Wave Optics

Question1

According to Rayleigh, when sunlight travels through atmosphere, the amount of scattering is proportional to nth power of wavelength of light. Then, the value of 'r is

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Options:

A.

4

B.

-4

C.

3

D.

-3

Answer: B

Solution:

According to **Rayleigh's law of scattering**, the intensity of scattered light I is inversely proportional to the **fourth power of the wavelength** of light, i.e.

$I \propto \frac{1}{\lambda^4}$

This can be expressed as scattering $\propto \lambda^n$.

So,

$n=-4$

✅ **Correct Option: (B) −4**

Question2

In Young' double slit experiment, if the distance between the slits is 2 mm and the distance of the screen from the slits is 100 cm , the fringe width is 0.36 mm . If the distance between the slit is decreased by 0.5 mm and the distance of the screen from the slits is increased by 50 cm , the fringe width becomes

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Options:

A.

0.84 mm

B.

0.96 mm

C.

0.48 mm

D.

0.72 mm

Answer: D

Solution:

$$\beta_1=\frac{D_1\lambda_1}{d_1}=0.36\times10^{-3}$$
$$\Rightarrow\quad\frac{1\times\lambda_1}{2\times10^{-3}}=0.36\times10^{-3}$$
$$\Rightarrow\quad\lambda_1=0.72\times10^{-6}\text{ m}$$

$$
\begin{aligned}
d_2 &= (2-0.5)\mathrm{mm} = 1.5\ \mathrm{mm} = 1.5\times10^{-3}\ \mathrm{m}\\
D_2 &= (100+50)\mathrm{cm} = 1.5\ \mathrm{m}\\
\lambda_2 &= \lambda_1 = 0.72\times10^{-6}\ \mathrm{m}\\
\therefore \beta &= \frac{D_2\lambda_2}{d_2} = \frac{1.5\times0.72\times10^{-6}}{1.5\times10^{-3}}\\
&= 0.72\times10^{-3}\ \mathrm{m} = 0.72\ \mathrm{mm}
\end{aligned}
$$

Question3

A narrow slit of width 2 mm is illuminated with a monochromatic light of wavelength 500 nm . If the distance between the slit and the screen is 1 m , then first minima are separated by a distance of

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Options:

A.

5 mm

B.

0.5 mm

C.

1 mm

D.

10 mm

Answer: B

Solution:

Position of first minima is given as

$$\begin{aligned} y_1 &= \frac{m\lambda D}{a} \\ &= \frac{\lambda D}{a} \qquad [\because m = 1] \\ &= \frac{500 \times 10^{-9} \times 1}{2 \times 10^{-3}} \\ &= 0.25 \times 10^{-3} \text{ m} \\ &= 0.25 \text{ mm} \end{aligned}$$

The first minima occur symmetrically on either side of the central maximum. Therefore, separation between the first minima $= 2y_1$

$$\begin{aligned} &= 2 \times 0.25 \text{ mm} \\ &= 0.5 \text{ mm} \end{aligned}$$

Question4

In Young's double slit experiment, if the distance between the slits is increased to 3 times initial distance, then the ratio of initial and final fringe widths is

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Options:

A.

9 : 1

B.

1 : 9

C.

1 : 3

D.

3 : 1

Answer: D

Solution:

Let's recall the formula for **fringe width** in Young's double-slit experiment:

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

where

λ = wavelength of light,

D = distance between slits and screen,

d = distance between the two slits.

Given:

- Initially, slit separation = d
- Finally, slit separation = $3d$

Find:

Ratio of **initial** and **final** fringe widths, i.e.

$\frac{\beta_{\text{initial}}}{\beta_{\text{final}}}$

Calculation:

$\beta_{\text{initial}} = \frac{\lambda D}{d}$

$\beta_{\text{final}} = \frac{\lambda D}{3d}$

Thus,

$\frac{\beta_{\text{initial}}}{\beta_{\text{final}}} = \frac{\lambda D/d}{\lambda D/3d} = 3$

So the ratio of initial : final fringe width is **3 : 1**.

