# Wave Optics

1. 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 **[AIEEE-2009]**

   (1) 885.0 nm

   (2) 442.5 nm

   (3) 776.8 nm

   (4) 393.4 nm

Directions : *Question numbers 2 to 4 are based on the following paragraph.*

An initially parallel cylindrical beam travels in a medium of refractive index $\mu(I) = \mu_0 + \mu_2 I$, where $\mu_0$ and $\mu_2$ are positive constants and $I$ is the intensity of the light beam. The intensity of the beam is decreasing with increasing radius. **[AIEEE-2010]**

2. The initial shape of the wavefront of the beam is

   (1) Planar

   (2) Convex

   (3) Concave

   (4) Convex near the axis and concave near the periphery

3. The speed of light in the medium is

   (1) Maximum on the axis of the beam

   (2) Minimum on the axis of the beam

   (3) The same everywhere in the beam

   (4) Directly proportional to the intensity $I$

4. As the beam enters the medium, it will

   (1) Travel as a cylindrical beam

   (2) Diverge

   (3) Converge

   (4) Diverge near the axis and converge near the periphery

5. In a Young's double slit experiment, the two slits act as coherent sources of waves of equal amplitude $A$ and wavelength $\lambda$. 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 **[AIEEE-2011]**

   (1) 0.5 (2) 4

   (3) 2 (4) 1

6. 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 sunlight by particles in the atmosphere. The scattering is largest for blue light. **[AIEEE-2011]**

   (1) Statement-1 is true, statement-2 is true; statement-2 is not the correct explanation of statement-1

   (2) Statement-1 is false, statement-2 is true

   (3) Statement-1 is true, statement-2 is false

   (4) Statement-1 is true, statement-2 is true; statement-2 is the correct explanation of statement-1

7. At two points $P$ and $Q$ on a 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 **[AIEEE-2011]**

   (1) 4 : 1 (2) 3 : 2

   (3) 2 : 1 (4) $\sqrt{2}:1$

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

(1) $\frac{I_m}{3}(1+2\cos^2\frac{\phi}{2})$ (2) $\frac{I_m}{5}\left(1+4\cos^2\frac{\phi}{2}\right)$

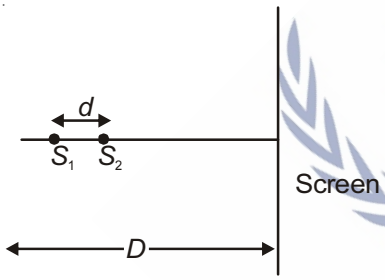
(3) $\frac{I_m}{9}\left(1+8\cos^2\frac{\phi}{2}\right)$ (4) $\frac{I_m}{9}(4+5\cos\phi)$

9. A beam of unpolarized 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 **[JEE (Main)-2013]**

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

(3) $\frac{I_0}{4}$ (4) $\frac{I_0}{8}$

10. 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 **[JEE (Main)-2013]**




(1) Points

(2) Straight lines

(3) Semi - circles

(4) Concentric Circles

11. 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 **[JEE (Main)-2014]**

(1) 3 (2) $\frac{3}{2}$

(3) 1 (4) $\frac{1}{3}$

12. On a hot summer night, the refractive index of air is smallest near the ground and increases with height form the ground. When a light beam is directed horizontally, the Huygen's principle leads us to conclude that as it travels, the light beam **[JEE (Main)-2015]**

(1) Becomes narrower

(2) Goes horizontally without any deflection

(3) Bends downwards

(4) Bends upwards

13. 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 **[JEE (Main)-2015]**

(1) 1 μm

(2) 30 μm

(3) 100 μm

(4) 300 μm

14. 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 **[JEE (Main)-2016]**

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

(2) $a=\sqrt{\lambda L}$ and $b_{min}=\sqrt{4\lambda L}$

(3) $a=\frac{\lambda^2}{L}$ and $b_{min}=\sqrt{4\lambda L}$

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

15. 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 = $3\times10^8$ $ms^{-1}$) **[JEE (Main)-2017]**

(1) 10.1 GHz

(2) 12.1 GHz

(3) 17.3 GHz

(4) 15.3 GHz

16. 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 **[JEE (Main)-2017]**

(1) 1.56 mm (2) 7.8 mm

(3) 9.75 mm (4) 15.6 mm

17. Unpolarized light of intensity $I$ passes through an ideal polarizer $A$. Another identical 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 **[JEE (Main)-2018]**

(1) 0° (2) 30°

(3) 45° (4) 60°

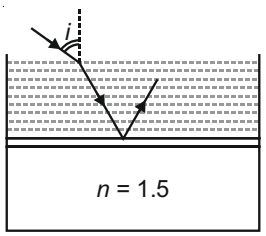
18. The angular width of the central maximum in a single slit diffraction pattern is 60°. The width of the slit is 1 μm. The slit is illuminated by monochromatic plane waves. If another slit of same width is made near it, Young's fringes can be observed on a screen placed at a distance 50 cm from the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

