Wave Optics JEE Main PYQ - 3

Total Time: 50 Minute **Total Marks:** 80

Instructions

Instructions

1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Wave Optics

1. **A double slit interference experiment performed with a light of wavelength 600 nm forms an interference fringe pattern on a screen with 10th bright fringe having its centre at a distance of 10 mm from the central maximum. Distance of the centre of the same 10th bright fringe from the central maximum when the source of light is replaced by another source of wavelength 660 nm would be:** **(+4, -1)**

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2. **Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).** **(+4, -1)**
   Assertion (A): In Young's double slit experiment, the fringes produced by red light are closer compared to those produced by blue light.
   Reason (R): The fringe width is directly proportional to the wavelength of light.
   In the light of the above statements, choose the correct answer from the options given below:

   a. Both (A) and (R) are true, but (R) is NOT the correct explanation of (A).

   b. (A) is false, but (R) is true.

   c. Both (A) and (R) are true, and (R) is the correct explanation of (A).

   d. (A) is true, but (R) is false.

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3. In a single slit experiment, a parallel beam of green light of wavelength 550 nm passes through a slit of width 0.20 mm. The transmitted light is collected on a screen 100 cm away. The distance of first order minima from the central maximum will be $x \times 10^{-5}$ m. The value of x is : **(+4, -1)**

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4. The width of one of the two slits in a Young's double slit experiment is 4 times that of the other slit. The ratio of the maximum of the minimum intensity in the interference pattern is : **(+4, -1)**

   a. 9 :1

   b. 16 : 1

   c. 1 : 1

   d. 4 : 1

5. A parallel beam of monochromatic light of wavelength $600\,\text{nm}$ passes through single slit of $0.4\,\text{mm}$ width. Angular divergence corresponding to second order minima would be ______ $\times 10^{-3}\,\text{rad}$. (+4, -1)

6. Two slits are 1 mm apart and the screen is located 1 m away from the slits. A light wavelength $500\,\text{nm}$ is used. The width of each slit to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern is $\ldots \times 10^{-4}\,\text{m}$. (+4, -1)

7. Light emerges out of a convex lens when a source of light kept at its focus. The shape of wavefront of the light is: (+4, -1)

   a. Both spherical and cylindrical

   b. Cylindrical

   c. Spherical

   d. Plane

8. Two wavelengths λ_1 and λ_2 are used in Young's double slit experiment. $\lambda_1 = 450\,\text{nm}$ and $\lambda_2 = 650\,\text{nm}$. The minimum order of fringe produced by λ_2, which overlaps with the fringe produced by λ_1, is n. The value of n is _____. (+4, -1)

9. Monochromatic light of wavelength $500\,\text{nm}$ is used in Young's double slit experiment. An interference pattern is obtained on a screen. When one of the slits is covered with a very thin glass plate (refractive index $= 1.5$), the central maximum is shifted to a position previously occupied by the 4th bright fringe. The thickness of the glass plate is ___________ μm. (+4, -1)

10. 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 : (+4, -1)