✅ **Correct Option: D) 3 : 1**

Question5

In Young's double slit experiment, the distance between the slits is 0.2 cm , the distance between the screen and the slits is 1 m . If the wavelength of light used in the experiment is $5000\overset{\circ}{A}$, then the distance between two consecutive dark fringes on the screen is

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Options:

A.

0.25 mm

B.

0.26 mm

C.

0.27 mm

D.

0.28 mm

Answer: A

Solution:

Given, $d = 0.2\,\text{cm} = 0.002\,\text{m}$

$\lambda = 5000\mathring{A} = 5000 \times 10^{-10}\,\text{m}$

The distance between two consecutive dark fringes is given by

$$\beta = \frac{\lambda D}{d} = \frac{(5000 \times 10^{-10})\text{m} \times 1\,\text{m}}{0.002\,\text{m}}$$

$$\beta = \frac{5 \times 10^{-7}}{2 \times 10^{-3}}\,\text{m}$$

$$\beta = 2.5 \times 10^{-4}\,\text{m} = 0.25\,\text{mm}$$

Question6

In Young's double slit experiment, the wavelength of monochromatic light is increased by 20% and the distance between the two slits is decreased by 25%. If the initial fringe width is 0.3 mm , then the final fringe width is

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Options:

A.

0.72 mm

B.

0.60 mm

C.

0.16 mm

D.

0.48 mm

Answer: D

Solution:

$$\text{Fringe width, } \beta = \frac{D\lambda}{d}$$
$$\frac{\beta_1}{\beta_2} = \frac{\lambda_1}{\lambda_2} \cdot \frac{d_2}{d_1}$$
$$= \left(\frac{\lambda_1}{\lambda_1 + 20\% \text{ of } \lambda_1}\right) \cdot \frac{(d_1 - 25\% \text{ of } d_1)}{d_1}$$
$$= \left(\frac{\lambda_1}{\lambda_1 + \frac{\lambda_1}{5}}\right)\left(\frac{d_1 - \frac{d_1}{4}}{d_1}\right) = \frac{5}{6} \times \frac{3}{4}$$
$$\Rightarrow \quad \frac{\beta_1}{\beta_2} = \frac{5}{8}$$
$$\Rightarrow \beta_2 = \frac{8}{5}\beta_1 = \frac{8}{5} \times 0.3 = 0.48 \text{ mm}$$

Question7

An unpolarised beam of light incidents on a group of three polarising sheets arranged such that the angle between the axes of any two adjascent sheets is 30°. The ratio of the intensities of polarised light emerging from the second and third sheets is

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Options:

A.

1 : 1

B.

2 : 1

C.

4 : 3

D.

3 : 2

Answer: C

Solution:

When unpolarised light of intensity (I_0) passes through the first polariser, the intensity reduces to half $\left(\frac{I_0}{2}\right)$.

According to law of Malus, intensity after second polariser.

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

The angle between the second and third polariser is also 30°. The intensity after the third polariser

$$\begin{aligned} & I_3 = I_2 \cos^2 30^\circ \\ & = \frac{3I_0}{8} \times \frac{3}{4} = \frac{9I_0}{32} \\ \therefore \quad & \frac{I_2}{I_3} = \frac{\frac{3I_0}{8}}{\frac{9I_0}{32}} = \frac{4}{3} \\ \therefore \quad & I_2 : I_3 = 4 : 3 \end{aligned}$$

Question8

In Young's double slit experiment, the wavelengths of red and blue lights used are 7.5×10^{-5} cm and 5×10^{-5} cm respectively. If nth bright fringe of red color coincides with $(n+1)$ th bright fringe of blue colour, then the value of ' n ' is

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Options:

A.

1

B.

2

C.

4

D.

