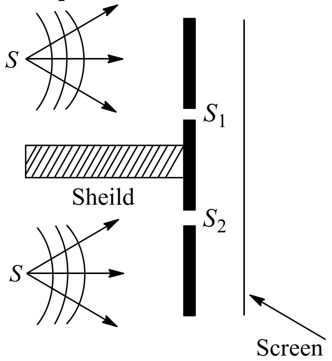
10.WAVE OPTICS

Single Correct Answer Type

1. What happens to the interference pattern if the two slits in Young's experiment are illuminated by two independent sources such as two sodium lamps S and S' as shown in figure



a) Two sets of interference fringes overlap
b) No fringes are observed
c) The intensity of the bright fringes is doubled
d) The intensity of the bright fringes becomes four times

2. A thin uniform film of refractive index 1.75 is placed on a sheet of glass of refractive index 1.5. At room temperature (20°C), this film is just thick enough for light with wavelength 600 nm reflected off the top of the film to be canceled by light reflected from the top of the glass. After the glass is placed in an oven and slowly heated to 170°C, the film concels reflected light with wavelength 606 nm. The coefficient of linear expansion of the film is (Ignore any changes in the refractive index of the film due to the temperature change)
a) 3.3×10^{-5} °C^{-1} b) 6.6×10^{-5} °C^{-1} c) 9.9×10^{-5} °C^{-1} d) 2.2×10^{-5} °C^{-1}

3. A certain region of a soap bubble reflects red light of vacuum wavelength $\lambda = 650$ nm. What is the minimum thickness that this region of the soap bubble could have? Take the index of reflection of the soap film to be 1.41
a) 1.2×10^{-7} m b) 650×10^{-9} m c) 120×10^{7} m d) 650×10^{5} m

4. In a Young's double-slit experiment, the slit separation is 0.5 mm and the screen is 0.5 m away from the slit. For a monochromatic light of wavelength 500 nm, the distance of 3rd maxima from the 2nd minima on the other side of central maxima is
a) 2.75 mm b) 2.5 mm c) 22.5 mm d) 2.25 mm

5. In Young's double-slit experiment, 12 fringes are observed to be formed in a certain segment of the screen when light of wavelength 600 nm is used. If the wavelength of light is changed to 400 nm, number of fringes observed in the same segment of the screen is given by
a) 12 b) 18 c) 24 d) 30

6. Two thin parallel slits that are 0.012 mm apart are illuminated by a laser beam of wavelength 650 nm. On a very large distance screen, the total number of bright fringes including the central fringe and those on both sides of it is
a) 38 b) 37 c) 40 d) 39

7. In a double-slit experiment, the slits are separated by a distance d and the screen is at a distance D from the slits. If a maximum is formed just opposite to each slit, then what is the order of the fringe so formed?
a) $\frac{d^2}{2\lambda D}$ b) $\frac{2d^2}{\lambda D}$ c) $\frac{d^2}{\lambda D}$ d) $\frac{d^2}{4\lambda D}$

8. Two wavelengths of light λ_1 and λ_2 are sent through a Young's double-slit apparatus simultaneously. If the third-order bright fringe coincides with the fourth-order bright fringe, then
a) $\frac{\lambda_1}{\lambda_2} = \frac{4}{3}$ b) $\frac{\lambda_1}{\lambda_2} = \frac{3}{4}$ c) $\frac{\lambda_1}{\lambda_2} = \frac{5}{4}$ d) $\frac{\lambda_1}{\lambda_2} = \frac{4}{5}$

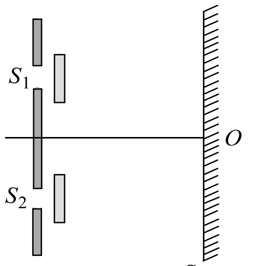
9. In Young's double-slit experiment, how many maximas can be obtained on a screen (including the central maximum) on both sides of the central fringe ($\lambda = 2000$ Å)?
a) 12 b) 7 c) 18 d) 4

10. The maximum intensity in Young's double-slit experiment is I_0. Distance between the slits is $d = 5\lambda$,

where λ is the wavelength of monochromatic light used in the experiment. What will be the intensity of light in front of one of the slits on a screen at a distance $D = d$?

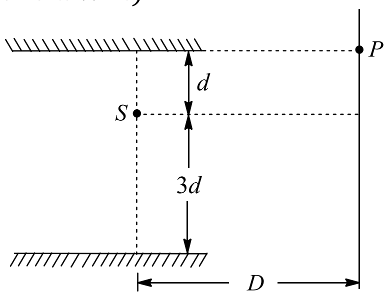
a) $\frac{I_0}{2}$ b) $\frac{3}{4}I_0$ c) I_0 d) $\frac{I_0}{4}$

11. Young's double-slit experiment is carried with two thin sheets of thickness 10.4 μm each and refractive index $\mu_1 = 1.52$ and $\mu_2 = 1.40$ covering the slits S_1 and S_2, respectively. If white light of range 400 nm to 780 nm is used, then which wavelength will form maxima exactly at point O, the centre of the screen?



a) 416 nm only b) 624 nm only
c) 416 nm and 624 nm only d) None of these

12. Consider the optical system shown in figure. The point source of light S is having wavelength equal to λ. The light is reaching screen after reflection. For point P to be 2nd maxima, the value of λ would be ($D \gg d$ and $d \gg \lambda$)



a) $\frac{12d^2}{D}$ b) $\frac{6d^2}{D}$ c) $\frac{3d^2}{D}$ d) $\frac{24d^2}{D}$

13. A beam of electron is used in an YDSE experiment. The slit width is d. When the velocity of electron is increased, then
a) No interference is observed
b) Fringe width increases
c) Fringe width decreases
d) Fringe width remains same

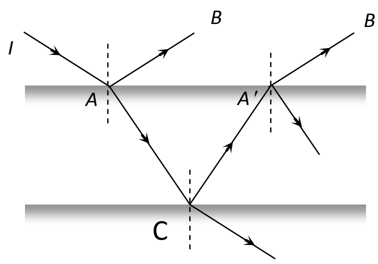
14. Microwaves from a transmitter are directed towards a plane reflector. A detector moves along the normal to the reflector. Between positions of 14 successive maxima, the detector travels a distance of 0.14 m. What is the frequency of transmitter?

a) 1.5×10^{10} Hz b) 3.0×10^{10} Hz c) 1.5×10^{9} Hz d) 3.0×10^{9} Hz

15. In YDSE of equal width slits, if intensity at the center of screen is I_0, then intensity at a distance of $\beta/4$ from the central maxima is

a) I_0 b) $\frac{I_0}{2}$ c) $\frac{I_0}{4}$ d) $\frac{I_0}{3}$

16. A ray of light of intensity I is incident on a parallel glass-slab at a point A as shown in fig. It undergoes partial reflection and refraction. At each reflection 25% of incident energy is reflected. The rays AB and $A'B'$ undergo interference. The ratio $I_{\text{max}}/I_{\text{min}}$ is



a) 4 : 1 b) 8 : 1 c) 7 : 1 d) 49 : 1

17. A double-slit arrangement produces interferences fringes for sodium light ($\lambda = 589$ nm) that have an angular separation of 3.50×0^{-3} rad. For what wavelength would the angular separation be 10% greater?
a) 527 nm b) 648 nm c) 722 nm d) 449 nm

18. Two identical sources each of intensity I_0 have a separation $d = \frac{\lambda}{8}$, where λ is the wavelength of the waves emitted by either source. The phase difference of the sources is $\frac{\pi}{4}$. The intensity distribution $I(\theta)$ in the radiation field as a function of θ, which specifies the direction from the sources to the distant observation point P is given by
a) $I(\theta) = I_0 \cos^2 \theta$
b) $I(\theta) = \frac{I_0}{4} \cos^2 \left(\frac{\pi\theta}{8}\right)$
c) $I(\theta) = 4I_0 \cos^2 \left[\frac{\pi}{8}(\sin\theta + 1)\right]$
d) $I(\theta) = I_0 \sin^2 \theta$

19. In a double-slit experiment, instead of taking slits of equal width, one slit is made twice as wide as the other. Then, in the interference pattern
a) The intensities of both the maxima and the minima increases
b) The intensity of the maximum increase and minima has zero intensity
c) The intensity of the maxima decreases and that of minima increases
d) The intensity of the maxima decreases and the minima has zero intensity

20. A double-slit experiment is immersed in a liquid of refractive index 1.33. It has slit separation of 1 mm and distance between the plane of slits and screen is 1.33 m. The slits are illuminated by a parallel beam of light whose wavelength in air is 6830 Å . Then the fringe width is
a) 6.3×10^{-4}m b) 8.3×10^{-4} m c) 6.3×10^{-2}m d) 6.3×10^{-5}m

21. In YDSE, find the thickness of a glass slab ($\mu = 1.5$) which should be placed before the upper slit S_1 so that the central maximum now lies at a point where 5th bright fringe was lying earlier (before inserting the slab). Wavelength of light used is 5000 Å
a) 5×10^{-6} m b) 3×10^{-6} m c) 10×10^{-6} m d) 5×10^{-5} m

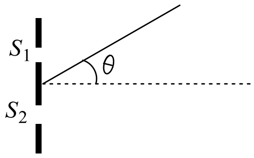
22. Light from a source emitting two wavelengths λ_1 and λ_2 is allowed to fall on Young's double-slit apparatus after filtering one of the wavelengths. The position of interference maxima is noted. When the filter is removed both the wavelengths are incident and it is found that maximum intensity is produced where the fourth maxima occurred previously. If the other wavelength is filtered, at the same location the third maxima is found. What is the ratio of wavelengths?
a) $\frac{2}{3}$ b) $\frac{3}{2}$ c) $\frac{3}{4}$ d) $\frac{4}{3}$

23. If the distance between the first maxima and fifth minima of a double-slit pattern is 7 mm and the slits are separated by 0.15 mm with the screen 50 cm from the slits, then wavelength of the light used is
a) 600 nm b) 525 nm c) 467 nm d) 420 nm

24. In a Young's double-slit experiment, the slits are illuminated by monochromatic light. The entire set-up is immersed in pure water. Which of the following act *cannot* restore the original fringe width?
a) Bringing the slits close together
b) Moving the screen away from the slit plane
c) Replacing the incident light by that of longer wavelength
d) Introducing a thin transparent slab in front of one of the slits

25. If one of the two slits of a Young's double-slit experiment is painted so that it transmits half the light intensity as the second slit, then
a) The fringe system will altogether disappear
b) The bright fringes will become brighter and the dark fringes will become darker
c) Both dark and bright fringes will become darker
d) Dark fringes will become brighter and bright fringes darker

26. Figure shows two coherent sources S_1 and S_2 emitting wavelength λ. The separation $S_1S_2 = 1.5\,\lambda$ and S_1 is ahead in phase by $\pi/2$ relative to S_2. Then, the maxima occur in direction θ given by $\sin^{-1}$ of



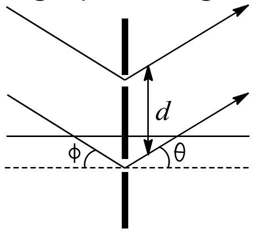
(i) 0 (ii) 1/2

(iii) −1/6 (iv) −5/6

Correct options are

a) (ii), (iii) and (iv) b) (i), (ii) and (iii) c) (i), (iii) and (iv) d) All the above

27. Light is incident at an angle ϕ with the normal to a plane containing two slits of separation d. Select the expression that correctly describes the positions of the interference maxima in terms of the incoming angle ϕ and outgoing angle θ



a) $\sin\phi + \sin\theta = \left(m + \frac{1}{2}\right)\frac{\lambda}{d}$ b) $d \sin\theta = m\lambda$

c) $\sin\phi - \sin\theta = (m + 1)\frac{\lambda}{d}$ d) $\sin\phi + \sin\theta = m\frac{\lambda}{d}$

28. In Young's double-slit experiment $\frac{d}{D} = 10^{-4} = 10^{-4}$ (d =distnace between slits, D =distance of screen from the slits). At a point P on the screen, resulting intensity is equal to the intensity due to the individual slit I_0. Then, the distance of point P from the central maximum is ($\lambda = 6000$ Å)

a) 2 mm b) 1 mm c) 0.5 mm d) 4 mm

29. A beam of light of wavelength 600 nm from a distant source falls on a single slit 1 mm wide and the resulting diffraction pattern is observed on a screen 2 m away. The distance between the first dark fringes on either side of the central bright fringe is

a) 1.2 mm b) 1.2 cm c) 2.4 cm d) 2.4 mm

30. Two identical coherent sources are placed on a diameter of a circle of radius R at separation $x(\ll R)$ symmetrical about the center of the circle. The sources emit identical wavelength λ each. The number of points on the circle of maximum intensity is ($x = 5\lambda$)

a) 20 b) 22 c) 24 d) 26

31. A thin film of refractive index 1.5 and thickness 4×10^{-5} cm is illuminated by light normal to the surface. What wavelength within the visible spectrum will be intensified in the reflected beam?

a) 4800 Å b) 5800 Å c) 6000 Å d) 6800 Å

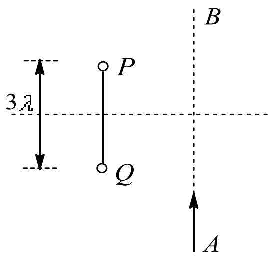
32. Light of wavelength $\lambda = 5890$ Å falls on a double-slit arrangement having separation $d = 0.2$ mm. A thin lens of focal length $f = 1$ m is placed near the slits. The linear separation of fringes on a screen placed in the focal plane of the lens is

a) 3 mm b) 4 mm c) 2 mm d) 1 mm

33. In hydrogen spectrum the wavelength of H_α line is 656 nm whereas in the spectrum of a distant galaxy, H_α line wavelength is 706 nm. Estimated speed of the galaxy with respect to earth is

a) $2 \times 10^8 m/s$ b) $2 \times 10^7 m/s$ c) $2 \times 10^6 m/s$ d) $2 \times 10^5 m/s$

34. Two coherent light sources, each of wavelength λ, are separated by a distance 3λ. The maximum number of minima formed on line AB, which runs from $-\infty$ to $+\infty$, is



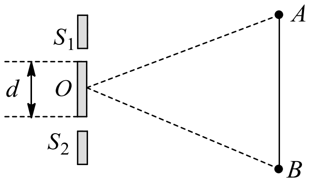
a) 2 b) 4 c) 6 d) 8

35. Two beams of light having intensities I and $4I$ interfere to produce a fringe pattern on a screen. The phase

between the beams is $\pi/2$ at point A and π at point B. Then, the difference between the resultant intensities at A and B is

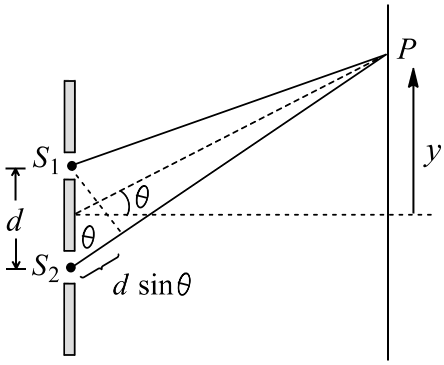
a) $2I$ b) $4I$ c) $5I$ d) $7I$

36. Figure shows two coherent sources S_1 and S_2 vibrating in same phase. AB is an irregular wire lying at a far distance from the sources S_1 and S_2. Let $\frac{\lambda}{d} = 10^{-3}$ $\angle BOA = 0.12°$. How many bright spots will be seen on the wire, including points A and B?



a) 2 b) 3 c) 4 d) More than 4

37. In a YDSE, light of wavelength $\lambda = 5000$ Å is used, which emerges in phase from two slits a distance $d = 3 \times 10^{-7}$m apart. A transparent sheet of thickness $t = 1.5 \times 10^{-7}$m, refractive index $n = 1.17$, is placed over one of the slits. Where does the central maxima of the interference now appear from the center of the screen? (Find the value of y?)



a) $\frac{D(\mu-1)t}{2d}$ b) $\frac{2D(\mu-1)t}{d}$ c) $\frac{D(\mu+1)t}{d}$ d) $\frac{D(\mu-1)t}{d}$

38. In Young's double-slit experiment, the slits are 0.5 mm apart and the interference is observed on a screen at a distance of 100 cm from the slits. It is found that the ninth bright fringe is at a distance of 7.5 mm found that the ninth bright fringe is at a distance of 7.5 mm from the second dark fringe from the center of the fringe pattern. The wavelength of the light used is

a) 5000 Å b) $\frac{5000}{7}$Å c) 2500 Å d) $\frac{2500}{7}$Å

39. In Young's double-slit experiment, the separation between two coherent sources S_1 and S_2 is d and the distance between the source and screen is D. In the interference pattern, it is found that exactly in front of one slit, there occurs a minimum. Then the possible wavelengths used in the experiment are

a) $\lambda = \frac{d^2}{D}, \frac{d^2}{3D}, \frac{d^2}{5D}$ b) $\lambda = \frac{d^2}{D}, \frac{d^2}{5D}, \frac{d^2}{9D}$ c) $\lambda = \frac{d^2}{D}, \frac{d^2}{2D}, \frac{d^2}{3D}$ d) $\lambda = \frac{d^2}{3D}, \frac{d^2}{7D}, \frac{d^2}{11D}$

