Chapter 23

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 4^{th} 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 μ_0 and μ_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 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 **[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 ϕ 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) $\frac{I_m}{9}(4+5\cos\phi)$

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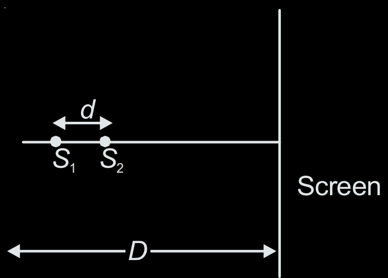
9. A beam of unpolarized light of intensity I_0 is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of A. The intensity of the emergent light is **[JEE (Main)-2013]**

(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 = 3×10^8 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

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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°

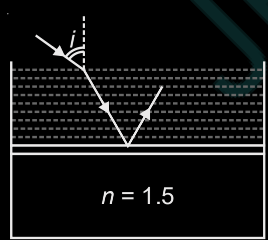
18. The angular width of the central maximum in a single slit diffraction pattern is 60°. The width of the slit is 1 μm. The slit is illuminated by monochromatic plane waves. If another slit of same width is made near it, Young's fringes can be observed on a screen placed at a distance 50 cm from the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

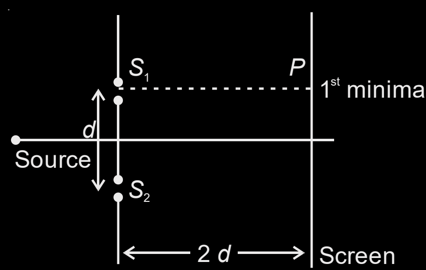
(3) 321 (4) 641

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 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 (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

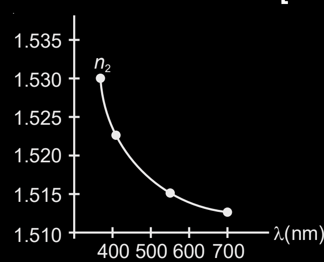
23. Consider a Young's double slit experiment as shown in figure. What should be the slit separation d in terms wavelength λ such that the first minima occurs directly in front of the slit (S_1)? **[JEE (Main)-2019]**



(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]**



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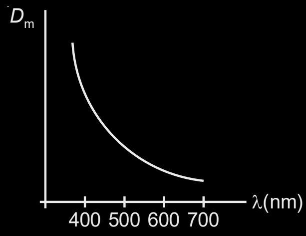
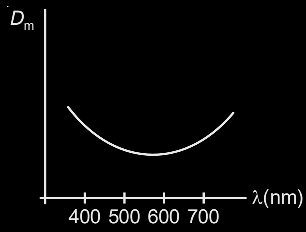
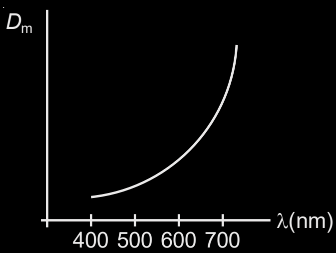
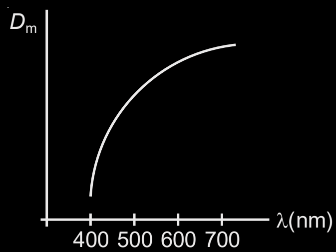
(1) 

(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

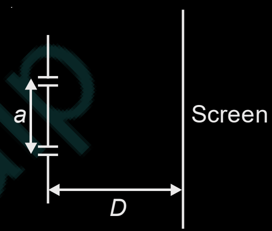
26. In a double-slit experiment, green light (5303 Å) falls on a double slit having a separation of 19.44 μm and a width of 4.05 μm. The number of bright fringes between the first and the second diffraction minima is **[JEE (Main)-2019]**

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

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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 θ_1, then θ_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 (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 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 λ 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

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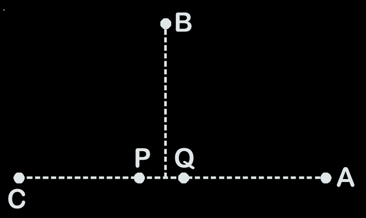
40. In the figure below, P and Q are two equally intense coherent sources emitting radiation of wavelength 20 m. The separation between P and Q is 5 m and the phase of P is ahead of that of Q by 90°. A, B and C are three distinct points of observation, each equidistant from the midpoint of PQ. The intensities 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 λ is used. Then the value of λ is (in nm) _____. **[JEE (Main)-2020]**

42. Orange light of wavelength 6000×10^{-10} m illuminates a single slit of width 0.6×10^{-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 = 1.6×10^{-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 λ. The intensity of light at a point on the screen, where the path difference is λ, 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]**

45. In a Young's double slit experiment, the width of the one of the slit is 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. **[JEE (Main)-2021]**

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

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

46. 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° in clockwise direction, the intensity of emerging light will be _______ Lumens.