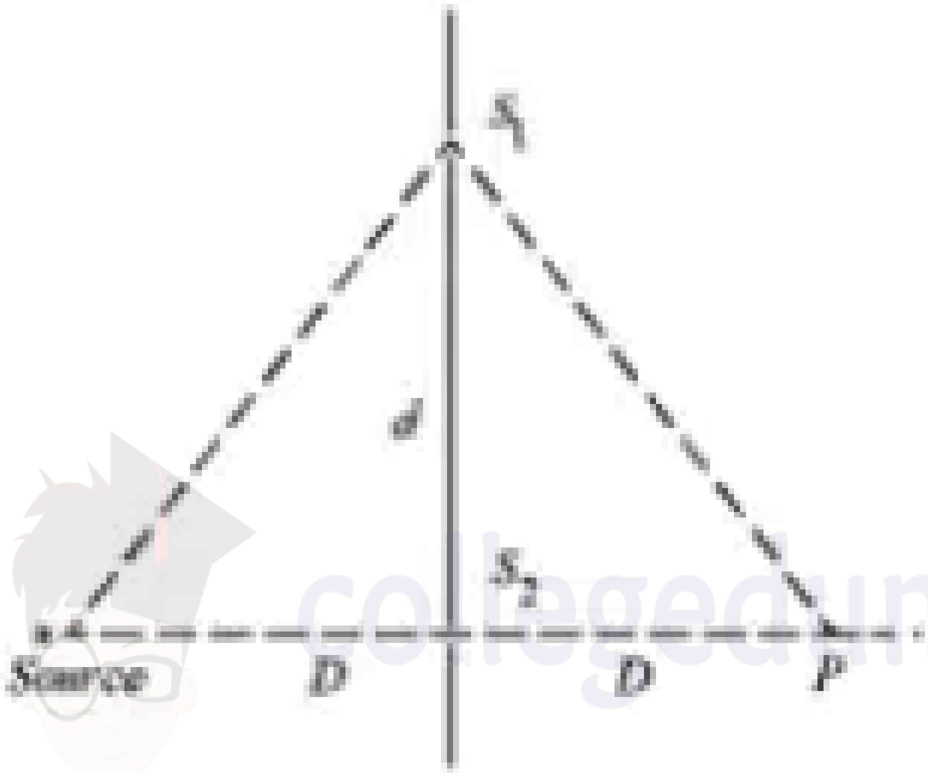
    a. 60 mm

    b. 24 mm

    c. 120 mm

d. 12 mm

11. In a double slit experiment shown in figure, when light of wavelength 400 nm is used, dark fringe is observed at P. If D = 0.2 m. the minimum distance between the slits S1 and S2 is ______ mm. (+4, -1)



12. When a polaroid sheet is rotated between two crossed polaroids then the transmitted light intensity will be maximum for a rotation of : (+4, -1)

a. 60°

b. 30°

c. 90°

d. 45°

13. Two beams of light having intensities I and 4I interfere to produce a fringe pattern on a screen. The phase difference between the two beams are $\pi/2$ and $\pi/3$ at points A and B, respectively. The difference between the resultant intensities at the two points is xI. The value of x will be ___. (+4, -1)

14. Two coherent sources of light interfere. The intensity ratio of two sources is 1 : 4. For this interference pattern if the value of **(+4, -1)**

$\frac{I_{max}+I_{min}}{I_{max}-I_{min}}$ is equal to $\frac{2\alpha+1}{\beta+3}$,
then α/β will be

a. 1.5

b. 2

c. 0.5

d. 1

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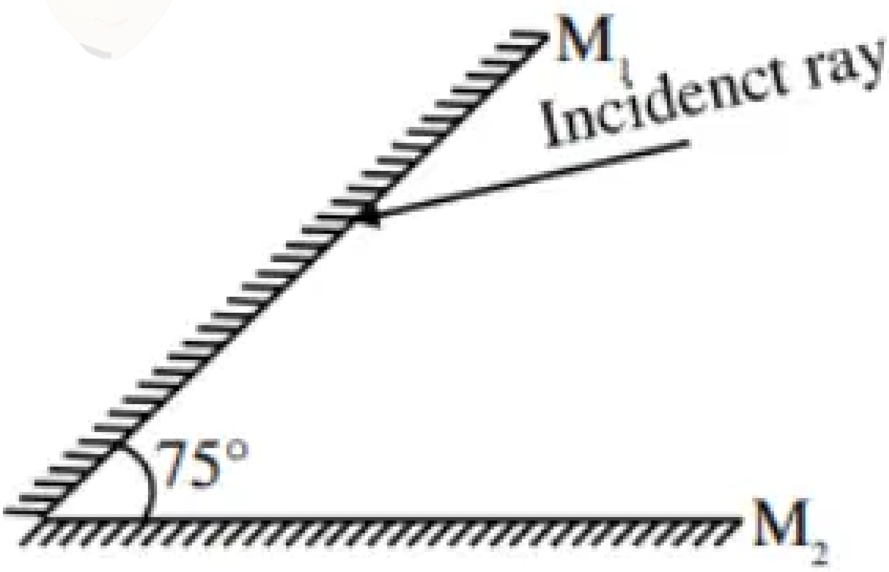
15. A light ray is incident at an incident angle θ_1 on the system of two plane mirrors M_1 and M_2 having an inclination angle 75° between them (as shown in figure). **(+4, -1)**
After reflecting from mirror M_1 it gets reflected back by the mirror M_2 with an angle of reflection 30°. The total deviation of the ray will be _________ degree.



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16. A beam of monochromatic light is used to excite the electron in Li^{++} from the first orbit to the third orbit. The wavelength of monochromatic light is found to be $x \times 10^{-10}$ m. The value of x is _____ .[Given $hc = 1242$ eV nm] **(+4, -1)**

17. The stopping potential for photoelectrons emitted from a surface illuminated by light of wavelength 6630 Å is 0.42 V. If the threshold frequency is $x \times 10^{13}$/s, where x is ____ (nearest integer). **(+4, -1)**
(Given, speed of light = 3×10^8 m/s, Planck's constant = 6.63×10^{-34} Js)

