2x_5 d}{D(2\times5-1)}$

Since $2x_5 = d$, it follows that:

$\lambda = \frac{d \cdot d}{D(10-1)}$

Simplifying gives:

$\lambda = \frac{d^2}{9D}$

Question160

The phenomenon of interference is based on

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Options:

A. conservation of momentum

B. quantum nature of light

C. conservation of energy

D. conservation of charge

Answer: C

Solution:

In interference phenomenon, energy is distributed such that intensity of resultant wave is maximum at some points and minimum at another points, therefore phenomenon of interference is based on conservation of energy.

Question161

Light of wavelength ' λ ' is incident on a single slit of width ' a ' and the distance between slit and screen is ' D '. In diffraction pattern, if slit width is equal to the width of the central maximum then ' D ' is equal to

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Options:

A. $\frac{a}{2\lambda}$

B. $\frac{a^2}{2\lambda}$

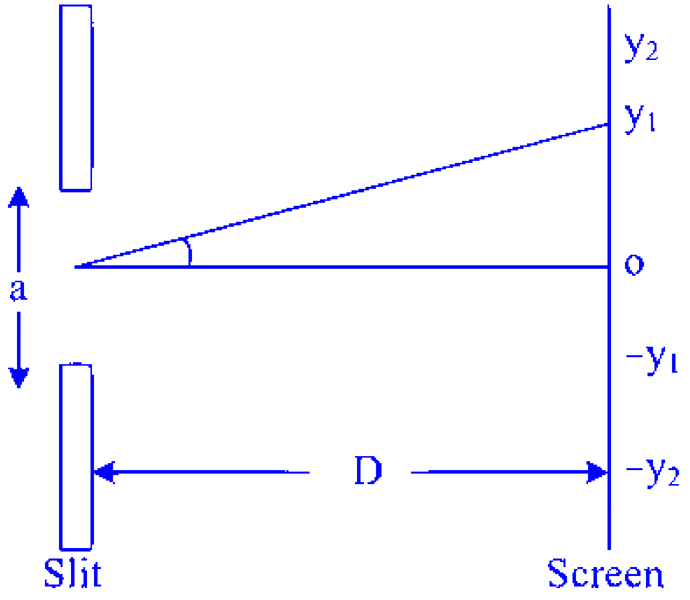
C. $\frac{a}{\lambda}$

D. $\frac{a^2}{\lambda}$

Answer: B

Solution:

The diffraction pattern due to a single slit is shown below



The width of central maximum is given by

$2y = \frac{2D\lambda}{a}$ .... (i)

where, $\lambda =$ wavelength of incident light.

Here, $a = 2y$, then from Eq. (i), we get

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

Question162

The luminous border that surrounds the profile of a mountain just before sun rises behind it, is an example of

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Options:

A. dispersion

B. total internal reflection

C. interference

D. diffraction

Answer: D

Solution:

The luminous border seen around the profile of a mountain just before the sun rises is a result of **diffraction**. This optical phenomenon occurs when light waves bend around the edges of an object, in this case, the mountain. As the sunlight approaches from behind, it diffracts around the mountain's edges, creating a glowing border.

Question163

In biprism experiment, the distance between source and eyepiece is 1.2 m, the distance between two virtual sources is 0.84 mm. Then the wavelength of light used if eyepiece is to be moved transversely through a distance of 2.799 cm to shift 30 fringes is

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Options:

A. 6533 $\stackrel{o}{A}$

B. 6537 $\overset{o}{A}$

C. 6535 $\overset{o}{A}$

D. 6351 $\overset{o}{A}$

Answer: A

Solution:

In a biprism experiment, wavelength of the light is given as

$\lambda = \frac{d\beta}{D}$ .... (i)

where, β is the fringe width,

d is the distance between the two sources and D is the distance between the source and eyepeice.

Given, $D = 1.2$ m,

$d = 0.84 \text{ mm} = 0.84 \times 10^{-3}$ m and

$$\beta = \frac{2.799 \times 10^{-2}}{30} = 9.33 \times 10^{-4}$$

Substituting these values in Eq. (i), we get

$$\lambda = \frac{0.84 \times 10^{-3} \times 9.33 \times 10^{-4}}{1.2}$$
$$= 6.531 \times 10^{-7} \text{ m} = 6531 \overset{o}{A}$$

Question164

If a star emitting yellow light is accelerated towards earth, then to an observer on earth it will appear

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Options:

A. becoming orange.

B. shining yellow.

C. gradually changing to blue.

D. gradually changing to red.

Answer: C

Solution:

Due to the doppler's effect of light, when an object moves closer to source the light moves to the blue end of the spectrum, as its wavelength get shorter. (or frequency increases) Thus, if a star emitting yellow light and is accelerating towards an observer on earth, it will appear that its colour is gradually changing to blue. So, option (c) is correct.