[JEE (Main)-2021]

47. If the source of light used in a Young's double slit experiment is changed from red to violet

[JEE (Main)-2021]

(1) The fringes will become brighter

(2) The central bright fringe will become a dark fringe

(3) Consecutive fringe lines will come closer

(4) The intensity of minima will increase

48. The 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 **[JEE (Main)-2021]**

(1) $\frac{\sqrt{2x}}{2x+1}$ (2) $\frac{\sqrt{2x}}{x+1}$

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

49. Consider the diffraction pattern obtained from the sunlight incident on a pinhole of diameter 0.1 μm. If the diameter of the pinhole is slightly increased, it will affect the diffraction pattern such that

[JEE (Main)-2021]

(1) Its size decreases, and intensity decreases

(2) Its size increases, and intensity increases

(3) Its size increases, but intensity decreases

(4) Its size decreases, but intensity increases

50. In a Young's double slit experiment two slits are separated by 2 mm and the screen is placed one meter away. When a light of wavelength 500 nm is used, the fringe separation will be :

[JEE (Main)-2021]

(1) 0.25 mm (2) 0.75 mm

(3) 0.50 mm (4) 1 mm

51. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : An electron microscope can achieve better resolving power than an optical microscope.

Reason R : The de Broglie's wavelength of the electrons emitted from an electron gun is much less than wavelength of visible light.

In the light of the above statements, choose the correct answer from the options given below:

[JEE (Main)-2021]

(1) A is false but R is true.

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

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

(4) A is true but R is false.

52. A fringe width of 6 mm was produced for two slits separated by 1 mm apart. The screen is placed 10 m away. The wavelength of light used is 'x' nm.

The value of 'x' to the nearest integer is______.

[JEE (Main)-2021]

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

[JEE (Main)-2021]

(1) 1178×10^{-9} m (2) 1178×10^{-6} m

(3) 1178×10^{-12} m (4) 5890×10^{-7} m

54. A galaxy is moving away from the earth at a speed of 286 kms^{-1}. The shift in the wavelength of a redline at 630 nm is $x \times 10^{-10}$ m.

The value of x, to the nearest integer, is ______.

[Take the value of speed of light c, as 3×10^8 ms^{-1}]

[JEE (Main)-2021]

55. In the Young's double slit experiment, the distance between the slits varies in time as $d(t) = d_0 + a_0 \sin\omega t$; 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:

[JEE (Main)-2021]

(1) $\dfrac{2\lambda D(d_0)}{\left(d_0^2 - a_0^2\right)}$ (2) $\dfrac{\lambda D}{d_0 + a_0}$

(3) $\dfrac{2\lambda D a_0}{\left(d_0^2 - a_0^2\right)}$ (4) $\dfrac{\lambda D}{d_0^2} a_0$

56. In Young's double slit experiment, if the source of light changes from orange to blue then

[JEE (Main)-2021]

(1) The distance between consecutive fringes will increase

(2) The central bright fringe will become a dark fringe

(3) The distance between consecutive fringes will decrease

(4) The intensity of the minima will increase

57. The difference in the number of waves when yellow light propagates through air and vacuum columns of the same thickness is one. The thickness of the air column is _______ mm.

[Refractive index of air = 1.0003, wavelength of yellow light in vacuum = 6000Å]

[JEE (Main)-2021]

58. White light is passed through a double slit and interference is observed on a screen 1.5 m 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 white fringes. The difference in wavelengths of red and violet light is _______ nm. **[JEE (Main)-2021]**

59. A source of light is placed in front of a screen. Intensity of light on the screen is *I*. Two Polaroid P_1 and P_2 are so placed in between the source of light and screen that the intensity of light on screen is *I*/2. P_2 should be rotated by an angle of ___ (degrees) so that the intensity of light on the screen becomes $\dfrac{3I}{8}$. **[JEE (Main)-2021]**

60. 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 of maxima?

[JEE (Main)-2021]

(1) $5 I_0$

(2) I_0

(3) $4 I_0$

(4) $2 I_0$

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

62. 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 **[JEE (Main)-2021]**

63. 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 2.0 m. The separation between the positions of the first maxima of diffraction pattern obtained in the two cases is _____ $\times 10^{-5}$ m.

[JEE (Main)-2022]

64. 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 $\pi/2$ at point P and π at point Q. Then the difference between the resultant intensities at P and Q will be:

[JEE (Main)-2022]

(1) $2I$ (2) $6I$

(3) $5I$ (4) $7I$

65. 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: [JEE (Main)-2022]

(1) 3 (2) 4

(3) 2 (4) 1

66. A light whose electric field vectors are completely removed by using a good polaroid, allowed to incident on the surface of the prism at Brewster's angle. Choose the most suitable option for the phenomenon related to the prism. [JEE (Main)-2022]

(1) Reflected and refracted rays will be perpendicular to each other.