(*i.e.* distance between the centres of each slit.)
**[JEE (Main)-2018]**

(1) 25 μm (2) 50 μm

(3) 75 μm (4) 100 μm

19. Consider a tank made of glass (refractive index 1.5) with a thick bottom. 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 **[JEE (Main)-2019]**




(1) $\frac{4}{3}$ (2) $\sqrt{\frac{5}{3}}$

(3) $\frac{3}{\sqrt{5}}$ (4) $\frac{5}{\sqrt{3}}$

20. 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: **[JEE (Main)-2019]**

(1) 25 : 9 (2) 4 : 1

(3) 16 : 9 (4) 5 : 3

21. In a Young's double slit experiment, the slits are placed 0.320 mm apart. Light of wavelength $\lambda$ = 500 nm is incident on the slits. The total number of bright fringes that are observed in the angular range $-30° \le \theta \le 30°$ is

**[JEE (Main)-2019]**

(1) 640 (2) 320

(3) 321 (4) 641

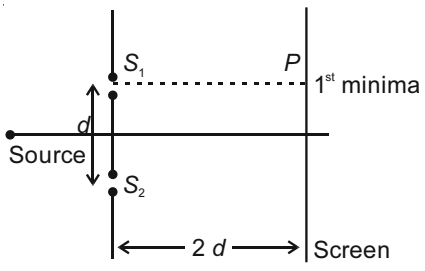
22. In a Young's double slit experiment with slit separation 0.1 mm, one observes a bright fringe at angle $\frac{1}{40}$ rad by using light of wavelength $\lambda_1$. When the light of wavelength $\lambda_2$ is used a bright fringe is seen at the same angle in the same set up. Given that $\lambda_1$ and $\lambda_2$ are in visible range (380 nm to 740 nm), their values are **[JEE (Main)-2019]**

(1) 380 nm, 500 nm (2) 625 nm, 500 nm

(3) 380 nm, 525 nm (4) 400 nm, 500 nm

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

**[JEE (Main)-2019]**

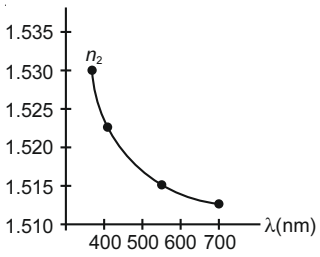


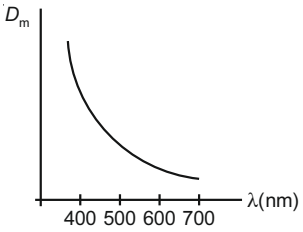

(1) $\frac{\lambda}{2(\sqrt{5}-2)}$ (2) $\frac{\lambda}{2(5-\sqrt{2})}$

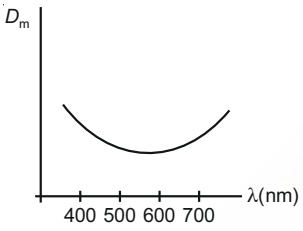
(3) $\frac{\lambda}{(5-\sqrt{2})}$ (4) $\frac{\lambda}{(\sqrt{5}-2)}$

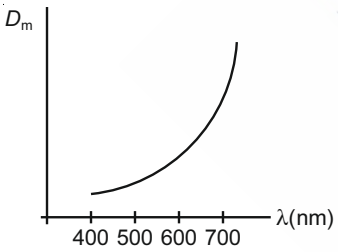
24. The variation of refractive index of a crown glass thin prism with wavelength of the incident light is shown. Which of the following graphs is the correct one, if $D_m$ is the angle of minimum deviation?

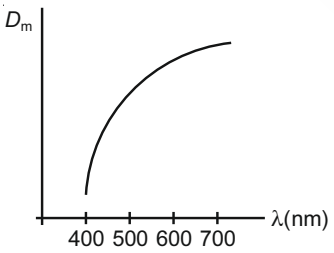
**[JEE (Main)-2019]**




(1)



(2)



(3)



(4)



25. 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. The ratio of the intensity at this point to that at the centre of a bright fringe is close to

**[JEE (Main)-2019]**

(1) 0.74 (2) 0.94

(3) 0.80 (4) 0.85

26. In a double-slit experiment, green light (5303 Å) 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 **[JEE (Main)-2019]**

(1) 05 (2) 09

(3) 10 (4) 04

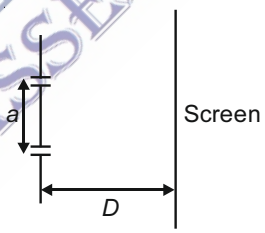
27. In an interference experiment the ratio of amplitudes of coherent waves is $\frac{a_1}{a_2} = \frac{1}{3}$. The ratio of maximum and minimum intensities of fringes will be **[JEE (Main)-2019]**