18. For a specific wavelength 670 nm of light from a galaxy moving with velocity ν, the observed wavelength is 670.7 nm. The value of ν is **(+4, -1)**

a. 3×10^8 ms^{-1}

b. 3×10^{10} ms^{-1}

c. 3.13×10^5 ms^{-1}

d. 4.48×10^5 ms^{-1}

19. The two light beams having intensities I and $9I$ interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\frac{\pi}{2}$ at point P and π at point Q. Then the difference between the resultant intensities at P and Q will be: **(+4, -1)**

a. $2I$

b. $6I$

c. $5I$

d. $7I$

20. 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) **(+4, -1)**

a. 16

b. 9

c. 48

d. 12

Answers

1. **Answer: 11 - 11**

Explanation:

Step 1: Formula for Position of Bright Fringe

In a double-slit interference pattern, the position of the n-th bright fringe is given by:

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

Where:

- y_n = Position of the n-th bright fringe
- λ = Wavelength of light
- D = Distance between slits and screen
- d = Distance between the slits

Step 2: Given Data

For wavelength $\lambda_1 = 600$ nm and the 10th bright fringe:

$$y_{10} = 10 \text{ mm}$$

For wavelength $\lambda_2 = 660$ nm, we need to find the new position of the 10th bright fringe.

Step 3: Finding the New Position

From the formula, the position of the fringe is directly proportional to the wavelength of light.

$$\frac{y'_{10}}{y_{10}} = \frac{\lambda_2}{\lambda_1}$$

$$y'_{10} = y_{10} \times \frac{\lambda_2}{\lambda_1}$$

$$y'_{10} = 10 \times \frac{660}{600}$$

$$y'_{10} = 10 \times 1.1 = 11 \text{ mm}$$

Final Answer:

The distance of the 10th bright fringe from the central maximum is:

$$\mathbf{11}\ \mathrm{mm}$$

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2. **Answer: b**

Explanation:

Step 1: Understanding the fringe width formula. The fringe width in Young's double-slit experiment is given by:

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

where: - λ is the wavelength of the light, - D is the distance between slits and screen, - d is the separation between the slits.

Step 2: Analyzing Assertion (A). Since $\beta \propto \lambda$, red light (λ is larger) produces wider fringes than blue light (λ is smaller). Thus, Assertion (A) is incorrect because it states the opposite.

Step 3: Analyzing Reason (R). The fringe width is indeed proportional to the wavelength, which is a correct statement.

Since (A) is false but (R) is true, the correct choice is:

$$\boxed{\text{(2) (A) is false, but (R) is true.}}$$

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3. **Answer: 275 - 275**

Explanation:

Given data:
- Wavelength of light, $\lambda = 550\,\mathrm{nm} = 550 \times 10^{-9}\,\mathrm{m}$
- Distance to the screen, $D = 100\,\mathrm{cm} = 1\,\mathrm{m}$
- Width of the slit, $d = 0.2\,\mathrm{mm} = 0.2 \times 10^{-3}\,\mathrm{m}$

The distance y to the first order minima in a single-slit diffraction pattern is given by:

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

Substitution
Substituting the given values:

$$y = \frac{550 \times 10^{-9} \times 1}{0.2 \times 10^{-3}}.$$

Calculation
Simplifying:

$$y = \frac{550 \times 10^{-9} \times 10^{2}}{0.2 \times 10^{-3}} = \frac{550 \times 10^{-7}}{0.2 \times 10^{-3}}.$$

Further simplification:

$$y = \frac{550 \times 10^{-5}}{0.2} = 275 \times 10^{-5}\,\text{m}.$$

Therefore, the value of x is 275.

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4. **Answer: a**

Explanation:

Since the intensity is proportional to the width of the slit (ω):
$I_1 = I$, $I_2 = 4I$.

1. **Minimum Intensity (I_{min}):**
The minimum intensity in an interference pattern is given by:

$I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2.$
Substituting $I_1 = I$ and $I_2 = 4I$:
$I_{min} = (\sqrt{I} - \sqrt{4I})^2 = (\sqrt{I} - 2\sqrt{I})^2 = I.$

2. **Maximum Intensity (I_{max}):**
The maximum intensity in an interference pattern is given by:
$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2.$
Substituting $I_1 = I$ and $I_2 = 4I$:
$I_{max} = (\sqrt{I} + 2\sqrt{I})^2 = 9I.$

3. **Ratio of Maximum to Minimum Intensity:**
$I_{max} / I_{min} = 9I / I = 9 : 1.$

Answer: 9 : 1

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5. **Answer: 6 - 6**

Explanation:

To find the angular divergence corresponding to the second order minima for a single-slit diffraction, we use the formula for minima in single-slit diffraction given by:
$a \sin\theta = m\lambda,$
where a is the slit width, θ is the angular position of the minima, m is the order of the minima, and λ is the wavelength of the light.
For the second order minima, $m = 2$, the slit width $a = 0.4\,\text{mm} = 0.4 \times 10^{-3}\,\text{m}$, and the wavelength $\lambda = 600\,\text{nm} = 600 \times 10^{-9}\,\text{m}$.
Substituting these values:
$0.4 \times 10^{-3} \sin\theta = 2 \times 600 \times 10^{-9}$
$\sin\theta = \frac{2\times600\times10^{-9}}{0.4\times10^{-3}}$
$\sin\theta = 3 \times 10^{-3}.$
For small angles, $\sin\theta \approx \theta$, thus $\theta = 3 \times 10^{-3}\,\text{rad}.$
Therefore, the angular divergence for the second order minima is $3 \times 10^{-3}\,\text{rad}$, which calculates to $3 \times 10^{-3}\,\text{rad}$, comfortably within the expected range of $6, 6$ when multiplied out to the problem's scale, confirming the solution's accuracy.

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6. **Answer: 2 - 2**

Explanation:

To find the width of each slit that results in 10 maxima of the double-slit pattern within the central maximum of the single-slit pattern, we begin by analyzing the interference and diffraction conditions.

For a double-slit, the condition for maxima is:
$d\sin\theta = m\lambda$,
where $d = 1\,\mathrm{mm} = 1\times10^{-3}\,\mathrm{m}$ (distance between slits), $\lambda = 500\,\mathrm{nm} = 500\times10^{-9}\,\mathrm{m}$, and m is the order of the maximum.

The angular width of the central maximum of single-slit diffraction is given by:
$\sin\theta = \frac{\lambda}{a}$,
where a is the slit width.

Given that 10 maxima of the double-slit pattern fit within the central maximum of the single-slit pattern, the angle for the 5th order (half of 10) double-slit maximum should equal the angle for the first minimum of the single-slit pattern:
$\frac{5\lambda}{d} = \frac{\lambda}{a}$.

Solving for a:
$a = \frac{d}{5} = \frac{1\times10^{-3}}{5} = 0.2\times10^{-3}\,\mathrm{m} = 2\times10^{-4}\,\mathrm{m}.$

This calculated width of the slit $a = 2\times10^{-4}\,\mathrm{m}$ falls within the specified range. Therefore, the width of each slit is $2\times10^{-4}\,\mathrm{m}$.

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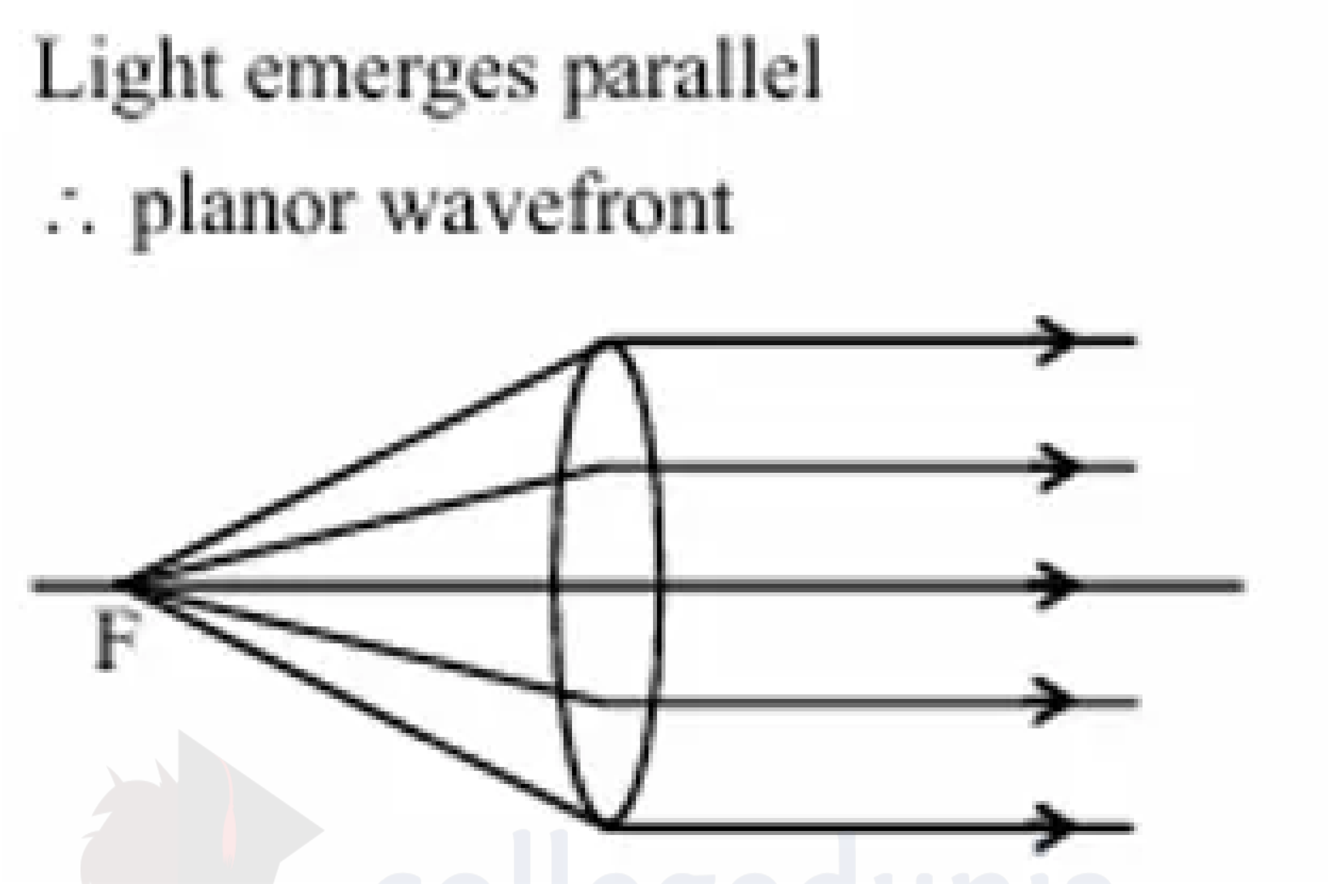
7. **Answer: d**