(2) Wave will propagate along the surface of prism.

(3) No refraction, and there will be total reflection of light.

(4) No reflection, and there will be total transmission of light.

67. 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: [JEE (Main)-2022]

(1) Reflection (2) Refraction

(3) Diffraction (4) Scattering

68. 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. [JEE (Main)-2022]

69. In Young's double slit experiment performed using a monochromatic light of wavelength λ, when a glass plate (μ = 1.5) of thickness $x\lambda$ 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:

[JEE (Main)-2022]

(1) 3 (2) 2

(3) 1.5 (4) 0.5

70. In a Young's double slit experiment, an angular width of the fringe is 0.35° on a screen placed at 2 m 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 _________. [JEE (Main)-2022]

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

(1) 0.5 mm (2) 1.0 mm

(3) 0.6 mm (4) 0.3 mm

72. 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. [JEE (Main)-2022]

73. Time taken by light to travel in two different materials A and B of refractive indices μ_A and μ_B of same thickness is t_1 and t_2 respectively. If $t_2 - t_1 = 5 \times 10^{-10}$ s and the ratio of μ_A to μ_B is 1 : 2. Then, the thickness of material, in meter is: (Given v_A and v_B are velocities of light in A and B materials respectively.) [JEE (Main)-2022]

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(1) $5 \times 10^{-10}\, v_A$ m

(2) 5×10^{-10} m

(3) 1.5×10^{-10} m

(4) $5 \times 10^{-10}\, v_B$ m

74. 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) **[JEE (Main)-2022]**

(1) 16 (2) 9

(3) 48 (4) 12

75. A microscope was initially placed in air (refractive index 1). It is then immersed in oil (refractive index 2). For a light whose wavelength in air is λ, calculate the change of microscope's resolving power due to oil and choose the correct option. **[JEE (Main)-2022]**

(1) Resolving power will be $\frac{1}{4}$ in the oil than it was in the air.

(2) Resolving power will be twice in the oil than it was in the air.

(3) Resolving power will be four times in the oil than it was in the air.

(4) Resolving power will be $\frac{1}{2}$ in the oil than it was in the air.

76. 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 ____. **[JEE (Main)-2022]**

77. 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 **[JEE (Main)-2022]**

(1) 1.5 (2) 2

(3) 0.5 (4) 1

78. 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. **[JEE (Main)-2022]**

79. Two light beams of intensities $4I$ and $9I$ interfere on a screen. The phase difference between these beams on the screen at point A is zero and at point B is π. The difference of resultant intensities, at the point A and B, will be_______ I. **[JEE (Main)-2022]**

80. 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 **[JEE (Main)-2022]**

(1) $\frac{I_0}{4}$ (2) $\frac{I_0}{2}$

(3) $\frac{3I_0}{4}$ (4) $\frac{3I_0}{2}$

81. Nearly 10% of the power of a 110 W light bulb is converted to visible radiation. The change in average intensities of visible radiation, at a distance of 1 m from the bulb to a distance of 5 m is $a \times 10^{-2}$ W.m^2. The value of 'a' will be _____ **[JEE (Main)-2022]**

82. Two light beams of intensities in the ratio of 9 : 4 are allowed to interfere. The ratio of the intensity of maxima and minima will be: **[JEE (Main)-2022]**

(1) 2 : 3 (2) 16 : 81

(3) 25 : 169 (4) 25 : 1

83. The aperture of the objective is 24.4 cm. The resolving power of this telescope, if a light of wavelength 2440 Å is used to see the object will be: **[JEE (Main)-2022]**

(1) 8.1×10^6

(2) 10.0×10^7

(3) 8.2×10^5

(4) 1.0×10^{-8}

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Chapter 23

Wave Optics

1. Answer (2)

As 4^{th} bright fringe of unknown wavelength coincides with 3^{rd} bright fringe of known wavelength

$$\Rightarrow \frac{4\lambda D}{d} = 3\frac{(590\text{ nm})D}{d}$$

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

2. Answer (1)

As the beam is initially parallel, the shape of wavefront is planar.

3. Answer (2)

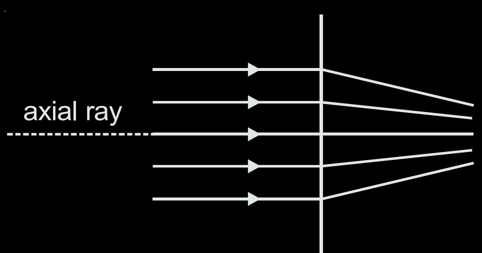
Given $\mu = \mu_0 + \mu_2 I$

Also, $\mu = \frac{c}{v} \Rightarrow v = \frac{c}{\mu_0 + \mu_2 I}$

As intensity is maximum at centre, so v is minimum on the axis.

