Wave Optics

Question1

When a polaroid sheet is rotated between two crossed polaroids then the transmitted light intensity will be maximum for a rotation of : [27-Jan-2024 Shift 2]

Options:

A. 60°

B. 30°

C. 90°

D. 45°

Answer: D

Solution:

Let I_0 be intensity of unpolarised light incident on first polaroid.

$I_1 =$ Intensity of light transmitted from 1^{st} polaroid

$= \frac{I_0}{2}$

θ be the angle between 1^{st} and 2^{nd} polaroid

ϕ be the angle between 2^{nd} and 3^{rd} polaroid

$\theta + \phi = 90^{\circ}$ (as 1^{st} and 3^{rd} polaroid are crossed)

$\phi = 90^{\circ} - \theta$

$I_2 =$ Intensity from 2^{nd} polaroid

$I_2 = I_1 \cos^2\theta = \frac{I_0}{2}\cos^2\theta$

$I_3 =$ Intensity from 3^{rd} polaroid

$I_3 = I_2 \cos^2\varphi$

$I_3 = I_1 \cos^2\theta \cos^2\phi$

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

$\phi = 90 - \theta$

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

$I_3 = \frac{I_0}{2}\left[\frac{2\sin\theta\cos\theta}{2}\right]^2$

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

I_3 will be maximum when $sin\ 2\theta = 1$

$2\theta = 90^\circ$

$\theta = 45^\circ$

Question2

A parallel beam of monochromatic light of wavelength 5000Å is incident normally on a single narrow slit of width 0.001 mm. The light is focused by convex lens on screen, placed on its focal plane. The first minima will be formed for the angle of diffraction of ____(degree).
[27-Jan-2024 Shift 2]

Answer: 30

Solution:

For first minima

$a \sin \theta = \lambda$

$$\Rightarrow \sin \theta = \frac{\lambda}{a} = \frac{5000 \times 10^{-10}}{1 \times 10^{-6}} = \frac{1}{2}$$

$\Rightarrow \theta = 30^\circ$

Answer: 0.20

Solution:

Path difference for minima at P

$$2\sqrt{D^2 + d^2} - 2D = \frac{\lambda}{2}$$

$$\therefore \sqrt{D^2 + d^2} - D = \frac{\lambda}{4}$$

$$\therefore \sqrt{D^2 + d^2} = \frac{\lambda}{4} + D$$

$$\Rightarrow D^2 + d^2 = D^2 + \frac{\lambda^2}{16} + \frac{D\lambda}{2}$$

$$\Rightarrow d^2 = \frac{D\lambda}{2} + \frac{\lambda^2}{16}$$

$$\Rightarrow d^2 = \frac{0.2 \times 400 \times 10^{-9}}{2} + \frac{4 \times 10^{-14}}{4}$$

$$\Rightarrow d^2 \approx 400 \times 10^{-10}$$

$$\therefore d = 20 \times 10^{-5}$$

$$\Rightarrow d = 0.20 \text{ mm}$$

$$\Delta x = \frac{7\lambda}{4}$$

$$\phi = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{\lambda} \times \frac{7\lambda}{4} = \frac{7\pi}{2}$$

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

$$\frac{I}{I_{max}} = \cos^2\left(\frac{\phi}{2}\right) = \cos^2\left(\frac{7\pi}{2\times 2}\right) = \cos^2\left(\frac{7\pi}{4}\right)$$

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

$$= \cos^2\frac{\pi}{4}$$

$$= \frac{1}{2}$$

Question5

In a single slit diffraction pattern, a light of wavelength 6000Å is used. The distance between the first and third minima in the diffraction pattern is found to be 3 mm when the screen in placed 50 cm away from slits. The width of the slit is $\times 10^{-4}$m
[29-Jan-2024 Shift 2]

Answer: 2

Solution:

For n^{th} minima

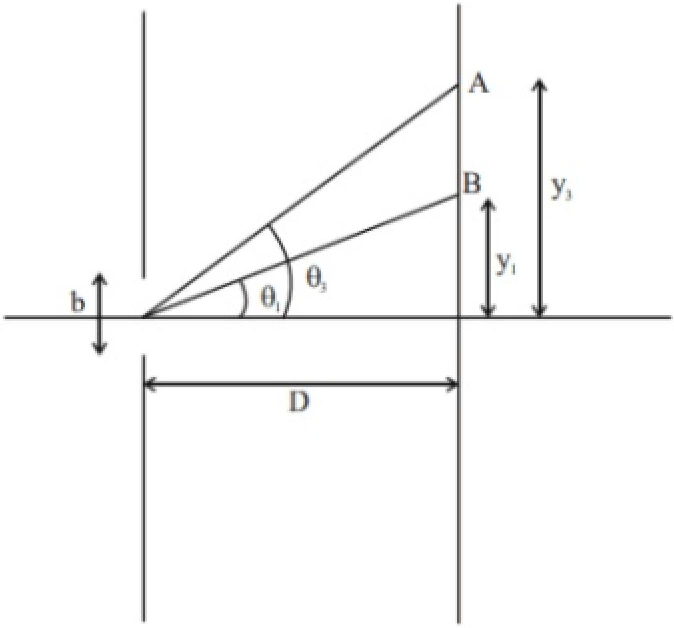
$b\sin\theta = n\lambda$

(λ is $small$ $so \sin\theta$ is small, hence $\sin\theta \simeq \tan\theta$)

$b\tan\theta = n\lambda$

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

$\Rightarrow y_n = \frac{n\lambda D}{b}$ (Position of n^{th} minima)



$B \longrightarrow 1^{st}$ minima, $A \longrightarrow 3^{rd}$ minima

$y_3 = \frac{3\lambda D}{b}, y_1 = \frac{\lambda D}{b}$

$\Delta y = y_3 - y_1 = \frac{2\lambda D}{b}$

$3 \times 10^{-3} = \frac{2 \times 6000 \times 10^{-10} \times 0.5}{b}$

$b = \frac{2 \times 6000 \times 10^{-10} \times 0.5}{3 \times 10^{-3}}$

$b = 2 \times 10^{-4} m$

$x = 2$

Question6

The diffraction pattern of a light of wavelength 400 nm diffracting from a slit of width 0.2 mm is focused on the focal plane of a convex lens of focal length 100 cm. The width of the 1^{st} secondary maxima will be : [30-Jan-2024 Shift 1]

Options:

A. 2 mm

B. 2 cm

C. 0.02 mm

D. 0.2 mm

Answer: A

Solution:

Width of 1 st secondary maxima $= \frac{\lambda}{a} \cdot D$

Here

$a = 0.2 \times 10^{-3}$m

$\lambda = 400 \times 10^{-9}$m

$D = 100 \times 10^{-2}$

Width of 1 st secondary maxima

$= \frac{400 \times 10^{-9}}{0.2 \times 10^{-3}} \times 100 \times 10^{-2}$

$= 2$ mm

Question7

A beam of unpolarised light of intensity I_0 is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of A. The intensity of emergent light is :
[30-Jan-2024 Shift 2]

Options:

A. $I_0 / 4$

B. I_0

C. $I_0 / 2$

D. $I_0 / 8$

Answer: A

Solution:

Intensity of emergent light

$= \frac{I_0}{2}\cos^2 45° = \frac{I_0}{4}$

Question8

Two waves of intensity ratio 1 : 9 cross each other at a point. The resultant intensities at the point, when (a) Waves are incoherent is I_1(b) Waves are coherent is I_2 and differ in phase by 60°. If $\frac{I_1}{I_2} = \frac{10}{x}$ then x = ____
[31-Jan-2024 Shift 1]

Answer: 13

Solution:

For incoherent wave $I_1 = I_A + I_B \Rightarrow I_1 = I_0 + 9I_0$

$I_1 = 10I_0$

For coherent wave $I_2 = I_A + I_B + 2\sqrt{I_A I_B}\cos 60^\circ$

$I_2 = I_0 + 9I_0 + 2\sqrt{9I_0^2} \cdot \frac{1}{2} = 13I_0$

$\frac{I_1}{I_2} = \frac{10}{13}$

Question9

When unpolarized light is incident at an angle of 60° on a transparent medium from air. The reflected ray is completely polarized. The angle of refraction in the medium is
[31-Jan-2024 Shift 2]

Options:

A. 30°

B. 60°

C. 90°

D. 45^0

Answer: A

Solution:

Question10

A monochromatic light of wavelength 6000Å is incident on the single slit of width 0.01 mm. If the diffraction pattern is formed at the focus of the convex lens of focal length 20 cm, the linear width of the central maximum is :
[1-Feb-2024 Shift 1]

Options:

A. 60 mm

B. 24 mm

C. 120 mm

D. 12 mm

Answer: B

Solution:

$$W = \frac{2\lambda d}{a} = \frac{2 \times 6 \times 10^{-7} \times 0.2}{1 \times 10^{-5}}$$

$$= 2.4 \times 10^{-2} = 24\text{ mm}$$

Question11

A microwave of wavelength 2.0 cm falls normally on a slit of width 4.0 cm. The angular spread of the central maxima of the diffraction pattern obtained on a screen 1.5m away from the slit, will be:
[1-Feb-2024 Shift 2]

Options:

A. 30°

B. 15°

C. 60°

D. 45°

Answer: C

Solution:

For first minima a $\sin\theta = \lambda$

$$\sin\theta = \frac{\lambda}{a} = \frac{1}{2}$$

$$\theta = 30^{\circ}$$

Question12

In Young's double slit experiment, monochromatic light of wavelength 5000Å is used. The slits are 1.0 mm apart and screen is placed at 1.0m away from slits. The distance from the centre of the screen where intensity becomes half of the maximum intensity for the first time is___ $\times 10^{-6}$m.
[1-Feb-2024 Shift 2]

Solution:

Let intensity of light on screen due to each slit is I_0

So internity at centre of screen is $4I_0$

[illegible] distance y from centre-

$I = I_0 + I_0 + 2\sqrt{I_0 I_0} \cos\phi$

$I_{max} = 4I_0$

$\frac{I_{max}}{2} = 2I_0 = 2I_0 + 2I_0 \cos\phi$

$\cos\phi = 0$

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

$K\Delta x = \frac{\pi}{2}$

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

$\frac{2}{\lambda} d \times \frac{y}{D} = \frac{1}{2}$

$y = \frac{\lambda D}{4d} = \frac{5 \times 10^{-7} \times 1}{4 \times 10^{-3}}$

$= 125 \times 10^{-6}$

$= 125$

Question13

Given below are two statements :
Statement I : If the Brewster's angle for the light propagating from air to glass is θ_B, then Brewster's angle for the light propagating from glass to air is $\frac{\pi}{2} - \theta_B$.
Statement II : The Brewster's angle for the light propagating from glass

to air is $\tan^{-1}(\mu_g)$ where μ_g is the refractive index of glass.
In the light of the above statements, choose the correct answer from the options given below :
[24-Jan-2023 Shift 1]

Options:

A. Both Statements I and Statement II are true.

B. Statement I is true but Statement II is false.

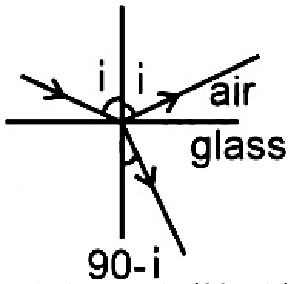
C. Both Statement I and Statement II are false.

D. Statement I is false but Statement II is true.

Answer: B

Solution:

Solution:



$\mu_a \sin i_1 = \mu_g \sin(90 - i_1)$

$\tan i_1 = \frac{\mu_g}{\mu_a}$

When going from glass to air $\tan i_2 = \frac{\mu_a}{\mu_g} = \cot i_1$

Hence

$i_2 = \frac{\pi}{2} - i_1$

Question14

In Young's double slits experiment, the position of 5^{th} bright fringe from the central maximum is $5\,cm$. The distance between slits and screen is 1m and wavelength of used monochromatic light is $600\,nm$. The separation between the slits is:
[25-Jan-2023 Shift 1]

Options:

A. 60μm

B. 48μm

C. 12μm

D. 36μm

Solution:

Given

$\lambda = 600 \times 10^{-9}$m
n = 5

As $y_{nth} = \frac{n\lambda D}{d}$

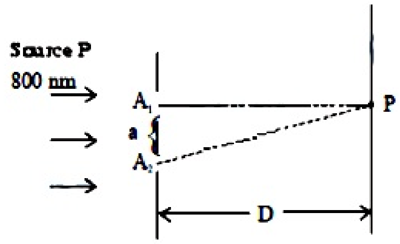
$\Rightarrow \frac{5 \times 600 \times 10^{-9} \times 1}{d} = 5 \times 10^{-2}$

$\Rightarrow d = \frac{5 \times 600 \times 10^{-9} \times 1}{5 \times 10^{-2}} = 60 \times 10^{-6}$m

$\Rightarrow d = 60\mu m$

Question15

In a Young's double slit experiment, two slits are illuminated with a light of wavelength 800 nm. The line joining A_1P is perpendicular to A_1A_2 as shown in the figure. If the first minimum is detected at P, the value of slits separation ' a ' will be :
The distance of screen from slits D = 5 cm



[29-Jan-2023 Shift 1]

Options:

A. 0.4 mm

B. 0.5 mm

C. 0.2 mm

D. 0.1 mm

Answer: C

Solution:

$A_2P - A_1P = \frac{\lambda}{2}$ (Condition of minima)

$\sqrt{D^2 + a^2} - D = \frac{\lambda}{2}$

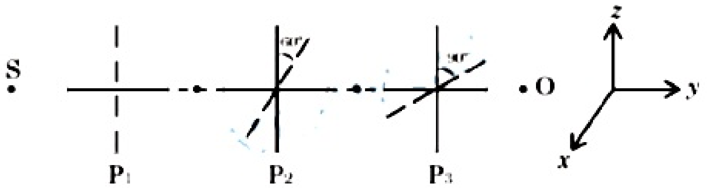
$D\left(1 + \frac{a^2}{D^2}\right)^{1/2} - D = \frac{\lambda}{2}$

$D\left(1 + \frac{1}{2} \times \frac{a^2}{D^2}\right) - D = \frac{\lambda}{2}$

$$\frac{a^2}{2D} = \frac{\lambda}{2} \Rightarrow a = \sqrt{\lambda . D}$$
$$= \sqrt{800 \times 10^{-6} \times 50}$$
$$a = 0.2\,\text{mm}$$

Question16

As shown in figures, 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 angle of 60° and 90° with respect to axis of P_1. The source S has an intensity of $256\ \frac{W}{m^2}$. The intensity of light at point O is $-----\ \frac{W}{m^2}$.



[29-Jan-2023 Shift 1]

Solution:

Solution:
By first polaroid P1 intensity will be halved then P2 and P3 will make intensity $\cos^2(60^\circ)$ and $\cos^2(30^\circ)$ times respectively.

$$\text{Intensity out} = \frac{256}{2} \times \frac{1}{4} \times \left(\frac{\sqrt{3}}{2}\right)^2 = \frac{256 \times 3}{2 \times 4 \times 4} = 24$$

Question17

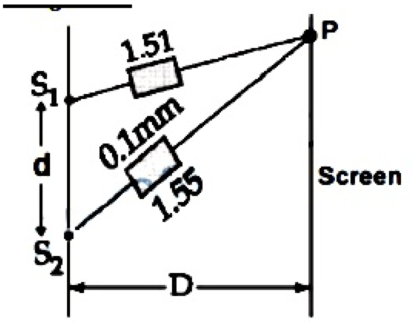
Unpolarised light is incident on the boundary between two dielectric media, whose dielectric constants are 2.8 (medium -1) and 6.8 (medium 2), respectively. To satisfy the condition, so that the reflected and refracted rays are perpendicular to each other, the angle of incidence should be $\tan^{-1}\left(1 + \frac{10}{\theta}\right)^{\frac{1}{2}}$ the value of θ is ______.
(Given for dielectric media, $\mu_r = 1$)
[29-Jan-2023 Shift 2]

Answer: 7

$\mu_1 = \sqrt{2.8 \times 1} = \sqrt{2.8}$
$\mu_2 = \sqrt{6.8 \times 1} = \sqrt{6.8}$
$\mu_1 \sin i = \mu_2 \cos i \quad \tan i = \frac{\mu_2}{\mu_1} = \sqrt{\frac{6.8}{2.8}}$
$\tan i = \left(\frac{2.8+4}{2.8}\right)^{1/2} \quad i = \tan^{-1}\left(1 + \frac{10}{7}\right)^{1/2}$
$\theta = 7$ Ans.