40. Sources 1 and 2 emit lights of different wavelengths whereas 3 and 4 emit lights of different intensities. The coherence

a) Can be obtained by using sources 1 and 2
b) Can be obtained by using sources 3 and 4
c) Cannot be obtained by any of these sources
d) Since contrast suffers when sources 3 and 4 are used so coherence cannot be obtained by using sources 3 and 4

41. A light ray of frequency v and wavelength λ enters a liquid of refractive index $\frac{3}{2}$. The ray travels in the liquid with

a) Frequency v and wavelength $\left(\frac{2}{3}\right)\lambda$ b) Frequency v and wavelength $\left(\frac{3}{2}\right)\lambda$
c) Frequency v and wavelength λ d) Frequency $\left(\frac{3}{2}\right)v$ and wavelength λ

42. Blue light of wavelength 480 nm is most strongly reflected off a thin film of oil on a glass slab when viewed near normal incidence. Assuming that the index of refraction of the oil is 1.2 and that of the glass is 1.6, what is the minimum thickness of the oil film (other than zero)?

a) 100 nm b) 200 nm c) 300 nm d) None

43. Intensity observed in an interference pattern is $I = I_0 \sin^2 \theta$. At $\theta = 30°$, intensity $I = 5 \pm 0.002$. The percentage error in angle is

a) $4\sqrt{3} \times 10^{-2}\%$ b) $\frac{4}{\pi} \times 10^{-2}\%$ c) $\frac{4\sqrt{3}}{\pi} \times 10^{-2}\%$ d) $\sqrt{3} \times 10^{-2}\%$

44. In a double-slit experiment, the distance between the slits is d. The screen is at a distance D from the slits. If a bright fringe is formed opposite to a slit on the screen, the order of the fringe is

a) $\frac{d^2}{2\lambda D}$ b) $\frac{d}{2\lambda D}$ c) $\frac{d^2}{4\lambda D}$ d) 0

45. In YDSE, the amplitude of intensity variation of the two sources is found to be 5% of the average intensity. The ratio of the intensities of two interfering sources is

a) 2564 b) 1089 c) 1681 d) 869

46. Light waves travel in vacuum along the y-axis. Which of the following may represent the wavefront?

a) x =constant b) y =constant c) z =constant d) $x + y + z$ =constant

47. In Young's double-slit experiment using monochromatic light, the light pattern shifts by a certain distance on the screen when a mica sheet of refractive index μ and thickness t microns is introduced in the path of one of the interfering waves. The mica sheet is then removed and the distance between the plane of slits and the screen is double. It is found that the distance between successive maxima (or minima) now is the same as the observed fringe shift upon the introduction of the mica sheet. Calculate the wavelength of light?

a) $(1/2)t(\mu - 1)$ b) $t(\mu - 1)$ c) μt d) $3\mu t$

48. Let S_1 and S_2 be the two slits in Young's double-slit experiment. If central maxima is observed at P and angle $\angle S_1PS_2 = \theta$, then the fringe width for the light of wavelength λ will be

a) λ/θ b) $\lambda\theta$ c) $2\lambda/\theta$ d) $\lambda/2\theta$

49. In Young's interference experiment, if the slits are of unequal width, then

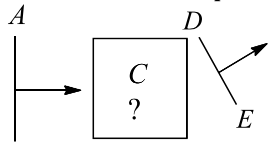
a) No fringes will be formed

b) The positions of minimum intensity will not be completely dark

c) Bright fringe as displaced from the original central position

d) Distance between two consecutive dark fringes will not be equal to the distance between two consecutive bright fringes

50. A wave front AB passing through a system C emerges as DE. The system C could be



a) A slit b) A biprism c) A prism d) A glass slab

51. One of the two slits in YDSE is painted over, so that is transmits only light waves having intensity half of the intensity of light waves having intensity half of the intensity of the light waves through the other slit. As a result of this

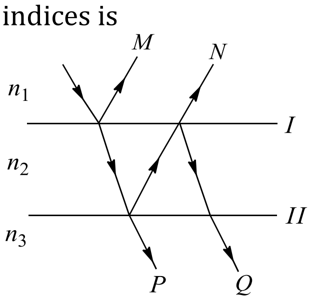
a) Fringe pattern disappears

b) Bright fringes become brighten and dark ones become darker

c) Dark and bright fringes get fainter

d) Dark fringes get brighter and bright fringes get darker

52. A ray of light is incident on a thin film. As shown in figure, M and N are two reflected rays while P and Q are two transmitted rays. Rays N and Q undergo a phase change of π. Correct ordering of the refracting indices is



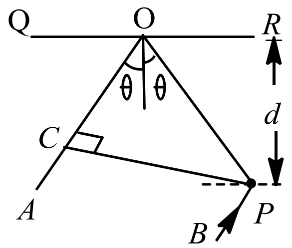
a) $n_2 > n_3 > n_1$ b) $n_3 > n_2 > n_1$

c) $n_3 > n_1 > n_2$ d) None of these, the specifie4d changes cannot occur

53. In YDSE, let A and B be two slits. Films of thickness t_A and t_B and refractive indices μ_A and μ_B are placed in front of A and B, respectively. If $\mu_A t_A = \mu_A t_B$, then the central maxima will
a) Not shift
b) Shift towards A
c) Shift towards B
d) (b) if $t_B < t_A$ and (c) if $t_B < t_A$

54. In Young's double-slit experiment, the y-coordinates of central maxima and 10th maxima are 2 cm and 5 cm, respectively. When the YDSE apparatus is immersed in a liquid of refractive index 1.5, the corresponding y-coordinates will be
a) 2 cm, 7.5 cm
b) 3 cm, 6 cm
c) 2 cm, 4 cm
d) 4/3 cm, 103 cm

55. In the adjacent diagram, CP represents a wavefront and AO and BP, the corresponding two rays. Find the condition on θ for constructive interference at Pbetween the ray BP and reflected ray OP



a) $\cos\theta = \frac{3\lambda}{2d}$
b) $\cos\theta = \frac{\lambda}{4d}$
c) $\sec\theta - \cos\theta = \frac{\lambda}{d}$
d) $\sec\theta - \cos\theta = \frac{4\lambda}{d}$

56. Two coherent monochromatic light beams of intensities I and $4I$ are superposed. The maximum and minimum possible intensities in the resulting beam are
a) $5I$ and I
b) $5I$ and $3I$
c) $9I$ and I
d) $9I$ and $3I$

57. In Young's experiment, the distance between the slits is reduced to half and the distance between the slit and screen is doubled, then the fringe width
a) Will not change
b) Will become half
c) Will be doubled
d) Will become four times

58. Young's double slit experiment is carried out by using green, red and blue light, one color at a time. The fringe widths recorded are β_G, β_R and β_B, respectively. Then
a) $\beta_G > \beta_B > \beta_R$
b) $\beta_B > \beta_G > \beta_R$
c) $\beta_R > \beta_B > \beta_G$
d) $\beta_R > \beta_G > \beta_B$

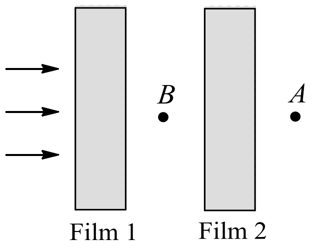
59. In a YDSE, $D = 1$ m, $d = 1$ mm and $\lambda = 5000$ nm. The distance of 100th maxima from the central maxima is
a) $\frac{1}{2}$ m
b) $\frac{\sqrt{3}}{2}$ m
c) $\frac{1}{\sqrt{3}}$ m
d) Does not exist

60. Calculate the wavelength of light used in an interference experiment from the following data: Fringe width = 0.03 cm. Distance between slits and eyepiece through which the interference pattern is observed is 1 m. Distance between the images of the virtual source when a convex lens of focal length 16 cm is used at a distance of 80 cm from the eyepiece is 0.8 cm
a) 6000 Å
b) 0.00006 Å
c) 6000 cm
d) 0.00006 m

61. To produce a minimum reflection of wavelengths near the middle of visible spectrum (550 nm) how thick should a coating of $MgF_2 (\mu = 1.38)$ be vacuum-coated on a glass surface?
a) 10^{-7}
b) 10^{-10}
c) 10^{-9} m
d) 10^{-8} m

62. Two light waves having the same wavelength λ in vacuum are in phase initially. Then, the first ray travels a path of length L_1 through a medium of refractive index μ_1. The second ray travels a path of length L_2 through a medium of refractive index μ_2. The two waves are then combined to observe interference effects. The phase difference between the two, when they interfere, is
a) $\frac{2\pi}{\lambda}(L_1 - L_2)$
b) $\frac{2\pi}{\lambda}(\mu_1 L_1 - \mu_2 L_2)$
c) $\frac{2\pi}{\lambda}(\mu_2 L_1 - \mu_1 L_2)$
d) $\frac{2\pi}{\lambda}\left[\frac{L_1}{\mu_1} - \frac{L_2}{\mu_2}\right]$

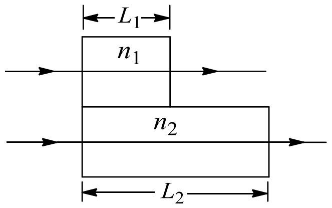
63. Two thin films of the same material but different thickness are separated by air. Monochromatic light is incident on the first film. When viewed normally from point A, the second film appears dark



From point B, on normal viewing

a) The first film will appear bright
b) The first film will appear dark
c) The second film will appear bright
d) The second film will appear dark

64. Two waves of light in air have the same wavelength and are initially in phase. They then travel through plastic layers with thickness of $L_1 = 3.5$ mm and $L_2 = 5.0$ mm and indices of refraction $n_1 = 1.7$ and $n_2 = 1.25$ as shown in the figure. The rays later arrive at a common point. The longest wavelength of light for which constructive interference occurs at the point is



a) 0.8 μm
b) 1.2 μm
c) 1.7 μm
d) 2.9 μm

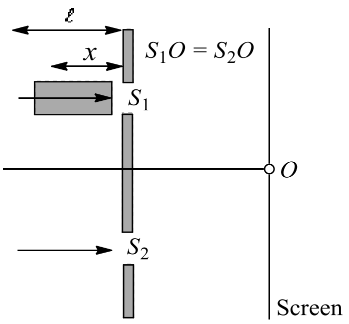
65. In YDSE, when a glass plate of refractive index 1.5 and thickness t is placed in the path of one of the interfering beams (wavelength λ), intensity at the position where central maximum occured previously remains unchanged. The minimum thickness of the glass plate is

a) 2λ
b) $(2/3)\lambda$
c) $\lambda/3$
d) λ

66. The wavefront of a light beam is given by the equation $x + 2y + 3x = c$ (where c is arbitrary constant), then the angle made by the direction of light with the y-axis is

a) $\cos^{-1}\frac{1}{\sqrt{14}}$
b) $\sin^{-1}\frac{2}{\sqrt{14}}$
c) $\cos^{-1}\frac{2}{\sqrt{14}}$
d) $\sin^{-1}\frac{3}{\sqrt{14}}$

67. In figure, a parallel beam of light is incident on the plane of the slits of a Young's double-slit experiment. Light incident on the slit S_1 passes through a medium of variable refractive index $\mu = 1 + ax$ (where 'x' is the distance from the plane of slits as shown), up to a distance 'l' before falling on S_1. Rest of the space is filled with air. If at 'O' a minima is formed, then the minimum value of the positive constant a (in terms of l and wavelength 'λ' in air) is

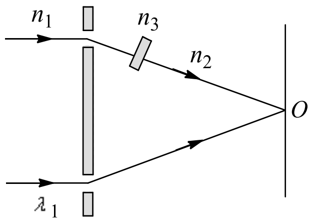


a) $\frac{\lambda}{\ell}$
b) $\frac{\lambda}{\ell^2}$
c) $\frac{\ell^2}{\lambda}$
d) None of these

68. In a double-slit experiment, two parallel slits are illuminated first by light of wavelength 400 nm and then by light of unknown wavelength. The fourth-order dark fringe resulting from the known wavelength of light falls in the same place on the screen as the second-order bright fringe from the unknown wavelength. The value of unknown wavelength of the light is

a) 900 nm
b) 700 nm
c) 300 nm
d) None of these

69. In a YDSE shown in figure, a parallel beam of light is incident on the slits from a medium of refractive index n_1. The wavelength of light in this medium is λ_1. A transparent slab of thickness 't' and refractive index n_3 is put in front of one slit. The medium between the screen and the plane of the slits is n_2. The phase difference between the light waves reaching point 'O' (symmetrical, relative to the slits) is



a) $\frac{2\pi}{n_1\lambda_1}(n_3 - n_2)t$ b) $\frac{2\pi}{\lambda_1}(n_3 - n_2)t$ c) $\frac{2\pi n_1}{n_2\lambda_1}\left(\frac{n_3}{n_2} - 1\right)t$ d) $\frac{2\pi n_1}{\lambda_1}(n_3 - n_2)t$

70. A long horizontal slit is placed 1 mm above a horizontal plane mirror. The interference between the light coming directly from the slit and that after reflection is seen on a screen 1 m away from the slit. If the mirror reflects only 64% of the light falling on it, the ratio of the maximum to the minimum intensity in the interference pattern observed on the screen is
a) 8:1 b) 3:1 c) 81:1 d) 9:1

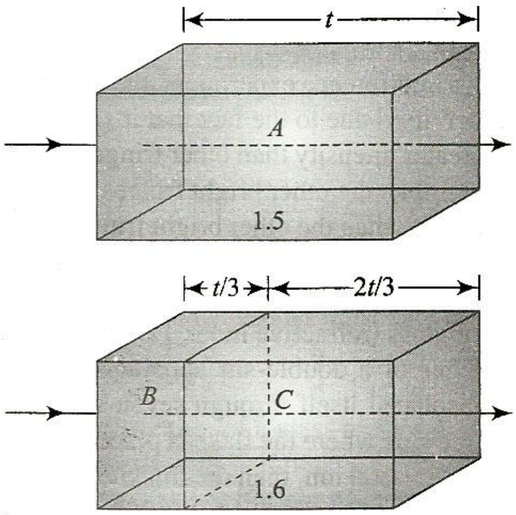
71. The index of refraction of a glass plate is 1.48 at $\theta_1 = 30°\text{C}$ and varies linearly with temperature with a coefficient of $2.5 \times 10^{-5}\ °\text{C}^{-1}$. The coefficient of linear expansion of the glass is $5 \times 10^{-5} °\text{C}^{-1}$. At 30°C, the length of the glass plate is 3 cm. This plate is placed in front of one of the slits in Young's double-slit experiment. If the plate is being heated so that its temperature incraeses at a rate of $5°\text{C}^{-1}$ min, the light source has wavelength $\lambda = 589$ nm and the glass plate initially is at $\theta = 30°\text{C}$. The number of fringes that shift on the screen in each minute is nearly (use approximation)
a) 1 b) 11 c) 110 d) 1.1×10^3

72. In a two-slit experiment with white light, a white fringe is observed on a screen kept behind the slits. When the screen in moved away by 0.05 m, this white fringe
a) Does not move at all b) Gets displaced from its earlier position
c) Becomes coloured d) Disappears

73. Two identical coherent sources of wavelength λ are placed at $(100\lambda, 0)$ and $(-50\lambda, 0)$, respectively. A detector moves slowly from the origin to $(50\lambda, 0)$ along x-axis. The number of maxima and minima detected are, respectively [include origin and $(50\lambda, 0)$]
a) 51 and 50 b) 101 and 100 c) 49 and 50 d) 50 and 49

74. Young's double-slit experiment is made in a liquid. The 10th bright fringe in liquid lies where 6th dark fringe lies in vacuum. The refractive index of the liquid is approximately
a) 1.8 b) 1.54 c) 1.67 d) 1.2

75. Two transparent slabs have the same thickness as shown in figure. One is made of material A of refractive index 1.5. The other is made of two materials B and C with thickness in the ratio 1:2. The refractive index of C is 1.6. If a monochromatic parallel beam passing through the slabs has the same number of wavelengths inside both, the refractive index of B is



a) 1.1 b) 1.2 c) 1.3 d) 1.4

76. In a Young's double-slit experiment, the separation between the slits is d, distance between the slit and screen is $D (D \gg d)$. In the interference pattern, there is a maxima exactly in front of each slit. Then, the possible wavelength(s) used in the experiment are
a) $d^2/D, d^2/2D, d^2/3D$ b) $d^2/D, d^2/3d, d^2/5D$ c) $d^2/2D, d^2/4D, d^2/6D$ d) None of these

77. A plane wave of monochromatic light falls normally on a uniform thin film of oil which covers a glass plate.

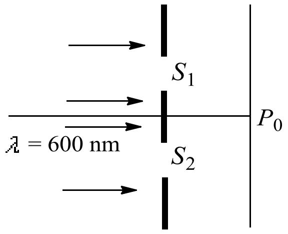
The wavelength of source can be varied continuously. Complete destructive interference is observed for $\lambda = 5000$ Å and $\lambda = 1000$ Å and for no other wavelength in between. If μ of oil is 1.3 and that of glass is 1.5, the thickness of the film will be

a) 6.738×10^{-5}cm b) 5.7×10^{-5} cm c) 4×10^{-5} cm d) 2.8×10^{-5} cm

78. Consider an YDSE that has different slit widths. As a result, amplitude of waves from two slits are A and $2A$, respectively. If I_0 be the maximum intensity of the interference pattern, then intensity of the pattern at a point where phase difference between waves is ϕ is

a) $I_0 \cos^2 \phi$ b) $\frac{I_0}{3} \sin^2 \frac{\phi}{2}$ c) $\frac{I_0}{9}[5 + 4\cos\phi]$ d) $\frac{I_0}{9}[5 + 8\cos\phi]$