4. Answer (3)

As the beam enters the medium, axial ray will travel slowest. So, it will lag behind. To compensate for the path, the rays will bend towards axis.



5. Answer (3)

$$I_1 = \left(\sqrt{I_0} + \sqrt{I_0}\right)^2$$

$$I_2 = I_0 + I_0$$

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

6. Answer (4)

When polarised light is passed through a calcite crystal, its intensity changes on rotation of crystal.

7. Answer (3)

$I_P = 4I_0$

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

Now, $\phi = \frac{\pi}{2} \Rightarrow I_Q = 2I_0$

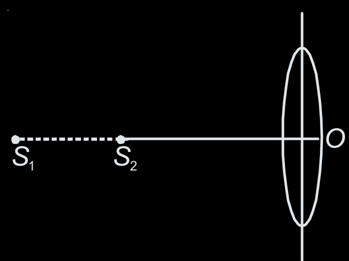
8. Answer (3)

9. Answer (3)

$$I_1 = \frac{I_0}{2},\ I_2 = I_1\cos^2 45° = \frac{I_0}{4}$$

10. Answer (4)

On any circle with centre at O, path difference will remain constant.



11. Answer (4)

By law of Malus, $I = I_0\cos^2\theta$

Now, $I_{A'} = I_A\cos^2 30$

$I_{B'} = I_B\cos^2 60$

As $I_{A'} = I_{B'}$

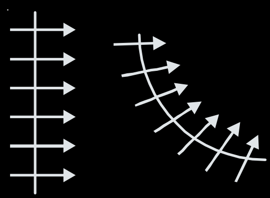
$$\Rightarrow I_A \times \frac{3}{4} = I_B \times \frac{1}{4}$$

$$\frac{I_A}{I_B} = \frac{1}{3}$$

12. Answer (4)

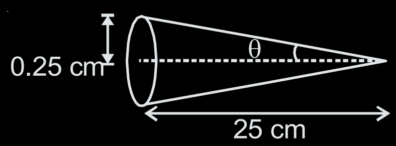
Consider a plane wavefront travelling horizontally. As it moves, its different parts move with different speeds. So, its shape will change as shown

$\Rightarrow$ Light bends upward



13. Answer (2)

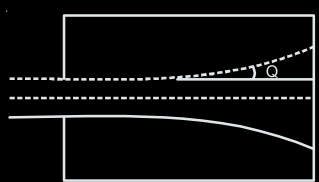
$$RP = \frac{1.22\lambda}{2\mu\sin\theta} = \frac{1.22\times(500\times10^{-9}\text{m})}{2\times1\times\left(\frac{1}{100}\right)}$$



$= 3.05 \times 10^{-5}$ m

$= 30\ \mu$m

14. Answer (2)



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

a

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

For b to be min, $a = \sqrt{\lambda L}$ $b_{min} = 2\sqrt{L\lambda}$

15. Answer (3)

For relativistic motion

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

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

16. Answer (2)

For λ_1	For λ_2
$y = \frac{m\lambda_1 D}{d}$	$y = \frac{n\lambda_2 D}{d}$

$$\Rightarrow \frac{m}{n} = \frac{\lambda_2}{\lambda_1} = \frac{4}{5}$$

For λ_1

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

$= 7.8$ mm

17. Answer (3)

Polaroids A and B are oriented with parallel pass axis

Let polaroid C is at angle θ with A then it makes θ with B also.

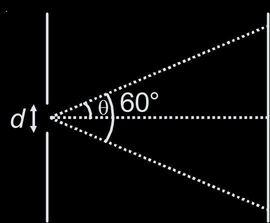
$$\because \frac{I}{8} = \left(\frac{I}{2}\times\cos^2\theta\right)\times\cos^2\theta$$

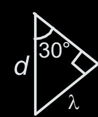
$$\Rightarrow \cos^2\theta = \frac{1}{2}$$

$\Rightarrow \theta = 45°$

18. Answer (1)

$d\sin\theta = \lambda$





$\lambda = \frac{d}{2}$ [$d = 1 \times 10^{-6}$ m]

$\Rightarrow \lambda = 5000$ Å

Fringe width, $B = \frac{\lambda D}{d'}$ (d' is slit separation)

$$10^{-2} = \frac{5000\times10^{-10}\times0.5}{d'}$$

$\Rightarrow d' = 25 \times 10^{-6}$ m $= 25\ \mu$m

19. Answer (3)

For air-medium interface

Max. angle of incidence = 90°

$$\frac{\sin 90°}{\sin r} = \mu$$

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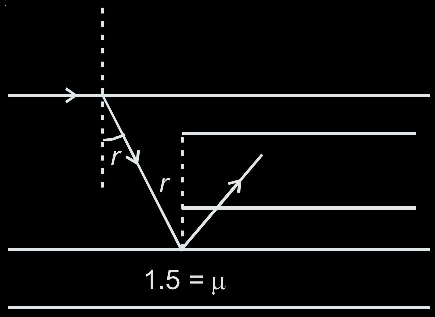
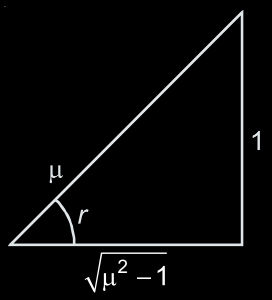