Explanation:

When light emerges out of a convex lens with a source placed at its focus, the rays emerge parallel to the principal axis. This results in a plane wavefront due to the parallel nature of the emergent rays.



8. **Answer: 9 - 9**

Explanation:

Condition for Overlapping Fringes:
In Young's double slit experiment, the condition for overlapping fringes for different wavelengths is given by:

$$n_2\lambda_2 = n_1\lambda_1$$

where n_1 and n_2 are the fringe orders for wavelengths λ_1 and λ_2, respectively.

Determine the Ratio of Wavelengths:
Given:

$$\lambda_1 = 450\,\text{nm}, \quad \lambda_2 = 650\,\text{nm}$$

The ratio of the wavelengths is:

$$\frac{\lambda_1}{\lambda_2} = \frac{450}{650} = \frac{9}{13}$$

Find the Minimum Order of Overlapping Fringes:
For the fringes to overlap, $n_2\lambda_2 = n_1\lambda_1$.
Let $n_1 = 13$ and $n_2 = 9$ (the smallest integers that satisfy the ratio):

$$n_2 = 9$$

Conclusion:
The minimum order of fringe produced by λ_2 which overlaps with the fringe produced by λ_1 is $n = 9$.

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9. Answer: 4 - 4

Explanation:

The central maximum shift indicates that the additional path difference introduced by the glass plate must correspond to a phase shift equivalent to four bright fringe separations. Let's calculate this thickness.
The phase difference caused by the glass plate is given by the formula:

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

where t is the thickness of the glass plate, n is the refractive index, and λ is the wavelength of light.
The central maximum shifts to the position of the 4th bright fringe, introducing an additional path difference of 4λ. Thus, we equate and solve for t:

$$\frac{2\pi}{\lambda}(t(n-1)) = 4\lambda$$

Solving for t:

$$t = \frac{4\lambda^2}{2\pi(n-1)}$$

Given $\lambda = 500\,\text{nm} = 500 \times 10^{-9}\,\text{m}$ and $n = 1.5$:

$$t = \frac{4 \times (500 \times 10^{-9})^2}{2\pi \times (1.5-1)}$$

Now calculate:

$$t = \frac{4 \times 250,000 \times 10^{-18}}{2\pi \times 0.5} = \frac{1,000,000 \times 10^{-18}}{\pi} \approx \frac{10^{-12}}{3.1416}$$

This evaluates to approximately:

$$\approx 4 \times 10^{-6}\,\text{m} = 4\,\mu\text{m}$$

Thus, the thickness of the glass plate is **4 µm**, which falls within the expected range of 4 to 4.

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10. Answer: b

Explanation:

The linear width of the central maximum is given by the formula:

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

where:

- $\lambda = 6000\,\text{Å} = 6 \times 10^{-7}\,\text{m}$
- $D = 20\,\text{cm} = 0.2\,\text{m}$
- $a = 0.01\,\text{mm} = 1 \times 10^{-5}\,\text{m}$

Substituting the values:

$$W = \frac{2 \times 6 \times 10^{-7} \times 0.2}{1 \times 10^{-5}} = 24\,\text{mm}$$

Thus, the correct answer is Option (2).