8

Answer: B

Solution:

For nth bright fringe of red light,

$d \sin \theta_r = n\lambda_r$

For $(n+1)$ th bright fringe of blue light

$d \sin \theta_b = (n+1)\lambda_b$

Since, the fringes coincide,

$$
\begin{aligned}
& \text{i.e. } \theta_r = \theta_b \\
\Rightarrow \quad & d \sin \theta_r = d \sin \theta_b \\
\Rightarrow \quad & n\lambda_r = (n+1)\lambda_b \\
\Rightarrow \quad & n \times 7.5 \times 10^{-5} = (n+1) 5 \times 10^{-5} \\
\Rightarrow \quad & 7.5n = 5n + 5 \\
\Rightarrow \quad & 2.5n = 5 \Rightarrow n = 2
\end{aligned}
$$

Question9

Two light waves of intensities I and $2I$ superimpose on each other. If the path difference between the light waves reaching a point is 12.5% of the wavelength of the light, then the resultant intensity at the point, is (Both the light waves have same wavelength)

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Options:

A. 1

B. 91

C. 31

D. 51

Answer: D

Solution:

When two light waves superimpose, the resultant intensity is influenced by both their individual intensities and the phase difference between them. In this case, the path difference is 12.5% of the wavelength, which translates into a phase difference:

$\frac{12.5}{100} \times 360^\circ = 45^\circ$

The formula for the resultant intensity when two waves interfere is given by:

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

Given:

$I_1 = I$

$I_2 = 2I$

The expression for the resultant intensity becomes:

$I_r = I + 2I + 2\sqrt{2I \times I} \cos(45^\circ)$

Calculating further:

$I_r = 3I + 2I\sqrt{2} \times \frac{\sqrt{2}}{2}$

$I_r = 3I + 2I = 5I$

Therefore, the resultant intensity at the point where the two light waves with a path difference of 12.5% of the wavelength superimpose is $5I$.

Question10

The angle between the axes of a polariser and an analyser is 45°. If the intensity of the unpolarised light incident on the polariser is I, then the intensity of light emerged from the analyser is

Options:

A. 21

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

C. 1

D. $\frac{1}{4}$

Answer: D

Solution:

Given:

Intensity of unpolarized light, I

Angle between the polarizer and analyser, $\theta = 45^{\circ}$

Step-by-step Breakdown

Initial Intensity after Polariser:

When unpolarized light passes through a polarizer, its intensity is reduced by half. Therefore, the intensity of polarized light emerging from the polarizer is:

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

Intensity after Analyser using Malus's Law:

According to Malus's law, the intensity I_{out} of the light after passing through the analyser is given by:

$I_{\text{out}} = I_0 \cos^2 \theta$

Substituting the given values:

$I_{\text{out}} = \frac{I}{2} \cos^2 45^{\circ}$

Knowing that $\cos 45^{\circ} = \frac{1}{\sqrt{2}} = \frac{1}{2}^{\frac{1}{2}}$, this becomes:

$I_{\text{out}} = \frac{I}{2} \times \left(\frac{1}{\sqrt{2}}\right)^2 = \frac{I}{2} \times \frac{1}{2}$

$I_{\text{out}} = \frac{I}{4}$

Thus, this derivation shows that the intensity of the light after it has passed through both the polariser and the analyser is $\frac{I}{4}$.

Question11

If a slit of width x was illuminated by red light having wavelength $6500 \mathring{A}$, the first minima was obtained at $\theta = 30^\circ$. Then, the value of x is

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Options:

A. $1.4 \times 10^{-4} \mu \mathrm{~m}$

B. $1.2 \times 10^{-5} \mathrm{~m}$

C. $1.3 \mu \mathrm{~m}$

D. $1.2 \mu \mathrm{~m}$

Answer: C

Solution:

Given the following parameters:

Width of slit, x

Wavelength, $\lambda = 6500 \text{ Å}$

First minima angle, $\theta = 30^\circ$

To find the slit width using the diffraction principle, we apply:

$a \sin \theta = n \lambda$

For the first minima ($n = 1$):

$a \sin 30^\circ = 1 \times (6500 \times 10^{-10})$

Calculating this step-by-step:

$a \times 0.5 = 6500 \times 10^{-10}$

$a \times 0.5 = 65 \times 10^{-8}$

Solving for a:

$a = \frac{65 \times 10^{-8}}{0.5}$

$a = 1.3 \times 10^{-6}$

Converting to micrometers:

$a = 1.3\,\mu\text{m}$

Therefore, the width of the slit x is $1.3\,\mu$m.

Question12

In case of diffraction, if a is a slit width and λ is the wavelength of the incident light, then the required condition for diffraction to take place is

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Options:

A. $\frac{a}{\lambda} = 1000$

B. $\frac{a}{\lambda} \leq 1$

C. $a \ll \lambda$

D. $a \gg \lambda$

Answer: B

Solution:

For diffraction to occur significantly, the slit width a should be comparable to the wavelength λ of the incident light. This means that the condition $a \leq \lambda$ or equivalently $\frac{a}{\lambda} \leq 1$ must be met.

Question13

If a microscope is placed in air, the minimum separation of two objects seen as distinct is 6μ m. If the same is placed in a medium of refractive index 1.5, then the minimum separation of the two objects to see as distinct is

Options:

A. 4μ m

B. 6μ m

C. 3μ m

D. 9μ m

Answer: A

Solution:

To determine the minimum separation at which two objects can be seen as distinct under a microscope, we use the formula:

$d = \frac{\lambda}{2 \cdot \mathrm{NA}}$

where NA, the numerical aperture, is defined as:

$\mathrm{NA} = n \sin \theta$

Here, n represents the refractive index of the medium.

Case 1: Microscope in Air

In air, the refractive index (n) is 1. The given minimum separation to see objects distinctly is $d = 6\ \mu\mathrm{m}$. The relationship between minimum separation d and refractive index n is:

$d \propto \frac{1}{n}$

Case 2: Microscope in a Medium with Refractive Index 1.5

In this scenario, the refractive index n is 1.5. The separation d' can be calculated as:

$d' = \frac{d}{1.5}$

Substitute the given values:

$d' = \frac{6\ \mu\mathrm{m}}{1.5} = 4\ \mu\mathrm{m}$

Thus, when the microscope is placed in a medium with a refractive index of 1.5, the minimum separation at which two objects can be seen as distinct is $4\ \mu\mathrm{m}$.

Question14

In Young's double slit experiment two slits are placed 2 mm from each other. Interference pattern is observed on a screen placed 2 m from the plane of the slits. Then the fringe width for a light of wavelength 400 nm is

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Options:

A. 0.4×10^{-6} m

B. 4×10^{-6} m

C. 0.4×10^{-3} m

D. 400 m

Answer: C

Solution:

In Young's double slit experiment, we have two slits separated by a distance of 2 mm. The interference pattern is projected onto a screen positioned 2 meters away from the slits. We are using light with a wavelength of 400 nm.

To find the fringe width (β), we use the formula:

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

Where:

$\lambda = 400 \text{ nm} = 400 \times 10^{-9}$ m is the wavelength of light.

$D = 2$ m is the distance from the slits to the screen.

$d = 2 \text{ mm} = 2 \times 10^{-3}$ m is the distance between the slits.

Plugging in the values:

$\beta = \frac{400 \times 10^{-9} \times 2}{2 \times 10^{-3}} = 4 \times 10^{-4} \text{ m} = 0.4 \times 10^{-3} \text{ m}$

Thus, the fringe width β is 0.4×10^{-3} m.

Question15

In Young's double slit experiment, the intensity at a point where the path difference is $\frac{\lambda}{6}$ (λ being the wavelength of the light used) is I.