$\sin r = \frac{1}{\mu}$



$\tan i_B = \frac{3}{2\mu}$ (Brewster's law)

$\Rightarrow \frac{1}{\sqrt{\mu^2 - 1}} < \frac{3}{2\mu}$

$\Rightarrow \mu \geq \frac{3}{\sqrt{5}}$

$\Rightarrow \mu_{\min} = \frac{3}{\sqrt{5}}$

20. Answer (1)

$$\frac{(\sqrt{I_1} + \sqrt{I_2})^2}{(\sqrt{I_1} - \sqrt{I_2})^2} = 16$$

$$\Rightarrow \frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}} = 4$$

$$\Rightarrow \frac{\sqrt{I_1}}{\sqrt{I_2}} = \frac{4+1}{4-1} = \frac{5}{3}$$

$$\Rightarrow \frac{I_1}{I_2} = \frac{25}{9}$$

21. Answer (4)

$$N = \frac{d \sin\theta}{\lambda} = \frac{0.320 \times 10^{-3}}{500 \times 10^{-9}} \times \frac{1}{2}$$

$= 320$

Number of Bright fringes = 2 × 320 + 1

= 641

22. Answer (2)

$d\theta = m_1 \lambda_1$

$d\theta = m_2 \lambda_2$

$$d\theta = \frac{0.1 \times 10^{-3}}{40} \times 10^9 \text{ nm}$$

$$d\theta = \frac{1}{40} \times 10^5 = 25 \times 10^2 \text{ nm}$$

$d\theta$ is LCM of λ_1 and λ_2

$\lambda_1 = 625$ nm and $\lambda_2 = 500$ nm

[By observation]

23. Answer (1)

For 1st minima

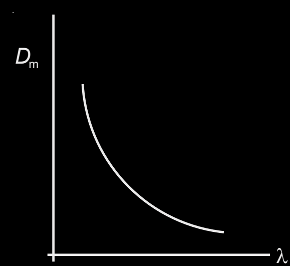
$$\sqrt{d^2 + (2d)^2} - 2d = \frac{\lambda}{2}$$

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

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

24. Answer (1)

$D_m = (\mu - 1)A$



25. Answer (4)

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

$$I = 4I_0 \cos^2(\pi / 8)$$

$$\frac{I}{4I_0} = \cos^2(\pi / 8) = 0.85$$

26. Answer (4)

Angular width between second and first diffraction minima $= \frac{\lambda}{a}$

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Angular width of a fringe $= \dfrac{\lambda}{d}$

$\therefore \quad n = \dfrac{d}{a} = \dfrac{19.44}{4.05}$

$\Rightarrow$ No. of bright fringes = 04

27. Answer (1)

$\dfrac{a_1}{a_2} = \dfrac{3}{1}$

$\therefore \quad \dfrac{I_{max}}{I_{min}} = \left(\dfrac{a_2 + a_1}{a_2 - a_1}\right)^2 = \left(\dfrac{3+1}{3-1}\right)^2 = 4$

28. Answer (3)

$(\mu - 1)t = n\lambda$

$t = \dfrac{n\lambda}{\mu - 1}$

29. Answer (4)

$I_1 = 4\, I_0$

$I_2 = I_0$

$\dfrac{I_{max}}{I_{min}} = \dfrac{\left(\sqrt{I_1} + \sqrt{I_2}\right)^2}{\left(\sqrt{I_1} - \sqrt{I_2}\right)^2} = \left(\dfrac{9}{1}\right)$

30. Answer (4)

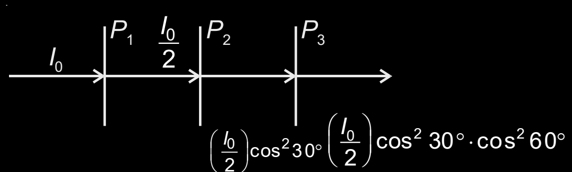
$\mu t - t = \lambda$

$\Rightarrow \quad t(\mu - 1) = \lambda$

$\Rightarrow \quad t = \dfrac{\lambda}{(\mu - 1)}$

31. Answer (3)

Angle between pass axes of P_1 and P_2 is 30°.