79. In a standard Young's double-slit experiment with coherent light of wavelength 600 nm, the fringe width of the fringes in the central region (near the central fringe, P_0) is observed to be 3 mm. An extremely thin glass plate is introduced in front of the first slit, and the fringes are observed to be displaced by 11 mm. Another thin plate is placed before the second slit and it is observed that the fringes are now displaced by and additional 12 mm. If the additional optical path lengths introduced are Δ_1 and Δ_2, then



a) $11\Delta_1 = 12\Delta_2$ b) $12\Delta_1 = 11\Delta_2$ c) $11\Delta_1 > 12\Delta_2$ d) None of the above

80. In YDSE, having slits of equal width, let β be the fringe width and I_0 be the maximum intensity. At a distance x from the central bright fringe, the intensity will be

a) $I_0 \cos\left(\frac{x}{\beta}\right)$ b) $I_0 \cos^2 \frac{2\pi x}{\beta}$ c) $I_0 \cos^2 \frac{\pi x}{\beta}$ d) $\frac{I_0}{4} \cos^2 \frac{\pi x}{\beta}$

81. In Young's double-slit experiment, the angular width of a fringe formed on a distant screen is 1°. The wavelength of light used is 6000 Å. What is the spacing between the slits?

a) 344 mm b) 0.1344 mm c) 0.0344 mm d) 0.034 mm

82. In Young's double-slit experiment, the intensity of light at a point on the screen where path difference is λ is I. If intensity at a point is $I/4$, then possible path difference at this point are

a) $\lambda/2, \lambda/3$ b) $\lambda/3, 2\lambda/3$ c) $\lambda/3, \lambda/4$ d) $2\lambda/3, \lambda/4$

83. In a Young's double-slit experiment, 12 fringes are observed to be formed in a certain segment of the screen when light of wavelength 600 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 is given by

a) 12 b) 18 c) 24 d) 30

84. In Young's double-slit interference experiment, if the slit separation is made threefold, the fringe width becomes

a) Sixfold b) Threefold c) 3/6-fold d) 1/3-fold

85. Light of wavelength λ_0 in air enters a medium of refractive index n. If two points A and B in this medium lie along the path of this light at a distance x, then phase difference ϕ_0 between these two points is

a) $\phi_0 = \frac{1}{n}\left(\frac{2\pi}{\lambda_0}\right)x$ b) $\phi_0 = n\left(\frac{2\pi}{\lambda_0}\right)x$ c) $\phi_0 = (n-1)\left(\frac{2\pi}{\lambda_0}\right)x$ d) $\phi_0 = \frac{1}{(n-1)}\left(\frac{2\pi}{\lambda_0}\right)x$

86. Two slits spaced 0.25 mm apart are placed 0.75 m from a screen and illuminated by coherent light with a wavelength of 650 nm. The intensity at the center of the central maximum ($\theta = 0°$) is I_0. The distance on the screen from the center of the central maximum to the point where the intensity has fallen to $I_0/2$ is nearly

a) 0.1 nmn b) .25 mm c) 0.4 mm d) 0.5 mm

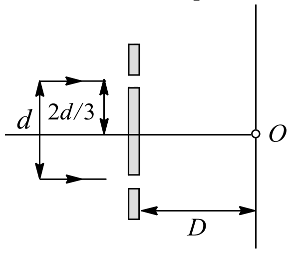
87. A parallel monochromatic beam of light is incident normally on a narrow slit. A diffraction pattern is formed on a screen placed perpendicular to the direction of incident beam. At the first maxima of the diffraction pattern the phase difference between the rays coming from the edges of the slit is

a) 0 b) $\frac{\pi}{2}$ c) π d) 2π

88. In YDSE, if a bichromatic light having wavelengths λ_1 and λ_2 is used, then the maxima due to both lights will overlap at a certain distance y of from the central maxima. Take separation between slits as d and distance between screen and slits as D. Then, the value of y will be

a) $\left(\frac{\lambda_1+\lambda_2}{2D}\right)d$ b) $\frac{\lambda_1-\lambda_2}{D}\times 2d$ c) LCM of $\frac{\lambda_1 D}{d}$ and $\frac{\lambda_2 D}{d}$ d) HCF of $\frac{\lambda_1 D}{d}$ and $\frac{\lambda_2 D}{d}$

89. In figure, if a parallel beam of while light is incident on the plane of the slits, then the distance of the nearest white spot on the screen from O is [assume $d \ll D, \lambda \ll d$]



a) 0 b) $d/2$ c) $d/3$ d) $d/6$

90. In Young's double-slit experiment using monochromatic light of wavelength λ, the fringe pattern shifts by a certain distance on the screen when a mica sheet of refractive index 1.6 and thickness 2.0 μm is introduced in the path of one of the interfering waves. The mica sheet is then removed and the distance between the plane of slits and the screen is doubled. It is found that the distance between successive maxima (or minima) now is the same as the observed fringe shift upon the introduction of the mica sheet. Calculate the wavelength of the light

a) 4500 Å b) 5700 Å c) 6000 Å d) 4000 Å

91. Interference fringes were produced using light in a double-slit experiment. When a mica sheet of uniform thickness and refractive index 1.6 (relative to air) is placed in the path of light from one of the slits, the central fringe moves through some distance. This distance is equal to the width of 30 interference bands if light of wavelength 4800 is used. The thickness (in μm) of mica is

a) 90 b) 12 c) 14 d) 24

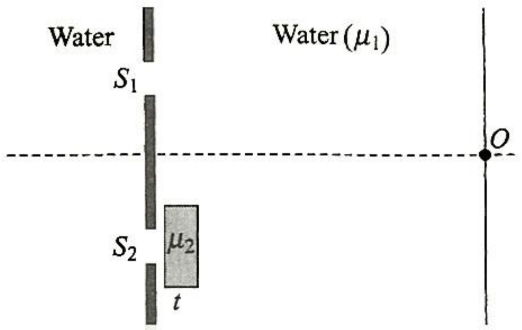
92. In Young's double slit experiment intensity at a point is (1/4) of the maximum intensity. Angular position of this point is

a) $\sin^{-1}(\lambda/d)$ b) $\sin^{-1}(\lambda/2d)$ c) $\sin^{-1}(\lambda/3d)$ d) $\sin^{-1}(\lambda/4d)$

93. High-quality camera lenses are often coated to prevent reflection. A lens has an optical index of refraction 1.72 and a coating with an optical index of refraction 1.31. For near normal incidence, the minimum thickness of the coating to prevent reflection for wavelength of 5.3×10^{-7} m is

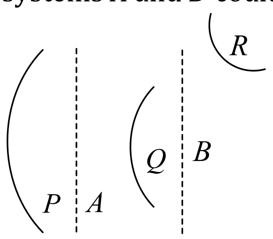
a) 0.75 μm b) 0.2 mm c) 0.1 μm d) 1.75 mm

94. A Young's double-slit experiment is conducted in water (μ_1) as shown in figure, and a glass plate of thickness t and refractive index μ_2 is placed in the path of S_2. Find the magnitude of the optical path difference at 'O'



a) $\left|\left(\frac{\mu_2}{\mu_1}-1\right)t\right|$ b) $\left|\left(\frac{\mu_1}{\mu_2}-1\right)t\right|$ c) $|(\mu_2-\mu_1)t|$ d) $|(\mu_2-1)t|$

95. Figure shows a wavefront P passing through two systems A and B, and emerging as Q and then as R. The systems A and B could, respectively, be



a) A prism and a convergent lens b) A convergent lens and a prism
c) A divergent lens and a prism d) A convergent lens and a divergent lens

96. In a Young's double-slit experiment, 30 fringes are obtained in the field of view of the observing telescope, when the wavelength of light used in 4000 Å. If we use monochromatic light of wavelength 6000 Å, the number of fringes obtained in the same field of view is

a) 30 b) 45 c) 20 d) None of these

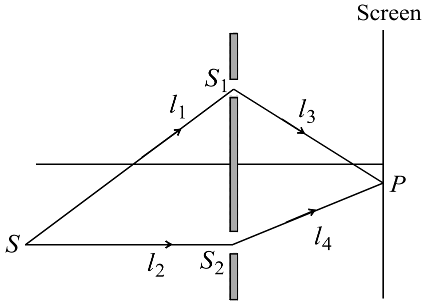
97. In a YDSE bi-chromatic light of wavelengths 400 nm and 560 nm are used. The distance between the slits is 0.1 mm and the distance between the plane of the slits and the screen is 1 m. The minimum distance between two successive regions of complete darkness is

a) 4 mm b) 5.6 mm c) 14 mm d) 28 mm

98. In YDSE, coherent monochromatic light having wavelength 600 nm falls on the slits. First-order bright fringe is at 4.84 mm from central maxima. Determine the wavelength for which the first-order dark fringe will be observed at the same location on screen. (Take $D = 3$ m)

a) 600 nm b) 1200 nm c) 300 nm d) 900 nm

99. The YDSE apparatus is as shown in figure. The condition for point P to be a dark fringe is



(l = wavelength of light waves)

a) $(l_1 - l_3) + (l_2 - l_4) = n\lambda$ b) $(l_1 - l_2) + (l_3 - l_4) = n\lambda$

c) $(l_1 + l_3) + (l_2 + l_4) = \frac{(2n-1)\lambda}{2}$ d) $(l_1 - l_2) + (l_4 - l_3) = \frac{(2n-1)\lambda}{2}$

100. In a Young's double-slit experiment, $\lambda = 500$ nm, $d = 1$ nm, and $D = 1$ m. The minimum distance from the central maximum for which the intensity is half of the maximum intensity is

a) 2×10^{-4} m b) 1.25×10^{-4} m c) 4×10^{-4} m d) 2.5×10^{-4} m

101. In Young's double-slit experiment, the wavelength of light was changed from 7000 Å to 3500 Å. While doubling the separation between the slits, which of the following is not true for this experiment?

a) The width of fringes changes

b) The colour of bright fringes changes

c) The separation between successive bright fringes changes

d) The separation between successive dark fringes remains unchanged

102. In Young's double-slit experiment, the intensity of light at a point on the screen, where the path difference is λ, is I. The intensity of light at a point where the path difference becomes $\lambda/3$ is

a) $\frac{I}{4}$ b) $\frac{I}{3}$ c) $\frac{I}{2}$ d) I

103. In YDSE, $d = 2$ mm $D = 2$ m and $\lambda = 500$ nm. If intensities of two slits are I_0 and $9I_0$, then find intensity at $y = \frac{1}{6}$ mm

a) $7I_0$ b) $10I_0$ c) $16I_0$ d) $4I_0$

104. In a double-slit experiment, instead of taking slits of equal width, one slit is made twice as wide as the other. Then, in the interferences pattern

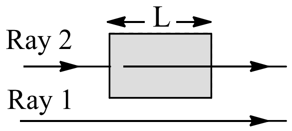
a) The intensities of both the maxima and the minima increase

b) The intensity of the maxima increases and the minima has zero intensity

c) The intensity of the maxima decreases and that of the minima increases

d) The intensity of the maxima decreases and the minima has zero intensity

105. As shown in figure, waves with identical wavelength and amplitudes and which are initially in phase travel through difference media. Ray 1 travels through air and Ray 2 through a transparent medium for equal length L, in four different situations. In each situation, the two rays reach a common point on the screen. The number of wavelengths in length L is N_2 for Ray 2 and N_1 for Ray 1. In the following table, values of N_1 and N_2 are given for all four situations. The order of the situations according to the intensity of the light at the common point in descending order is



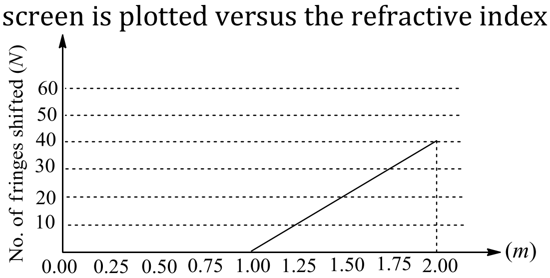
Situations	1	2	3	4
N_1	2.25	1.80	3.00	3.25
N_2	2.75	2.80	3.25	4.00

a) $I_3 = I_4 > I_2 > I_1$
b) $I_1 > I_3 => I_4 > I_2$
c) $I_1 > I_2 > I_3 > I_4$
d) $I_2 > I_3 = I_4 > I_1$

106. A light of wavelength 6000 Å shines on two narrow slits separated by a distance 1.0 mm and illuminates a screen at a distance 1.5 m away. When one slit is covered by a thin glass plate of refractive index 1.8 and other slit by a thin glass plate of refractive index μ, the central maxima shifts by 0.1 rad. Both plates have the same thickness of 0.5 mm. The value of refractive index μ of the glass is
a) 1.4
b) 1.5
c) 1.6
d) None of these

107. In the ideal double-slit experiment, when a glass plate (refractive index 1.5) of thickness t is introduced in the path of one of the interfering beams (wavelength λ), the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glass plate is
a) 2λ
b) $2\lambda/3$
c) $\lambda/3$
d) λ

108. The slits in a double-slit interference experiment are illuminated by orange light ($\lambda = 60$ nm). A thin transparent plastic of thickness t is placed in front of one of the slits. The number of fringes shifting on screen is plotted versus the refractive index μ of the plastic in graph shown in figure. The value of t is



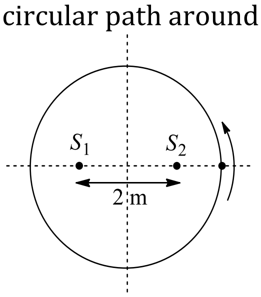
a) 4.8 mm
b) 640 μm
c) 24 μm
d) None of these

109. Let S_1 and S_2 be the two slits in Young's double-slit experiment. If central maxima is observed at P and angle $\angle S_1PS_2 = \theta$, then the fringe width for the light of wavelength λ will be (assume θ to be a small angle)
a) λ/θ
b) $\lambda\theta$
c) $2\lambda/\theta$
d) $\lambda/2\theta$

110. In a Young's double-slit experiment, the slits are 2 mm apart and are illuminated with a mixture of two wavelengths $\lambda_0 = 750$ nm and $\lambda = 900$ nm. The minimum distance from the common central bright fringe on a screen 2 m from the slits, where a bright fringe from one interference pattern coincides with a bright fringe from the other, is
a) 1.5 mm
b) 3 mm
c) 4.5 mm
d) 6 mm

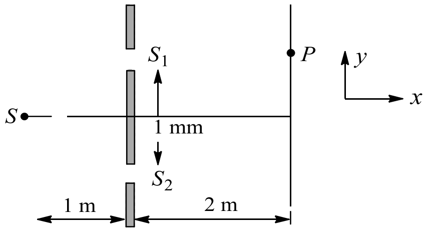
111. A parallel beam of white light is incident on a thin film of air of uniform thickness. Wavelengths 7200 Å and 5400 Å are observed to be missing from the spectrum of reflected light viewed normally. The other wavelength in the visible region missing in the reflected spectrum is
a) 6000 Å
b) 4320 Å
c) 5500 Å
d) 6500 Å

112. Two point sources separated by 2.0 m are radiating in phase with $\lambda = 0.50$ m. A detector moves in a circular path around the two sources in a plane containing them. How many maxima are detected?