Question18

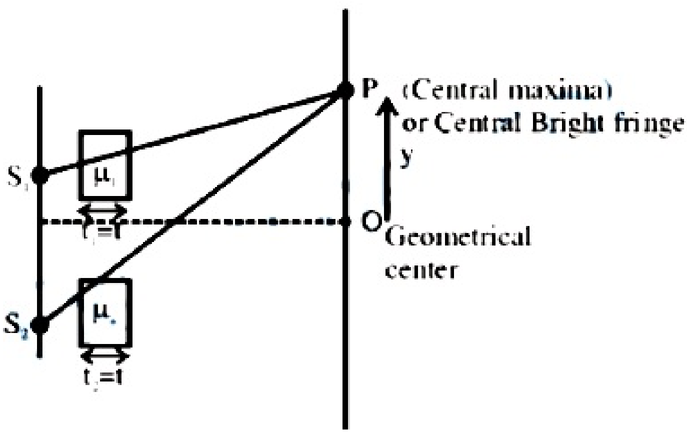
In Young's double slit experiment, two slits S_1 and S_2 are ' d ' distance apart and the separation from slits to screen is D (as shown in figure). Now if two transparent slabs of equal thickness 0.1 mm but refractive index 1.51 and 1.55 are introduced in the path of beam ($\lambda = 4000Å$) from S_1 and S_2 respectively. The central bright fringe spot will shift by ______ number of fringes.



[30-Jan-2023 Shift 1]

Answer: 10

Solution:



Path difference at P be Δx
$\Delta x = (\mu_2 - \mu_1)t$
$= (1.55 - 1.51)0.1\text{ mm}$
$= 0.04 \times 10^{-4}$
$\Delta x = 4 \times 10^{-6} = 4\mu m$
$y = \frac{\Delta x D}{d} = 4 \times 10^{-6}\frac{D}{d}$
y is the distance of central maxima from geometric center
fringe width

$(\beta) = \frac{\lambda D}{d} = 4 \times 10^{-6} m \frac{D}{d} = 4 \mu m \frac{D}{d}$

Central bright fringe spot will shift by ' x '

Number of shift $= \frac{y}{\beta}$

$= \frac{4 \times 10^{-6} D / d}{4 \times 10^{-7} D / d} = 10$ Ans

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Question19

In a Young's double slit experiment, the intensities at two points, for the path difference $\frac{\lambda}{4}$ and $\frac{\lambda}{3}$ (λ being the 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 $\frac{I_1 + I_2}{I_0}$ = ...
[30-Jan-2023 Shift 2]

Answer: 3

Solution:

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

$$I_1 = 4I_0 \cos^2\left(\frac{\pi}{4}\right) = 2I_0$$

$$I_2 = 4I_0 \cos^2\left(\frac{2\pi}{3}\right) = I_0$$

$$\Rightarrow \frac{I_1 + I_2}{I_0} = 3$$

Question20

Two polaroide A and B are placed in such a way that the pass-axis of polaroids are perpendicular to each other. Now, another polaroid C is placed between A and B bisecting angle between them. If intensity of unpolarised light is I_0 then intensity of transmitted light after passing through polaroid B will be :
[31-Jan-2023 Shift 1]

Options:

A. $\frac{I_0}{4}$

B. $\frac{I_0}{2}$

D. Zero

Answer: C

Solution:

$$I_C = \frac{I_\circ}{2}\cos^2 45 = \frac{I_o}{4}$$

$$I_B = I_C \cos^2 45 = \frac{I_o}{8}$$

Option 3.

Question21

Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R
Assertion A: The beam of electrons shows wave nature and exhibit interference and diffraction.
Reason R : Davisson Germer Experimentally verified the wave nature of electrons.
In the light of the above statements. Choose the most appropriate answer from the options given below :
[31-Jan-2023 Shift 1]

Options:

A. A is correct but R is not correct

B. A is not correct but R is correct

C. Both A and R are correct but R is Not the correct explanation of A

D. Both A and R are correct and R is the correct explanation of A

Answer: D

Solution:

Solution:
Conceptual

Question22

Two light waves of wavelengths 800 and 600 nm are used in Young's double slit experiment to obtain interference fringes on a screen placed 7m away from plane of slits. If the two slits are separated by 0.35 mm, then shortest distance from the central bright maximum to the point

mm.
[31-Jan-2023 Shift 2]

Solution:

$\omega_1 = \frac{\lambda_1 D}{d}$ and $\omega_2 = \frac{\lambda_2 D}{d}$
$\omega_1 = 16\,\text{mm}$ and $\omega_2 = 12\,\text{mm}$
So $\text{LCM}(\omega_1, \omega_2) = 48\,\text{mm}$
So at $48\,\text{mm}$ distance both bright fringes will be found.

Question23

' n ' polarizing sheets are arranged such that each makes an angle 45° with the proceeding sheet. An unpolarized light of intensity I is incident into this arrangement. The output intensity is found to be $\frac{I}{64}$. The value of n will be:
[1-Feb-2023 Shift 1]

Options:

A. 3

B. 6

C. 5

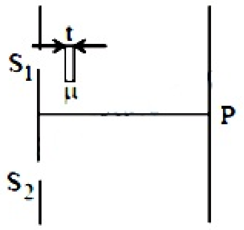
D. 4

Answer: B

Solution:

After passing through first sheet
$I_1 = \frac{I}{2}$
After passing through second sheet
$I_2 = I_1 \cos^2(45^\circ) = \frac{I}{4}$
After passing through n^{th} sheet
$I_n = \frac{I}{2^n} = \frac{I}{64}$
$n = 6$

As shown in the figure, in Young's double slit experiment, a thin plate of thickness $t = 10 \mu m$ and refractive index $\mu = 1.2$ is inserted infront of slit S_1. The experiment is conducted in air ($\mu = 1$) and uses a monochromatic light of wavelength $\lambda = 500\,nm$. Due to the insertion of the plate, central maxima is shifted by a distance of $x\beta_0$. β_0 is the fringe-width before the insertion of the plate. The value of the x is ______.



[1-Feb-2023 Shift 2]

Solution:

$$\text{Fringe shift} = \frac{t(\mu - 1)}{\lambda} B$$

$$= \frac{10 \times 10^{-6}(1.2 - 1)}{\times 10^{-7}} B$$

$$= \frac{10^{-[illegible]} \times 0.2}{5 \times 10^{-7}} = 4$$

Question25

A beam of light consisting of two wavelengths 7000Å and 5500Å is used to obtain interference pattern in Young's double slit experiment. The distance between the slits is 2.5 mm and the distance between the place of slits and the screen is 150 cm. The least distance from the central fringe, where the bright fringes due to both the wavelengths coincide, is $n \times 10^{-5}$m. The value of n is ________
[6-Apr-2023 shift 2]

Answer: 462

Let n_1 maxima of 7000Å coincides with n_2 maxima of 5500Å
therefore $n_1\beta_1 = n_2\beta_2$

or $\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{5500}{7000} = \frac{11}{14}$
therefore 11^{th} maxima of 7000Å will coincide with 14^{th} maximum of 5500Å
To find the least distance of this
$y = n_1\beta_1$
or $y = \frac{n_1\lambda_1 D}{d} = \frac{11 \times 7000 \times 10^{-10} \times 150 \times 10^{-2}}{2.5 \times 10^{-3}}$
$= \frac{11 \times 7 \times 5}{2.5} \times 10^{-5}m$
or $y = 462 \times 10^{-5}m$
therefore $n = 462$

Question26

The width of fringe is 2 mm on the screen in a double slits experiment for the light of wavelength of 400 nm. The width of the fringe for the light of wavelength 600 nm will be:
[8-Apr-2023 shift 2]

Options:

A. 1.33 mm

B. 3 mm

C. 2 mm

D. 4 mm

Answer: B

Solution:

$$\beta = \frac{D\lambda}{d}$$
$$\Rightarrow \beta \propto \lambda$$
$$\frac{\beta_1}{\beta_2} = \frac{\lambda_1}{\lambda_2} \Rightarrow \frac{2}{\beta} = \frac{400}{600}$$
$$\beta = 3\,mm$$

Question27

Unpolarised light of intensity $32Wm^{-2}$ passes through the combination of three polaroids such that the pass axis of the last polaroid is perpendicular to that of the pass axis of first polaroid. If intensity of emerging light is $3\ Wm^{-2}$, then the angle between pass axis of first two polaroids is ________.
[10-Apr-2023 shift 1]

Answer: 30

Solution:

$I_{net} = 3 = \frac{32}{8}(\sin 2\theta)^2 = \frac{I_0}{2}\cos^2\theta\sin^2\theta$

$\text{Sin}(2\theta) = \frac{\sqrt{3}}{2} \Rightarrow 2\theta = 60\&120^\circ = \frac{I_0}{8}(\sin 2\theta)^2$

$\theta = 30^\circ\&60^\circ$

Question28

The ratio of intensities at two points P and Q on the screen in a Young's double slit experiment where phase difference between two waves of same amplitude are π / 3 and π / 2, respectively are
[10-Apr-2023 shift 2]

Options:

A. 3 : 2

B. 3 : 1

C. 2 : 3

D. 1 : 3

Answer: A

Solution:

$I_{res} = 4I_o\cos^2\left(\frac{\theta}{2}\right)$

If $\theta = \frac{\pi}{3}, I_{res} = 4I_o \cdot \cos^2\left[\frac{\pi}{6}\right]$

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

$I_1 = (4I_0)\left(\frac{3}{4}\right) = 3I_0$

If $\theta = \frac{\pi}{2}, I_{res} = 4I_0 \cdot \cos^2\left(\frac{\pi}{2}\right)$

$= 4I_0\left(\frac{1}{\sqrt{2}}\right)^2$

$= (4I_o)\left(\frac{1}{2}\right)$

$I_2 = 2I_o$

Question29

In a Young's double slits experiment, the ratio of amplitude of light coming from slits is 2 : 1. The ratio of the maximum to minimum intensity in the interference pattern is :
[13-Apr-2023 shift 2]

Options:

A. 9 : 1

B. 9 : 4

C. 2 : 1

D. 25 : 9

Answer: A

Solution:

Given that

$$\frac{A_1}{A_2} = \frac{2}{1}$$

$$\frac{I_{max}}{I_{min}} = \frac{(A_1 + A_2)^2}{(A_1 - A_2)^2} = \frac{9}{1}$$

$= 9 : 1$

Question30

A single slit of width a is illuminated by a monochromatic light of wavelength 600 nm. The value of 'a' for which first minimum appears at $\theta = 30^{\circ}$ on the screen will be :
[15-Apr-2023 shift 1]

Options:

A. 0.6μm

B. 3μm

C. 1.8μm

D. 1.2μm

Answer: D

Solution:

Solution:

$a = \frac{\lambda}{\sin 30^{\circ}} = 2\lambda$
$a = 1200 \, nm$
$a = 1.2 \mu m$

Question31

Sodium light of wavelengths 650 nm and 655 nm is used to study diffraction at a single slit of aperture 0.5 mm. The distance between the slit and the screen is 2.0m. The separation between the positions of the first maxima of diffraction pattern obtained in the two cases is ______ $\times 10^{-5}$ m.
[24-Jun-2022-Shift-1]

Solution:

Position of 1^{st} maxima is $\frac{3}{2} \frac{\lambda D}{a}$

⇒ According to given values, required separation $= \frac{3}{2} \times (655 \, nm - 650 \, nm) \times \frac{2m}{0.5 \, mm}$

⇒ Required separation $= 3 \times 10^{-5} m$.

Question32

The two light beams having intensities I and 91 interfere to produce a fringe pattern on a screen. The phase difference between the beams is π / 2 at point P and π at point Q. Then the difference between the resultant intensities at P and Q will be :
[25-Jun-2022-Shift-1]

Options:

A. 21

B. α

C. 51

D. 71

Answer: B

Solution:

$I_P = I + 9I + 2\sqrt{I \times 9I} \cos\frac{\pi}{2} = 10I$

$I_Q = I + 9I + 2\sqrt{I \times 9I} \cos\pi = 4I$

So, $I_P - I_Q = 6I$

Question33

The interference pattern is obtained with two coherent light sources of intensity ratio 4 : 1. And the ratio $\frac{I_{max} + I_{min}}{I_{max} - I_{min}}$ is $\frac{5}{x}$. Then, the value of x will be equal to :
[25-Jun-2022-Shift-2]

Options:

A. 3

B. 4

C. 2

D. 1

Answer: B

Solution:

$$\frac{I_{max} + I_{min}}{I_{max} - I_{min}} = \frac{I_1 + I_2 + 2\sqrt{I_1 I_2} + I_1 + I_2 - 2\sqrt{I_1 I_2}}{I_1 + I_2 + 2\sqrt{I_1 I_2} - I_1 - I_2 + 2\sqrt{I_1 I_2}}$$

$$= \frac{2(I_1 + I_2)}{4\sqrt{I_1 I_2}}$$

$$= \frac{\left(\frac{I_1}{I_2} + 1\right)}{2\sqrt{\frac{I_1}{I_2}}} = \frac{4 + 1}{2 \times 2} = \frac{5}{4}$$

So $x = 4$

Question34

In free space, an electromagnetic wave of 3 GHz frequency strikes over the edge of an object of size $\frac{\lambda}{100}$, where λ is the wavelength of the wave in free space. The phenomenon, which happens there will be :
[26-Jun-2022-Shift-1]

Options:

A. Reflection

B. Refraction

C. Diffraction

D. Scattering

Answer: D

Solution:

$\frac{a}{\lambda} = \frac{1}{100}$

For reflection size of obstacle must be much larger than wavelength, for diffraction size should be order of wavelength.

Since the object is of size $\frac{\lambda}{100}$, much smaller than wavelength, so scattering will occur.

Question35

For a specific wavelength 670 nm of light coming from a galaxy moving with velocity v, the observed wavelength is 670.7 nm. The value of v is : [26-Jun-2022-Shift-2]

Options:

A. $3 \times 10^{8} ms^{-1}$

B. $3 \times 10^{10} ms^{-1}$

C. $3.13 \times 10^{5} ms^{-1}$

D. $4.48 \times 10^{5} ms^{-1}$

Answer: C

Solution:

$$\lambda_{obs} = \lambda_{source} \sqrt{\frac{1 + \frac{v}{C}}{1 - \frac{v}{C}}}$$

For $v < < C$,

$\frac{670.7}{670} = 1 + \frac{v}{C}$

$\Rightarrow v = \frac{0.7}{670} \times 3 \times 10^{8} m / s$

$\Rightarrow v \simeq 3.13 \times 10^{5} m / s$

Question36

In Young's double slit experiment the two slits are 0.6 mm distance apart. Interference pattern is observed on a screen at a distance 80 cm from the slits. The first dark fringe is observed on the screen directly opposite to one of the slits. The wavelength of light will be____ nm. [27-Jun-2022-Shift-1]

Answer: 450

Solution:

$y = \dfrac{d}{2}$

$\therefore \Delta x = y\dfrac{d}{D}$

$\Rightarrow \dfrac{d^2}{2D} = \dfrac{\lambda}{2}$

$\Rightarrow \lambda = \dfrac{(0.6 \times 10^{-3})^2}{0.8}$

$= 450\,\text{nm}$

Question37

In Young's double slit experiment performed using a monochromatic light of wavelength λ, when a glass plate (μ = 1.5) of thickness xλ is introduced in the path of the one of the interfering beams, the intensity at the position where the central maximum occurred previously remains unchanged. The value of x will be :
[28-Jun-2022-Shift-2]

Options:

A. 3

B. 2

C. 1.5

D. 0.5

Answer: B

Solution:

Solution:
For the intensity to remain same the position must be of a maxima so path difference must be $n\lambda$ so
$(1.5-1) \times \lambda = n\lambda$
$x = 2n (n = 0, 1, 2 \ldots)$
So, value of x will be
$x = 0, 2, 4, 6 \ldots$

Question38

In a Young's double slit experiment, an angular width of the fringe is 0.35° on a screen placed at 2m away for particular wavelength of

450 nm. The angular width of the fringe, when whole system is immersed in a medium of refractive index 7 / 5, is $\frac{1}{\alpha}$. The value of α is____
[28-Jun-2022-Shift-2]

Solution:

Angular fringe width $\theta = \frac{\lambda}{D}$

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

$\theta_2 = \frac{0.35^\circ}{450\text{ nm}} \times \frac{450\text{ nm}}{715} = 0.25^\circ = \frac{1}{4}$

So $\alpha = 4$

Question39

Using Young's double slit experiment, a monochromatic light of wavelength 5000Å produces fringes of fringe width 0.5 mm. If another monochromatic light of wavelength 6000Å is used and the separation between the slits is doubled, then the new fringe width will be :
[29-Jun-2022-Shift-1]

Options:

A. 0.5 mm

B. 1.0 mm

C. 0.6 mm

D. 0.3 mm

Answer: D

Solution:

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

⇒ Fringe width $\propto \frac{\lambda}{d}$

⇒ New fringe width $= 0.5\text{ mm} \times \frac{1.2}{2} = 0.3\text{ mm}$

Question40

In a double slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the plane of slits. If the screen is moved by 5×10^{-2}m towards the slits, the change in fringe width is 3×10^{-3} cm. If the distance between the slits is 1 mm, then the wavelength of the light will be____ nm.
[29-Jun-2022-Shift-2]

Solution:

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

$\Rightarrow |d\beta| = \frac{\lambda}{d}|d(D)|$

$\Rightarrow 3 \times 10^{-3}\,\text{cm} = \frac{\lambda}{1\,\text{mm}}(5 \times 10^{-2}\,\text{m})$