$I = \dfrac{I_0}{2} \cdot \cos^2 30° \cdot \cos^2 60° = \dfrac{I_0}{2} \times \dfrac{3}{4} \times \dfrac{1}{4} = \dfrac{3I_0}{32}$

$\Rightarrow \quad \dfrac{I_0}{I} = \dfrac{32}{3} = 10.67$

32. Answer (1)

$d \sin\theta_2 = 2\lambda$ (for 2nd minima)

$\Rightarrow \quad d \times \left(\dfrac{\sqrt{3}}{2}\right) = 2\lambda \qquad \text{... (i)}$

For first minima,

$d \sin\theta_1 = \lambda$

$\Rightarrow \quad \sin\theta_1 = \dfrac{\lambda}{d} = \dfrac{\sqrt{3}}{4} = 0.43$

$\Rightarrow \quad \theta_1 < 30°, \ \Rightarrow \ \theta_1 \approx 25°$

33. Answer (3)

Fringe-width, $\omega = \dfrac{D}{d}\lambda = \dfrac{1.5}{0.15 \times 10^{-3}} \times 589 \times 10^{-9}$ m

= 589 × 10^{-2} mm = 5.89 mm

≈ 5.9 mm

34. Answer (3)

$\Delta x = \lambda/8$

$\therefore$ Phase difference $\Rightarrow \Delta\phi = \dfrac{\pi}{4}$

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

$\therefore \quad \dfrac{I}{I_0} = 0.853$

35. Answer (1)

P.D = (d) sinθ

$= (d)\dfrac{Y}{D}$

$= \dfrac{(10^{-3})(1.27 \times 10^{-3})}{1}$

= 1.27 μm

36. Answer (1)

$N_1\lambda_1 = N_2\lambda_2$

16 × 700 = N_2 × 400

$\Rightarrow$ N_2 = 28

37. Answer (3)

$: \theta = \dfrac{\lambda}{d} = \dfrac{500 \times 10^{-9}}{5 \times 10^{-5}}$

= 0.01 rad

= 0.57°

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38. Answer (3)

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

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

39. Answer (2)

$I = I_0\cos^2(\omega t)$

$$\Rightarrow \quad I_{av} = \frac{I_0}{2}$$

$$\therefore \quad E = \frac{I_0}{2} \times A \times (\Delta t)$$

$$\Delta t = \frac{2\pi}{\omega} = \frac{2 \times 3.14}{31.4} = \frac{1}{5}\,s$$

$$\therefore \quad E = \frac{3.3}{2} \times 3 \times 10^{-4} \times \frac{1}{5} = 1 \times 10^{-4}\ \text{J}$$

40. Answer (3)

$$\phi_A = \frac{\pi}{2} - \frac{2\pi}{\lambda} \times \frac{5}{20} = 0$$

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

$$\phi_C = \frac{\pi}{2} + \frac{2\pi}{\lambda} \times \frac{5}{20} = \pi$$

$I_A = 4I_0$

$I_B = 2I_0$

$I_C = 0$

41. Answer (750)

$15\lambda_1 = 10\lambda_2$

$\lambda_2 = 1.5\lambda_1$

$\lambda_2 = 750$ nm

42. Answer (198)

For minima

d $\sin\theta$ = na

$\Rightarrow$ for n to be maximum $\sin\theta = 1$

$$\Rightarrow \quad n = \frac{6 \times 10^{-5}}{6 \times 10^{-7}} = 100$$

Since n = 100 will corresponds to infinity.

So No. of minima possible in one side is 99.

And in both side it is 198

43. Answer (50.47)

$$\frac{1}{2}mv^2 = E$$

$$\Rightarrow \quad P = \sqrt{2Em} \qquad \therefore \quad \lambda = \frac{h}{\sqrt{2\,Em}}$$

For first maxima,

2d $\sin\theta = \lambda$

$$\Rightarrow \quad 2 \times 10^{-10} \times \frac{\sqrt{3}}{2} = \frac{h}{\sqrt{2\,Em}}$$

$$\Rightarrow \quad 2\,Em = \frac{(10^{10} \times h)^2}{3}$$

$$\Rightarrow \quad E = \frac{(10^{10} \times h)^2}{6m_e \times e}\ (\text{eV})$$

$\Rightarrow$ E = 50.47 eV

44. Answer (09)

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

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

$n = 9$

45. Answer (1)

$I_1 = I_0$

$I_2 = 9I_0$ as $I \propto A^2$

$$\therefore \quad \frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{I_2} + \sqrt{I_1}\right)^2}{\left(\sqrt{I_2} - \sqrt{I_1}\right)^2} = \left(\frac{3+1}{3-1}\right)^2 = 4:1$$

46. Answer (75)

Assuming initially transmission axes of polarizer and analyser are parallel.

$$I = \frac{I_0}{2} = 100 \text{ Lumen}$$

Now if analyser is rotated by angle of 30°, then –

$$I' = \frac{I_0}{2}\cos^2\theta = 100 \times \frac{3}{4} = 75 \text{ Lumen}$$

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47. Answer (3)

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

and $\lambda_v < \lambda_{red}$

$\Rightarrow$ Fringe width will decrease.