If I_0 denotes the maximum intensity, $\frac{I}{I_0}$ is equal to

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Options:

A. $\frac{1}{\sqrt{2}}$

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

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

D. $\frac{3}{4}$

Answer: D

Solution:

In Young's Double Slit Experiment, we have the following:

Path difference, $x = \frac{\lambda}{6}$

To find the phase difference ϕ, we use the formula:

$\phi = \frac{2\pi}{\lambda} \times x = \frac{2\pi}{\lambda} \times \frac{\lambda}{6}$

Solving this gives us:

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

The intensity I at a point in terms of maximum intensity I_0 is given by:

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

Substituting $\phi = \frac{\pi}{3}$ into the equation, we get:

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

We know that $\cos\left(\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2}$, so substituting that value in gives:

$I = I_0\left(\frac{\sqrt{3}}{2}\right)^2 \Rightarrow I = I_0 \cdot \frac{3}{4}$

Thus, the ratio $\frac{I}{I_0}$ is:

$\frac{I}{I_0} = \frac{3}{4}$

Question16

In Young's double slit experiment with monochromatic light of wavelength 6000 A . The fringe width is 3 mm . If the distance between the screen and slits is increased by 50% and the distance between the slits is decreased by 10%, then the fringe width is

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Options:

A. 12 mm

B. 5 mm

C. 6 mm

D. 10 mm

Answer: B

Solution:

In Young's double slit experiment using monochromatic light with a wavelength of 6000 Å, the initial fringe width (β_1) is 3 mm. We are tasked with determining the new fringe width when the distance between the screen and the slits is increased by 50%, and the distance between the slits is decreased by 10%.

Given:

Wavelength, $\lambda = 6000\ \mathring{A}$

Initial fringe width, $\beta_1 = 3\,\text{mm}$

The formula for fringe width (β) in Young's experiment is:

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

where D is the distance between the screen and the slits, and d is the distance between the slits. From the given information:

$3 = \frac{D \times 6000}{d}$

Now, recalculating for the changed conditions:

The new distance between the screen and slits, D', when increased by 50%:

$D' = D + \frac{D \times 50}{100} = 1.5D$

The new distance between the slits, d', when decreased by 10%:

$d' = d - \frac{d \times 10}{100} = 0.9d$

Now, the new fringe width, β', is given by:

$\beta' = \frac{D'\lambda}{d'} = \frac{1.5 \times D \times 6000}{0.9 \times d}$

Substituting Eq. (1) into the equation:

$\beta' = \frac{1.5}{0.9} \times 3$

Calculating the above expression:

$\beta' = \frac{45}{9} = 5\,\text{mm}$

Thus, the new fringe width is 5 mm.

Question17

Young's double slit experiment is conducted with monochromatic light of wavelength $5000\overset{o}{A}$, with slit separation of 3 mm and observer at 20 cm away from the slits. If a 1 mm transparent plate is placed infront of one of the slits, the fringes shift by 6 mm . The refractive index of the transparent plate is

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Options:

A. 1.08

B. 1.09

C. 1.1

D. 1.2

Answer: B

Solution:

Given, wavelength, $\lambda = 5000\overset{o}{A} = 5 \times 10^{-7}\,\text{m}$

Slit separation, $d = 3\text{ mm} = 3 \times 10^{-3}\,\text{m}$

Distance between slit and screen,

$D = 20 \text{ cm} = 0.2 \text{ m}$

Thickness of transparent plate $= 1 \text{ mm} = 1 \times 10^{-3}$ m Fringe shift, $\Delta x = 6 \text{ mm} = 6 \times 10^{-3}$ m

Fringe shift is given by

$$\Delta x = \frac{D}{d}(\mu - 1)t$$
$$\Rightarrow \quad 6 \times 10^{-3} = \frac{0.2}{3 \times 10^{-3}}(\mu - 1) \times 10^{-3}$$
$$\Rightarrow \frac{6 \times 3 \times 10^{-3}}{0.2} = \mu - 1 \Rightarrow 9 \times 10^{-2} = \mu - 1$$
$$\Rightarrow \quad \mu = 1.09$$

Hence, refractive index of transparent plate is 1.09.