$\Rightarrow \lambda = \frac{3 \times 10^{-8}}{5 \times 10^{-2}}\text{m}$

$\Rightarrow \lambda = 600\,\text{nm}$

Question41

In Young's double slit experiment, the fringe width is 12 mm. If entire arrangement is placed in water of refractive index $\frac{4}{3}$, the fringe width becomes (in mm):
[26-Jul-2022-Shift-1]

Options:

A. 16

B. 9

C. 48

D. 12

B

Solution:

$B = 12 \times 10^{-3}$

Question42

In Young's double slit experiment, the fringe width is 12 mm. If the entire arrangement is placed in water of refractive index $\frac{4}{3}$, then the fringe width becomes (in mm):
[26-Jul-2022-Shift-1]

Options:

A. 16

B. 9

C. 48

D. 12

Answer: B

Solution:

$: 10^{-3}$

$$\beta' = \frac{\beta}{\mu} = \frac{12 \times 10^{-3}}{\frac{4}{3}}$$

$$= 9 \times 10^{-3} \text{m} = 9 \text{ mm}$$

Question43

Two coherent sources of light interfere. The intensity ratio of two sources is 1 : 4. For this interference pattern if the value of $\frac{I_{max} + I_{min}}{I_{max} - I_{min}}$ is equal to $\frac{2\alpha + 1}{\beta + 3}$, then $\frac{\alpha}{\beta}$ will be :
[27-Jul-2022-Shift-2]

Options:

A. 1.5

B. 2

C. 0.5

D. 1

Answer: B

Solution:

$I_2 = 4I_1$

$I_{max} = I_1 + 4I_1 + 2\sqrt{I_1 4I_1} = 9I_1$

$I_{min} = I_1 + 4I_1 - 2\sqrt{I_1 4I_1} = I_1$

$\therefore \frac{9I_1 + I_1}{9I_1 - I_1} = \frac{10}{8} = \frac{5}{4} = \frac{2\alpha + 1}{\beta + 1}$

$\alpha = 2 \quad \beta = 1$

$\therefore \frac{\alpha}{\beta} = \frac{2}{1} = 2$

Question44

In a Young's double slit experiment, a laser light of 560 nm produces an interference pattern with consecutive bright fringes' separation of 7.2 mm. Now another light is used to produce an interference pattern with consecutive bright fringes' separation of 8.1 mm. The wavelength of second light is ________ nm.
[28-Jul-2022-Shift-1]

Solution:

Solution:

$\beta \propto \lambda$

$\lambda_2 = \frac{9}{8}\lambda_1$

$\therefore \beta_2 = \frac{9}{8}\beta_1 = \frac{9}{8} \times 560 = 630\,\text{nm}.$

Question45

An unpolarised light beam of intensity $2I_0$ is passed through a polaroid P and then through another polaroid Q which is oriented in such a way that its passing axis makes an angle of 30° relative to that of P. The intensity of the emergent light is
[29-Jul-2022-Shift-2]

Options:

A. $\frac{I_0}{4}$

B. $\frac{I_0}{2}$

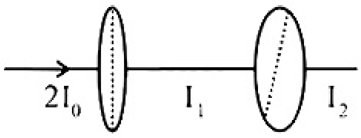
C. $\frac{3I_0}{\ldots}$

D. $\frac{3I_0}{2}$

Answer: C

Solution:

Solution:



$I_1 = \frac{1}{2}(2I_0) = I_0$
$I_2 = I_1 \cos^2 30^\circ$
$= I_0 \cdot \frac{3}{4} = \frac{3I_0}{4}$

Question46

Consider the diffraction pattern obtained from the sunlight incident on a pinhole of diameter 0.1μm. If the diameter of the pinhole is slightly increased, it will affect the diffraction pattern such that [25 Feb 2021 Shift 2]

Options:

A. its size increases and intensity increases

B. its size increases, but intensity decreases

C. its size decreases, but intensity increases

D. its size decreases and intensity decreases

Answer: C

Solution:

Solution:
Given, diameter of pinhole, $a = 0.1\mu m = 0.1 \times 10^{-6} m$
∵ Path difference $(\Delta x) = a \sin \varphi = n\lambda$ . . . (i)
where, φ is the phase difference and λ be the wavelength.
As, $I = 4I_0 \cos^2 \varphi$
and $\sin \varphi = \frac{n\lambda}{a}$ [from Eq. (i)]
If a increases $\leftrightarrow \sin \varphi$ or φ decreases
As φ decreases $\leftrightarrow \cos \varphi$ increases
∴ Intensity increases.
Hence, on decreasing diameter of pinhloe, the size of diffraction pattern decreases and intensity increases.

Question47

three times the other slit. The amplitude of the light coming from a slit is proportional to the slit-width. Find the ratio of the maximum to the minimum intensity in the interference pattern.
[24feb2021shift1]

Options:

A. 1 : 4

B. 3 : 1

C. 4 : 1

D. 2 : 1

Answer: C

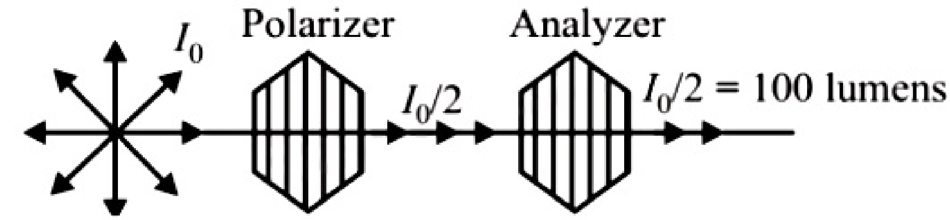
Solution:

Solution:
Let the amplitude of light wave coming from the narrower slit be A_1 and amplitude of light wave from the wider slit be A_2
.
As amplitude ∝ Width of slit
$\therefore A_2 = 3A_1$
Maximum intensity occurs where constructive interference takes place and the minimum intensity where destructive interference takes place.
$\therefore A_{max} = 3A_1 + A_1 = 4A_1$ and
$A_{min} = 3A_1 - A_1 = 2A_1$
$\because$ Intensity $I \propto A^2$
$\therefore \frac{I_{max}}{I_{min}} = \frac{A_{max}^2}{A_{min}^2} = \left(\frac{4A_1}{2A_1}\right)^2 = 4 : 1$

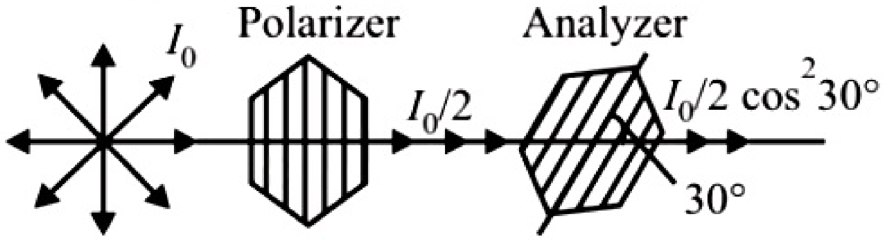
Question48

An unpolarized light beam is incident on the polarizer of a polarization experiment and the intensity of light beam emerging from the analyzer is measured as 100 Lumens. Now, if the analyzer is rotated around the horizontal axis (direction of light) by 30^{circ} in clockwise direction, the intensity of emerging light will be Lumens.
[24feb2021shift1]

Solution:



When the angle between axis of polarizer and analyzer is 30°.



Now emerging intensity $= \frac{I_0}{2}\cos^2 30°$

$= 100\left(\frac{\sqrt{3}}{2}\right)^2 = 100 \times \frac{3}{4} = 75$

Question49

In a Young's double slit experiment, two slits are separated by 2mm and the screen is placed one metre away. When a light of wavelength 500nm is used, the fringe separation will be
[26 Feb 2021 Shift 1]

Options:

A. 0.25mm

B. 0.50mm

C. 0.75mm

D. 1mm

Answer: A

Solution:

Given, in YDSE, the separation between two slits, $d = 2\text{mm}$
$= 2 \times 10^{-3}\text{m}$
Distance between slit and screen, $D = 1\text{m}$
Wavelength of light, $\lambda = 500\text{nm}$
$= 500 \times 10^{-9}\text{m}$
Let B will be the fringe width

$$\therefore B = \frac{\lambda D}{d} = \frac{500 \times 10^{-9} \times 1}{2 \times 10^{-3}} = 250 \times 10^{-6}$$

$= 0.25\text{mm}$

Question50

Two coherent light sources having intensity in the ratio 2x produce an

interference pattern. The ratio $\frac{I_{max} - I_{min}}{I_{max} + I_{min}}$ will be
[25 Feb 2021 Shift 1]

Options:

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

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

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

D. $\frac{2\sqrt{2x}}{2x+1}$

Answer: D

Solution:

I_1 $2x$

2

$\Rightarrow I_1 = 2I_2x$

As we know, and

$I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2$

$\therefore \frac{I_{max} - I_{min}}{I_{max} + I_{min}} = \frac{2\sqrt{I_1 I_2}}{I_1 + I_2}$ (using dividendo rule)

$= \frac{2\sqrt{2I_2x \cdot I_2}}{2I_2x + I_2} = \frac{2\sqrt{2x}}{2x+1}$

Question51

If the source of light used in a Young's double slit experiment is changed from red to violet, then
[24 Feb 2021 Shift 2]

Options:

A. the consecutive fringe lines will come closer

B. the central bright fringe will become a dark fringe

C. the fringes will become brighter

D. the intensity of minima will increase

Answer: A

Solution:

Solution:
According to Young's double slit experiment, The distance of nth bright fringe from the centre,
$n\lambda D$

Since, $\lambda_{violet} < \lambda_{red}$
$\therefore y_{violet} < y_{red}$
∴ Consecutive fringe lines will come closer.

Question52

In Young's double slit arrangement, slits are separated by a gap of 0.5mm, and the screen is placed at a distance of 0.5m from them. The distance between the first and the third bright fringe formed when the slits are illuminated by a monochromatic light of 5890Å is [18 Mar 2021 Shift 1]

Options:

A. 1178×10^{-9}m

B. 1178×10^{-6}m

C. 1178×10^{-12}m

D. 5890×10^{-7}m

Answer: B

Solution:

Solution:
Given,
The distance of sources from the screen, $D = 0.5m$
The distance between the slits, $d = 0.5mm = 0.0005m$
The wavelength of the monochromatic light,
$\lambda = 5890\,\text{Å} = 5890 \times 10^{-10}m$
$Y = 2\beta$
As we know, $\beta = \frac{\lambda D}{d}$
Substituting the values in the above equation.
$Y = 2\left(\frac{\lambda D}{d}\right) = 2\left(\frac{5890 \times 10^{-10} \times 0.5}{0.0005}\right)$
$= 1178 \times 10^{-6}m$

Question53

A fringe width of 6mm was produced for two slits separated by 1mm apart. The screen is placed 10m away. The wavelength of light used is xnm. The value of x to the nearest integer is .... [16 Mar 2021 Shift 1]

Solution:

Given,
Slit width, $d = 1\text{mm} = 10^{-3}\text{m}$
Fringe width, $\beta = 6\text{mm} = 6 \times 10^{-3}\text{m}$
Distance between the screen and the slit, $D = 10\text{m}$
Wavelength of light used $\lambda = ?$

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

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

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

$= 6 \times 10^{-7}\text{m} = 600 \times 10^{-9}\text{m}$

$= 600\text{nm}$

Question54

A galaxy is moving away from the Earth at a speed of 286kms^{-1}. The shift in the wavelength of a red line at 630nm is $x \times 10^{-10}\text{m}$. The value of x to the nearest integer, is ....
(Take the value of speed of light c, as $3 \times 10^{8}\text{ms}^{-1}$)
[18 Mar 2021 Shift 2]

Answer: 6

Solution:

The shift in the wavelength of a red line,

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

$\frac{v}{c} \times \lambda$

$= \frac{286 \times 10^{3}}{3 \times 10^{8}} \times 630 \times 10^{-9}$

$= 6 \times 10^{-10}\text{m}$

Hence, the value of the x to the nearest integer is 6 .

Question55

In Young's double slit experiment, if the source of light changes from orange to blue then :
[27 Jul 2021 Shift 1]

Options:

A. the central bright fringe will become a dark fringe.

B. the distance between consecutive fringes will decrease.

C. the distance between consecutive fringes will increase.

D. the intensity of the minima will increase.

Answer: B

Solution:

Fringe width = λD/d
as λ decreases , fringe width also decreases

Question56

In the Young's double slit experiment, the distance between the slits varies in time asd (t) = $d_0 + a_0 \sin \omega t$; where d_0, ω and a_0 are constants. The difference between the largest fringe width and the smallest fringe width obtained over time is given as :
[25 Jul 2021 Shift 1]

Options:

A. $\frac{2\lambda D(d_0)}{(d_0^2 - a_0^2)}$

B. $\frac{2\lambda D a_0}{(d_0^2 - a_0^2)}$

C. $\frac{\lambda D}{d_0^2} a_0$

D. $\frac{\lambda D}{d_0 + a_0}$

Answer: B

Solution:

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

$\beta_{max} \Rightarrow d_{min}$ and $\beta_{min} \Rightarrow d_{max}$

$d = d_0 + a_0 \sin \omega t$

$d_{max} = d_0 + a_0$ and $d_{min} = d_0 - a_0$

$\therefore \beta_{min} = \frac{\lambda D}{d_0 + a_0}$ and $\therefore \beta_{max} = \frac{\lambda D}{d_0 - a_0}$

$\beta_{max} - \beta_{min} = \frac{\lambda D}{d_0 - a_0} - \frac{\lambda D}{d_0 + a_0} = \frac{2\lambda D a_0}{d_0^2 - a_0^2}$

Question57

With what speed should a galaxy move outward with respect to earth so that the sodium-D line at wavelength 5890 Å is observed at 5896 Å ?
[20 Jul 2021 Shift 2]

Options:

A. 306 km/sec

B. 322 km/sec

C. 296 km/sec

D. 336 km/sec

Answer: A

Solution:

[illegible] $\beta = \frac{v}{c}$

$\frac{f}{f_0} \sqrt{\frac{1+\beta}{1-\beta}}$

$\left(1 + \frac{\Delta f}{f_0}\right)^2 = (1+\beta)(1-\beta)^{-1}$

β is small compared to 1

$\left(1 + \frac{2\Delta f}{f_0}\right) = (1 + 2\beta)$

$\beta = \frac{\Delta f}{f_0} = \frac{v}{c}$

$v = 6 \times \frac{c}{5890} = 305.6 \text{km} / \text{s}$

Question58

White light is passed through a double slit and interference is observed on a screen 1.5m away. The separation between the slits is 0.3 mm. The first violet and red fringes are formed 2.0 mm and 3.5 mm away from the central whitefringes. The difference in wavelengths of red and violet light is ...... nm.
[26 Aug 2021 Shift 1]

Answer: 300

Solution:
In a Young's double slit experiment for interference pattern, the position of bright fringe is given by

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

Here, D = 1.5 m,

$d = 0.3 \times 10^{-3} \times m$

and n = 1

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

For first violet, $y_n = 2 \text{ mm} = 2 \times 10^{-3} \text{m}$

$\therefore \lambda_{violet} = 2 \times 10^{-3}\frac{d}{D}$

For first red $y_n = 3.5\,mm = 3.5 \times 10^{-3} m$

$\lambda_{red} = 3.5 \times 10^{-3}\frac{d}{D}$

The difference in wavelengths of red and violet light is

$\Delta\lambda = \lambda_{red} - \lambda_{violet}$

$= 3.5 \times 10^{-3}\frac{d}{D} - 2 \times 10^{-3}\frac{d}{D}$

$= \frac{d}{D}(1.5) \times 10^{-3}$

$= \frac{0.3 \times 10^{-3}}{1.5} \times 1.5 \times 10^{-3}$

$= 0.3 \times 10^{-6}$

$= 0.3 \times 10^{-6} \times 10^{3} \times 10^{-3}$

$= 300 \times 10^{-9}$

$= 300\,nm$

Question59

A source of light is placed in front of a screen. Intensity of light on the screen is /. Two polaroids P_1 and P_2 are so placed in between the source of light and screen that the intensity of light on screen is $\frac{1}{2}$. P_2 should be rotatedby an angle of .... (degrees), so that the intensity of light on the screen becomes $\frac{31}{8}$.

[26 Aug 2021 Shift 2]

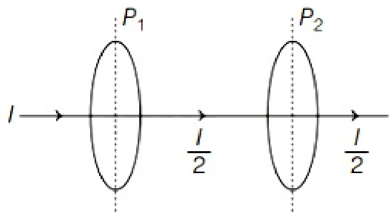
Solution:

Given, intensity of light falling on screen is I.

Intensity of light when P_1 and P_2 placed between screen and source is I/2.

As per Malus's law, the intensity of transmitted light when passing through a pair of polariser and analyser having angle ϕ between their axis is given as

$I = I_0 \cos^2\phi$



Initially let us consider the angle between analyser and polariser is 0°.