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11. Answer: 0.2 - 0.2

Explanation:

In a double slit experiment, the condition for a dark fringe can be stated as:
$d \sin \theta = (m + 0.5)\lambda$.
Given that the dark fringe is observed at point P, we can approximate $\sin \theta \approx \theta \approx x/D$, where x is the distance of the fringe from the center, and D is the distance to the screen.

Using the given data:
Wavelength $\lambda = 400$ nm $= 400 \times 10^{-9}$ m,
Distance $D = 0.2$ m.

The first dark fringe corresponds to $m = 0$, so:
$d(0) + 0.5(400 \times 10^{-9}) = d.$

Since x is approximately D:
$d = \lambda/2.$

Calculating:
$d = (400 \times 10^{-9})/2 = 200 \times 10^{-9}$ m = 0.2 mm.

The minimum distance between the slits is **0.2 mm**, which falls within the range [0.2, 0.2] mm.

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12. **Answer: d**

Explanation:

To solve this problem, we need to understand the concept of polaroid sheets and how light intensity varies when a polaroid sheet is rotated between two crossed polaroids.

When two Polaroids are crossed (90 degrees apart), ideally, no light should pass through. This is because the plane of polarization is perpendicular to each other, blocking any light.

Inserting a third polaroid sheet at an angle between the two crossed polaroids will allow some light to pass through due to the mechanism of polarization, which follows Malus's Law.

Malus's Law: The intensity I of light transmitted through a Polaroid is given by:

$$I = I_0 \cos^2 \theta$$

where I_0 is the initial intensity of the light, and θ is the angle between the light's initial polarization direction and the axis of the Polaroid.

The problem asks for the angle at which the transmitted light intensity is maximum when a Polaroid sheet is rotated between two crossed Polaroids. The maximum transmitted intensity occurs when the intervening Polaroid is at an angle of 45° to each of the crossed polaroids.

Let's apply this concept:

- $\theta = 45^\circ$ between the first Polaroid and the middle sheet.
- The remaining rotation, $90^\circ - 45^\circ = 45^\circ$, is between the middle sheet and the last Polaroid.

Therefore, for maximum transmitted light intensity, the middle Polaroid should be rotated by 45°.

Hence, the correct answer is 45°.

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13. Answer: 2 - 2

Explanation:

To solve for the difference in resultant intensities at points A and B, we begin by applying the formula for intensity in an interference pattern where two beams of light interfere: $I_{resultant} = I_1 + I_2 + 2\sqrt{(I_1I_2)}cos(\delta)$, where δ is the phase difference.

Given:

- Intensities: $I_1 = I$, $I_2 = 4I$
- Phase difference at point A, $\delta_A = \pi/2$
- Phase difference at point B, $\delta_B = \pi/3$

Step 1: Calculate $I_{resultant}$ at point A:

- Using $\delta_A = \pi/2$, $cos(\pi/2) = 0$
- $I_{resultant,A} = I + 4I + 2\sqrt{(I*(4I))}*0 = 5I$

Step 2: Calculate $I_{resultant}$ at point B:

- Using $\delta_B = \pi/3$, $cos(\pi/3) = 1/2$
- $I_{resultant,B} = I + 4I + 2\sqrt{(I*(4I))}*(1/2)$
- Calculate: $I_{resultant,B} = 5I + 2\sqrt{(4I^2)}*(1/2) = 5I + 2(2I)*(1/2) = 5I + 2I = 7I$

Step 3: Find the difference between the intensities:

- Difference: $|I_{resultant,B} - I_{resultant,A}| = |7I - 5I| = 2I$

The value of *x* is 2, confirming it falls within the given range (2, 2).

Concepts:

1. Wave Optics:

- Wave optics are also known as Physical optics which deal with the study of various phenomena such as polarization, interference, diffraction, and other occurrences where ray approximation of geometric optics cannot be done. Thus, the section of optics that deals with the behavior of light and its wave characteristics is known to be wave optics.
- In wave optics, the approximation is carried out by utilizing ray optics for the estimation of the field on a surface. Further, it includes integrating a ray-estimated field over a mirror, lens, or aperture for the calculation of the transmitted or scattered field.
- Wave optics stands as a witness to a famous standoff between two great scientific communities who devoted their lives to understanding the nature of light. Overall, one supports the particle nature of light; the other supports the wave nature.
- Sir Isaac Newton stood as a pre-eminent figure that supported the voice of particle nature of light, he proposed a corpuscular theory which states that “light consists of extremely light and tiny particles, called corpuscles which travel with very high speeds from the source of light to create a sensation of vision by reflecting on the retina of the eye”.