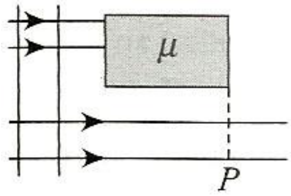
a) 16
b) 20
c) 24
d) 32

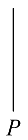
113. In a Young's double-slit experiment setup, source S of wavelength 50 nm illuminates two slits S_1 and S_2 which act as two coherent sources. The source S oscillates about its own position according to the equation $y = 0.5 \sin \pi t$, where y is in nm and t is seconds. The minimum value of time t for which the intensity at point P on the screen exactly in front of the upper slit becomes minimum is



a) 1 s b) 2 s c) 3 s d) 1.5 s

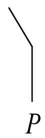
114. In Young's interference experiment, the central bright fringe can be identified due to the fact that it
    a) Has greater intensity than other fringes which are bright
    b) Is wider than the other bright fringes
    c) Is narrower than the other bright fringes
    d) Can be obtained by using white light instead of monochromatic light
115. A plane wavefront travelling in a straight line in vacuum encounters a medium of refractive index m. At P, the shape of the wavefront is



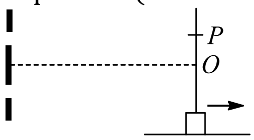
a) 

b) 

c) 

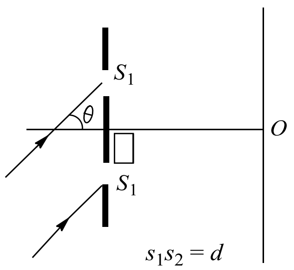
d) 

116. In a Young's double-slit experiment, first maxima is observed at a fixed point P on the screen. Now, the screen is continuously moved away from the plane of slits. The ratio of intensity at point P to the intensity at point O (centre of the screen)



a) Remains constant
b) Keeps on decreasing
c) First decreases and then increases
d) First decreases and then becomes constant

117. A monochromatic beam of light falls on YDSE apparatus at some angle (say θ) as shown in figure. A thin sheet of glass is inserted in front of the lower slit s_2. The central bright fringe (path difference $=0$) will be obtained



a) At O
b) Above O
c) Below O
d) Anywhere depending an angle θ, thickness of plate t, and refractive index of glass μ

118. The path difference between two interfering waves at a point on the screen is $\lambda/6$. The ratio of intensity at this point and that at the central bright fringe will be (assume that intensity due to each slit in same)
    a) 0.853 b) 8.53 c) 0.75 d) 7.5
119. In a YDSE with identical slits, the intensity of the central bright fringe is I_0. If one of the slits is convered, the intensity at the same point is
    a) $2I_0$ b) I_0 c) $I_0/2$ d) $I_0/4$

120. In YDSE, find the missing wavelength at $y = d$, where symbols have their usual meaning (take $D \gg d$)

a) $\frac{d^2}{D}$ b) $\frac{2d^2}{7D}$ c) $\frac{3d^2}{D}$ d) $\frac{d^2}{3D}$

121. Two thin parallel slits are made in an opaque sheet of film when a monochromatic beam of light is shone through them at normal incidence. The first bright fringes in the transmitted light occur at $\pm 45°$ with the original direction of the light beam on a distant screen when the apparatus is in air. When the apparatus is immersed in a liquid, the same bright fringes now occurs at $\pm 30°$. The index of refraction of the liquid is

a) $\sqrt{2}$ b) $\sqrt{3}$ c) $\frac{4}{3}$ d) $\frac{3}{2}$

122. Microwaves from a transmitter are directed normally towards a plane reflector. A detector. A detector moves along the normal to the reflector. Between positions of 14 successive maxima the detector travels a distance 0.14 m. The frequency of the transmitter is ($c = 3 \times 10^8$ m/s)

a) 1.5×10^{10}Hz b) 10^{10}Hz c) 3×10^{10}Hz d) 6×10^{10}Hz

123. In YDSE, water is filled in the space between the slits and screen. Then,

a) Fringe pattern shifts upward but fringe width remains unchanged

b) Fringe width decreases and fringe pattern shifts upward

c) Fringe width remains unchanged and central fringe does not shift

d) Fringe width decreases and fringe pattern does not shift

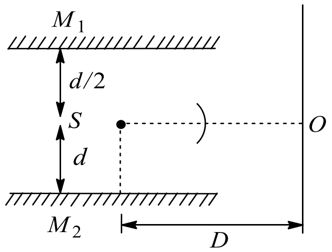
124. A flake of glass (refractive index 1.5) is placed over one of the openings of a double-slit apparatus. The interference pattern displaced itself through seven successive maxima towards the side where the flake is placed. If wavelength of the light is $\lambda = 600$ nm, then the thickness of the flake is

a) 2100 nm b) 4200 nm c) 8400 nm d) None of above

125. In Young's double-slit experiment, the two slits act as coherent sources of equal amplitude A and wavelength λ. In another experiment with the same setup, the two slits are sources of equal amplitude A and wavelength λ, but are incoherent. The ratio of intensity of light at the mid-point of the screen in the first case to that in the second case is

a) 1:1 b) 1:2 c) 2:1 d) 4:1

126. M_1 and M_2 are plane mirrors and kept parallel to each other. At point O, there will be a maxima for wavelength λ. Light from a monochromatic source S of wavelength λ is not reaching directly on the screen. Then, λ is



a) $\frac{3d^2}{D}$ b) $\frac{3d^2}{2D}$ c) $\frac{d^2}{D}$ d) $\frac{2d^2}{D}$

127. A plate of thickness t made of a material of refractive index μ is placed in front of one of the slits in a double-slit experiment. What should be the minimum thickness t which will make the intensity at the center of the fringe pattern zero?

a) $(\mu - 1)\frac{\lambda}{2}$ b) $(\mu - 1)\lambda$ c) $\frac{\lambda}{2(\mu - 1)}$ d) $\frac{\lambda}{(\mu - 1)}$

Multiple Correct Answers Type

128. In Young's double-slit experiment, two wavelengths of light are used simultaneously where $\lambda_2 = 2\lambda_1$. In the fringe pattern observed on the screen

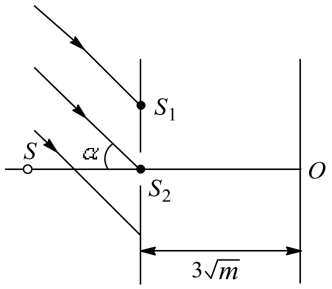
a) Maxima of wavelength λ_2 can coincide with minima of wavelength λ_1

b) Fringe width of λ_2 will be double that of fringe width of λ_1 and nth order maxima of λ_2 will coincide with 2nd order maxima of λ_1

c) nth order minima of λ_2 will coincide with $2n$th order minima of λ_1

d) None of the above

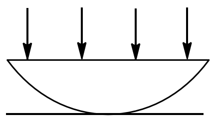
129. A parallel beam of light ($\lambda = 500$) is incident at an angle $\alpha = 30°$ with the normal to the slit plane in a Young's double-slit experiment. Assume that the intensity due to each slit at any point on the screen is I_0. Point O is equidistant from S_1 and S_2. The distance between slits is 1 mm. Then,



a) The intensity at O is $4I_0$
b) The intensity at O is zero
c) The intensity at a point on the screen 1 m below O is $4I_0$
d) The intensity at a point on the screen 1 m below O is zero

130. Two monochromatic coherent point sources S_1 and S_2 are separated by a distance L. Each source emits light of wavelength λ; where $L \gg \lambda$. The line S_1S_2 when extended meets a screen perpendicular to it at a point A. Then,
a) The interference fringes on the screen are circular in shape
b) The interference fringes on the screen are straight lines perpendicular to the line S_1S_2A
c) The point A is an intensity maxima if $L = n\lambda$
d) The point A is always an intensity maxima for any separation L

131. A thin slice is cut out of a glass cylinder along a plane parallel to its axis. The slice is placed on a flat glass plate as shown in figure. The observed interference fringes from this combination shall be



a) Straight
b) Circular
c) Equally spaced
d) Having fringe spacing which increases as we go outwards

132. In Young's double-slit experiment, let A and B be the two slits. A thin film of thickness t and refractive index μ is placed in front of A. Let β =fringe width. Then, the central maxima will shift
a) Towards A b) Towards B c) By $t(\mu - 1)\frac{\beta}{\lambda}$ d) By $\mu t\frac{\beta}{\lambda}$

133. In the Young's double slit experiment, the ratio of intensities of bright and dark fringes is 9. This means that
a) The intensities of individual sources are 5 and 4 units respectively
b) The intensities of individual sources are 4 and 1 units respectively
c) The ratio of their amplitudes is 3
d) The ratio of their amplitudes is 2

134. In the Young's double-slit experiment, the interference pattern is found to have an intensity ratio between the bright and dark fringes as 9. This implies that
a) The intensities at the screen due to the two slits are 5 units and 4 units, respectively
b) The intensities at the screen due to the two slits are 4 units and 1 units, respectively
c) The amplitude ratio is 3
d) The amplitude ratio is 2

135. In a Young's double-slit experiment, 12 fringes are observed to be formed in a certain segment of the screen when light of wavelength 600 nm is used. If the wavelength of light is changed to 400 nm, number of fringes observed in the same segment of the screen is given by
a) 12 b) 18 c) 24 d) 30

136. The slit 1 of a Young's double-slit experiment is wider than slit 2, so that the light from slits are given as

$A_1 = A_0 \sin \omega t$ and $A_2 = A_3 A_0 \sin\left(\omega t + \frac{\pi}{3}\right)$. The resultant amplitude and intensity, at a point where the path difference between them is zero, are A and I, respectively. Then,

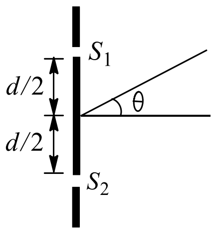
a) $A = \sqrt{13}\, A_0$ b) $A = 4\, A_0$ c) $I \propto 16\, A_0^2$ d) $I \propto 13\, A_0^2$

137. In Young's double slit experiment, if the two slits are illuminated with separate sources, no interference pattern is observed because
   a) There will be no constant phase difference between the two waves
   b) The wavelength are not equal
   c) The amplitudes are not equal
   d) None of the above

138. A two-slit interference experiment uses coherent light of wavelength 5×10^{-7} m. Intensity in the interference pattern for the following points are I_1, I_2, I_3 and I_4, respectively
   1. A point that is close to one slit than the other by 5×10^{-7} m
   2. A point where the light waves received from the two slits are out of phase by $\frac{4\pi}{3}$ rad
   3. A point that is closer to one slit than the other by 7.5×10^{-7} m
   4. A point where the light waves received by the two slits are out of phase by $\frac{\pi}{3}$ rad

   Then, which of following statements is/are correct?
   a) $I_1 > I_4 > I_2 > I_3$ b) $I_1 > I_2 > I_3 > I_4$ c) $3I_2 = I_4$ d) $I_3 = 0$

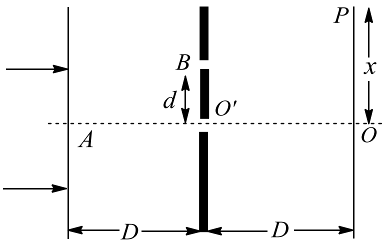
139. In an interference arrangement similar to Young's double-slit experiment, the slits S_1 and S_2 are illuminated with coherent microwave sources, each of frequency 10^6 Hz. The sources are synchronized to have zero phase difference. The slits are separated by a distance $d = 150.0$ m. The intensity $I(\theta)$ is measured as a function of θ, where θ is defined as shown. If I_0 is the maximum intensity, then $I(\theta)$ for $0 \le \theta \le 90°$ is given by



   a) $I(\theta) = I_0/2$ for $\theta = 30°$ b) $I(\theta) = I_0/4$ for $\theta = 90°$
   c) $I(\theta) = I_0$ for $\theta = 0°$ d) $I(\theta)$ is constant for all values of θ

140. A ray of light of wavelength u_0 and frequency v_0 enters a glass slab of refractive index μ from air. Then,
   a) Its wavelength increases, frequency decreases
   b) Its wavelength decreases, frequency remains same
   c) Its wavelength increases, frequency remains same
   d) $\Delta\lambda = \lambda_0\left(\frac{1}{\mu} - 1\right)$ and $\Delta v = 0$

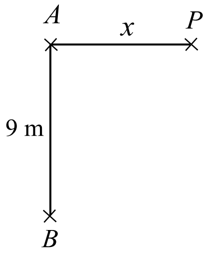
141. The minimum value of d so that there is a dark fringe at O is $d_{\min}$. For the value of $d_{\min}$, the distance at which the next bright fringe is formed is x. Then,



   a) $d_{\min} = \sqrt{\lambda D}$ b) $d_{\min} = \sqrt{\dfrac{\lambda D}{2}}$ c) $x = \dfrac{d_{\min}}{2}$ d) $x = d_{\min}$

142. A radio transmitting station operating at a frequency of 120 MHz has two identical antennas that radiate in phase. Antenna B is 9 m to the right of antenna A. Consider point P at a horizontal distance x to the right

of antenna A as shown in figure. The value of x and order for which the constructive interference will occur at point P are



a) $x = 14.95$ m, $n = 1$ b) $x = 5.6$ m, $n = 2$ c) $x = 1.65$ m, $n = 3$ d) $x = 0, n = 3.6$

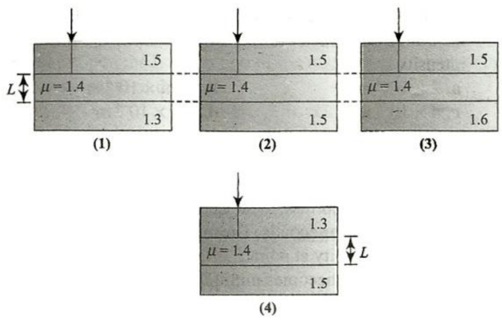
143. With a monochromatic light, the fringe width using a glass biprism setup in air is 2 mm. Given ${}_a\pi_g = 3/2$ and ${}_a\pi_r = 5/3$. The whole set up is immersed in liquid, then the new fringe width is

a) 2 mm b) 6 mm c) 6/5 mm d) 8/3 mm

144. In a double-slit experiment instead of taking slits of equal widths, one slit is made twice as wide as the other. Then, in the interference pattern

a) The intensities of both the maxima and the minima increase
b) The intensity of the maxima increases and the minima hss zero intensity
c) The intensity of the maxima decreases and that of the minima increases
d) The intensity of the maxima decreases and the minima has zero intensity

145. Consider a film of thickness L as shown in four different cases below. Notice the observation of film with perpendicularly falling light. Mark the correct statement(s)



(Take $L = 1.5\,\lambda$)

a) For (1) and (2), the reflection at film interfaces causes zero phase difference for two reflected rays
b) For (2) and (3), the reflection at film interfaces causes a phase difference of π for two reflected rays
c) For (1), the film will appear dark, if it is observed through reflected rays from film interfaces
d) For (3), the film will appear dark, if it is observed through reflected rays from film interfaces

146. A light wave of wavelength λ_0 propagates from point A to point B. We introduce in its path a glass plate of refractive index n and thickness ℓ. The introduction of the plate alters the phase of the plate at B by an angle ϕ. If λ is the wavelength of light on emerging from the plate, then

a) $\Delta\phi = 0$ b) $\Delta\phi = \frac{2\pi\ell}{\lambda_0}$ c) $\Delta\phi = 2\pi\ell\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$ d) $\Delta\phi = \frac{2\pi\ell}{\lambda_0}(n-1)$

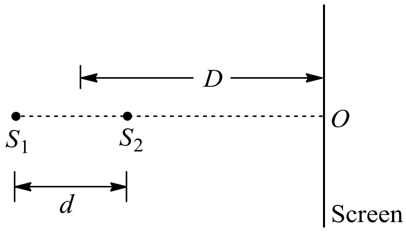
147. A transparent slab of thickness t and refractive index μ is inserted in front of upper slit of YDSE apparatus. The wavelength of light used is λ. Assume that there is no absorption of light by the slab. Mar the correct statement(s)

a) The intensity of dark fringes will be 0, if slits are identical
b) The change in optical path due to insertion of plate is μt
c) The change in optical path due to insertion of plate is $(\mu - 1)t$
d) For making intensity zero at center of screen, the thickness can be $\frac{5\lambda}{2(\mu-1)}$

148. In young's double slit experiment with a source of light of wavelength 6320 Å, the first maxima will occur when

a) Path difference is 9480 Å b) Phase difference is 2π radian
c) Path difference is 6320 Å d) Phase difference is π radian

149. In the Young's double-slit experiment, the interference pattern is found to have an intensity ratio between the bright and dark fringes as 9. This implies that
a) The intensities at the screen due to the two slits are 5 units and 4 units, respectively
b) The intensities at the screen due to the two slits are 4 units and 1 units, respectively
c) The amplitude ratio is 3
d) The amplitude ratio is 2
150. Two beams of light having intensities I and $4I$ interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\pi/2$ at point A and π at point B. Then, the difference between the resultant intensities at A and B is
a) $2I$ b) $4I$ c) $5I$ d) $7I$
151. If one of the slits of a standard Young's double-slit experiment is covered by a thin parallel sides glass slab so that it transmits only one-half the light intensity of the other, then
a) The fringe pattern will get shifted toward the covered slit
b) The fringe pattern will get shifted away from the covered slit
c) The bright fringes will becomes less bright and the dark ones will becomes more bright
d) The fringe width will remain unchanged
152. In YDSE, the source is placed symmetrical to the slits. If a transparent slab is placed in front of the upper slit, then (slab can absorb a fraction of light)
a) Intensity of central maxima may change
b) Intensity of central maxima may not change
c) Central maxima will be shifted up
d) Intensity of dark fringes will be always zero
153. In Young's double slit experiment, on interference, ratio of intensities of a bright band and a dark band is 6:1. The ratio of amplitudes of interfering waves is
a) 16 b) 5/3 c) 4 d) 1/4
154. Two points monochromatic and coherent sources of light of wavelength λ each are placed as shown in figure. The initial phase difference between the sources is zero O. ($D \gg d$). Mark the correct statement(s)



a) If $d = \frac{7\lambda}{2}$, O will be a minima
b) If $d = \lambda$, only one maxima can be observed on the screen
c) If $d = 4.8\,\lambda$, then total 10 minima would be there on the screen
d) If $d = \frac{5\lambda}{2}$, the intensity at O would be minimum
155. Four light waves are represented by
(i) $y = a_1 \sin \omega t$ (ii) $y = a_2 \sin(\omega t + \phi)$
(iii) $y = a_1 \sin 2\omega t$ (iv) $y = a_2 \sin 2(\omega t + \phi)$
Interference fringes may be observed due to superposition of
a) (i) and (ii) b) (i) and (iii) c) (ii) and (iv) d) (iii) and (iv)
156. In a Young's double slit experiment, the separation between the two slits is d and the wavelength of the light is λ. The intensity of light falling on slit 1 is four times the intensity of light falling on slit 2. Choose the correct choice (s)
a) If $d = \lambda$, the screen will contain only one maximum
b) If $\lambda < d < 2\lambda$, at least one more maximum (besides the central maximum) will be observed on the screen
c) If the intensity of light falling on slit 1 is reduced so that it becomes equal to that of slit 2, the intensities of the observed dark and bright fringes will increase

d) If the intensity of light falling on slit 2 is increased so that it becomes equal to that of slit 1, the intensities of the observed dark and bright fringes will increase