Then, the intensity of transmitted light is I / 2. Thus, intensity of light become I / 2 after transmitting through 1st polariser as shown in the figure.

If we rotate the polarise P_2 by angle ϕ, then the resulting intensity of light on screen will be 3/ / 8.

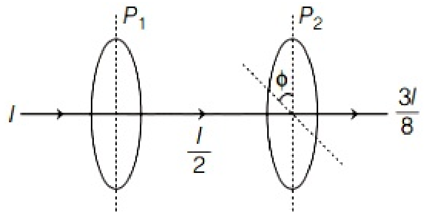
Now, for second condition, apply Malus's law,

$\frac{3I}{8} = \frac{I}{2}\cos^2\phi$

$\cos^2\phi = \frac{3}{4}$

$\Rightarrow \cos\phi = \frac{\sqrt{3}}{2}$

$\phi = 30°$.



Thus, P_2 should be rotated by 30° to get intensity of light 31/ / 8 on screen.

Question60

In a Young's double slit experiment, the slits are separated by 0.3 mm and the screen is 1.5m away from the plane of slits. Distance between fourth bright fringes on both sides of central bright is 2.4 cm. The frequency of light used is.......... $\times 10^{14}$ Hz.
[31 Aug 2021 Shift 2]

Solution:

Given, slit separation, $d = 0.3\,mm = 0.3 \times 10^{-3} m$
Distance between slit and screen, D = 1.5 m
Distance between 4th bright fringes $= 2Y_4 = 2.4\,cm$
Position of 4th fringe,

$Y_4 = \frac{2.4}{2} = 1.2\,cm = 1.2 \times 10^{-2} m$

Using equation, $Y_n = \frac{n\lambda D}{d}$

For n = 4

$1.2 \times 10^{-2} = \frac{4 \times \lambda \times 1.5}{0.3 \times 10^{-3}}$

∴ Wavelength, $\lambda = 6 \times 10^{-7} m$
Using c = λf

$\Rightarrow f = \frac{c}{\lambda} = \frac{3 \times 10^8}{6 \times 10^{-7}} = 5 \times 10^{14}\,Hz$

Hence, the frequency of light is 5×10^{14} Hz.
So, correct answer is 5.

Question61

The light waves from two coherent sources have same intensity $I_1 = I_2 = I_0$. In interference pattern the intensity of light at minima is zero. What will be the intensity of light at maxima?
[27 Aug 2021 Shift 2]

Options:

A. I_0

B. $2I_0$

C. $5I_0$

D. $4I_0$

Answer: D

Solution:

Given, intensity of two light waves
$I_1 = I_2 = I_0$
Since, $I_{min} = 0$
Since, $I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2$
and $= (\sqrt{I_0} + \sqrt{I_0})^2 I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$
$= (2\sqrt{I_0})^2 = 41_0$

Question62

The width of one of the two slits in a Young's double slit experiment is three times the other slit. If the amplitude of the light coming from a slit is proportional to the slit-width, the ratio of minimum to maximum intensity in the interference pattern is x : 4 where x is ....
[1 Sep 2021 Shift 2]

Answer: 1

Given, $b_1 = 3b_2$
Here, b_1 = width of the one of the two slit
and b_2 = width of the other slit.
As we know that,
Intensity, I $\propto (\text{Amplitude})^2$

$$\Rightarrow \frac{I_1}{I_2} = \left(\frac{b_1}{b_2}\right)^2$$

$$\Rightarrow \frac{I_1}{I_2} = \left(\frac{3b_2}{b_2}\right)^2$$

As we know, the ratio of the minimum intensity to the maximum intensity in the interference pattern,

$$\frac{I_{min}}{I_{max}} = \left(\frac{\sqrt{I_1} - \sqrt{I_2}}{\sqrt{I_1} + \sqrt{I_2}}\right)^2$$

Substituting the values in the above equations, we get

$$\frac{I_{min}}{I_{max}} = \frac{(\sqrt{9I_2} - \sqrt{I_2})^2}{(\sqrt{9I_2} + \sqrt{I_2})^2} = \sqrt{\left(\frac{3-1}{3+1}\right)^2}$$

$$\frac{I_{min}}{I_{max}} = \frac{1}{4}$$

Comparing with, $\frac{I_{min}}{I_{max}} = \frac{x}{4}$

The value of x = 1.

Question63

In a Young's double slit experiment 15 fringes are observed on a small portion of the screen when light of wavelength 500 nm is used. Ten fringes are observed on the same section of the screen when another light source of wavelength λ is used. Then the value of λ is (in nm) _____.
[NA 9 Jan 2020 II]

Solution:

Fringe width, $\beta = \frac{\lambda D}{d}$ where, $\lambda =$ wavelength, $D =$ distance of screen from slits, $d =$ distance between slits

ATQ

$15 \times \frac{\lambda_1 D}{d} = 10 \times \frac{\lambda_2 D}{d}$

$\Rightarrow 15\lambda_1 = 10\lambda_2$

$\Rightarrow \lambda_2 = 1.5\lambda_1 15\lambda_1 = 1.5 \times 500\text{nm}$

$\Rightarrow \lambda_2 = 750\text{nm}$

Question64

In a double-slit experiment, at a certain point on the screen the path difference between the two interfering waves is $\frac{1}{8}$ th of a wavelength. The ratio of the intensity of light at that point to that at the centre of a bright fringe is:
[8 Jan 2020 II]

Options:

A. 0.853

B. 0.672

C. 0.568

D. 0.760

Answer: A

Solution:

Given, Path difference, $\Delta x = \frac{\lambda}{8}$

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

$= \frac{2\pi}{\lambda} \times \frac{\lambda}{8} = \frac{\pi}{4}$

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

$\Rightarrow \frac{I}{I_0} = \cos^2\left(\frac{\frac{\pi}{4}}{2}\right) = \cos^2\left(\frac{\pi}{8}\right)$

$\Rightarrow \frac{I}{I_0} = 0.853$

Question65

In a Young's double slit experiment, the separation between the slits is 0.15 mm. In the experiment, a source of light of wavelength 589 nm is used and the interference pattern is observed on a screen kept 1.5 m away. The separation between the successive bright fringes on the screen is:
[7 Jan 2020 II]

Options:

A. 6.9 mm

B. 3.9 mm

C. 5.9 mm

D. 4.9 mm

Answer: C

Solution:

Solution:
Given, distance between screen and slits, $D = 1.5\text{m}$
Seperation between slits, $d = 0.15\text{mm}$
Wavelength of source of light, $\lambda = 589\text{nm}$
Fringe-width,
$w = \frac{D}{d}\lambda = \frac{1.5}{0.15 \times 10^{-3}} \times 589 \times 10^{-9}\text{m}$
$= 589 \times 10^{-2}\text{mm} = 5.89\text{mm} \approx 5.9\text{mm}$

Question66

The aperture diameter of telescope is 5m. The separation between the moon and the earth is 4×10^5 km. With light of wavelength of 5500 Å, the minimum separation between objects on the surface of moon, so that they are just resolved, is close to:
[9 Jan. 2020 I]

A. 60 m

B. 20 m

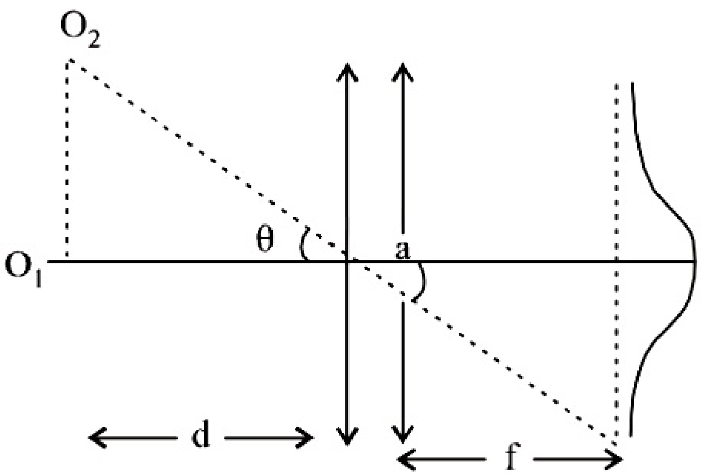
C. 200 m

D. 600 m

Answer: A

Solution:

Solution:



Smallest angular separation between two distant objects here moon and earth,

$\theta = 1.22 \frac{\lambda}{a}$

a = aperture diameter of telescope

Distance $O_1O_2 = (\theta)d$

Minimum separation between objects on the surface of moon, $= \left(1.22 \frac{\lambda}{a}\right) d$

$= \frac{(1.22)(5500 \times 10^{-10}) \times 4 \times 10^5 \times 10^3}{5}$

$= 5368 \times 10^{-2} \text{m} = 53.68 \text{m} \approx 60 \text{m}$

Question67

A polarizer - analyser set is adjusted such that the intensity of light coming out of the analyser is just 10% of the original intensity. Assuming that the polarizer - analyser set does not absorb any light, the angle by which the analyser need to be rotated further to reduce the output intensity to be zero, is:
[7 Jan. 2020 I]

Options:

A. 71.6°

B. 18.4°

C. 90°

D. 45°

Solution:

Solution:
According to question, the intensity of light coming out of the analyser is just 10% of the original intensity (I_0)
Using, $I = I_0 \cos^2\theta$
$\Rightarrow \frac{I_0}{10} = I_0 \cos^2\theta \Rightarrow \frac{1}{10} = \cos^2\theta$
$\Rightarrow \cos\theta = \frac{1}{\sqrt{10}} = 0.316 \Rightarrow \theta \approx 71.6°$
Therefore, the angle by which the analyser need to be rotated further to reduced the output intensity to be zero
$\phi = 90° - \theta = 90° - 71.6° = 18.4°$

Question68

In a double slit experiment, when a thin film of thickness t having refractive index μ is introduced in front of one of the slits, the maximum at the centre of the fringe pattern shifts by one fringe width. The value of t is (≈ is the wavelength of the light used) :
[12 April 2020 I]

Options:

A. $\frac{2\lambda}{(\mu - 1)}$

B. $\frac{\lambda}{2(\mu - 1)}$

C. $\frac{\lambda}{(\mu - 1)}$

D. $\frac{\lambda}{(2\mu - 1)}$

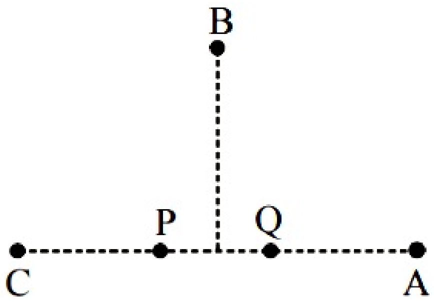
Answer: C

Solution:

Solution:
Given, $\Delta = \beta$
or $\frac{D(\mu - 1)t}{d} = \frac{D\lambda}{d}$
$\therefore t = \frac{\lambda}{(\mu - 1)}$

Question69

In the figure below, P and Q are two equally intense coherent sources emitting radiation of wavelength 20 m. The separation between P and Q is 5 m and the phase of P is ahead of that of Q by 90º. A, B and C are three distinct points of observation, each equidistant from the midpoint of PQ. The intensities of radiation at A, B, C will be in the ratio :



[Sep. 06, 2020 (I)]

Options:

A. 0 : 1 : 4

B. 2 : 1 : 0

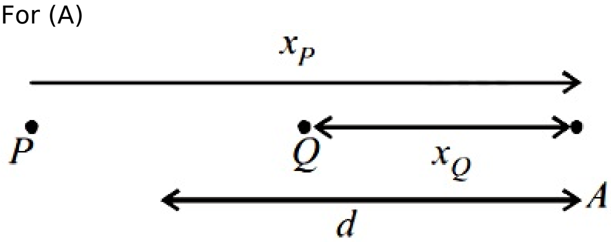
C. 0 : 1 : 2

D. 4 : 1 : 0

Answer: B

Solution:

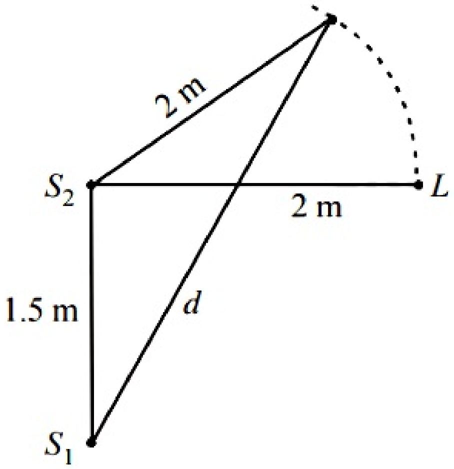
Solution:
For (A)



$x_P - x_Q = (d + 2.5) - (d - 2.5) = 5m$
Phase difference $\Delta\phi$ due to path difference
$= \frac{2\pi}{\lambda}(\Delta x) = \frac{2\pi}{20}(5) = \frac{\pi}{2}$
At A, Q is ahead of P by path, as wave emitted by Q reaches before wave emitted by P.
$\therefore$ Total phase difference at A $\frac{\pi}{2} - \frac{\pi}{2} = 0$
(due to P being ahead of Q by $90°$)
$I_A = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\Delta\phi$
$= I + I + 2\sqrt{I}\sqrt{I}\cos(0) = 4I$
For C
Path difference, $x_Q - x_P = 5m$
Phase difference $\Delta\phi$ due to path difference
$= \frac{2\pi}{\lambda}(\Delta x) = \frac{2\pi}{20}(5) = \frac{\pi}{2}$
Total phase difference at C $= \frac{\pi}{2} + \frac{\pi}{2} = \pi$
$I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos(\Delta\phi)$
$= I + I + 2\sqrt{I}\sqrt{I}\cos(\pi) = 0$
For B,
Path difference, $x_P - x_O = 0$
Phase difference, $\Delta\phi = \frac{\pi}{2}$
(due to P being ahead of Q by $90°$)
$I_B = I + I + 2\sqrt{I}\sqrt{I}\cos\frac{\pi}{2} = 2I$
Therefore intensities of radiation at A, B and C will be in the ratio
$I_A : I_B : I_C = 4I : 2I : 0 = 2 : 1 : 0$

Question70

Two coherent sources of sound, S_1 and S_2, produce sound waves of the same wavelength, $\lambda = 1m$, in phase. S_1 and S_2 are placed 1.5m apart (see fig.). A listener, located at L directly in front of S_2 finds that the intensity is at a minimum when he is 2m away from S_2. The listener moves away from S_1, keeping his distance from S_2 fixed. The adjacent maximum of intensity is observed when the listener is at a distance d from S_1. Then, d is:



[Sep. 05,2020 (II)]

Options:

A. 12 m

B. 5 m

C. 2 m

D. 3 m

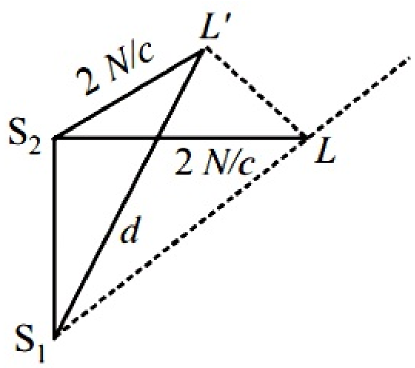
Answer: D

Solution:

Initially, $S_2L = 2m$

$\overline{\quad + \left(\frac{3}{2}\right)^2} = \frac{5}{2} = 2.5m$

Path difference, $\Delta x = S_1L - S_2L = 0.5m = \frac{\lambda}{2}$



When the listner move from L, first maxima will appear if path difference is integral multiple of wavelength. For example

$\Delta x = n\lambda = 1\lambda$ ($n = 1$ for first maxima)
$\therefore \Delta x = \lambda = S_1L' - S_2L$
$\Rightarrow 1 = d - 2 \Rightarrow d = 3m$

Question71

Two light waves having the same wavelength lambda in vacuum are in phase initially. Then the first wave travels a path L_1 through a medium of refractive index n_1 while the second wave travels a path of length L_2 through a medium of refractive index n_2. After this the phase difference between the two waves is :
[Sep. 03,2020 (II)]

Options:

A. $\frac{2\pi}{\lambda}\left(\frac{L_2}{n_1} - \frac{L_1}{n_2}\right)$

B. $\frac{2\pi}{\lambda}\left(\frac{L_1}{n_1} - \frac{L_2}{n_2}\right)$

C. $\frac{2\pi}{\lambda}(n_1L_1 - n_2L_2)$

D. $\frac{2\pi}{\lambda}(n_2L_1 - n_1L_2)$

Answer: C

Solution:

Solution:
The distance traversed by light in a medium of refractive index m in time t is given by
$d = vt$ ....(i)
where v is velocity of light in the medium. The distance traversed by light in a vacuum in this time,
$\Delta ct = c \times \frac{d}{v}$ [from equation (i)]
$= d\frac{c}{v} = \mu d$ ......(ii) $\left(\because \mu = \frac{c}{v}\right)$
This distance is the equvalent distance in vacuum and is called optical path.
Optical path for first ray which travels a path L_1 through a medium of refractive index $n_1 = n_1L_1$
Optical path for second ray which travels a path L_2 through a medium of refractive index $n_2 = n_2L_2$
Path difference $= n_1L_1 - n_2L_2$
Now, phase difference $= \frac{2\pi}{\lambda} \times$ path difference $= \frac{2\pi}{\lambda} \times (n_1L_1 - n_2L_2)$