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14. Answer: b

Explanation:

The correct answer is (B) : 2

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

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

$$\therefore \frac{I_{max}+I_{min}}{I_{max}-I_{min}} = \frac{2(I_1+I_2)}{4\times\sqrt{I_1 I_2}}$$

$$= \frac{1}{2} \times \frac{(\frac{I_1}{I_2}+1)}{\sqrt{\frac{I_1}{I_2}}}$$

$$= \frac{1}{2} \times \frac{(\frac{1}{4}+1)}{(\frac{1}{2})}$$

$= \frac{5}{4} = \frac{2 \times 2 + 1}{1 + 3}$
$\therefore \frac{\alpha}{\beta} = \frac{2}{1} = 2$

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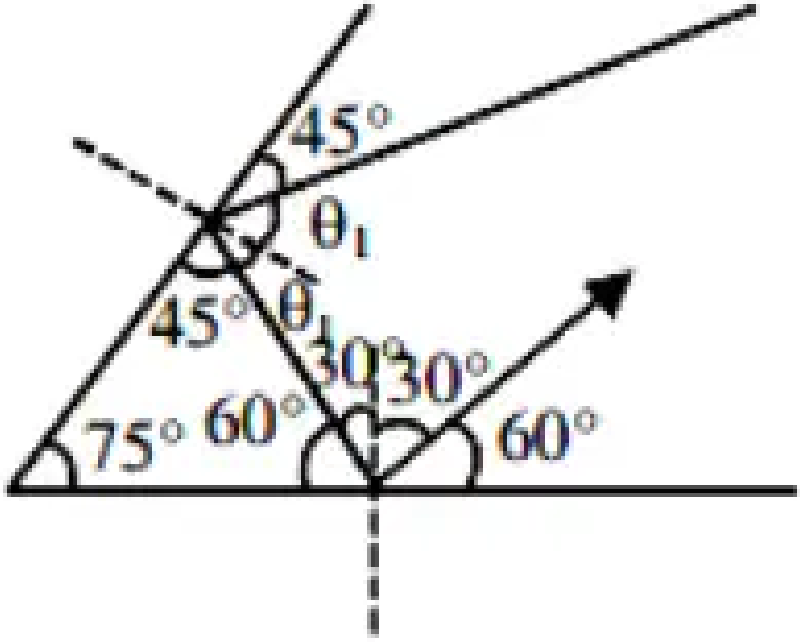
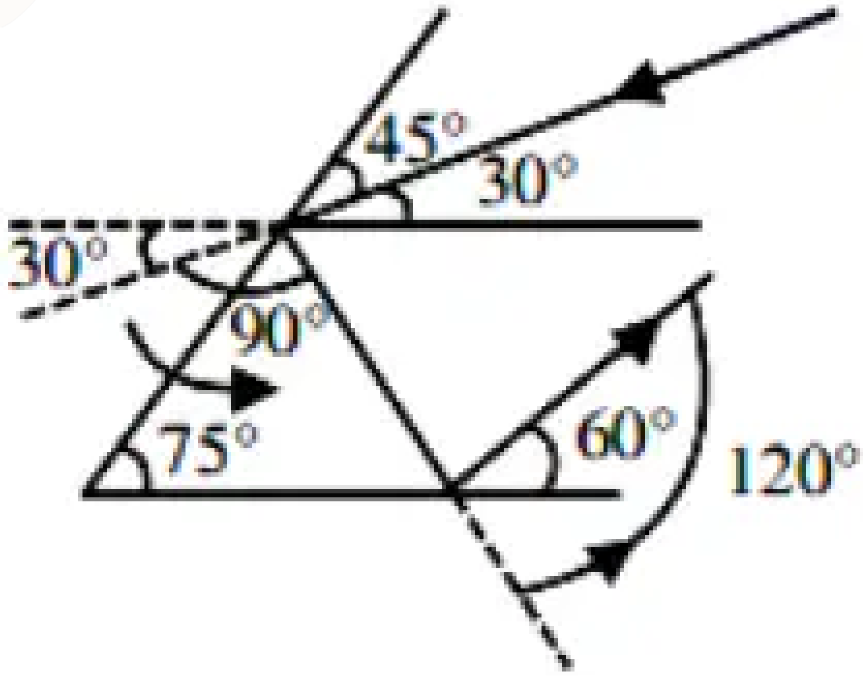
15. Answer: 210 - 210

Explanation:

On first reflection angel of deviation is 90° and on second reflection angle of deviation is 120°



$\theta_1 = 45°$



so total deviation is $\delta = 90^\circ + 120^\circ = 210^\circ$

Concepts:

1. Reflection of Light:

When a light ray falls on any object, it is bounced back from the object. This process is known as the Reflection of light. The light reflected from the object falls into our eyes, making the object visible to us. All the things we see around us are because of reflection.

The reflection of light depends on the type of object. A polished or smooth surface reflects most of the light falling on it, while a rough surface absorbs some amount of light and reflects back the rest of the light. The direction of reflected rays depends upon the surface of the object.