157. A light of wavelength 6000 Å in air enters a medium of refractive index 1.5. Inside the medium, its frequency is v and its wavelength is λ.

a) $v = 5 \times 10^{14}$ Hz b) $v = 7.5 \times 10^{14}$ Hz c) $\lambda = 4000$Å d) $\lambda = 9000$Å

158. Light waves travel in vacuum along X-axis. Which of the following may represent the wavefronts?

a) $x = a$ b) $y = a$ c) $x = a'$ d) $x + y + z = a$

159. White light is used to illuminate the two slits in a Young's double-slit experiment. The separation between the slits is b and the screen is at a distance d $(> b)$ from the slits. At a point on the screen directly in front of one of the slits, certain wavelengths are missing. Some of these missing wavelengths are

a) $\lambda = \dfrac{b^2}{d}$ b) $\lambda = \dfrac{2b^2}{d}$ c) $\lambda = \dfrac{b^2}{3d}$ d) $\lambda = \dfrac{2b^2}{3d}$

160. In Young's double slit experiment, the distance between the two slits is 0.1 mm and wavelength of light used is 4×10^{-7} m. If the width of fringe on screen is 4 mm, the distance between screen and slit is

a) 0.1 mm b) 1 cm c) 0.1 cm d) 1m

161. If the first minima in a Young's double-slit experiment occurs directly in front of one of the slits (distance between slit and screen $D = 12$ cm and distance between slits $d = 5$ cm), then the wavelength of the radiation used can be

a) 2 cm b) 4 cm c) $\dfrac{2}{3}$ cm d) $\dfrac{4}{3}$ cm

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 162 to 161. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

162

Statement 1: In Hertz experiment, the electric vector of radiation produced by the source gap is parallel to the gap

Statement 2: Production of sparks between the detector gap is maximum when it is placed perpendicular to the source gap

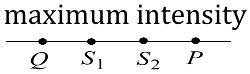
163

Statement 1: For cooking in a microwave oven, food is always kept in metal containers

Statement 2: The energy of microwave is easily transferred to the food in metal container

164

Statement 1: Two point coherent sources of light S_1 and S_2 are placed on a line as shown in figure. P and Q are two points on that line. If at point P maximum intensity is observed, then maximum intensity should also be observed at Q



Statement 2: In figure, the distance $|S_1P - S_2P|$ is equal to distance $|S_1Q - S_2Q|$

165

Statement 1: The unpolarised light and polarized light can be distinguished from each other by using polariod.

Statement 2: A polariod is capable o producing plane polarized beams of light.

166

Statement 1: Thin films such as soap bubble or a thin layer of oil on water show beautiful colours when illuminated by white light

Statement 2: It happens due to the interference of light reflected from the upper surface of thin film

167

Statement 1: Short wave bands are used for transmission of radio waves to a large distance

Statement 2: Short waves are reflected by ionosphere

168 A thin air film is formed by putting the convex surface of a plane-convex lens over a plane glass plate. With monochromatic light, this film gives an interference pattern due to light reflected from the top (convex) surface and the bottom (glass plate) surface of the film

Statement 1: When light reflects from the air-glass plate interface, the reflected wave suffers a phase change of π

Statement 2: The centre of the interference pattern is dark

169

Statement 1: In Young's experiment, the fringe width for dark fringes is same as that of the white fringes

Statement 2: In Young's double-slit experiment, the fringes are performed with a source of white light, then only black and bright fringes are observed

170

Statement 1: Out of radio waves and microwaves, the former undergoes more diffraction.

Statement 2: Radio waves have greater frequency compare to microwaves.

171

Statement 1: In everyday life the Doppler's effect is observed readily for sound waves than light waves

Statement 2: Velocity of light is greater than that of sound

172

Statement 1: An electron beam is used to obtain interference in a simple Young's double-slit experiment arrangement with appropriate distance between the slits. If the speed of electrons is increased, the fringe width decreases

Statement 2: de Broglie wavelength of electron is inversely proportional to the speed of the electrons

173

Statement 1: Thin films such as soap bubble or a thin layer of oil on water show beautiful colours when illuminated by white light.

Statement 2: It happens due to the interference of light reflected from the upper surface of the thin film.

174

Statement 1: When a tiny circular obstacle is placed in the path of light from some distance, a bright spot is seen at the centre of shadow of the obstacle.

Statement 2: Destructive interference occurs at the centre of the shadow.

175

Statement 1: X-ray astronomy is possible only from satellites orbiting the earth

Statement 2: Efficiency of X-rays telescope is large as compared to any other telescope

176

Statement 1: The cloud in sky generally appears to be whitish

Statement 2: Diffraction due to clouds is efficient in equal measure at all wavelengths

177

Statement 1: Microwave communication is preferred over optical communication

Statement 2: Microwaves provide large number of channels and band width compared to optical signals

178

Statement 1: In YDSE, if separation between the slits is less than wavelength of light, then no interference pattern can be observed

Statement 2: For interference pattern to be observed, light sources have to be coherent

179

Statement 1: For best contrast between maxima and minima in the interference pattern of Young's double slit experiment, the intensity of light emerging out of the two slits should be equal

Statement 2: The intensity of interference pattern is proportional to square of amplitude

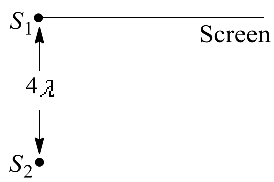
180

Statement 1: In interference, all the fringes are of same width

Statement 2: In interference, fringe width is independent of the position of fringe

181

Statement 1: For the situation shown in figure, two identical coherent light sources produce interference pattern on the screen. The intensity of minima nearest to S_1 is not exactly zero



Statement 2: Minimum intensity is zero, when interfering waves have same intensity at the location of superposition

182

Statement 1: It is necessary to use satellites for long distance T.V. transmission

Statement 2: The television signals are low frequency signals

183

Statement 1: To observe diffraction of light the size of obstacle/aperture should be of the order of 10^{-7}m.

Statement 2: 10^{-7}m is the order of wavelength of visible light.

184

Statement 1: The pattern and position of fringes always remain same even after the introduction of transparent medium in a path of one of the slits

Statement 2: The central fringe is bright or dark does not depend upon the initial phase difference between the two coherence sources

185

Statement 1: In calculating the disturbance produced by a pair of superimposed incoherent wave trains, you can add their intensities

Statement 2: $I_1 + I_2 + 2\sqrt{I_1 I_2} \cos \delta$. The average value of $\cos \delta = 0$ for incoherent waves

186

Statement 1: Corpuscular theory fails in explaining the velocities of light in air and water.

Statement 2: According to corpuscular theory, light should travel faster in denser media than in rarer media.

187

Statement 1: Radio waves can be polarized

Statement 2: Sound waves in air are longitudinal in nature

188

Statement 1: Corpuscular theory fails in explaining the velocities of light in air and water.

Statement 2: According to Corpuscular theory, light should travel faster in denser media then in rarer media.

189

Statement 1: Fringe width depends upon refractive index of the medium

Statement 2: Refractive index changes optical path of ray of light forming fringe pattern

190

Statement 1: A famous painting was painted by not using brush strokes in the usual manner, but rather a myriad of small colour dots. In the painting the colour you see at any given place on the painting changes as you move away.

Statement 2: The angular separation of adjacent dots changes with the distance from the painting.

191

Statement 1: Interference pattern is made by using blue light instead of red light, the fringes becomes narrower

Statement 2: In Young's double slit experiment, fringe width is given by relation $\beta = \frac{\lambda D}{d}$

192

Statement 1: No diffraction is produced in sound waves near a very small opening.

Statement 2: For diffraction to take place the aperture of opening should be of the same order as wavelength of the waves.

193

Statement 1: When a light wave travels from a rarer to a denser medium, it loses speed. The reduction in speed imply a reduction in energy carried by the light wave

Statement 2: The energy of a wave is proportional to velocity of wave

194

Statement 1: In Young's experiment, for two coherent sources, the resultant intensity is given by $I = 4I_0 \cos^2 \frac{\phi}{2}$.

Statement 2: Ratio of maximum to minimum intensity is $\frac{I_{\max}}{I_{\min}} = \frac{(\sqrt{I_1}+\sqrt{I_2})^2}{(\sqrt{I_1}-\sqrt{I_2})^2}$.

195

Statement 1: Two coherent point sources of light having non-zero phase difference are separated by a small distance. Then, on the perpendicular bisector of line segment joining both the point sources, constructive interference cannot be obtained

Statement 2: For two waves from coherent point sources to interfere constructively at a point, the magnitude of their phase difference at that point must be $2m\pi$ (where m is a non-negative integer)

196

Statement 1: We can hear around corners, but we cannot see around corners

Statement 2: Wavelength of sound is much greater than wavelength of light

197

Statement 1: The unpolarised light and polarized light can be distinguished from each other by using polaroid

Statement 2: A polaroid is capable of producing plane polarized beams of light

198

Statement 1: Like light radiation, thermal radiations are also electromagnetic radiation

Statement 2: The thermal radiations require no medium for propagation

199

Statement 1: Television signals are received through sky-wave propagation

Statement 2: The ionosphere reflects electromagnetic waves of frequencies greater than a certain critical frequency

200

Statement 1: Newton's rings are formed in the reflected system when the space between the lens and the glass plate is filled with a liquid of refractive index greater than that of glass; the central spot of the pattern is dark.

Statement 2: The refraction in Newton's ring cases will be from denser to rarer medium and the two interfering rays are reflected under similar conditions.

201

Statement 1: In Young's experiment, for two coherent sources, the resultant intensity is given by $I = 4I_0 \cos^2 \frac{\phi}{2}$

Statement 2: Ratio of maximum to minimum intensity is $\frac{I_{\max}}{I_{\min}} = \frac{(\sqrt{I_1}+\sqrt{I_2})^2}{(\sqrt{I_1}-\sqrt{I_2})^2}$

202

Statement 1: Newton's rings are formed in the reflected system. When the space between the lens and the glass plate is filled with a liquid of refractive index greater than that of glass, the central spot of the pattern is dark

Statement 2: The reflection in Newton's ring case will be from a denser to a rarer medium and the two interfering rays are reflected under similar conditions

203

Statement 1: Environmental damage has increased the amount of ozone in the atmosphere

Statement 2: Increase of ozone increases the amount of ultraviolet radiation on earth

204

Statement 1: The electrical conductivity of earth's atmosphere decrease with altitude

Statement 2: The high energy particles ($i.e.$, γ-rays and cosmic rays) coming from outer space and entering our earth's atmosphere causes ionization of the atoms of the gases present there and the pressure of gases decreases with increase in altitude

205

Statement 1: In Young's double-slit experiment, the two slits are at distance d apart. Interference pattern is observed on a screen at distance D from the slits. At a point on the screen which is directly opposite one of the slits, a dark fringe is observed. Then, the wavelength of wave is proportional to the square of distance between the two slits

Statement 2: For a dark fringe, intensity is zero

206

Statement 1: In Young's double slit experiment, the fringes become indistinct if one of the slits is covered with cellophane paper

Statement 2: The cellophane paper decreases the wavelength of light

207

Statement 1: The film which appears bright in reflected system will appear dark in the transmitted light and vice-versa

Statement 2: The conditions for film to appear bright or dark in reflected light are just reverse to those in the transmitted light

208

Statement 1: Coloured spectrum is seen when we look through a muslin cloth

Statement 2: It is due to the diffraction of white light on passing through fine slits

209

Statement 1: In Young's experiment, for two coherent sources, the resultant intensity given by$I = 4I_0 \cos^2 \frac{\phi}{2}$.

Statement 2: Ratio of maximum and minimum intensity $\frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2}$.

210

Statement 1: A narrow pulse of light is sent through a medium. The pulse will retain its shape as it travels through the medium

Statement 2: A narrow pulse is made of harmonic waves with a large range of wavelengths

211

Statement 1: Nicol prism is used to produce and analyse plane polarized light

Statement 2: Nicol prism reduces the intensity of light to zero

212

Statement 1: Ultraviolet radiations of higher frequency waves are dangerous to human being

Statement 2: Ultraviolet radiation are absorbed by the atmosphere

213

Statement 1: In Young's double slit experiment the two slits are at distance d apart. Interference pattern is observed on a screen at distance D from the slits. At a point on the screen when it is directly opposite to one of the slits, a dark fringe is observed. Then, the wavelength of wave is proportional to square of distance of two slits

Statement 2: For a dark fringe intensity is zero

214

Statement 1: While calculating intensities in interference pattern, we can add the intensities of the individual waves

Statement 2: Principle of superposition is valid for linear waves

215

Statement 1: In Young's experiment, the fringe width for dark fringes is different from that for white fringes

Statement 2: In Young's double-slit experiment, when the fringes are observed with a source of white light, then only black and bright fringes are observed

216

Statement 1: In Young's experiment, the fringe width for dark fringes is same from that for white fringes.

Statement 2: In Young's double slits experiment, when the fringes are performed with a source of white light, then only black and bright fringes are observed.

217

Statement 1: When a tiny circular obstacle is placed in the path of light from some distance, a bright spot is seen at the centre of shadow of the obstacle

Statement 2: Destructive interference occurs at the centre of the shadow

218

Statement 1: The earth without atmosphere would be inhospitably cold

Statement 2: All heat would escape in the absence of atmosphere

219

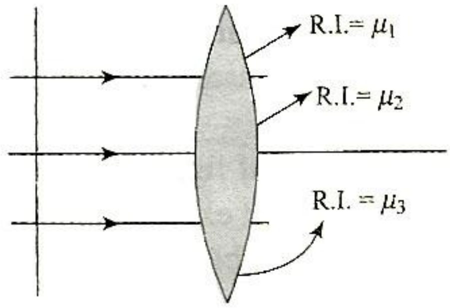
Statement 1: Corpuscular theory fails in explaining the velocities of light in air and water

Statement 2: According to corpuscular theory, light should travel faster in denser medium than, in rarer medium

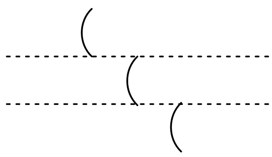
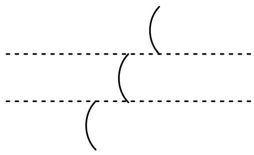
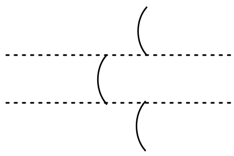
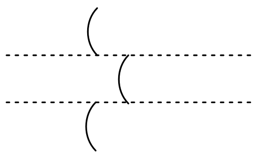
Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

220. For the situation shown in figure, Column I relates the values of μ_1, μ_2 and μ_3 and Column II shows the possible shapes of wavefronts. Match Column I entries with Column II entries



Plane wavefront

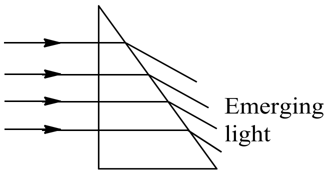
Column-I	Column- II
(A) $\mu_1 = 1.4, \mu_2 = 1.5, \mu_3 = 1.6$	(p) 
(B) $\mu_1 = 1.6, \mu_2 = 1.5, \mu_3 = 1.4$	(q) 
(C) $\mu_1 = 1.7, \mu_2 = 1.5, \mu_3 = 1.7$	(r) 
(D) $\mu_1 = 1.3, \mu_2 = 1.5, \mu_3 = 1.3$	(s) 

CODES :

A **B** **C** **D**

a)	p	q	r	s
b)	q	r	s	p
c)	r	s	p	q
d)	s	p	q	r

221.