Question72

A young's double-slit experiment is performed using monochromatic light of wavelength λ. The intensity of light at a point on the screen, where the path difference is lambda, is K units. The intensity of light at a point where the path difference is $\frac{\lambda}{6}$ is given by $\frac{nK}{12}$, where n is an

[NA Sep. 06, 2020 (II)]

Solution:

In young's double slit experiment, intensity at a point is given by

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

where, $\phi =$ phase difference,

Using phase difference, $\phi = \frac{2\pi}{\lambda} \times$ path difference

For path difference λ, phase difference $\phi_1 = 2\pi$

For path difference, $\frac{\lambda}{6}$, phase difference $\phi_2 = \frac{\pi}{3}$

Using equation (i),

$$\frac{I_1}{I_2} = \frac{\cos^2\left(\frac{\phi_1}{2}\right)}{\cos^2\left(\frac{\phi_2}{2}\right)} = \frac{\cos^2\left(\frac{2\pi}{2}\right)}{\cos^2\left(\frac{\pi}{3}\right)}$$

$$\Rightarrow \frac{K}{I_2} = \frac{1}{\frac{3}{4}} = \frac{4}{3} \Rightarrow I_2 = \frac{3K}{4} = \frac{9K}{12}$$

$\therefore n = 9$

Question73

In a Young's double slit experiment, light of 500 nm is used to produce an interference pattern. When the distance between the slits is 0.05 mm, the angular width (in degree) of the fringes formed on the distance screen is close to :
[Sep. 03, 2020 (I)]

Options:

A. 0.17°

B. 0.57°

C. 1.7°

D. 0.07°

Answer: B

Solution:

Given : Wavelength of light, $\lambda = 500\text{nm}$
Distance between the slits, $d = 0.05\text{mm}$
Angular width of the fringe formed,

$$\theta = \frac{\lambda}{d} = \frac{500 \times 10^{-9}}{0.05 \times 10^{-3}} = 0.01 \text{ rad} = 0.57°.$$

Question74

Interference fringes are observed on a screen by illuminating two thin slits 1 mm apart with a light source (λ = 632.8 nm). The distance between the screen and the slits is 100 cm. If a bright fringe is observed on a screen at a distance of 1.27 mm from the central bright fringe, then the path difference between the waves, which are reaching this point from the slits is close to :
[Sep. 02, 2020 (I)]

Options:

A. 1.27 μm

B. 2.87 nm

C. 2 nm

D. 2.05 μm

Answer: A

Solution:

Path difference, $\text{Delta}\, P = d \sin\theta = d\,\theta$
ance between slits $= 1\text{mm} = 10^{-3}\text{mm}$
$D =$ distance between the slits and screen $= 100\text{cm} = 1\text{m}$
$y =$ distance between central bright fringe and observed fringe $= 1.27\text{mm}$

$$\therefore \Delta P = \frac{d\,y}{D} = \frac{10^{-3} \times 1.270\text{mm}}{1\text{m}} = 1.27\mu\text{m}$$

Question75

In a Young's double slit experiment, 16 fringes are observed in a certain segment of the screen when light of wavelength 700 nm is used. If the wavelength of light is changed to 400 nm, the number of fringes observed in the same segment of the screen would be :
[Sep. 02, 2020 (II)]

Options:

A. 24

B. 30

C. 18

D. 28

Answer: D

Solution:

Let n_1 fringes are visible with light of wavelength λ_1 and n_2 with light of wavelength λ_2. Then

$\beta = \frac{n_1 D\lambda_1}{d} = \frac{n_2 D\lambda_2}{d}\left(\because \beta = \frac{n\lambda D}{d}\right)$

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

$\Rightarrow n_2 = \frac{700}{400} \times 16 = 28$

Question76

A beam of plane polarised light of large cross-sectional area and uniform intensity of $3.3 \mathrm{W\,m}^{-2}$ falls normally on a polariser (cross sectional area 3 times $10^{-4}\,\mathrm{m}^2$) which rotates about its axis with an angular speed of $31.4\,\mathrm{rad / s}$. The energy of light passing through the polariser per revolution, is close to :
[Sep. 04, 2020 (I)]

Options:

A. $1.0 \times 10^{-5} \mathrm{J}$

B. $1.0 \times 10^{-4} \mathrm{J}$

C. $1.5 \times 10^{-4} \mathrm{J}$

D. $5.0 \times 10^{-4} \mathrm{J}$

Answer: D

Solution:

Gi

$_0 = 3.3 \mathrm{W\,m}^{-2}$

Area, $A = 3 \times 10^{-4} \mathrm{m}^2$

Angular speed, $\omega = 31.4\,\mathrm{rad / s}$

Average energy $= I_0 A < \cos^2\theta >$

$\because < \cos^2\theta > = \frac{1}{2}$ per revolution

$\therefore$ Average energy $= \frac{(3.3)(3 \times 10^{-4})}{2} \simeq 5 \times 10^{-4} \mathrm{J}$

Question77

Orange light of wavelength $6000 \times 10^{-10}\mathrm{m}$ illuminates a single slit of width $0.6 \times 10^{-4}\mathrm{m}$. The maximum possible number of diffraction minima produced on both sides of the central maximum is ______.
[NA Sep. 04, 2020 (II)]

Answer: 198

Solution:

:ondary minima at a point path difference should be integral multiple of wavelength

$\therefore \sin\theta = \frac{n\lambda}{d}$

For n to be maximum $\sin\theta = 1$

$n = \frac{d}{\lambda} = \frac{6 \times 10^{-5}}{6 \times 10^{-7}} = 100$

Total number of minima on one side $= 99$

Total number of minima $= 198$.

Question78

Two coherent sources produce waves of different intensities which interfere. After interference, the ratio of the maximum intensity to the minimum intensity is 16. The intensity of the waves are in the ratio: [9 Jan. 2019 I]

Options:

A. 16 : 9

B. 25 : 9

C. 4 : 1

D. 5 : 3

Answer: B

Solution:

Solution:

As we know, $\frac{I_{max}}{I_{min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2$

and $\sqrt{\frac{I_1}{I_2}} = \frac{A_1}{A_2}$

$\frac{I_{max}}{I_{min}} = 16 \Rightarrow \frac{A_{max}}{A_{min}} = 4 \Rightarrow \frac{A_1 + A_2}{A_1 - A_2} = \frac{4}{1}$

Using componendo and dividendo.

$\frac{A_1}{A_2} = \frac{5}{3} \Rightarrow \frac{I_1}{I_2} = \left(\frac{5}{3}\right)^2 = \frac{25}{9}$

Question79

In a Young's double slit experiment, the path difference, at a certain point on the screen, between two interfering waves is $\frac{1}{8}$th of wavelength.

fringe is close to:
[11 Jan 2019 I]

Options:

A. 0.74

B. 0.85

C. 0.94

D. 0.80

Answer: B

Solution:

difference, $\Delta x = \frac{\lambda}{8}$

Phase difference ($\Delta\phi$) is given by

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

$\Delta\phi = \frac{(2\pi)}{\lambda}\frac{\lambda}{8} = \frac{\pi}{4}$

For two sources in different phases,

$I = I_0 \cos^2\left(\frac{\pi}{8}\right)$

$\frac{I}{I_0} = \cos^2\left(\frac{\pi}{8}\right)$

$$= \frac{1 + \cos\frac{\pi}{4}}{2} = \frac{1 + \frac{1}{\sqrt{2}}}{2} = 0.85$$

Question80

In a Young's double slit experiment with slit separation0.1mm, one observes a bright fringe at angle $\frac{1}{40}$rad by using light of wavelength λ_1 When the light of wavelength λ_2 is used a bright fringe is seen at the same angle in the same set up. Given that λ_1 and λ_2 are in visible range (380nm to 740nm), their values are:
[10 Jan. 2019 I]

Options:

A. 625 nm, 500 nm

B. 380 nm, 525 nm

C. 380 nm, 500 nm

D. 400 nm, 500 nm

Answer: A

Solution:

Path difference $= d \sin\theta \approx d\theta$

$= 0.1 \times \frac{1}{40}\text{mm} = 2500\text{nm}$

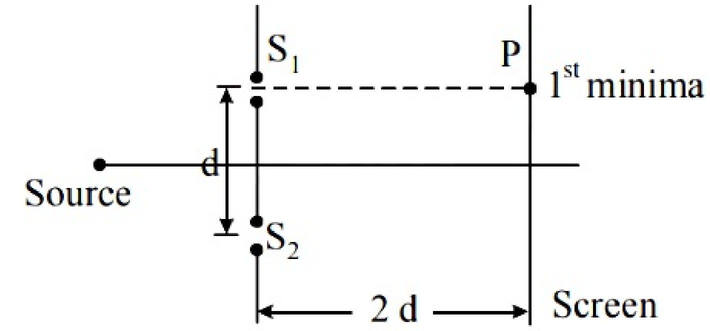
For bright fringe, path difference must be integral multiple of λ.

$\therefore 2500 = n\lambda_1 = m\lambda_2$

$\therefore \lambda_1 = 625(\text{ for } n = 4), \lambda_2 = 500(\text{ for } m = 5)$

Question81

Consider a Young's double slit experiment as shown in figure. What should be the slit separation d in terms of wavelength λ such that the first minima occurs directly in front of the slit (S_1)?



[10 Jan. 2019 II]

Options:

A. $\frac{\lambda}{2(\sqrt{5}-2)}$

B. $\frac{\lambda}{(\sqrt{5}-2)}$

C. $\frac{\lambda}{2(5-\sqrt{2})}$

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

Answer: A

Solution:

Here, $x_1 = 2d$ and $x_2 = \sqrt{5}d$

For, first minima, $\Delta x = \frac{\lambda}{2}$

$\therefore \Delta x = x_2 - x_1 = \sqrt{5}d - 2d = \frac{\lambda}{2}$

$\Rightarrow d = \frac{\lambda}{2(\sqrt{5}-2)}$

Question82

In a Young's double slit experiment, the slits are placed 0.320mm apart.

of bright fringes that are observed in the angular range $-30° \le \theta \le 30°$ is
[9 Jan. 2019 II]

Options:

A. 640

B. 320

C. 321

D. 641

Answer: D

Solution:

ber of maximas

$0.32 \times 10^{-3} \sin 30° = n \times 500 \times 10^{-9}$

$\therefore n = \dfrac{0.32 \times 10^{-3}}{500 \times 10^{-9}} \times \dfrac{1}{2} = 320$

Hence total no. of maximas observed in angular range $-30° \le \theta \le 30°$

$= 320 + 1 + 320 = 641$

Question83

In a double-slit experiment, green light (5303Å) falls on a double slit having a separation of 19.44 µm and a width of 4.05 µm. The number of bright fringes between the first and the second diffraction minima is :
[11 Jan 2019 II]

Options:

A. 10

B. 05

C. 04

D. 09

Answer: B

Solution:

Solution:

Question84

It is filled with a liquid of refractive index μ. A student finds that, irrespective of what the incident angle i (see figure) is for a beam of light entering the liquid, the light reflected from the liquid glass interface is never completely polarized. For this to happen, the minimum value of μ is:
[9 Jan. 2019 I]

Options:

A. $\sqrt{\frac{5}{3}}$

B. $\frac{3}{\sqrt{5}}$

C. $\frac{5}{\sqrt{3}}$

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

Answer: B

Solution:

Solution:
According to Brewster's law, refractive index of material (μ) is equal to tangent of polarising angle

$\because \tan i_b = \mu = \frac{1.5}{\mu}$

$\frac{1}{\mu} < \frac{1.5}{\sqrt{\mu^2 + (1.5)^2}} (\because \sin i_c < \sin i_b)$

$\therefore \sin i_b = \frac{1.5}{\sqrt{\mu^2 + (1.5)^2}}$

or, $\sqrt{\mu^2 + (1.5)^2} < 1.5 \times \mu$

$\Rightarrow \mu^2 + (1.5)^2 < (\mu \times 1.5)^2$

$\Rightarrow \mu < \frac{3}{\sqrt{5}}$ i.e. minimum value of μ shouldbe $\frac{3}{\sqrt{5}}$

Question85

In an interference experiment the ratio of amplitudes of coherent waves is $\frac{a_1}{a_2} = \frac{1}{3}$. The ratio of maximum and minimum intensities of fringes will be :
[8 April 2019 I]

Options:

A. 2

B. 18

C. 4

D. 9

Solution:

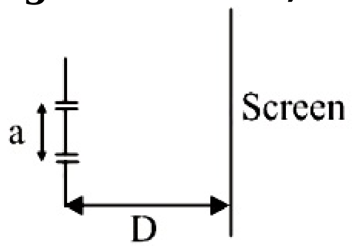
'itude ratio of waves is $\frac{a_1}{a_2} = \frac{3}{1}$

so, $\frac{I_{max}}{I_{min}} = \left(\frac{a_2 + a_1}{a_2 - a_1}\right)^2$

$$= \left(\frac{\frac{a_2}{a_1} + 1}{\frac{a_2}{a_1} - 1}\right)^2 = \left(\frac{3+1}{3-1}\right)^2 = \left(\frac{4}{2}\right)^2 = \frac{4}{1} = 4$$

Question86

The figure shows a Young's double slit experimental setup. It is observed that when a thin transparent sheet of thickness t and refractive index $\frac{1}{4}$ is put in front of one of the slits, the central maximum gets shifted by a distance equal to n fringe widths. If the wavelength of light used is », t will be:



[9 April 2019 I]

Options:

A. $\frac{2nD\lambda}{a(\mu - 1)}$

B. $\frac{nD\lambda}{a(\mu - 1)}$

C. $\frac{D\lambda}{a(\mu - 1)}$

D. $\frac{2D\lambda}{a(\mu - 1)}$

E. (Bonus)

Answer: E

Solution:

Solution:
Shift $= n\beta$ (given)
$\therefore D\frac{(\mu - 1)t}{a} = \frac{n\lambda D}{a}\left[\because \text{Shift } = \frac{D(\mu - 1)t}{a}\right]$
or $t = \frac{n\lambda}{(\mu - 1)}$

Question87

The value of numerical aperature of the objective lens of a microscope is 1.25. If light of wavelength 5000 Å is used, the minimum separation between two points, to be seen as distinct, will be :
[12 April 2019 I]

Options:

A. 0.24 μm

B. 0.38 μm

C. 0.12 μm

D. 0.48 μm

Answer: A

Solution:

Solution:

$x = \frac{1.22\lambda}{2\mu \sin\theta}$

$= \frac{1.22 \times 5000}{2 \times 1.25} = 0.24\mu m$

Question88

A system of three polarizers P_1, P_2, P_3 is set up such that the pass axis of P_3 is crossed with respect to that of P_1. The pass axis of P_2 is inclined at 60° to the pass axis of P_3. When a beam of unpolarized light of intensity I_o is incident on P_1, the intensity of light transmitted by the three polarizers is I. The ratio (I_0/I) equals (nearly):
[12 April 2019 II]

Options:

A. 5.33

B. 16.00

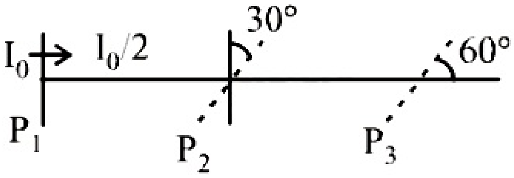
C. 10.67

D. 1.80

Answer: C

Solution:

Solution:



$= \frac{I_0}{2} \times \frac{3}{4} \times \frac{1}{4}$

$\therefore \frac{I_0}{I} = \frac{32}{3} = 10.67$

Question89

Diameter of the objective lens of a telescope is 250cm. For light of wavelength 600nm. Coming from a distant object, the limit of resolution of the telescope is close to:
[9 April 2019 II]

Options:

A. 1.5×10^{-7}rad

B. 2.0×10^{-7}rad

C. 3.0×10^{-7}rad

D. 4.5×10^{-7}rad

Answer: C

Solution:

Solution:

$\theta = \frac{1.22\lambda}{d} = \frac{1.22 \times 600 \times 10^{-9}}{250 \times 10^{-2}}$

$= 3.0 \times 10^{-7}$rad

Question90

Calculate the limit of resolution of a telescope objective having a diameter of 200cm, if it has to detect light of wavelength 500nm coming from a star.
[8 April 2019 II]

Options:

A. 305×10^{-9} radian

B. 610×10^{-9} radian

C. 152.5×10^{-9} radian

D. 457.5×10^{-9} radian

Answer: A

Solution:

Solution:

$\theta = \frac{1.22\lambda}{d} = \frac{1.22 \times 500 \times 10^{-9}}{2} = 305 \times 10^{-9}\text{rad}$

Question91

The angular width of the central maximum in a single slit diffraction pattern is 60°. The width of the slit is 1 μm. The slit is illuminated by monochromatic plane waves. If another slit of same width is made near it, Young's fringes can be observed on a screen placed at a distance 50 cm from the slits. If the observed fringe width is 1 cm, what is slit separation distance?
(i.e. distance between the centres of each slit.)
[2018]

Options:

A. 25 μm

B. 50 μm

C. 75 μm

D. 100 μm

Answer: A

Solution:

Solution:

Angular width of central maxima $= \frac{2\lambda}{d}$

or, $\lambda = \frac{d}{2}$; Fringe width, $\beta = \frac{\lambda \times D}{d'}$

$10^{-2} = \frac{d}{2} \times \frac{50 \times 10^{-2}}{d'} = \frac{10^{-6} \times 50 \times 10^{-2}}{2 \times d'}$

Therefore, slit separation distance, $d' = 25\mu m$

Question92

Unpolarized light of intensity I passes through an ideal polarizer A. Another indentical polarizer B is placed behind A. The intensity of light beyond B is found to be $\frac{I}{2}$. Now another identical polarizer C is placed between A and B. The intensity beyond B is now found to be $\frac{I}{8}$. The angle between polarizer A and C is:

Options:

A. 0°

B. 30°

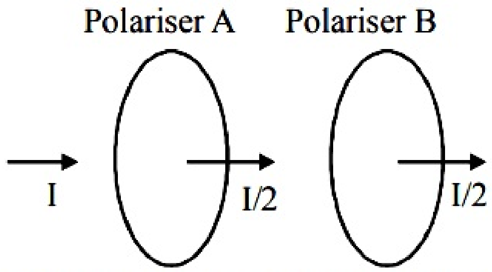
C. 45°

D. 60°

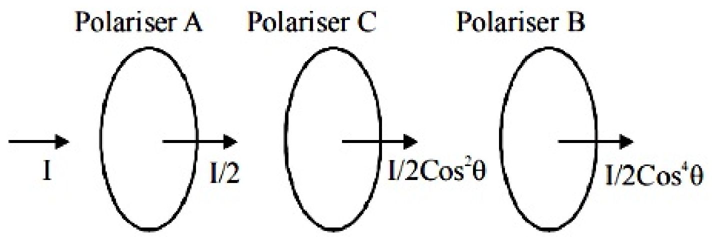
Answer: C

Solution:

Solution:
Axis of transmission of A & B are parallel.