$\Rightarrow$ Fringe lines will come closer.

48. Answer (4)

$\frac{I_2}{I_1} = 2X$

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

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

$$= \frac{4\sqrt{2x}}{4x+2} = \frac{2\sqrt{2x}}{2x+1}$$

49. Answer (4)

$\because \quad r_{dark} = \frac{1.22\,\lambda D}{b}$, where b is opening diameter.

When opening size is increased, the diffraction size decreases but intensity increases.

50. Answer (1)

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

$= \frac{500 \times 10^{-9} \times 1}{2 \times 10^{-3}}$

$= 250 \times 10^{-6}$

$= 0.25$ mm

51. Answer (2)

Resolving power increases on decreasing the wavelength.

52. Answer (600)

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

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

$\lambda = 600$ nm

53. Answer (2)

d = 0.5 mm

D = 0.5 m

Required distance $= 2\beta = \frac{2\lambda D}{d}$

$= \frac{2 \times 5890 \times 10^{-10} \times 0.5}{0.5 \times 10^{-3}}$

$= 1178 \times 10^{-6}$ m

54. Answer (6)

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

$\Rightarrow \quad \Delta\lambda = \frac{v}{c} \times \lambda$

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

$= 6.006 \times 10^{-10}$ m

55. Answer (3)

$\beta_{max} = \frac{\lambda D}{d_0 + a_0}$

$\beta_{min} = \frac{\lambda D}{d_0 - a_0}$

$\beta_{max} - \beta_{min} = \lambda D\left[\frac{1}{d_0 - a_0} - \frac{1}{(d_0 + a_0)}\right]$

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

56. Answer (3)

$\lambda_O > \lambda_B$

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

$\Rightarrow \quad \beta_O > \beta_{Blue}$

57. Answer (2)

$\Delta n = \frac{d}{\lambda_1} - \frac{d}{\lambda_2}$

$1 = \frac{(\mu - 1)d}{\lambda_0}$

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$\Rightarrow \quad d = 6 \times 10^{-7}/.0003$

$= 2 \times 10^{-3}$ m

58. Answer (300)

$$Y_1 = \frac{D\lambda_1}{d}$$

$$Y_2 = \frac{D\lambda_2}{d}$$

$$\lambda_2 - \lambda_1 = (Y_2 - Y_1)\frac{d}{D}$$

= 300 nm

59. Answer (30)

Initially the polaroids are aligned i.e. angle between their axes is 0°.

Now if polaroid P_2 is rotated by angle θ to obtain required result then

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

$$\Rightarrow \quad \cos\theta = \frac{\sqrt{3}}{2} \quad \text{or} \quad \theta = 30^\circ$$

60. Answer (3)

$$I_{max} = \left(\sqrt{I}_1 + \sqrt{I}_2\right)^2$$

$$= \left(2\sqrt{I}_0\right)^2 = 4\, I_0$$

61. Answer (5)

$$\Delta y = 2 \cdot \frac{4\,D\lambda}{d}$$

$$2.4 \times 10^{-2} = \frac{8 \times 1.5 \times \lambda}{0.3 \times 10^{-3}}$$

$\Rightarrow \quad \lambda = 600$ nm

$$f = \frac{c}{\lambda} = 5 \times 10^{14} \text{ Hz}$$

62. Answer (1)

$$\frac{I_{min}}{I_{max}} = \left(\frac{A_1 - A_2}{A_1 + A_2}\right)^2 = \left(\frac{3-1}{3+1}\right)^2 = \frac{1}{4}$$

63. Answer (3)

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

$\Rightarrow$ According to given values, required separation

$$= \frac{3}{2} \times (655\text{ nm} - 650\text{ nm}) \times \frac{2\text{m}}{0.5\text{ mm}}$$

$\Rightarrow$ Required separation = 3×10^{-5} m.

64. Answer (2)

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

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

So, $I_P - I_Q = 6I$

65. Answer (2)

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

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

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

So x = 4

66. Answer (4)

When electric field vector is completely removed and incident on Brewster's angle then only refraction takes place.

67. Answer (4)

Since size is of the order of $\frac{\lambda}{100}$, hence scattering will take place.