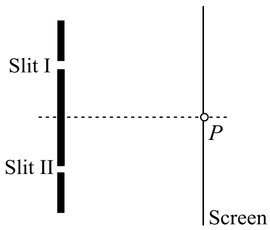
	Column-I		**Column- II**
(A)	Light diverging from a point source	(p)	Plane wavefront
(B)	Light emerging from a convex lens when a point source is placed at its focus	(q)	Spherical wavefront
(C)	Light reflected from a concave mirror when a point source is placed at its focus	(r)	Cylindrical wavefront
(D)		(s)	Concave right wavefront

CODES :

	A	**B**	**C**	**D**
a)	q	r	p	s
b)	r	p	s	q
c)	p	s	q	r
d)	q	p	p	p

222. A double-slit interference pattern is produced on a screen, as shown in figure, using monochromatic light of wavelength 500 nm. Point P is the location of the central bright fringe, that is produced when light waves arrive in phase without any path difference. A choice of three strips A, B and C of transparent materials with different thickness and refractive indices is available, as shown in the table. These are placed over one or both of the slits, singularly or in conjunction, causing the interference pattern to be shifted across the screen from the original pattern. In Column I, how the strips have been placed, is mentioned whereas in Column II, order of the fringe at point P on the screen that will be produced due to the placement of the strip(s), is shown. Correctly match both the columns

Film	***A***	***B***	***C***
Thickness (in μm)	5	1.5	0.25
Refractive index	1.5	2.5	2

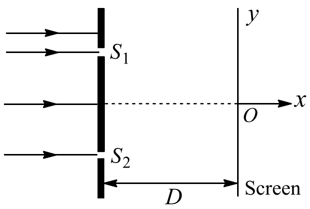


Column-I		Column- II	
(A)	Only strip B is placed over slit I	(p)	First bright
(B)	Strip A is placed over slit I and strip C is placed over slit II	(q)	Fourth dark
(C)	Strip A is placed over slit I and strip B and strip C are placed over slit II in conjunction	(r)	Fifth dark
(D)	Strip A and strip C are placed over slit I (in conjunction) and strip B is placed over slit II	(s)	Central bright

CODES :

	A	**B**	**C**	**D**
a)	r	r	s	p
b)	p	q	r	s
c)	q	r	s	p
d)	r	s	p	q

223. A monochromatic parallel beam of light of wavelength λ is incident normally on the plane containing slits S_1 and S_2. The slits are of unequal width such that intensity only due to one slit on screen is four times that only due to the other slit. The screen is placed along y-axis as shown in figure. The distance between slits is d and that between the screen and slits is D. Match the statements in Column I with results in Column II:

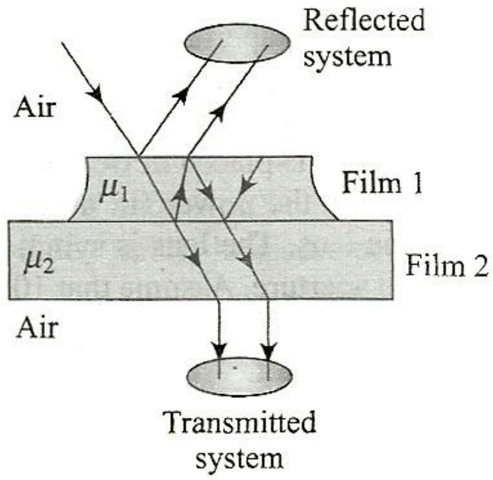


Column-I		Column- II	
(A)	The distance between two points on the screen having equal intensities, such that intensity at those points is $\frac{1}{9}$ th of maximum intensity	(p)	$\frac{D\lambda}{3d}$
(B)	The distance between two points on the screen having equal intensities, such that intensity at those points is $\frac{3}{9}$ th of maximum intensity	(q)	$\frac{D\lambda}{d}$
(C)	The distance between two points on the screen having equal intensities, such that intensity at those points is $\frac{5}{9}$ th of maximum intensity	(r)	$\frac{2D\lambda}{d}$
(D)	The distance between two points on the screen having equal intensities, such that intensity at those points is $\frac{7}{9}$ th of maximum intensity	(s)	$\frac{3D\lambda}{d}$

CODES :

	A	B	C	D
a)	P,q,r,s	q,r,s	p,q,r,s	q,r,s
b)	q,r,s	p,q,r,s	q,r,s	p,q,r,s
c)	p,q	s,r	p,r	q,s
d)	s,r	p,r	q,s	p,q

224. For the situation shown in figure, match the entries of Column I with Column II



Assume thickness of films to be very small compared to wavelength of incident light

Column-I	Column- II
(A) $\mu_1 = \mu_2$	(p) Film 1 appears shiny from the reflected system
(B) $\mu_1 > \mu_2$	(q) Film 1 appears dark from the reflected system
(C) $\mu_1 < \mu_2$	(r) Film 1 appears shiny from the transmitted system
(D) $\mu_1 \neq \mu_2$	(s) Film 1 appears dark from the transmitted system

CODES :

	A	B	C	D
a)	P,q	r,s	q,r	p,q
b)	r,s	q,r	p,q	p,q
c)	q,r	q,s	p,s	p,q,r,s
d)	q,s	p,s	p,q,r,s	q,r

225. If (μ_1, λ_1, v_1) and (μ_2, λ_2, v_2) are refractive indices, wavelengths and speeds of two light waves, respectively, then

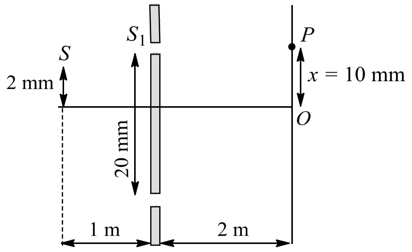
Column-I	Column- II
(A) $\mu_1 > \mu_2$	(p) $v_1 < v_2$
(B) $\mu_1 < \mu_2$	(q) $v_1 > v_2$
(C) $\mu_1 \neq \mu_2$	(r) $\lambda_1 = \lambda_2$

(D)	$\mu_1 = \mu_2$	(s)	$\lambda_1 < \lambda_2$

CODES :

	A	B	C	D
a)	q	p,q,s	r	p,q
b)	p,s	q	p,q,s	r
c)	p,s	r,q	s,r	r,s
d)	r,q	s,r	r,s	p,s

226. In Young's double-slit experiment, the point source S is placed slightly off the central axis as shown in figure. If $\lambda = 500$ nm, then match the following



	Column-I		Column- II
(A)	Nature and order of interference at the point $P, OP = 10$ mm	(p)	Bright fringe of order 80
(B)	Nature and order of interference at point O	(q)	Bright fringe of order 262
(C)	If a transparent paper (refractive index $\mu = 1.45$) of thickness $t = 0.02$ mm is pasted on S_1, i.e., one of the slits, the nature and order of the interference at P	(r)	Bright fringe of order 62
(D)	After inserting the transparent paper in front of slit S_1, the nature and order of interference at O	(s)	Bright fringe of order 280

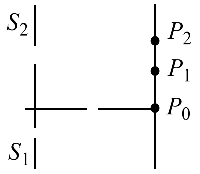
CODES :

	A	B	C	D
a)	q	r	s	p
b)	r	s	p	q
c)	s	p	q	r
d)	p	q	r	s

227. Column I shows four situations of standard Young's double slit arrangement with the screen placed far away from the slits S_1 and S_2. In each of these cases $S_1P_0 = S_2P_0$, $S_1P_1 - S_2P_1 = \lambda/4$ and $S_1P_2 - S_2P_2 = \lambda/3$, where λ is the wavelength of the light used. In the cases B, C and D, a transparent sheet of refractive index μ and thickness t is pasted on slit S_2. The thickness of the sheets are different in different cases. The phase difference between the light waves reaching a point P on the screen from the two slits is denoted by $\delta(P)$ and the intensity by $I(P)$. Match each situation given in Column I with the statement(s) in Column II valid for that situation

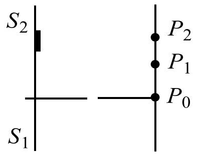
Column-I | **Column- II**

(A)



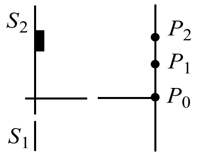
(p) $\delta(P_0) = 0$

(B) $(\mu - 1)t = \lambda/4$



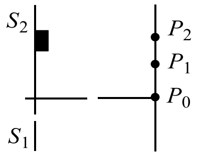
(q) $\delta(P_1) = 0$

(C) $(\mu - 1)t = \lambda/2$



(r) $I(P_1) = 0$

(D) $(\mu - 1)t = 3\lambda/4$



(s) $I(P_0) > I(P_1)$

(t) $I(P_2) > (P_1)$

CODES :

	A	**B**	**C**	**D**
a)	P,s	q	t	r,s,t
b)	q	t	r,s,t	p,s
c)	t	p,s	q	r,s,t
d)	r,s,t	q	p,s	t

Linked Comprehension Type

This section contain(s) 41 paragraph(s) and based upon each paragraph, multiple choice questions have to be answered. Each question has atleast 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 228 to -228

Wave property of electrons implies that they show diffraction from crystals. The law governing the diffraction from a crystal is obtained by requiring that electron waves reflected from the planes requiring that electron wave reflected from the planes of atoms in a crystal interfere constructively

228. Electrons accelerated potential V are diffracted from a crystal. If $d = 1$ Å and $i = 30°, V$ should be about $(h = 6.6 \times 10^{-34}$ Js, $m_e = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19} C$

a) 2000 V | b) 50 V | c) 500 V | d) 1000 V

Paragraph for Question Nos. 229 to - 229

The cell potential (E_{cell}) of a reaction is related as $\Delta G = -nFE_{\text{cell}}$, where ΔG represents maximum useful

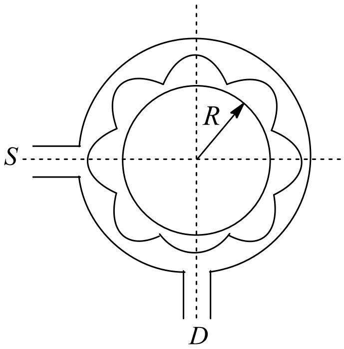
electronic work. $n =$ number of moles of electrons exchanged during the reaction for reversible cell reaction
$d(\Delta G) = (\Delta_r V)dp - (\Delta_r S) \cdot dT$
At constant pressure, $d(\Delta G) = -(\Delta_r S) \cdot dT$
$\because$At constant pressure, $\Delta G = \Delta H - T \cdot \Delta S$
$\therefore\ \Delta G = \Delta H + T\left(\frac{d\Delta G}{dT}\right)_p$

229. The light waves from two coherent sources are represented by $y_1 = a_1 \sin \omega t$ and $y_2 = a_2 \sin(\omega t + \pi/2)$ The resultant amplitude will be

a) a_1 b) a_2 c) $a_1 + a_2$ d) $\sqrt{a_1^2 + a_2^2}$

Paragraph for Question Nos. 230 to - 230

A narrow tube is bent in the form of a circle of radius R, as shown in figure. Two small holes S and D are made in the tube at the positions at right angle to each other. A source placed at S generates a wave of intensity I_0 which is equally divided into two parts: one part travels along the longer path, while the other travels along the shorter path. Both the waves meet at the point D where a detector is placed

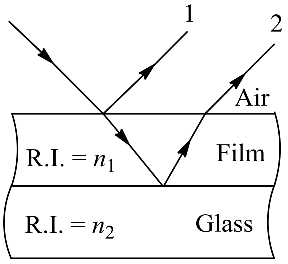


230. If a maxima is formed at a detector, then the magnitude of wavelength λ of the wave produced is given by

a) nR b) $\frac{nR}{2}$ c) $\frac{nR}{4}$ d) All of these

Paragraph for Question Nos. 231 to - 231

A thin film of a specific material can be used to decrease the intensity of reflected light. There is destructive interference of waves reflected from upper and lower surfaces of the film. These films are called non-reflecting or anti-reflection coatings. The process of coating the lens or surface with non-reflecting film is called blooming as shown in figure. The refracting index of coating (n_1) is less than half of the glass (n_2)

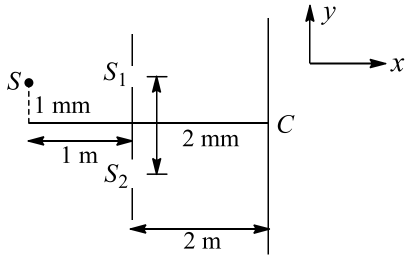


231. If a light of wavelength λ is incident normally and the thickness of film is 't', then optical path difference between waves reflected from upper and lower surface of the film is

a) $2n_1t$ b) $2n_1t - \frac{\lambda}{2}$ c) $2n_1t + \frac{\lambda}{2}$ d) $2t$

Paragraph for Question Nos. 232 to - 232

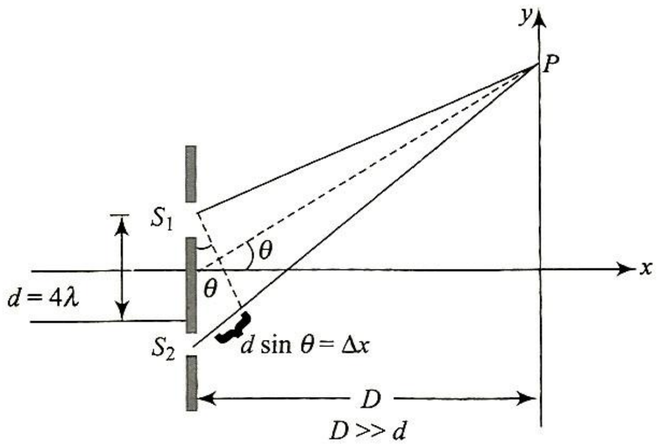
In a Young's double-slit experiment setup, source S of wavelength 6000 Å illuminates two slits S_1 and S_2 which act two coherent sources. The source S oscillates about its shown position according to the equation $y = 1 + \cos \pi t$, where y is in millimeter and t in second



232. At $t = 0$, fringe width is β_1, and at $t = 2$ s, fringe width of figure is β_2. Then,
a) $\beta_1 > \beta_2$ b) $\beta_2 > \beta_1$ c) $\beta_1 = \beta_2$ d) Data is insufficient

Paragraph for Question Nos. 233 to - 233

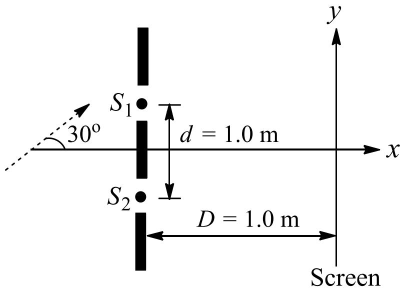
Two coherent sources emit light of wavelength λ. Separation between them, $d = 4\lambda$



233. If a detector moves along the y-axis, what is the maximum number of minima observed?
a) 6 b) 9 c) 5 d) 4

Paragraph for Question Nos. 234 to - 234

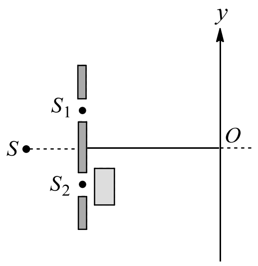
A coherent parallel beam of microwaves of wavelength $\lambda = 0.5$ mm falls on a Young's double-slit apparatus. The separation between the slits is 1.0 mm. The intensity of microwaves is measured on a screen placed parallel to the plane of the slits at a distance of 1.0 m from it as shown in figure



234. If the incident beam falls normally on the double-slit apparatus, find the order of the interference minima on the screen
   a) Only the first order minima are possible
   b) Only the first and second order minima are possible
   c) Total six minima appear on the screen
   d) Total eight minima appear on the screen

Paragraph for Question Nos. 235 to - 235

A YDSE is performed in a medium of refractive index 4/3. A light of 600 nm wavelength is falling on the slits having 0.45 nm separation. The lower slit S_2 is covered by a thin glass plate of thickness 10.4 nm and refractive index 1.5. The interference pattern is observed on a screen placed 1.5 m from the slits as shown in figure (All the wavelengths in this problem are for the given medium of refractive index 4/3, ignore absorption)



235. The location of the central maximum (bright fringe with zero path difference) on the y-axis will be
   a) 2.33 mm b) 4.33 mm c) 6.33 mm d) 4.43 mm

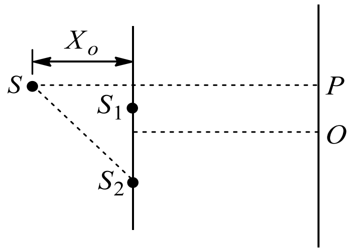
Paragraph for Question Nos. 236 to - 236

In a YDSE performed with light of wavelength 600 Å, the screen is placed 1 m from the slits. Fringes formed on the screen are observed by a student sitting close to the slits. The student's eye can distinguish two neighboring fringes. If they subtend an angle more than 1 minute of arc, then

236. In order to have the clear visibility of the fringe, the maximum distance that can be maintained between the slits is
   a) 3.06 mm b) 2.06 mm c) 1.31 mm d) 3.31 mm

Paragraph for Question Nos. 237 to - 237

In a modified YDSE, source S is kept in front of slit S_1. Find the phase difference at a point O that is equidistant from slits S_1 and S_2, and a point P that is in front of silt S_1 in the following situations

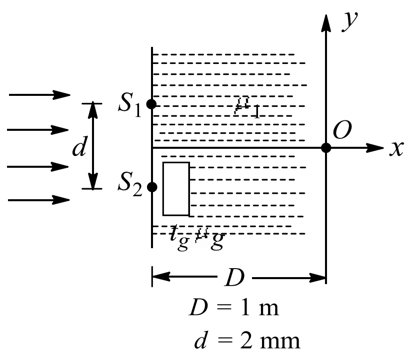


237. A liquid of refractive index μ is filled between the screen and slits

a) $\frac{2\pi}{\lambda}\left[\left[\sqrt{d^2+x_0^2}+x_0\right]+\frac{\mu d^2}{2D}\right]$
b) $\frac{2\pi}{\lambda}\left[\left[\sqrt{d^2+x_0^2}-x_0\right]+\frac{\mu d^2}{2D}\right]$
c) $\frac{2\pi}{\lambda}\left[\left[\sqrt{d^2-x_0^2}+x_0\right]+\frac{\mu d^2}{2D}\right]$
d) $\frac{2\pi}{\lambda}\left[\left[\sqrt{d^2-x_0^2}-x_0\right]+\frac{\mu d^2}{2D}\right]$