After introducing polariser C between A and B,



$\frac{I}{2}\cos^4\theta = \frac{I}{8} \Rightarrow \cos^4\theta = \frac{1}{4}$

$\Rightarrow \cos\theta = \frac{1}{\sqrt{2}}$ or, $\theta = 45°$

Question93

Light of wavelength 550nm falls normally on a slit of width 22.0×10^{-5}cm. The angular position of the second minima from the central maximum will be (in radians)
[Online April 15,2018]

Options:

A. $\frac{\pi}{8}$

B. $\frac{\pi}{12}$

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

D. $\frac{\pi}{6}$

Solution:

Solution:

If angular position of 2nd maxima from central maxima is θ then

$\sin\theta = \frac{(2n-1)\lambda}{2a} = \frac{3\lambda}{20} = \frac{3\times 550\times 10^{-9}}{2\times 22\times 10^{-7}}$

$\therefore \theta \simeq \frac{\pi}{8}\text{rad}$

Question94

Unpolarized light of intensity I is incident on a system of two polarizers, A followed by B. The intensity of emergent light is I / 2. If a third polarizer C is placed between A and B, the intensity of emergent light is reduced to I / 3. The angle between the polarizers A and C is θ. Then [Online April 16,2018]

Options:

A. $\cos\theta = \left(\frac{2}{3}\right)^{1/4}$

B. $\cos\theta = \left(\frac{1}{3}\right)^{1/4}$

C. $\cos\theta = \left(\frac{1}{3}\right)^{1/2}$

D. $\cos\theta = \left(\frac{2}{3}\right)^{1/2}$

Answer: A

Solution:

Polariser A and B have same alignment of transmission axis.

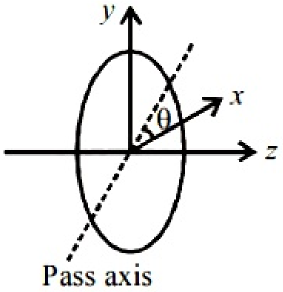
ime polariser c is introduced at θ angle

$\frac{1}{2}\cos^2\theta \times \cos^2\theta = \frac{1}{3}$

or, $\cos^4\theta = \frac{2}{3} \Rightarrow \cos\theta = \left(\frac{2}{3}\right)^{1/4}$

Question95

A plane polarized light is incident on a polariser with its pass axis making angle q with x-axis, as shown in the figure. At four different values of q, q = 8°, 38°, 188° and 218°, the observed intensities are same. What is the angle between the direction of polarization and x-axis



[Online April 15,2018]

Options:

A. 203°

B. 45°

C. 98°

D. 128°

Answer: A

Solution:

Solution:

Question96

In a Young's double slit experiment, slits are separated by 0.5 mm, and the screen is placed 150 cm away. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes on the screen. The least distance from the common central maximum to the point where the bright fringes due to both the wavelengths coincide is :
[2017]

Options:

A. 9.75 mm

B. 15. 6 mm

C. 1.56 mm

D. 7.8 mm

Answer: D

Solution:

Solution:
For common maxima, $n_1\lambda_1 = n_2\lambda_2$

$\Rightarrow \frac{n_1}{\ } = \frac{\lambda_2}{\lambda} = \frac{520 \times 10^{-9}}{9} = \frac{4}{5}$

$y = \frac{n_1 \lambda_1 D}{d}, \lambda_1 = 650nm$

$y = \frac{4 \times 650 \times 10^{-9} \times 1.5}{0.5 \times 10^{-3}}$ or, $y = 7.8mm$

Question97

An observer is moving with half the speed of light towards a stationary microwave source emitting waves at frequency 10 GHz. What is the frequency of the microwave measured by the observer? (speed of light $= 3 \times 10^8 ms^{-1}$)
[2017]

Options:

A. 17.3 GHz

B. 15.3 GHz

C. 10.1 GHz

D. 12.1 GHz

Answer: A

Solution:

Solution:
Use relativistic doppler's effect as velocity of observer is not small as compared to light

$f = f_0 \sqrt{\frac{c+v}{c+v}}$; $V =$ relative speed of approach

$f_0 = 10GHz$

$f = 10\sqrt{c + \frac{c}{2}c - \frac{c}{2}} = 10\sqrt{3} = 17.3GHz$

Question98

A single slit of width 0.1 mm is illuminated by a parallel beam of light of wavelength 6000 Å and diffraction bands are observed on a screen 0.5 m from the slit. The distance of the third dark band from the central bright band is :
[Online April 9, 2017]

Options:

A. 3 mm

B. 9 mm

C. 4.5 mm

D. 1.5 mm

Solution:

Solution:

$a = 0.1\text{mm} = 10^{-4}\text{cm}$

$\lambda = 6000 \times 10^{-10}\text{cm} = 6 \times 10^{-7}\text{cm}, D = 0.5\text{m}$

for 3^{rd} dark band, $a \sin\theta = 3\lambda$ or $\sin\theta = \frac{3\lambda}{a} = \frac{x}{D}$

The distance of the third dark band from the central bright band$x = \frac{3\lambda D}{a} = \frac{3 \times 6 \times 10^{-7} \times 0.5}{10^{-4}} = 9\text{mm}$

Question99

A single slit of width b is illuminated by a coherent monochromatic light of wavelength λ. If the second and fourth minima in the diffraction pattern at a distance l m from the slit are at 3 cm and 6 cm respectively from the central maximum, what is the width of the central maximum? (i.e. distance between first minimum on either side of the central maximum)
[Online April 8, 2017]

Options:

A. 1.5 cm

B. 3.0 cm

C. 4.5 cm

D. 6.0 cm

Answer: B

Solution:

For secondary minima,

$$n\lambda \Rightarrow \sin\theta = \frac{n\lambda}{b}$$

Distance of n^{th} secondary minima $x = D\sin\theta$

or $\sin\theta_1 = \frac{x_1}{D}$

$\sin\theta_1 = \frac{2\lambda}{b}$

$n = 4$

$\sin\theta_2 = \frac{4\lambda}{b} = \frac{x_2}{D}$

$x_2 - x_1 = \frac{4\lambda}{b} - \frac{2\lambda}{b} = \frac{2\lambda}{b}$

$3 = \frac{2\lambda}{b} \Rightarrow b = \frac{2\lambda}{3}$ ....(i)

Width of central maxima $= \frac{2\lambda}{b}$

$= \frac{2\lambda}{\frac{2\lambda}{3}} = 3\text{cm}$ .. from eq. (i)

Question100

The box of a pin hole camera, of length L, has a hole of radius a. It is assumed that when the hole is illuminated by a parallel beam of light of wavelength λ the spread of the spot (obtained on the opposite wall of the camera) is the sum of its geometrical spread and the spread due to diffraction. The spot would then have its minimum size (say b_{min}) when :
[2016]

Options:

A. $a=\sqrt{\lambda L}$ and $b_{min}=\sqrt{4\lambda L}$

B. $a=\frac{\lambda^2}{L}$ and $b_{min}=\sqrt{4\lambda L}$

C. $a=\frac{\lambda^2}{L}$ and $b_{min}=\left(\frac{2\lambda^2}{L}\right)$

D. $a=\sqrt{\lambda}$ and $b_{min}=\left(\frac{2\lambda^2}{L}\right)$

Answer: A

Solution:

Given geometrical spread $=a$

n spread $=\frac{\lambda}{a}\times L=\frac{\lambda L}{a}$

The sum $b=a+\frac{\lambda L}{a}$

For b to be minimum

$\frac{db}{da}=0\frac{d}{da}\left(a+\frac{\lambda L}{a}\right)=0$

$a=\sqrt{\lambda L}$

$b\min=\sqrt{\lambda L}+\sqrt{\lambda L}=2\sqrt{\lambda L}=\sqrt{4\lambda L}$

Question101

Two stars are 10 light years away from the earth. They are seen through a telescope of objective diameter 30cm. The wavelength of light is 600nm. To see the stars just resolved by the telescope, the minimum distance between them should be (1 light year $=9.46\times10^{15}$m) of the order of :
[Online April 10,2016]

Options:

A. 10^8km

B. 10^{10}km

C. 10^{11}km

D. 10^{6}km

Answer: A

Solution:

that $\Delta\theta = \frac{0.61\lambda}{4} = \frac{l}{R}$

The minimum distance between theml $= \frac{R}{9}0.61 \times \lambda = \frac{9.46 \times 10^{15} \times 10 \times 0.61 \times 600 \times 10^{-9}}{0.3}$

$= 1.15 \times 10^{11}$m

$\Rightarrow 1.115 \times 10^{8}$km

Question102

In Young's double slit experiment, the distance between slits and the screen is 1.0m and monochromatic light of 600nm is being used. A person standing near the slits is looking at the fringe pattern. When the separation between the slits is varied, the interference pattern disappears for a particular distance d_0 between the slits. If the angular resolution of the eye is $\frac{1°}{60}$, the value of d_0 is close to
[Online April 9,2016]

Options:

A. 1 mm

B. 3 mm

C. 2 mm

D. 4 mm

Answer: C

Solution:

Solution:
Given D = 1.0m, wavelength of monochromatic light $\lambda = 600$nm.
$d : D\theta = 1 \times \frac{\pi}{180} \times \frac{1}{60}$
$d_0 = 2 \times 10^{-3} = 2$mm

Question103

On a hot summer night, the refractive index of air is smallest near the ground and increases with height from the ground. When a light beam

as it travels, the light beam :
[2015]

Options:

A. bends downwards

B. bends upwards

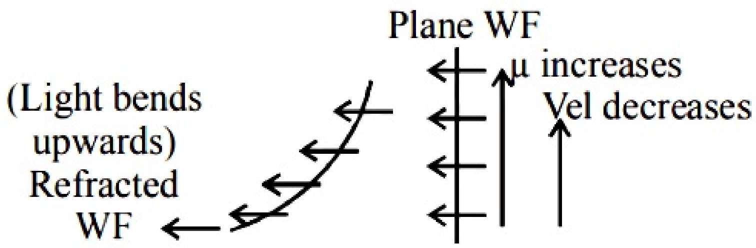
C. becomes narrower

D. goes horizontally without any deflection

Answer: B

Solution:

Solution:



Question104

In a Young's double slit experiment with light of wavelength λ the separation of slits is d and distance of screen is D such that D> > d > > λ. If the fringe width is β, the distance from point of maximum intensity to the point where intensity falls to half of maximum intensity on either side is:
[Online April 11,2015]

Options:

A. $\frac{\beta}{6}$

B. $\frac{\beta}{3}$

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

D. $\frac{\beta}{2}$

Answer: C

Solution:

Solution:

But, $\Delta\phi = \frac{2\pi}{\lambda}\Delta x$ so, $\Delta x = \frac{\lambda}{4}$

$\frac{d\,y}{D} = \frac{\lambda}{4}$ ....(i)

$\frac{\lambda D}{d} = \beta$ ....(ii)

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

$y = \frac{\beta}{4}$

Question105

Assuming human pupil to have a radius of 0.25 cm and a comfortable viewing distance of 25 cm, the minimum separation between two objects that human eye can resolve at 500 nm wavelength is :
[2015]

Options:

A. 100 μm

B. 300 μm

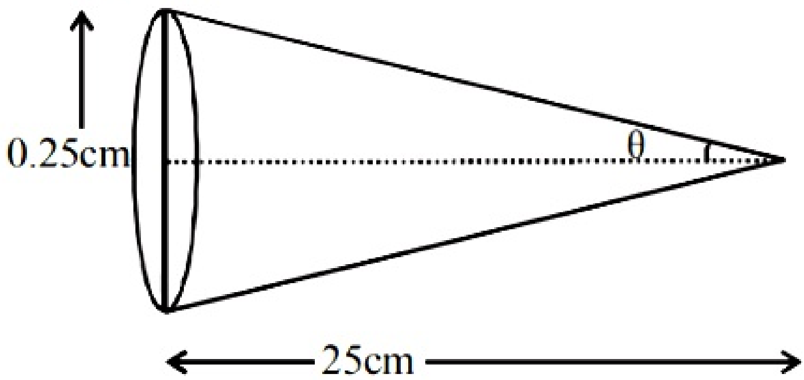
C. 1 μm

D. 30 μm

Answer: D

Solution:

$\sin\theta = \frac{0.25}{25} = \frac{1}{100}$



Resolving power $= \frac{1.22\lambda}{2\mu\sin\theta} = 30\mu m$

Question106

Unpolarized light of intensity I_0 is incident on surface of a block of glass at Brewster's angle. In that case, which one of the following statements is true ?
[Online April 11, 2015]

A. reflected light is completely polarized with intensityless than $\frac{I_0}{2}$

B. transmitted light is completely polarized with intensityless than $\frac{I_0}{2}$

C. transmitted light is partially polarized with intensity$\frac{I_0}{2}$

D. reflected light is partially polarized with intensity $\frac{I_0}{2}$

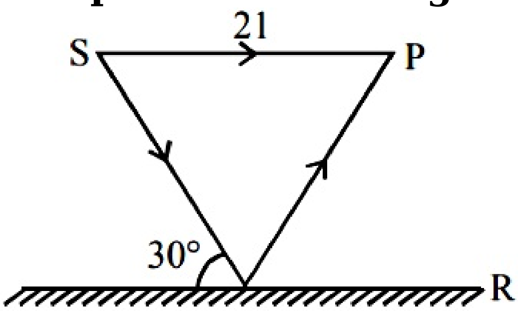
Answer: A

Solution:

Solution:
When unpolarised light is incident at Brewster's angle then reflected light is completely polarized and the intensity of the reflected light is less than half of the incident light.