68. Answer (450)

$$y = \frac{d}{2},$$

$$\therefore \quad \Delta x = y\frac{d}{D}$$

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

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$$\Rightarrow \quad \lambda = \frac{\left(0.6\times10^{-3}\right)^2}{0.8}$$

$= 450$ nm

69. Answer (2)

For the intensity to remain same the position must be of a maxima so path difference must be $n\lambda$ so

$(1.5 - 1)x\lambda = n\lambda$

$x = 2n$ $\quad\quad$ $(n = 0, 1, 2 \ldots)$

So, value of x will be

$x = 0, 2, 4, 6\ldots$

70. Answer (4)

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

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

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

So $\alpha = 4$

71. Answer (4)

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

$\Rightarrow$ Fringe width $\propto \dfrac{\lambda}{d}$

$\Rightarrow$ New fringe width $= 0.5\text{ mm} \times \dfrac{1.2}{2} = 0.3\text{ mm}$

72. Answer (600)

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

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

$$\Rightarrow \quad 3\times10^{-3}\text{cm} = \frac{\lambda}{1\text{ mm}}\left(5\times10^{-2}\text{ m}\right)$$

$$\Rightarrow \quad \lambda = \frac{3\times10^{-8}}{5\times10^{-2}}\text{ m}$$

$\Rightarrow \lambda = 600$ nm

73. Answer (A)

$t_2 - t_1 = 5 \times 10^{-10}$

$$\Rightarrow \quad \frac{d}{v_B} - \frac{d}{v_A} = 5\times10^{-10}$$

and, $\dfrac{v_B}{v_A} = \dfrac{\mu_A}{\mu_B} = \dfrac{1}{2}$

$$\Rightarrow \quad d\left(1 - \frac{v_B}{v_A}\right) = 5\times10^{-10}\times v_B$$

$$\Rightarrow \quad d\left(1 - \frac{1}{2}\right) = 5\times10^{-10}\times v_B$$

$\Rightarrow$ $d = 10 \times 10^{-10} \times v_B$ m

$\Rightarrow$ $d = 5 \times 10^{-10} \times v_A$ m

74. Answer (2)

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

$$\beta' = \frac{\beta}{\mu} = \frac{12\times10^{-3}}{\frac{4}{3}}$$

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

75. Answer (3)

$\because$ Resolving power $= \dfrac{2\mu\sin\theta}{1.22\lambda}$

$$\frac{P_1}{P_2} = \frac{\mu_1}{\mu_2}\times\frac{\mu_1}{\mu_2}$$

$$= \left(\frac{\mu_1}{\mu_2}\right)^2$$

$$\Rightarrow \quad \frac{P_1}{P_2} = \frac{1}{4}$$

$\Rightarrow$ $P_2 = 4P_1$

76. Answer (2)

$$I_{R_1} = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$$

$$I_A = I + 4I + 2\sqrt{I.4I}\cos 90°$$

$= 5I$

$$I_B = I + 4I + 2\sqrt{I.4I}\cos 60°$$

$= 7I$

$I_B - I_A = 2I$

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77. Answer (2)

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

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

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

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

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

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

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

78. Answer (630)

$\lambda = 560 \times 10^{-9}$

$B_1 = 7.2 \times 10^{-3}$

$B_2 = 8.1 \times 10^{-3}$

$$\frac{B_1}{B_2} = \frac{\lambda_1}{\lambda_2}$$

$$\Rightarrow \quad \lambda_2 = \frac{560 \times 10^{-9} \times 8.1 \times 10^{-3}}{7.2 \times 10^{-3}}$$

$= 6.3 \times 10^{-7}$ m

$= 630$ nm

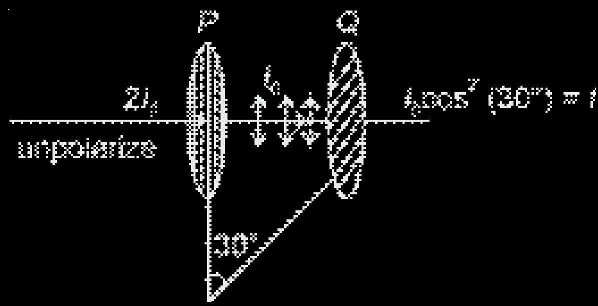
79. Answer (24)

$$I_A = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = 25I$$

$$I_B = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2 = I$$

So, $I_A - I_B = 24I$

80. Answer (C)



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

81. Answer (84)

$P_{radiation} = 0.1 \times 110 = 11$ W

$$\Delta I_{radiation_1} = I_{radiation_1} - I_{radiation_2}$$

$$= 11\left(\frac{1}{4\pi} - \frac{1}{4\pi \times 25}\right) = \frac{11 \times 24}{4\pi \times 25}$$

$= 84 \times 10^{-2}$ W/m^2

82. Answer (4)

$$\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}\right)^2 = \left(\frac{5}{1}\right)^2$$

$$= \frac{25}{1}$$

83. Answer (3)

$$\text{R.P.} = \frac{1}{1.22\,\lambda/a}$$

$$= \frac{24.4 \times 10^{-2}}{1.22 \times 2440 \times 10^{-10}}$$

$= 8.2 \times 10^5$

Option (C) is correct

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