Paragraph for Question Nos. 238 to - 238

In a modified YDSE, the region between the screen and slits is immersed in a liquid whose refractive index varies with time as $\mu_1 = (5/2) - (T/4)$ until it reaches a steady state value of 5/4. A glass plate of thickness 36 μm and refractive index 3/2 is introduced in front of one of the slits



238. Find the time when central maxima is at point O, located symmetrically on the x-axis

a) 2 s
b) 4 s
c) 6 s
d) 8 s

Paragraph for Question Nos. 239 to - 239

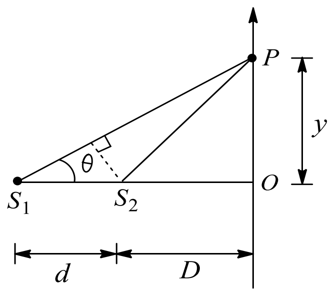
In a YDSE using monochromatic visible light, the distance between the plane of slits and the screen is 1.7 m. At a point (P) on the screen which is directly in front of the upper slit, maximum path is observed. Now, the screen is moved 50 cm closer to the plane of slits. Point P now lies between third and fourth minima above the central maxima and the intensity at P is one-fourth of the maximum intensity on the screen

239. Find the value of n

a) 4
b) 6
c) 2
d) 8

Paragraph for Question Nos. 240 to - 240

In figure, a screen is placed normal to the line joining the two point coherent sources S_1 and S_2. The interference pattern consists of concentric circles

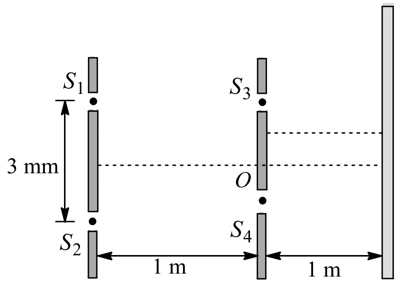


240. Find the radius of the nth bright ring

a) $D\sqrt{1\left(1-\frac{n\lambda}{d}\right)}$ b) $D\sqrt{2\left(1-\frac{n\lambda}{d}\right)}$ c) $2D\sqrt{2\left(1-\frac{n\lambda}{d}\right)}$ d) $D\sqrt{2\left(1-\frac{n\lambda}{2d}\right)}$

Paragraph for Question Nos. 241 to - 241

In the arrangement shown in figure, light of wavelength 6000 Å is incident on slits S_1 and S_2. Slits S_3 and S_4 have been opened such that S_3 is the position of first maximum above the central maximum and S_4 is the closest position where intensity is same as that of the light used, below the central maximum. The point O is equidistant from S_1 and S_2 and O' is equidistant from S_3 and S_4. The intensity of incident light is I_0

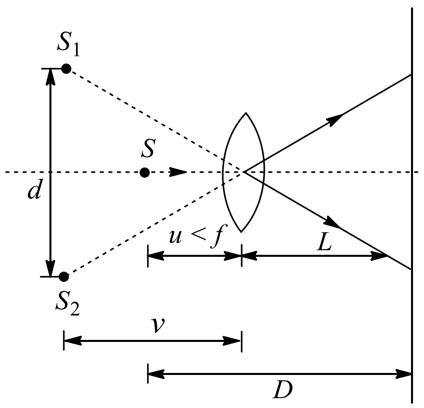


241. Find the intensity at O' (on the screen)

a) $4.5I_0$ b) $3I_0$ c) $2I_0$ d) $5I_0$

Paragraph for Question Nos. 242 to - 242

A lens of focal length f is cut along the diameter into two identical halves. In this process, a layer of the lens t in thickness is lost, then the halves are put together to form a composite lens. In between the focal plane and the composite lens, a narrow slit is placed near the focal plane. The slit is emitting monochromatic light with wavelength λ. Behind the lens, a screen is located at a distance L from it

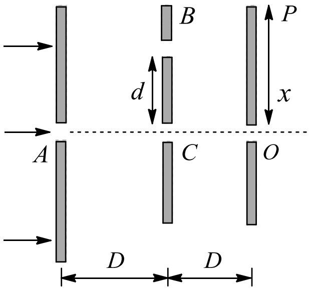


242. Find the fringe width for the pattern obtained under given arrangement on the screen

a) $\frac{\lambda f}{2t}$ b) $\frac{\lambda f}{t}$ c) $\frac{tf}{\lambda}$ d) $\frac{tf}{2\lambda}$

Paragraph for Question Nos. 243 to - 243

In the arrangement shown figure, $D \gg d$

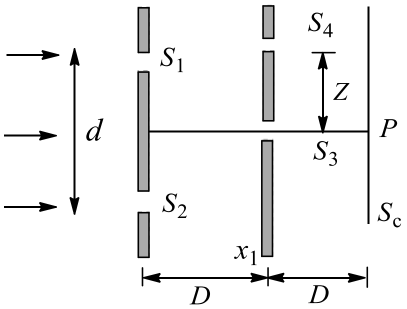


243. For what minimum value of d, is there a dark band at the point O on the screen

a) $\sqrt{\frac{D\lambda}{4}}$ b) $\sqrt{\frac{3D\lambda}{4}}$ c) $\sqrt{\frac{D\lambda}{8}}$ d) $\sqrt{\frac{2D\lambda}{3}}$

Paragraph for Question Nos. 244 to - 244

Consider the situation shown in figure. The two slits S_1 and S_2 placed symmetrically around the central line are illuminated by monochromatic light of wavelength λ. The separation between the slits is d. The light transmitted by the slits falls on a screen S_0 placed at a distance D from the slits. The slit S_3 is at the central line and the slit S_4 is at a distance z from S_3. Another screen S_c is placed a further distance D away from S_c. Find the ratio of the maximum to minimum intensity observed on S_c

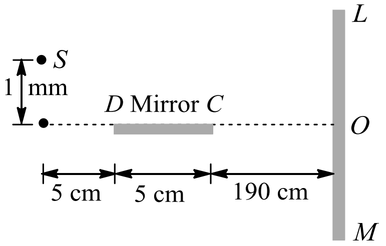


244. If $z = \frac{\lambda D}{2d}$

a) 1 b) 1/2 c) 3/2 d) 2

Paragraph for Question Nos. 245 to - 245

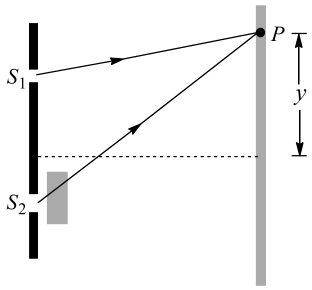
The arrangement for a mirror experiment is shown in figure. 'S' is a point source of frequency 6×10^{14} Hz. D and C represent the two ends of a mirror placed horizontally and LOM represents the screen



245. Determine the width of the region where the fringes will be visible
    a) 4 cm   b) 6 cm   c) 2 cm   d) 3 cm

Paragraph for Question Nos. 246 to - 246

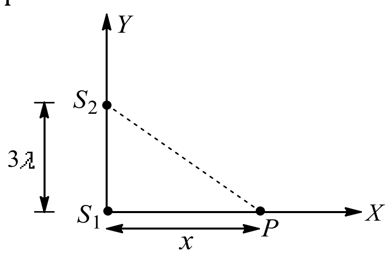
In Young's double-slit experiment setup with light of wavelength $\lambda = 6000$ Å, distance between the two slits is 2 mm and distance between the plane of slits and the screen is 2 m. The slits are of equal intensity. When a sheet of glass of refractive index 1.5 (which permits only a fraction η of the incident light to pass through) and thickness 8000 Å is placed in front of the lower slit, it is observed that the intensity at a point P, 0.15 mm above the central maxima, does not change



246. The phase difference at point P without inserting the slab is
    a) $3\pi/4$ b) $\pi/4$ c) $\pi/2$ d) $\pi/3$

Paragraph for Question Nos. 247 to - 247

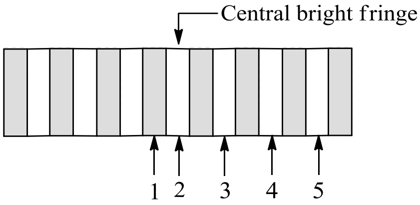
An interference is observed due to two coherent sources S_1 placed at origin and S_2 placed at $(0, 3l, 0)$. Here, λ is the wavelength of the sources. Both sources are having equal intensity I_0. A detector D is moved along the positive x-axis



247. Total number of black points observed by the observer on positive x-axis is
    a) Two   b) Four   c) Three   d) Five

Paragraph for Question Nos. 248 to - 248

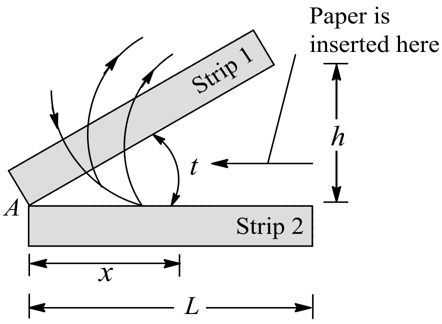
Figure shows the interference pattern obtained in a double-slit experiment using light of wavelength 600 nm. 1, 2, 3, 4 and 5 are marked on five fringes



248. The third-order bright fringe is
a) 2 b) 3 c) 4 d) 5

Paragraph for Question Nos. 249 to - 249

This interference film is used to measure the thickness of slides, paper, etc. The arrangement is as shown in figure

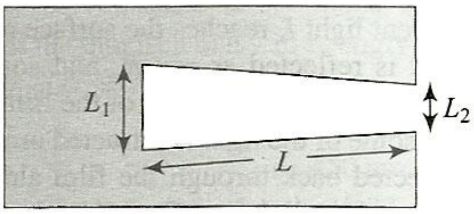


For the sake of clarity, the two strips are shown thick. Consider the wedge formed in between strips 1 and 2. If the interference pattern because of the two waves reflected from wedge surface is observed, then from the observed data we can compute thickness of paper, refractive index of the medium filled in wedge, number of bonds formed, etc
Consider the strips to be thick as compared to wavelength of light and light is incident normally
Neglect the effect due to reflection from top surface of strip 1 and bottom surface of strip 2. Take $L = 5$ cm and $\lambda_{\text{air}} = 40$ nm

249. Consider an air wedge is formed by two glass plates having refractive index 1.5 by placing a piece of paper of thickness 20 mm. Determine the number of dark bands formed
a) 1000 b) 500 c) 5000 d) 100

Paragraph for Question Nos. 250 to - 250

A block of plastic having a thin air cavity (whose thickness is comparable to wavelength of light waves) is shown in figure. The thickness of air cavity (which can be considered as air wedge for interference pattern) is varying linearly from one end to other as shown.
A broad beam of monochromatic light is incident normally from the top of the plastic box. Some light is reflected back from top and some from the bottom of cavity. The plastic layers above and below the cavity are having thickness much large than wavelength of incident light. An observer when looking down from top sees an interference pattern consisting of eight dark fringes and seven bright fringes along the wedge. Take wavelength of incident light in air as λ_0 and refractive index of plastic as μ



Front view of plastic box

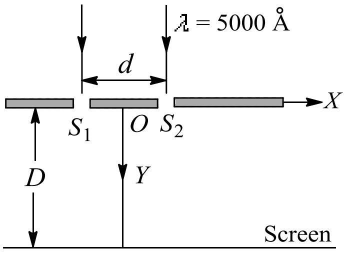
Assume that the thickness of the ends of air cavity are such that formation of fringes takes place there

250. Determine the difference $L_1 - L_2 (= \Delta L)$ in terms of λ_0

a) $\frac{4\lambda_0}{\mu}$ b) $\frac{7\lambda_0}{2\mu}$ c) $\frac{3\lambda_0}{\mu}$ d) None of the above

Paragraph for Question Nos. 251 to - 251

In figure, light of wavelength $\lambda = 5000$ Å is incident on the slits (in a horizontally fixed place)



Here, $d = 1$ mm and $D = 1$ m

Take origin at O and XY plane as shown in the figure. The screen is released from rest from the initial position as shown

251. The velocity of central maxima at $t = 5$ s is

a) 50 m s^{-1} along Y-axis b) 50 m s^{-1} along negative Y-axis
c) 25 m s^{-1} along Y-axis d) 3×10^8 m s^{-1} along Y-axis

Paragraph for Question Nos. 252 to - 252

When two coherent sources interact with each other there will be production of alternate bright and dark fringes on the screen. The Young's double-slit experiment demonstrates the idea of making two coherent sources. For better visibility, one has to choose proper amplitude for the sources. The phenomenon is good enough to satisfy the conservation of energy principle. The pattern formed in YDSE is of uniform thickness and is nicely placed on a long distance screen

252. Law of conservation of energy is satisfied because

a) Equal loss and gain in intensity is observed
b) All bright fringes are equally bright
c) All dark fringes are of zero brightness
d) The average intensity on screen is equal to the sum of intensities of the two sources

Paragraph for Question Nos. 253 to - 253

When a light wave passes from a rarer medium to a denser medium, there will be a phase change of π radians.

This difference brings change in the conditions for constructive and destructive interference. This phenomena also reasons the formation of interference pattern in thin films like, oily layer, soap film, etc., but has no reason on the shifting of fringes from the central portion outward. The shift is dependent on the refractive index of the material as per the relation, $\Delta y = (\mu - 1)t$

253. Thin film interference happens with
   a) Point or spherical source
   b) Broad source
   c) Film thickness of the order of 10,000 Å
   d) Very thick transparent slabs

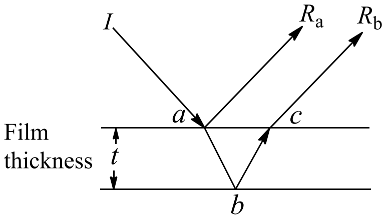
Paragraph for Question Nos. 254 to - 254

When light from two sources (say slits S_1 and S_2) interfere, they form alternate dark and bright fringes. Bright fringe is formed at all points where the path difference is an odd multiple of half wavelength. At the condition of equal amplitudes, $A_1 = A_2 = a$, the maximum intensity will be $4a^2$ and the visibility improves. The resultant intensity can also be indicated with phase factor as $I = 2a^2 \cos^2(\phi/2)$. Using this passage, answer the following questions

254. If the path difference between the slits S_1 and S_2 is $\frac{\lambda}{2}$, the central fringe will have an intensity of
   a) 0
   b) a^2
   c) $2a^2$
   d) $4a^2$

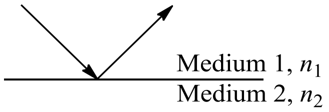
Paragraph for Question Nos. 255 to - 255

Thin films, including soap bubbles and oil show patterns of alternative dark and bright regions resulting from interference among the reflected light waves. If two waves are in phase, their crests and troughs will coincide. The interference will be constructive and the amplitude of resultant wave will be greater than either of constituent waves. If the two waves are out of phase by half a wavelength (180°), the crests of one wave will coincide with the troughs of the other wave. The interference will be destructive and the amplitude of the resultant wave will be less than that of either constituent wave
At the interference between two transparent media, some light is reflected and some light is refracted
1. When incident light I, reaches the surface at point a, some of the light is reflected as ray R_a and some is refracted following the path ab to the back of the film
2. At point b, some of the light is refracted out of the film and part is reflected back through the film along path bc. At point c, some of the light is reflected back into the film and part is reflected out of the film as ray R_c



R_a and R_c are parallel. However, R_c has travelled the extra distance within the film of abc. If the angle of incidence is small, then abc is approximately twice the film's thickness
If R_a and R_c are in phase, they will undergo constructive interference and the region ac will be bright. If R_a and R_c are out of phase, they will undergo destructive interference and the region ac will be dark
The thickness of the film and the refractive indices of the media at each interface determine the final phase relationship between R_a and R_c
1. Refraction at an interface never changes the phase of the wave
2. For reflection at the interface between two media 1 and 2, if $n_1 > n_2$, the reflected wave will change

phase. If $n_1 < n_2$, the reflected wave will not undergo a phase change



For reference, $n_{air} = 1.00$

3. If the waves are in phase after reflection at all interfaces, then the effects of path length in the film are:

Constructive interference occurs when $2t = m\lambda/n, m = 0, 1, 2, 3, ...$

Constructive interference occurs when $2t = \left(m + \frac{1}{2}\right)\frac{\lambda}{n}, m = 0, 1, 2, 3, ...$

If the waves are 180° out of the phase after reflection at all interfaces, then the effects of path length in the film are:

Constructive interference occurs when

$$2t = \left(m + \frac{1}{2}\right)\frac{\lambda}{n}, m = 0, 1, 2, 3, ...$$

Destructive interference occurs when

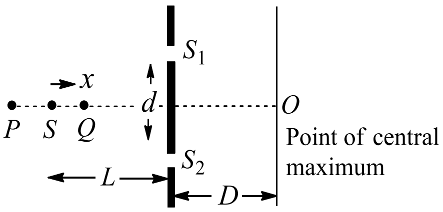
$$2t = \frac{m\lambda}{n}, m = 0, 1, 2, 3, ...$$