Question107

Interference pattern is observed at 'P' due to superimposition of two rays coming out from a source 'S' as shown in the figure. The value of 'l' for which maxima is obtained at 'P' is:
(R is perfect reflecting surface)



[Online April 12, 2014]

Options:

A. $l = \frac{2n\lambda}{\sqrt{3}-1}$

B. $l = \frac{(2n-1)\lambda}{2(\sqrt{3}-1)}$

C. $l = \frac{(2n-1)\lambda\sqrt{3}}{4(2-\sqrt{3})}$

D. $l = \frac{(2n-1)\lambda}{\sqrt{3}-1}$

Answer: C

Solution:

Question108

Two monochromatic light beams of intensity 16 and 9 units are interfering. The ratio of intensities of bright and dark parts of the resultant pattern is:
[Online April 11, 2014]

Options:

A. $\frac{16}{9}$

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

C. $\frac{7}{1}$

D. $\frac{49}{1}$

Answer: D

Solution:

$\frac{I_1}{I_2} = \frac{16}{9} = \frac{a_1^2}{a_2^2}$ (amplitude)^2

$\Rightarrow a_1 = 4;\ a_2 = 3$

Therefore the ratio of intensities of bright and dark parts $\frac{I_{Bright}}{I_{Dark}} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2} = \frac{(4 + 3)^2}{(4 - 3)^2} = \frac{49}{1}$

Question109

In a Young's double slit experiment, the distance between the two identical slits is 6.1 times larger than the slit width. Then the number of intensity maxima observed within the central maximum of the single slit diffraction pattern is:
[Online April 19, 2014]

Options:

A. 3

B. 6

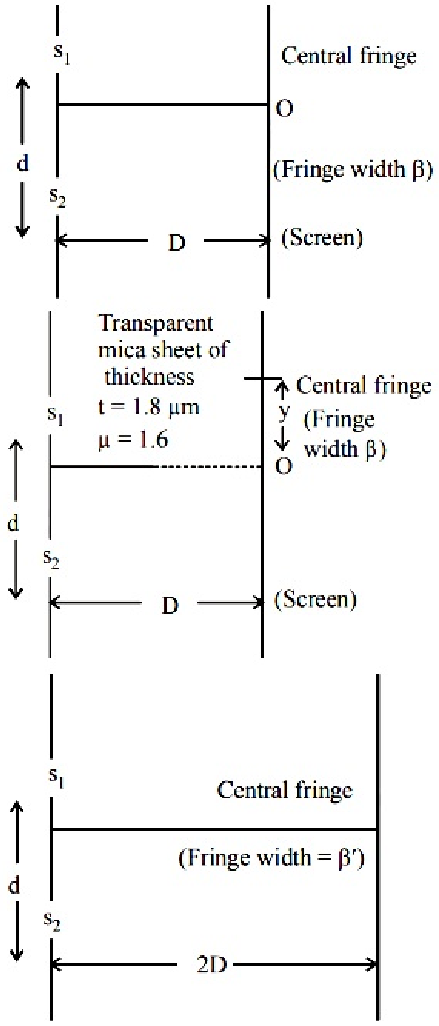
C. 12

D. 24

Answer: C

Question110

Using monochromatic light of wavelength λ , an experimentalist sets up the Young's double slit experiment in three ways as shown.
If she observes that y = β' , the wavelength of light used is:



[Online April 9, 2014]

Options:

A. 520 nm

B. 540 nm

C. 560 nm

D. 580 nm

Answer: B

Solution:

(b) Given $t = 1.8 \times 10^{-6}$m

n = 2 (from figure) Applying formula $(\mu - 1)t = n\lambda$

$(1.6-1)\times 1.8\times 10^{-6}=2\lambda$
or, $\lambda=\frac{1.8\times 10^{-6}\times 0.6}{2}$
$=540$ nm

Question111

Two beams, A and B, of plane polarized light with mutually perpendicular planes of polarization are seen through a polaroid. From the position when the beam A has maximum intensity (and beam B has zero intensity), a rotation of polaroid through 30° makes the two beams appear equally bright. If the initial intensities of the two beams are I_A and I_B respectively, then $\frac{I_A}{I_B}$ equals:
[2014]

Options:

A. 3

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

C. 1

D. $\frac{1}{3}$

Answer: D

Solution:

According to malus law, intensity of emerging beam is given by,
$I=I_0\cos^2\theta$
Now, $I_{A'}=I_A\cos^2 30°$
$I_{B'}=I_B\cos^2 60°$
As $I_{A'}=I_{B'}$
$\Rightarrow I_A\times\frac{3}{4}=I_B\times\frac{1}{4};\ \frac{I_A}{I_B}=\frac{1}{3}$

Question112

The diameter of the objective lens of microscope makes an angle beta at the focus of the microscope. Further, the medium between the object and the lens is an oil of refractive index n. Then the resolving power of the microscope
[Online April 19,2014]

Options:

A. increases with decreasing value of n

B. increases with decreasing value of β

C. increases with increasing value of $n \sin 2\beta$

D. increases with increasing value of $\frac{1}{n \sin 2\beta}$

Answer: C

Solution:

Resolving power of microscope,
$R.P. = \frac{2n\sin\theta}{\lambda}$
$\lambda =$ Wavelength of light used to illuminate the object
$n =$ Refractive index of the medium between object and objective
$\theta =$ Angle

Question113

A ray of light is incident from a denser to a rarer medium. The critical angle for total internal reflection is θ_{iC} and Brewster's angle of incidence is θ_{iB}, such that $\sin\theta_{iC} / \sin\theta_{iB} = \eta = 1.28$. The relative refractive index of the two media is:
[Online April 19,2014]

Options:

A. 0.2

B. 0.4

C. 0.8

D. 0.9

Answer: C

Solution:

Solution:
Here ,$\sin\frac{\theta_{ic}}{\sin}\theta_{iB} = 1.28$
As we know,
$\mu = \frac{\sin\theta_{iB}}{\sin\left(\frac{\pi}{2} - \theta_{iB}\right)}$
where, θ_{iB} is Brewster's angle of incidence,
And, $\mu = \frac{1}{\sin\theta_{ic}}$
On solving we get, relative refractive index of the two media.

In an experiment of single slit diffraction pattern, first minimum for red light coincides with first maximum of some other wavelength. If wavelength of red light is 6600 Å, then wavelength of first maximum will be:
[Online April 12, 2014]

Options:

A. 3300Å

B. 4400Å

C. 5500Å

D. 6600Å

Answer: B

Solution:

In a single slit experiment,
ction maxima,
$a \sin \theta = (2n + 1)\frac{\lambda}{2}$
and for diffraction minima,
$a \sin \theta = n\lambda$
According to question,
$(2 \times 1 + 1)\frac{\lambda}{2} = 1 \times 6600$
$(\because \lambda_R = 6600Å)$
$\lambda = \frac{6600 \times 2}{3}$
$\lambda = 4400Å$

Question115

n identical waves each of intensity I_0 interfere with each other. The ratio of maximum intensities if the interference is (i) coherent and (ii) incoherent is:
[Online April 23, 2013]

Options:

A. n^2

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

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

D. n

Answer: D

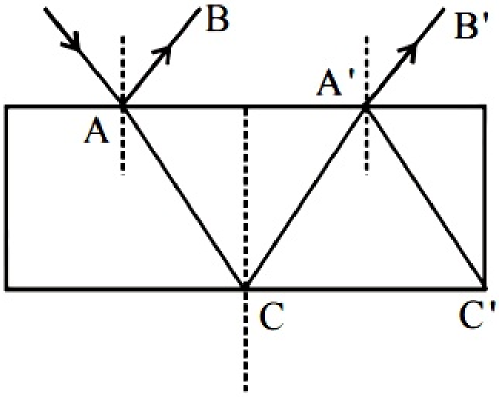
Solution:

$$\frac{(\text{ Maximum intensity) coherent interference}}{(\text{Maximum intensity) in coherent interference}}$$

$$= \frac{n^2 I_0}{n I_0} = n$$

Question116

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



[Online April 9, 2013]

Options:

A. 49 : 1

B. 7 : 1

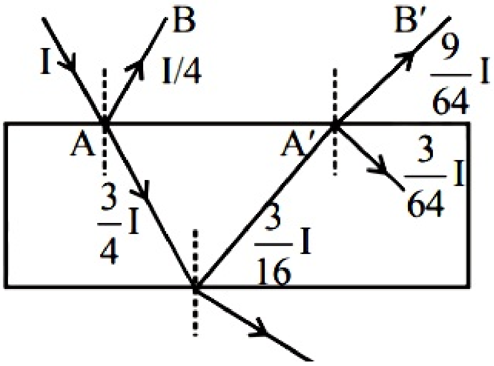
C. 4 : 1

D. 8 : 1

Answer: A

Solution:

Solution:



From figure $I_1 = \frac{I}{4}$ and $I_2 = \frac{9I}{64}$

$\Rightarrow \frac{I_2}{I_1} = \frac{9}{16}$

By using $\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{\frac{I_2}{I_1}} + 1}{\sqrt{\frac{I_2}{I_1}} - 1} \right)^2$

$= \left(\frac{\sqrt{\frac{9}{16}} + 1}{\sqrt{\frac{9}{16}} - 1} \right)^2 = \frac{49}{1}$

Question117

Two coherent point sources S_1 and S_2 are separated by a small distance 'd' as shown. The fringes obtained on the screen will be
[2013]

Options:

A. points

B. straight lines

C. semi-circles

D. concentric circles

Answer: D

Solution:

Solution:
It will be concentric circles.

Question118

The source that illuminates the double - slit in 'double - slit interference experiment' emits two distinct monochromatic waves of wavelength 500 nm and 600 nm, each of them producing its own pattern on the screen. At the central point of the pattern when path difference is zero, maxima of both the patterns coincide and the resulting interference pattern is most distinct at the region of zero path difference.
But as one moves out of this central region, the two fringe systems are gradually out of step such that maximum due to on wavelength coincides with the minimum due to the other and the combined fringe system becomes completely indistinct. This may happen when path difference in nm is :
[Online April 25, 2013]

Options:

B. 3000

C. 1000

D. 1500

Answer: D

Solution:

Solution:

Question119

A thin glass plate of thickness is $\frac{2500}{3}\lambda$(λ is wavelength of light used) and refractive index $\mu = 1.5$ is inserted between one of the slits and the screen in Young's double slit experiment. At a point on the screen equidistant from the slits, the ratio of the intensities before and after the introduction of the glass plate is :
[Online April 25, 2013]

Options:

A. 2 : 1

B. 1 : 4

C. 4 : 1

D. 4 : 3

Answer: C

Solution:

Solution:

Question120

This question has Statement-1 and Statement-2. Of thefour choices given after the Statements, choose the onethat best describes the two Statements.
Statement-1: In Young’s double slit experiment, the number of fringes observed in the field of view is small with longer wavelength of light and is large with shorter wavelength of light.
Statement-2: In the double slit experiment the fringe width depends directly on the wavelength of light.
[Online April 22, 2013]

A. Statement-1 is true, Statement-2 is true and the Statement - 2 is correct explanation of the Statement-1.

B. Statement-1 is false and the Statement- 2 is true.

C. Statement-1 is true Statement-2 is true and the Statement-2 is not correct explanation of the Statement-1.

D. Statement-1 is true and the Statement-2 is false.

Answer: C

Solution:

Solution:

Fringe width $B = \frac{D}{d}\lambda$

And number of fringes observed in the field of view is obtained by $\frac{d}{\lambda}$

Question121

Abeam of unpolarised light of intensity I_0 is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of A. The intensity of the emergent light is
[2013]

Options:

A. I_0

B. $I_0 / 2$

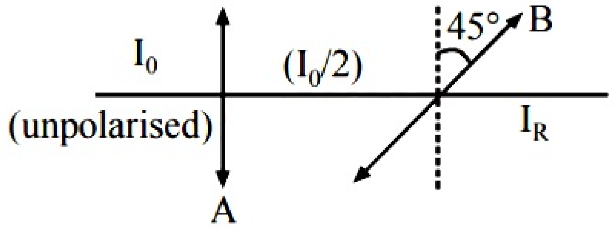
C. $I_0 / 4$

D. $\frac{I_0}{8}$

Answer: C

Solution:

Solution:
Relation between intensities



$I_r = \left(\frac{I_0}{2}\right)\cos^2(45°) = \frac{I_0}{2} \times \frac{1}{2} = \frac{I_0}{4}$

Question122

This question has Statement-1 and Statements-2. Of the four choices given after the Statements, choose the one that best describes the two Statements.
Statement-1 : Out of radio waves and microwaves, the radio waves undergo more diffraction.
Statement-2 : Radio waves have greater frequency compared to microwaves.
[Online April 25, 2013]

Options:

A. Statement-l is true, Statement-2 is true andStatement-2 is the correct explanation of Statement-1

B. Statement-1 is false , Statement-2 is true.

C. Statement-1 is true, Statement-2 is false.

D. Statement-1 is true, Statement-2 is true but Statement2 is not the correct explanation of Statement-1

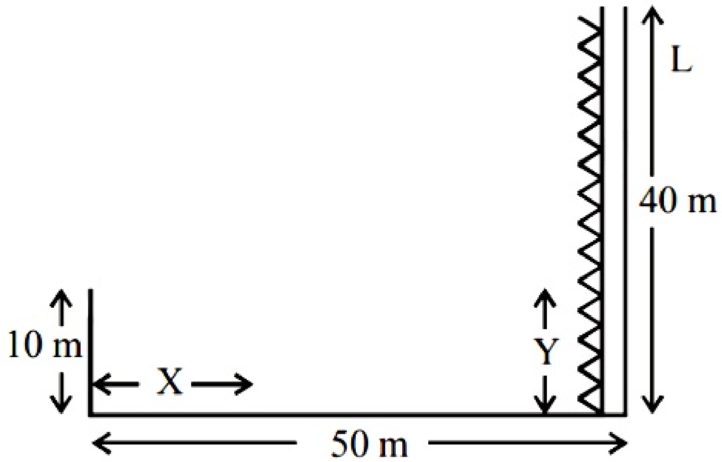
Answer: C

Solution:

Solution:
Wavelength of radio waves is greater than microwaves hence frequency of radio waves is less than microwaves.
The degree of diffraction is greater whose wavelength is greater.

Question123

A person lives in a high-rise building on the bank of a river 50 m wide. Across the river is a well lit tower of height 40 m. When the person, who is at a height of 10 m, looks through a polarizer at an appropriate angle at light of the tower reflecting from the river surface, he notes that intensity of light coming from distance X from his building is the least and this corresponds to the light coming from light bulbs at height 'Y' on the tower. The values of X and Y are respectively close to (refractive index of water $\simeq \frac{4}{3}$



[Online April 9, 2013]

Options:

A. 25 m, 10 m

B. 13 m, 27 m

C. 22 m, 13 m

D. 17 m, 20 m

Answer: B

Solution:

Solution:

Question124

Two coherent plane light waves of equal amplitude makes a small angle $\alpha (< < 1)$ with each other. They fall almost normally on a screen. If λ is the wavelength of light waves, the fringe width Δx of interference patterns of the two sets of waves on the screen is
[Online May 19, 2012]

Options:

A. $\frac{2\lambda}{\alpha}$

B. $\frac{\lambda}{\alpha}$

C. $\frac{\lambda}{(2\alpha)}$

D. $\frac{\lambda}{\sqrt{\alpha}}$

Answer: C

Solution:

$$\Delta x = \frac{\lambda}{(2\alpha)}$$

Question125

In Young's double slit experiment, one of the slit is wider than other, so that amplitude of the light from one slit is double of that other slit. If I_m be the maximum intensity, the resultant intensity I when they interfere at phase difference ϕ is given by:
[2012]

Options:

A. $\frac{I_m}{9}(4 + 5\cos\phi)$

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

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

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

Answer: D

Solution:

Let a, be the amplitude of light from first slit and a_2 be the amplitude of light from second slit.
$a_1 = a$, Then $a_2 = 2a$
Intensity $I \propto (\text{amplitude})^2$
$\therefore I_1 = a_1^2 = a^2$
$I_2 = a_2^2 = 4a^2 = 4I$
$I_r = a_1^2 + a_2^2 + 2a_1a_2\cos\phi$
$= I_1 + I_2 + 2\sqrt{I_1I_2}\cos\phi$
$I_r = I_1 + 4I_1 + 2\sqrt{4I_1^2}\cos\phi$
$\Rightarrow I_r = 5I_1 + 4I_1\cos\phi$ . ... (1)
Now, $I_{max} = (a_1 + a_2)^2 = (a + 2a)^2 = 9a^2$
$I_{max} = 9I_1 \Rightarrow I_1 = \frac{I_{max}}{9}$
Substituting in equation (1)
$I_r = \frac{5I_{max}}{9} + \frac{4I_{max}}{9}\cos\phi$
$I_r = \frac{I_{max}}{9}[5 + 4\cos\phi]$
$I_r = \frac{I_{max}}{9}\left[5 + 8\cos^2\frac{\phi}{2} - 4\right]$
$I_r = \frac{I_{max}}{9}\left[1 + 8\cos^2\frac{\phi}{2}\right]$

In Young's double slit interference experiment, the slit widths are in the ratio 1 : 25. Then the ratio of intensity at the maxima and minima in the interference pattern is
[Online May 26, 2012]

Options:

A. 3 : 2

B. 1 : 25

C. 9 : 4

D. 1 : 5

Answer: C

Solution:

Solution:
We know that,

$$\frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{\frac{\omega_1}{\omega_2}}+1\right)^2}{\left(\sqrt{\frac{\omega_1}{\omega_2}}-1\right)^2}$$

I_{max} and I_{min} are maximum and minium intensityω_1 and ω_2 are widths of two slits

$$\therefore \frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{\frac{1}{25}}+1\right)^2}{\left(\sqrt{\frac{1}{25}}-1\right)^2} \left(\frac{\omega_1}{\omega_2} = \frac{1}{25} \text{given}\right)$$

On solving we get,

$$\frac{I_{max}}{I_{min}} = \frac{\frac{36}{25}}{\frac{16}{25}} = \frac{9}{4} = 9:4$$

Question127

The maximum number of possible interference maxima for slit separation equal to 1.8λ, where λ is the wavelength of light used, in a Young's double slit experiment is
[Online May 12, 2012]