Question18

In Young's double slit experiment the slits are 3 mm apart and are illuminated by light of two wavelengths $3750\overset{o}{A}$ and $7500\overset{o}{A}$. The screen is placed at 4 m from the slits. The minimum distance from the common central bright fringe on the screen at which the bright fringe of one interference pattern due to one wavelength coincide with the bright fringe of the other is

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Options:

A. 2 mm

B. 3 mm

C. 1 mm

D. 8 mm

Answer: C

Solution:

Given :

$\lambda_1 = 3750\,\AA$
$\lambda_2 = 7500\,\AA$
$D = 4\,\mathrm{m}$
$d = 3\,\mathrm{mm} = 3 \times 10^{-3}\,\mathrm{m}$

Since,

$\frac{\lambda_1}{\lambda_2} = \frac{3750}{7500} = \frac{1}{2}$

We know that,

$\Rightarrow n_1\lambda_1 = n_2\lambda_2 \Rightarrow \frac{n_2}{n_1} = \frac{\lambda_1}{\lambda_2} = \frac{1}{2}$

Therefore, the required minimum distance is:

$$\begin{aligned} x &= \frac{n_1\lambda_1 D}{d} \\ &= \frac{2 \times 3750 \times 10^{-10} \times 4}{3 \times 10^{-3}} \\ &= \frac{3 \times 10^4 \times 10^{-10}}{3 \times 10^{-3}} \\ &= 10^{-3}\,\mathrm{m} = 1\,\mathrm{mm} \end{aligned}$$

Question19

When monochromatic light of wavelength 600 nm is used in Young's double slit experiment, the fifth order bright fringe is formed at 6 mm from the central bright fringe on the screen. If the experiment is conducted with light of wavelength 400 nm from the central bright fringe, the third order bright fringe will be located at

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Options:

A. 1.6 mm

B. 2 mm

C. 2.4 mm

D. 3 mm

Answer: C

Solution:

For the given condition,

$\frac{n_1 \lambda_1}{x_1}=\frac{n_2 \lambda_2}{x_2} \quad \text{.... (i)}$

Here, $n_1=5$ (for fifth order)

$$
\begin{aligned}
& \lambda_1=600 \mathrm{~nm}=6 \times 10^{-7} \mathrm{~m} \\
& x_1=6 \mathrm{~mm}=6 \times 10^{-3} \mathrm{~m} \\
& n_2=3(\text { for third order }) \\
& \lambda_2=400 \mathrm{~nm}=4 \times 10^{-7} \mathrm{~m} \\
& x_2=?
\end{aligned}
$$

Putting these values in Eq. (i), we get

$\frac{5 \times 6 \times 10^{-7}}{6 \times 10^{-3}}=\frac{3 \times 4 \times 10^{-7}}{x_2}$

$$
\begin{aligned}
\Rightarrow \quad & 5 x_2=12 \times 10^{-3} \\
\Rightarrow \quad & x_2=2.4 \times 10^{-3} \mathrm{~m} \\
& =2.4 \mathrm{~mm}
\end{aligned}
$$

Question20

The wavefront is a surface in which

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Options:

A. all points are in the same phase

B. there are pairs of points in opposite phase

C. there are pairs of points with phase difference $\left(\frac{\pi}{2}\right)$

D. there is no relation between the phases

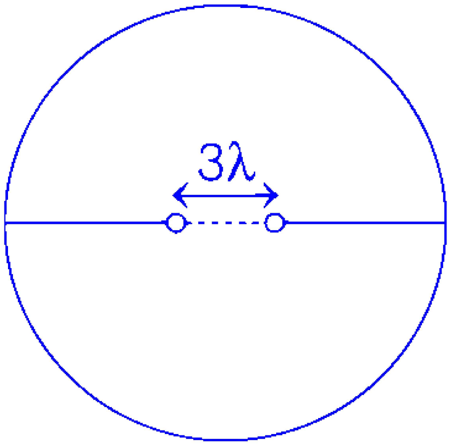
Answer: A

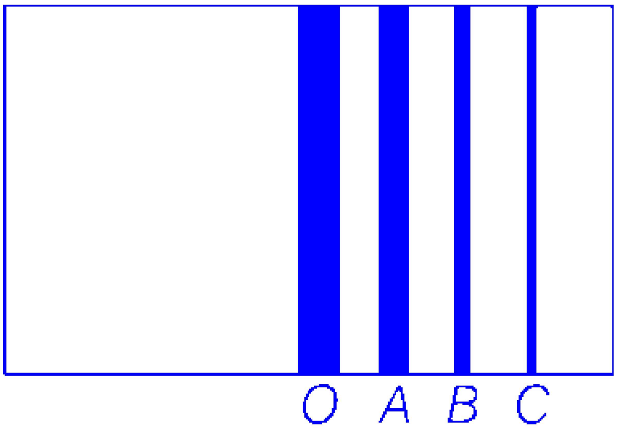
Solution:

As we know that, wavefront is defined as thelocus of all points in same phase.

Question21

The position of the direct image obtained atO, when a monochromatic beam of light ispassed through a plane transmission gratingat normal incidence is shown in figure.The diffracted images A, B, and C correspondto the first, second and third orderdiffraction. When the source is replaced byanother source of shorter wavelength,





Options:

A. all the four will shift in the direction C to O

B. all the four will shift in the direction O to C

C. the images C, B and A will shift towards O

D. the images C, B and A will shift away from O

Answer: C

Solution:

As we know that,

for diffraction, $d \sin \theta = n\lambda$

where, d is slit width, θ is angular width and λ is wavelength.

Now, if λ decreases then $\sin \theta$ decreases and pattern shrinks. So, images moves towards O.

Question22

In Young's double slit experiment, theseparation between the slits is halved and thedistance between the screen is doubled. Thefringe width is

Options:

A. unchanged

B. halved

C. doubled

D. quadrupled

Answer: D

Solution:

Initially, separation between slits $= d$

Distance of slit from screen $= D$

Initial and final fringe widths be β and β'.

Finally, separation between slits, $d' = d/2$

Distance from screen $D' = 2D$

As,

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

$$\therefore \beta' = \frac{\lambda D'}{d'} = \frac{\lambda 2D}{d/2} = \frac{4\lambda D}{d}$$

$$\Rightarrow \quad \beta' = 4\beta$$

Question23

In a diffraction pattern due to a single slit of width a, the first minimum is observed at an angle 30Υ when light of wavelength $500\ \mathrm{nm}$ is incident on the slit. The first secondary maximum is observed at an angle of

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. $\sin^{-1}\left(\frac{2}{3}\right)$

Answer: B

Solution:

Angular width for Ist minima, $\theta_1 = 30^\circ = \pi/6$ rad

Wavelength, $\lambda = 500$ nm = 500×10^{-9} m

Let first secondary maximum occur at angle θ_2.

$\because n\lambda = a \sin \theta_1$

where, a is slit width.

$\therefore a = \frac{n\lambda}{\sin 30Υ} = 2\lambda\ [\because n = 1]$

and for maxima

$(2n+1)\frac{\lambda}{2} = a \sin \theta_2$

$\Rightarrow (2+1)\frac{\lambda}{2} = a \sin \theta_2$

$\Rightarrow \sin \theta_2 = 3\lambda/2a$ ..... (i)

Substituting the value $a = 2\pi$ in Eq. (i), we get

$$\therefore \quad \sin \theta_2 = \frac{3\lambda}{2 \times 2\lambda} = \frac{3}{4}$$
$$\Rightarrow \quad \theta_2 = \sin^{-1}(3/4)$$