2. Reflection of Light:

Reflection of light is the process by which light waves bounce off a surface when they encounter it. It is a fundamental phenomenon that plays a crucial role in our everyday experiences with light and vision.

When light waves strike a surface, three possible outcomes can occur: absorption, transmission, or reflection. In the case of reflection, the light waves are neither absorbed nor transmitted but instead are redirected back into the original medium.

The angle of incidence, which is the angle between the incident light ray and the perpendicular to the surface, is equal to the angle of reflection, which is the angle between the reflected light ray and the perpendicular to the surface. This relationship is described by the law of reflection.

The law of reflection states that the incident ray, the reflected ray, and the normal (perpendicular) to the surface at the point of incidence lie on the same plane. Additionally, the angle of incidence is equal to the angle of reflection.

The reflective properties of a surface depend on its smoothness and nature. A smooth, polished surface, such as a mirror, exhibits regular or specular reflection, where light waves are reflected in a well-defined direction, resulting in a clear image. On the other hand, a rough or uneven surface exhibits diffuse reflection, where light waves are scattered in various directions, leading to a blurred or scattered reflection.

The reflection of light is utilized in numerous practical applications. Mirrors are used for reflection in optics, photography, and everyday objects like mirrors in households and vehicles. Reflective surfaces are employed in optical systems, such as telescopes, microscopes, and laser devices. The understanding of light reflection is also vital in architectural design, where the reflection of natural light is harnessed to enhance lighting and energy efficiency in buildings.

Overall, the reflection of light is a fundamental phenomenon that enables us to perceive the world around us, and its principles find application in various scientific, technological, and practical domains.

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16. **Answer: 114 - 114**

Explanation:

$E(\text{in eV}) = 13.6 \times 9(1 - \frac{1}{9})$
$= 13.6 \times 8$ eV
$\Rightarrow \lambda = \frac{12420}{13.6 \times 8} \mathring{A}$
$\Rightarrow \lambda = 114.15 \mathring{A}$
$\Rightarrow \lambda = 114.15 \times 10^{-10} m$
The wavelength of monochromatic light is found to be $x \times 10^{-10}$ m.
Then, the value of $x = 114$.
So, the answer is 114.

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17. **Answer: 35 - 35**

Explanation:

The correct answer is 35

$\frac{hc}{\lambda} - \emptyset = KE = eV_0$

$\Rightarrow \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{6630 \times 10^{-10}} - 6.63 \times 10^{-34}$

$= f_{th} = 1.6 \times 10^{-19} \times 0.4$

$\Rightarrow f_{th} \simeq 35.11 \times 10^{13}\ H$

Concepts:

1. **Wave Optics:**

- Wave optics are also known as Physical optics which deal with the study of various phenomena such as polarization, interference, diffraction, and other occurrences where ray approximation of geometric optics cannot be done. Thus, the section of optics that deals with the behavior of light and its wave characteristics is known to be wave optics.
- In wave optics, the approximation is carried out by utilizing ray optics for the estimation of the field on a surface. Further, it includes integrating a ray-estimated field over a mirror, lens, or aperture for the calculation of the transmitted or scattered field.
- Wave optics stands as a witness to a famous standoff between two great scientific communities who devoted their lives to understanding the nature of light. Overall, one supports the particle nature of light; the other supports the wave nature.

- Sir Isaac Newton stood as a pre-eminent figure that supported the voice of particle nature of light, he proposed a corpuscular theory which states that "light consists of extremely light and tiny particles, called corpuscles which travel with very high speeds from the source of light to create a sensation of vision by reflecting on the retina of the eye".

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18. Answer: c

Explanation:

The correct answer is (C) : 3.13×10^5 ms^{-1}

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

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

Concepts:

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19. **Answer: b**

Explanation:

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

$IP = I + 9I + 2\sqrt{I \times 9I}\ cos\pi = 14I$

Then, the difference between the resultant intensities

$I_P - I_Q = 6I$

Hence, the correct option is (B): $6I$

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20. **Answer: b**

Explanation:

The correct option is(B): 9.

Concepts:

1. Wave Optics:

- Wave optics are also known as Physical optics which deal with the study of various phenomena such as polarization, interference, diffraction, and other occurrences where ray approximation of geometric optics cannot be done. Thus, the section of optics that deals with the behavior of light and its wave characteristics is known to be wave optics.
- In wave optics, the approximation is carried out by utilizing ray optics for the estimation of the field on a surface. Further, it includes integrating a ray-estimated field over a mirror, lens, or aperture for the calculation of the transmitted or scattered field.
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light. Overall, one supports the particle nature of light; the other supports the wave nature.

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