(1) 4 (2) 18

(3) 9 (4) 2

28. 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 μ 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 λ, $t$ will be

**[JEE (Main)-2019]**




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

(3) $\frac{n\lambda}{(\mu-1)}$ (4) $\frac{\lambda}{(\mu-1)}$

29. In a Young's double slit experiment, the ratio of the slit's width is 4 : 1. The ratio of the intensity of maxima to minima, close to the central fringe on the screen, will be : **[JEE (Main)-2019]**

(1) $(\sqrt{3}+1)^4 : 16$ (2) 4 : 1

(3) 25 : 9 (4) 9 : 1

30. 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 (λ is the wavelength of the light used) : **[JEE (Main)-2019]**

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

(3) $\frac{\lambda}{(2\mu-1)}$ (4) $\frac{\lambda}{(\mu-1)}$

31. 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°C to the pass axis of $P_3$. When a beam of unpolarized light of intensity $I_0$ is incident on $P_1$, the intensity of light transmitted by the three polarizers is $I$. The ratio ($I_0/I$) equals (nearly) **[JEE (Main)-2019]**

(1) 1.80 (2) 5.33

(3) 10.67 (4) 16.00

32. Visible light of wavelength 6000 × $10^{-8}$ cm falls normally on a single slit and produces a diffraction pattern. It is found that the second diffraction minimum is at 60° from the central maximum. If the first minimum is produced at $\theta_1$, then $\theta_1$ is close to **[JEE (Main)-2020]**

(1) 25° (2) 30°

(3) 20° (4) 45°

33. 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 **[JEE (Main)-2020]**

(1) 3.9 mm (2) 6.9 mm

(3) 5.9 mm (4) 4.9 mm

34. 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 **[JEE (Main)-2020]**

(1) 0.568 (2) 0.760

(3) 0.853 (4) 0.672

35. Interference fringes are observed on a screen by illuminating two thin slits 1 mm apart with a light source ($\lambda$ = 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 is **[JEE (Main)-2020]**

(1) 1.27 μm (2) 2.05 μm

(3) 2.87 nm (4) 2 nm

36. In a Young's double slit experiment, 16 fringes are observed in a certain segment of the screen when light of a 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 **[JEE (Main)-2020]**

(1) 28 (2) 24

(3) 30 (4) 18

37. 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 **[JEE (Main)-2020]**

(1) 0.17° (2) 1.7°

(3) 0.57° (4) 0.07°

38. 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 **[JEE (Main)-2020]**

(1) $\frac{2\pi}{\lambda}(n_2L_1 - n_1L_2)$ (2) $\frac{2\pi}{\lambda}\left(\frac{L_1}{n_1} - \frac{L_2}{n_2}\right)$

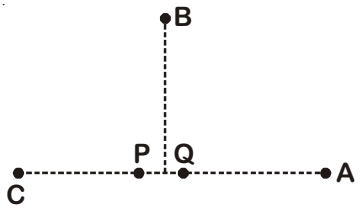
(3) $\frac{2\pi}{\lambda}(n_1L_1 - n_2L_2)$ (4) $\frac{2\pi}{\lambda}\left(\frac{L_2}{n_1} - \frac{L_1}{n_2}\right)$

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

(1) 1.0 × $10^{-5}$ J (2) 1.0 × $10^{-4}$ J

(3) 5.0 × $10^{-4}$ J (4) 1.5 × $10^{-4}$ J

40. 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 90°. *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 **[JEE (Main)-2020]**




(1) 0 : 1 : 2 (2) 4 : 1 : 0

(3) 2 : 1 : 0 (4) 0 : 1 : 4

41. 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 $\lambda$ is used. Then the value of $\lambda$ is (in nm) _____. **[JEE (Main)-2020]**

42. Orange light of wavelength $6000 \times 10^{-10}$ m illuminates a single slit of width $0.6 \times 10^{-4}$ m. The maximum possible number of diffraction minima produced on both sides of the central maximum is _____. **[JEE (Main)-2020]**

43. A beam of electrons of energy *E* scatters from a target having atomic spacing of 1 Å. The first maximum intensity occurs at $\theta = 60°$. Then *E* (in eV) is _____. **[JEE (Main)-2020]**

(Planck constant $h = 6.64 \times 10^{-34}$ Js, 1 eV = $1.6 \times 10^{-19}$ J, electron mass $m = 9.1 \times 10^{-31}$ kg)

44. A Young's double-slit experiment is performed using monochromatic light of wavelength $\lambda$. 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 integer. The value of *n* is _____. **[JEE (Main)-2020]**

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