Options:

A. zero

B. 3

C. infinite

D. 5

Answer: B

As $\sin\theta = \frac{n\lambda}{d}$ and $\sin\theta$ cannot be $\neq 1$

$\therefore 1 = \frac{n\lambda}{1.8\lambda}$

or $n = 1.8$ Hence maximum number of possible interference maximas, 0, ± 1 i.e. 3

Question128

In a Young's double slit experiment with light of wavelength λ, fringe pattern on the screen has fringe width β. When two thin transparent glass (refractive index μ) plates of thickness t_1 and $t_2 (t_1 > t_2)$ are placed in the path of the two beams respectively, the fringe pattern will shift by a distance
[Online May 7, 2012]

Options:

A. $\frac{\beta(\mu-1)}{\lambda}\left(\frac{t_1}{t_2}\right)$

B. $\frac{\mu\beta}{\lambda}\frac{t_1}{t_2}$

C. $\frac{\beta(\mu-1)}{\lambda}(t_1 - t_2)$

D. $(\mu-1)\frac{\lambda}{\beta}(t_1 + t_2)$

Answer: C

Solution:

Shift = $\frac{\beta(\mu-1)}{\lambda}t_1 - \frac{\beta(\mu-1)}{\lambda}t_2$

$= \frac{\beta(\mu-1)}{\lambda}(t_1 - t_2)$

Question129

The first diffraction minimum due to the single slit diffraction is seen at $\theta = 30°$ for a light of wavelength 5000 Å falling perpendicularly on the slit. The width of the slit is
[Online May 12, 2012]

Options:

A. 2.5×10^{-5}cm

B. 1.25×10^{-5}cm

D. 5×10^{-5}cm

Answer: C

Solution:

For first minimum,
$d \sin \theta = \lambda$

$$\Rightarrow d = \frac{\lambda}{\sin \theta} = \frac{5000 \times 10^{-8}\text{cm}}{\sin 30°}$$

$$= \frac{5000 \times 10^{-8}\text{cm}}{1/2} = 10 \times 10^{-5}\text{cm}$$

Question130

Two polaroids have their polarizing directions parallel so that the intensity of a transmitted light is maximum. The angle through which either polaroid must be turned if the intensity is to drop by one-half is [Online May 7, 2012]

Options:

A. 135°

B. 90°

C. 120°

D. 180°

Answer: A

Solution:

Solution:
For $I = \frac{I_0}{2}$ and $I = I_0 \cos^2\theta = \frac{I_0}{2}$
$\therefore \theta = 45°$
Therefore the angle through which either polaroids turned is $135° (= 180° - 45°)$

Question131

This question has a paragraph followed by two statements, Statement – 1 and Statement – 2. Of the given fouralternatives after the statements, choose the one thatdescribes the statements.
A thin air film is formed by putting the convex surface of a plane-convex lens over a plane glass plate. With monochromatic light, this film gives an interference pattern due to light reflected from the top (convex) surface and the bottom (glass plate) surface of the film.
Statement – 1 : When light reflects from the air-glass plate interface

the reflected wave suffers a phase change of π.
Statement – 2 : The centre of the interference pattern is dark.
[2011]

Options:

A. Statement – 1 is true, Statement – 2 is true, Statement – 2 is the correct explanation of Statement – 1.

B. Statement – 1 is true, Statement – 2 is true, Statement – 2 is not the correct explanation of Statement – 1.

C. Statement – 1 is false, Statement – 2 is true.

D. Statement – 1 is true, Statement – 2 is false.

Answer: B

Solution:

Solution:
A phase change of π rad appears when the ray reflects at the glass-air interface. As a result, there will be a destructive interference at the centre. So, the centre of the interference pattern is dark.

Question132

At two points P and Q on screen in Young's double slit experiment, waves from slits S_1 and S_2 have a path difference of 0 and $\frac{\lambda}{4}$, respectively. The ratio of intensities at P and Q will be: [2011 RS]

Options:

A. 2: 1

B. $\sqrt{2}$: 1

C. 4: 1

D. 3: 2

Answer: A

Solution:

Path difference at P$\Delta x_1 = 0$

difference at P will be

$\Delta\phi_1 = \frac{2\pi}{\lambda}\Delta x_1$

$= \frac{2\pi}{\lambda} \times 0$

$= 0°$

Resultant Intensity at

P $I_1 = I_0 + I_0 + 2I_0 \cos 0° = 4I_0$

$\Delta x_2 = \frac{\lambda}{4}$

∴ Phase difference at Q

$\Delta = \frac{2\pi}{\lambda} \cdot \frac{\lambda}{4} = \left(\frac{\pi}{2}\right)$

Resultant intensity at Q.

$I_2 = I_0 + I_0 + 2I_0 \cos\frac{\pi}{2} = 2I_0$

Thus, $\frac{I_1}{I_2} = \frac{4I_0}{2I_0} = \frac{2}{1}$

Question133

In a Young's double slit experiment, the two slits act as coherent sources of wave of equal amplitude A and wavelength λ. In another experiment with the same arrangement the two slits are made to act as incoherent sources of waves of same amplitude and wavelength. If the intensity at the middle point of the screen in the first case is I_1 and in the second case is I_2, then the ratio $\frac{I_1}{I_2}$ is

[2011 RS]

Options:

A. 2

B. 1

C. 0.5

D. 4

Answer: A

Solution:

Solution:

For coherent sources, intensity at mid point $I_1 \propto (a + a)^2$

$\Rightarrow I_1 \propto (2a)^2$

For incoherent sources, intensity of mid point is $I_2 \propto 2a^2$

$\therefore \frac{I_1}{I_2} = \frac{2}{1}$

Question134

Statement - 1: On viewing the clear blue portion of the sky through a Calcite Crystal, the intensity of transmitted light varies as the crystal is rotated.

Statement - 2: The light coming from the sky is polarized due to scattering of sun light by particles in the atmosphere. The scattering is largest for blue light.

Options:

A. Statement -1 is true, statement-2 is false.

B. Statement-1 is true, statement-2 is true, statement-2 is the correct explanation of statement-1

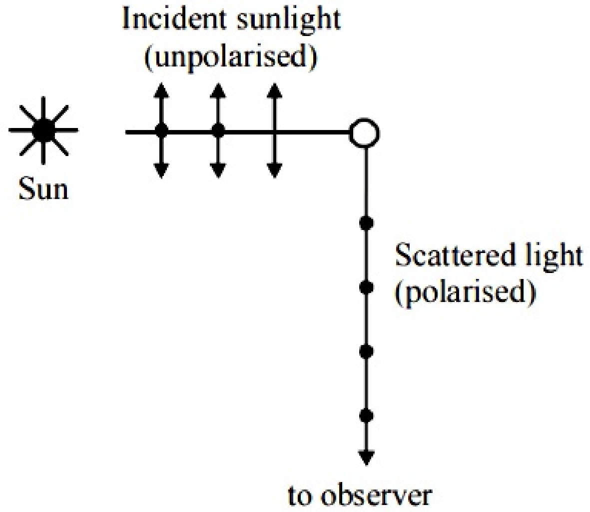
C. Statement-1 is true, statement-2 is true, statement-2 isnot the correct explanation of statement-1

D. Statement-1 is false, statement-2 is true.

Answer: B

Solution:

Solution:
When viewed through a polaroid which is rotated then the light from a clear blue portion of the sky shows a rise and fall of intensity. The light coming from the sky is polarised due to scattering of sunlight by particles in the atmosphere.



Question135

As the beam enters the medium , it will [2010]

Options:

A. diverge

B. converge

C. diverge near the axis and converge near the periphery

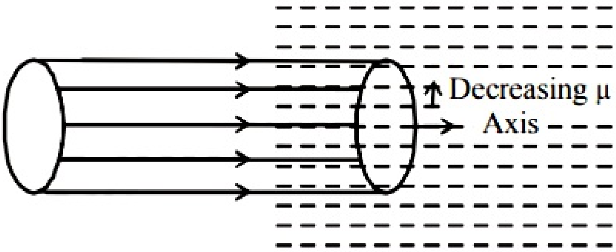
D. travel as a cylindrical beam

Answer: B

Solution:

When light beam is moving and as it enters the medium, the refractive index will decrease from the axis towards the the beam.
Therefore, the beam will conver less distance as one move from the axis to the periphery and hence the beam will

converge.



Question136

The initial shape of the wavefront of the beam is [2010]

Options:

A. convex

B. concave

C. convex near the axis and concave near the periphery

D. planar

Answer: D

Solution:

Solution:
Initially the parallel beam is cylindrical. Therefore, the wavefront will be planar.

Question137

The speed of light in the medium is [2010]

Options:

A. minimum on the axis of the beam

B. the same everywhere in the beam

C. directly proportional to the intensity I

D. maximum on the axis of the beam

Answer: A

Solution:

Solution:

$\therefore v = \frac{c}{\mu} = c\mu_0 + \mu_2(I)$

As I is decreasing with increasing radius, it is maximum on the axis of the beam. Therefore, v is minimum on the axis of the beam.

Question138

A mixture of light, consisting of wavelength 590 nm and an unknown wavelength, illuminates Young's double slit and gives rise to two overlapping interference patterns on the screen. The central maximum of both lights coincide. Further, it is observed that the third bright fringe of known light coincides with the 4th bright fringe of the unknown light. From this data, the wavelength of the unknown light is: [2009]

Options:

A. 885.0 nm

B. 442.5 nm

C. 776.8 nm

D. 393.4 nm

Answer: B

Solution:

Solution:

Let λ be the wavelength of unknown light. Third bright fringe of known light coincides with the 4th bright fringe of the unknown light.

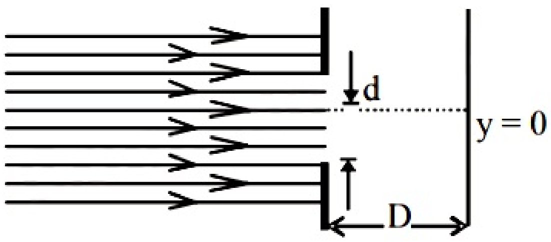
$\therefore \frac{3\lambda_1 D}{d} = \frac{4\lambda_D}{d}$

$\therefore \frac{3(590)D}{d} = \frac{4\lambda D}{d}$

$\Rightarrow \lambda = \frac{3}{4} \times 590 = 442.5 \text{nm}$

Question139

In an experiment, electrons are made to pass through a narrow slit of width 'd' comparable to their de Broglie wavelength.
They are detected on a screen at a distance 'D' from the slit (see figure).

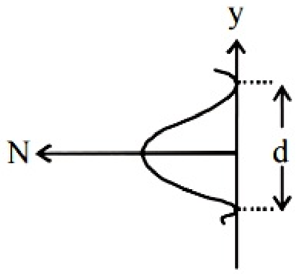


Which of the following graphs can be expected to represent the number of electrons 'N' detected as a function of the detector position 'y'(y = 0

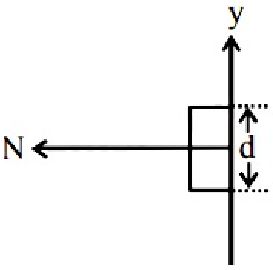
[2008]

Options:

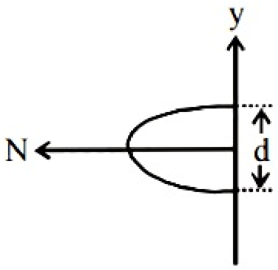
A.



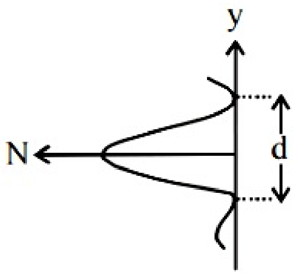
B.



C.



D.



Answer: D

Solution:

Solution:
The electron beam will be diffracted and the maxima is obtained at $y = 0$
Also, the diffraction pattern, should be wider than the slit width.

Question140

In a Young's double slit experiment the intensity at a point where the path difference is $\frac{\lambda}{6}$(λ being the wavelength of light used) is I . If I_0 denotes the maximum intensity, $\frac{I}{I_0}$ is equal to
[2007]

Options:

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

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

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

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

Answer: A

Solution:

Solution:

For path difference of λ, the phase difference is 2π For path difference of $\frac{\lambda}{6}$, the phase difference is

$\frac{2\pi \times \lambda / 6}{\lambda} = \frac{\pi}{3}$

Resultant intensity

$I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2} \cos\frac{\pi}{3}$

$\therefore I = I_1 + I_2 + \sqrt{I_1}\sqrt{I_2}$

For two identical source, $I_1 = I_2 = I$ (say)

then $I = 3I'$

$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$

Maximum resultant intensity,

$= (\sqrt{I'} + \sqrt{I'})^2 = (2\sqrt{I'})^2 = 4I'$

$\therefore \frac{I}{I_{max}} = \frac{3}{4}$

Question141

A Young's double slit experiment uses a monochromatic source. The shape of the interference fringes formed on a screen is
[2005]

Options:

A. circle

B. hyperbola

C. parabola

D. straight line

Answer: D

Solution:

Solution:
The light passing through the slits interfere and produce dark and bright band one screen. The shape of interference fringes formed on a screen in case of a monochromatic source is a straight line.

Question142

If I_0 is the intensity of the principal maximum in the single slit diffraction pattern, then what will be its intensity when the slit width is doubled?
[2005]

Options:

A. $4I_0$

B. $2I_0$

C. $\frac{I_0}{2}$

D. I_0

Answer: A

Solution:

Solution:
$I = I_0\left(\frac{\sin\phi}{\phi}\right)^2$ and $\phi = \frac{\pi}{\lambda}(b\sin\theta)$
When the slit width is doubled, the amplitude of the wave at the centre of the screen is doubled, so the intensity a the centre is increased by a factor 4.

Question143

When an unpolarized light of intensity I_0 is incident on a polarizing sheet, the intensity of the light which does not get transmitted is
[2005]

Options:

A. $\frac{1}{4}I_0$

B. $\frac{1}{2}I_0$

C. I_0

D. zero

Solution:

Solution:
From the law of Malus, $I = I_0 \cos^2\theta$
When an unpolarised light is converted into plane polarised light by passing through polariod, its intensity become hafl.
$\therefore$ Intensity of polarized light $= \frac{I_0}{2}$
$\Rightarrow$ Intensity of untransmitted light $= I_0 - \frac{I_0}{2} = \frac{I_0}{2}$

Question144

Two point white dots are 1 mm apart on a black paper.They are viewed by eye of pupil diameter 3 mm.Approximately, what is the maximum distance at which these dots can be resolved by the eye?
[Take wavelength of light = 500 nm]
[2005]

Options:

A. 1 m

B. 5 m

C. 3 m

D. 6 m

Answer: B

Solution:

Solution:
$\frac{y}{D} \geq 1.22\frac{\lambda}{d}$
$\Rightarrow D \leq \frac{yd}{(1.22)\lambda} = \frac{10^{-3} \times 3 \times 10^{-3}}{(1.22) \times 5 \times 10^{-7}} = \frac{30}{6.1} \approx 5\text{m}$
$\therefore D_{max} = 5\text{m}$

Question145

The maximum number of possible interference maxima for slit-separation equal to twice the wavelength in Young's double-slit experiment is
[2004]

Options:

A. three

B. five

C. infinite

D. zero

Answer: B

Solution:

Solution:
For constructive interference path difference (As $\sin\theta \leq 1$)
$d\ \sin\theta = n\lambda$
Given $d\ = 2\lambda$
$\therefore 2\lambda \sin\theta = n\lambda \Rightarrow \sin\theta = \frac{n}{2}$
$n = 0, 1, -1, 2, -2$ hence five maxima are possible

Question146

The angle of incidence at which reflected light is totally polarized for reflection from air to glass (refractive index n), is [2004]

Options:

A. $\tan^{-1}(1 / n)$

B. $\sin^{-1}(1 / n)$

C. $\sin^{-1}(n)$

D. $\tan^{-1}(n)$

Answer: D

Solution:

Solution:
From the Brewster's law, angle of incidence for total polarization is given by $\tan\theta = n$
$\Rightarrow \theta = \tan^{-1} n$
Where n is the refractive index of the glass.

Question147

To demonstrate the phenomenon of interference, we require two sources which emit radiation [2003]

Options:

A. of nearly the same frequency

B. of the same frequency

D. of the same frequency and having a definite phase relationship

Answer: D

Solution:

To demonstrate the phenomenon of interference we require two sources of light which emit radiation of same frequency and having a definite phase relationship (a phase relationship that does not change with time)

Question148

Wavelength of light used in an optical instrument are λ_1 = 4000Å and λ_2 = 25000Å , then ratio of their respective resolving powers (corresponding to λ_1 and λ_2) is [2002]

Options:

A. 16 : 25

B. 9 : 1

C. 4 : 5

D. 5 : 4

Answer: D

Solution:

The resolving power of an optical instrument is inversely proportional to the wavelength of light used.

$$\frac{(R.P)_1}{(R.P)_2} = \frac{\lambda_2}{\lambda_1} = \frac{5}{4}$$