255. A thin film with index of refraction 1.50 coats a glass lens with index of refraction 1.80. What is the minimum thickness of the film that will strongly reflect light with wavelength 600 nm?

a) 150 nm　　b) 200 nm　　c) 300 nm　　d) 450 nm

Paragraph for Question Nos. 256 to - 256

In a YDSE set-up (see figure), the light source executes SHM between P and Q according to the equation $x = A \sin \omega t$, S being the mean position. Assume $d \to 0$ and $A \ll L$. ω is small enough to neglect Doppler effect. If the source were stationary at S, intensity at O would be I_0



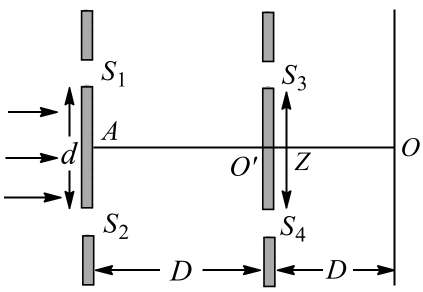
Read the paragraph carefully and answer the following questions

256. The fractional change in intensity of the central maximum as function of time is

a) $\frac{A \sin \omega t}{L}$　　b) $\frac{2A \sin \omega t}{L}$　　c) $\frac{3A \sin \omega t}{L}$　　d) $\frac{4A \sin \omega t}{L}$

Paragraph for Question Nos. 257 to - 257

In the arrangement shown in figure, slits S_1 and S_4 are having a variable separation Z. Point O on the screen is at the common perpendicular bisector of S_1S_2 and S_3S_4



257. When $Z = \frac{\lambda D}{2d}$, the intensity measured at O is I_0. The intensity at O when $Z = \frac{2\lambda D}{d}$ is

a) I_0 b) $2I_0$ c) $3I_0$ d) $4I_0$

Paragraph for Question Nos. 258 to - 258

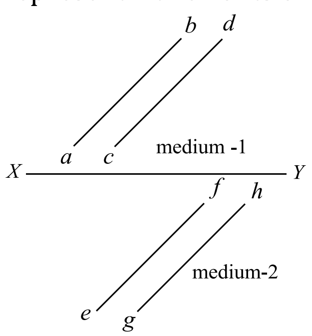
An initially parallel cylindrical beam travels in a medium of refractive index $\mu(I) = \mu_0 + \mu_2 I$, where μ_0 and μ_2 are positive constants and I is the intensity of the light beam. the intensity of the beam is decreasing with increasing radius

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

a) Planar
b) Convex
c) Concave
d) Convex near the axis and concave near the periphery

Paragraph for Question Nos. 259 to - 259

The figure shows a surface XY separating two transparent media, medium-1 and medium-2. The lines ab and cd represent wavefronts of a light wave travelling in medium-1 and incident on XY. The lines ef and gh represent wavefronts of the light wave in medium-2 after refraction



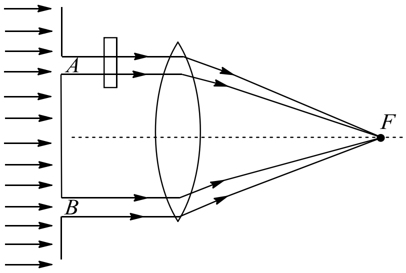
259. Speed of light is

a) The same in medium-1 and medium-2
b) Larger in medium-1 than in medium-2
c) Larger in medium-2 than in medium-1
d) Different at b and d

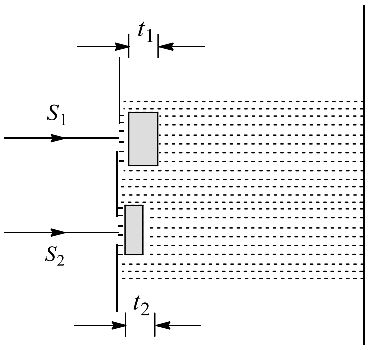
Integer Answer Type

260. A monochromatic light of $\lambda = 500$ Å is incident on two identical slits separated by a distance of 5×10^{-4}m. The interference pattern is seen on a screen placed at a distance of 1 m from the plane of slits. A thin glass plate of thickness 1.5×10^{-6}m and refractive index $\mu = 1.5$ is placed between one of the slits and the screen. Find the intensity at the centre of the slit now

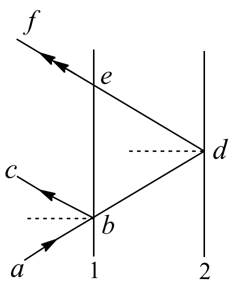
261. In a modified Young's double slit experiment, a monochromatic uniform and parallel beam of light of wavelength 6000 Å and intensity $(10/\pi)\text{Wm}^{-2}$ is incident normally on two circular apertures A and B of radii 0.001 m and 0.002 m, respectively. A perfectly transparent film of thickness 2000 Å and refractive index 1.5 for the wavelength of 6000 Å is placed in front of aperture A (see the figure). Calculate the power (in mW) received at the focal spot F of the lens. The lens is symmetrical placed with respect to the aperture. Assume that 10% of the power received by each aperture goes in the original direction and is brought to the focal spot



262. A glass of refractive index 1.5 is coated with a thin layer of thickness of t of refractive index 1.8. light of wavelength λ travelling in air is incident normally on the layer. It is partly reflected at the upper and the lower surfaces of the layer and the two reflected rays interfere. If $\lambda = 648$ nm, obtain the least value of t (in 10^{-8} m) for which the rays interfere constructively
263. A screen is at a distance $D = 80$ cm from a diaphragm having two narrow slits S_1 and S_2 which are $d = 2$ mm apart. Slit S_1 is covered by a transparent sheet of thickness $t_1 = 2.5$ μm and S_2 by another sheet of thickness $t_2 = 1.25$ μm as shown in the figure. Both sheets are made of same material having refractive index $\mu = 1.40$. Water is filled in space between diaphragm and screen. A monochromatic light beam of wavelength $\lambda = 5000$ Å is incident normally on the diaphragm. Assuming intensity of beam to be uniform, calculate ratio of intensity of centre of screen to intensity of individual slit, ($\mu_w = 4/3$)



264. A monochromatic beam of light of wavelength 5000 Å is used in Young's double slit experiment. If one of the slits is covered by a transparent sheet of thickness 1.4×10^{-5} m, having refractive index of its medium 1.25. Then the number of fringes shifted is
265. In a Young's double slit experiment $\lambda = 500$ nm, $d = 1$ mm, and $D = 4$ m. The minimum distance from the central maximum for which the intensity is half of the maximum intensity is '*' × 10^{-4} m. What is the value of '*'?
266. In YDSE find the thickness (in μm) of a glass slab ($\mu = 1.5$) which should be placed before the upper slit S_1 so that the central maximum now lies at a point where 5th bright fringe was lying earlier (before inserting the slab). Wavelength of light used is 5000 Å
267. A narrow monochromatic beam of light of intensity 1 is incident on a glass plate as shown in the figure. Another identical glass plate is kept close to the first one and parallel to it. Each glass plate reflects 25% of the light incident on it and transmits the remaining. Find the ratio $\sqrt{\frac{I_{\max}}{I_{\min}}}$ the interference pattern formed by two beams obtained after one reflection at each plate



: ANSWER KEY :

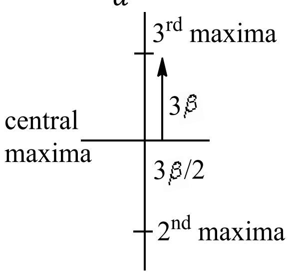
1)	b	2)	b	3)	a	4)	d		a,c,d						
5)	b	6)	b	7)	a	8)	a	21)	b,c	22)	b,d	23)	b	24)	
9)	b	10)	a	11)	c	12)	a		a,c,d						
13)	c	14)	a	15)	b	16)	d	25)	a,b,c	26)	b	27)	a,b,c,d	28)	
17)	b	18)	c	19)	a	20)	a		a,d						
21)	a	22)	c	23)	a	24)	d	29)	a,b	30)	a,c	31)	a,c	32)	
25)	d	26)	a	27)	d	28)	a		a,c						
29)	d	30)	a	31)	a	32)	a	33)	d	34)	a,c	1)	c	2)	d
33)	b	34)	c	35)	b	36)	b		3)	d	4)	a			
37)	d	38)	a	39)	a	40)	b	5)	c	6)	b	7)	a	8)	c
41)	a	42)	b	43)	c	44)	a	9)	c	10)	b	11)	a	12)	c
45)	c	46)	b	47)	a	48)	a	13)	c	14)	c	15)	c	16)	a
49)	b	50)	c	51)	d	52)	b	17)	b	18)	b	19)	a	20)	a
53)	d	54)	c	55)	b	56)	c	21)	c	22)	a	23)	d	24)	a
57)	d	58)	d	59)	c	60)	a	25)	b	26)	b	27)	a	28)	b
61)	a	62)	c	63)	d	64)	b	29)	a	30)	a	31)	a	32)	d
65)	a	66)	c	67)	b	68)	b	33)	b	34)	d	35)	a	36)	a
69)	a	70)	c	71)	b	72)	a	37)	b	38)	d	39)	d	40)	b
73)	b	74)	a	75)	c	76)	c	41)	d	42)	d	43)	e	44)	b
77)	a	78)	c	79)	b	80)	c	45)	c	46)	a	47)	a	48)	a
81)	c	82)	b	83)	b	84)	d	49)	e	50)	c	51)	b	52)	b
85)	b	86)	d	87)	d	88)	c	53)	d	54)	d	55)	c	56)	c
89)	d	90)	c	91)	d	92)	c	57)	a	58)	a	1)	a	2)	d
93)	c	94)	a	95)	b	96)	c		3)	a	4)	b			
97)	d	98)	b	99)	b	100)	b	5)	c	6)	b	7)	c	8)	a
101)	d	102)	a	103)	a	104)	a	1)	b	2)	d	3)	d	4)	a
105)	d	106)	c	107)	a	108)	c	5)	b	6)	b	7)	b	8)	b
109)	a	110)	c	111)	b	112)	a	9)	b	10)	b	11)	b	12)	c
113)	a	114)	d	115)	b	116)	c	13)	b	14)	b	15)	b	16)	a
117)	d	118)	c	119)	d	120)	b	17)	a	18)	c	19)	c	20)	b
121)	a	122)	a	123)	d	124)	c	21)	d	22)	b	23)	b	24)	a
125)	c	126)	b	127)	c	1)		25)	d	26)	b,c	27)	a	28)	b
	b,c	2)	a,c	3)	a,c	4)	a	29)	b	30)	b	31)	a	32)	b
5)	a,c	6)	b,d	7)	b,d	8)	b	1)	0	2)	7	3)	a	4)	3
9)	a,d	10)	a,b	11)	a	12)	c	5)	7	6)	5	7)	5	8)	7
13)	b,d	14)	b,d	15)	a,b,c	16)	c								
17)	a	18)	b,d	19)	c,d	20)									

: HINTS AND SOLUTIONS :

1 **(b)**
No fringes are observed as two independent sources are not coherent

2 **(b)**
For destructive reflection:
At $\theta_1 = 20°\text{C}, \frac{2\mu_1}{\mu_g} t_1 = n\lambda_1$ (i)
At $\theta_2 = 170°\text{C}, \frac{2\mu_1}{u_g} t_2 = n\lambda_2$ (ii)
$$\frac{t_2}{t_1} = \frac{\lambda_2}{\lambda_1}$$
$$\frac{t_1[1 + \alpha(\theta_2 - \theta_1)]}{t_1} = \frac{\lambda_2}{\lambda_1}$$
(α is the coefficient of linear expansion of the film)
$$\Rightarrow \ [1 + \alpha(170 - 20)] = \frac{606}{600}$$
or $\alpha = \frac{60}{600 \times 150} = 6.6 \times 10^{-5}°\text{C}^{-1}$

3 **(a)**
There is air on both sides of the soap film.
Therefore, the reflections of the light produces a net 180° phase shift
The condition for bright fringes is
$$2t = \left(m + \frac{1}{2}\right)\lambda_{\text{film}}$$
$$t = \frac{\left(m + \frac{1}{2}\right)\lambda_{\text{film}}}{2} = \frac{\left(m + \frac{1}{2}\right)\lambda}{2n}$$
$$= \frac{\left(\frac{1}{2}\right)(650 \times 10^{-9}\text{ m})}{2(1.41)} = 1.2 \times 10^{-7}\text{ m}$$

4 **(d)**
$d = 0.5$ mm and $D = 0.5$ m
Separation $= 3\beta + 1.5\beta = 4.5\beta$
$$= 4.5 \times \frac{\lambda D}{d} = 2.22\text{ mm}$$


5 **(b)**
$$n_1\left(\frac{\lambda_1 D}{d}\right) = n_2\left(\frac{\lambda_2 D}{d}\right)$$
$\Rightarrow n_1\lambda_1 = n_2\lambda_2$
$\Rightarrow (12)(600) = n_2(400)$
$\Rightarrow n_2 = 18$

6 **(b)**
For constructive interference,
$d\sin\theta = n\lambda$
$(\sin\theta)_{\max} = 1$
$$n_{\max} = \frac{d}{\lambda} = \frac{0.012 \times 10^{-3}}{650 \times 10^{-9}} = 18.46$$
Therefore, total number of bright fringes including the central fringe is $18 + 18 + 1 = 37$

7 **(a)**
$$y_n(\max) = n\frac{D\lambda}{d}$$
Here, $y_n(\max) = d/2$
So, $n\frac{D\lambda}{d} = \frac{d}{2}$ or $n = \frac{d^2}{2\lambda D}$

8 **(a)**
$$y_1 = 3\left(\frac{\lambda_1 D}{d}\right) \text{ and } y_2 = 4\left(\frac{\lambda_2 D}{d}\right)$$
Since both fall at the same location, so
$y_1 = y_2$
$$\frac{\lambda_1}{\lambda_2} = \frac{4}{3}$$

9 **(b)**
For maximum intensity on the screen,
$d\sin\theta = n\lambda$
Or $\sin\theta = \frac{n\lambda}{d}$
$$= \frac{(n)(2000)}{(7000)} = \frac{n}{35}$$
$\sin\theta \geq 1 \ \Rightarrow \ n = 0, 1, 2, 3$ only
Thus, only seven maxima can be obtained on both sides of the screen

10 **(a)**
Path difference, $\Delta x = \frac{yd}{D}$
Here, $y = \frac{5\lambda}{2}$
and $D = 10d = 50\lambda$ (as $d = 5\lambda$)
So, $\Delta x = \left(\frac{5\lambda}{2}\right)\left(\frac{5\lambda}{50\lambda}\right) = \frac{\lambda}{4}$
Corresponding phase difference will be
$$\phi = \left(\frac{2\pi}{\lambda}\right)(\Delta x) = \left(\frac{2\pi}{\lambda}\right)\left(\frac{\lambda}{4}\right) = \frac{\pi}{2}$$
Or $\frac{\phi}{2} = \frac{\pi}{4}$
$$\therefore I = I_0\cos^2\left(\frac{\phi}{2}\right)$$
$$= I_0\cos^2\left(\frac{\pi}{4}\right) = \frac{I_0}{2}$$

11 **(c)**
Path difference $= (\mu_2 - \mu_1)t = 12480$ Å
For maxima,
$n\lambda = 12480$ Å
$\lambda_1 = 12480$ Å
$\lambda_2 = 6240$ Å
$\lambda_3 = 4160$ Å
$\lambda_4 = 3120$ Å
Therefore, only 6240 Å and 4160 Å exist in the spectrum

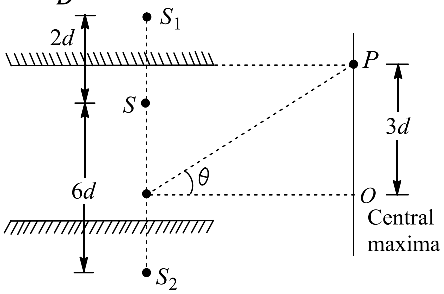
12 **(a)**

At P, $\Delta x = \frac{(8d)\times 3d}{D}$

For 2nd maxima,

$\Delta x = 2\lambda$

$\Rightarrow \frac{24d^2}{D} = 2\lambda$



$\Rightarrow \lambda = \frac{12d^2}{D}$

13 **(c)**

As velocity (or momentum) of electron is increased, the wavelength $\left(\lambda = \frac{h}{p}\right)$ will decrease.

Hence, fringe width will decrease ($\omega \propto \lambda$)

14 **(a)**

Detector receives both the direct as well as the reflected waves. Distance between two consecutive maxima $= \lambda/2$

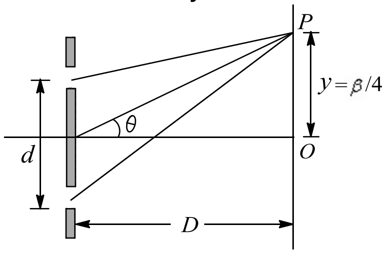
For 14 maxima, distance $= 14 \times \frac{\lambda}{2} = 0.14$ m

$\therefore \lambda = 0.02$ m

$v = \frac{c}{\lambda} = \frac{3\times 10^8}{0.02} = 1.5 \times 10^{10}$ Hz

15 **(b)**

Let the intensity of individual waves be I. Then



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

At P,

$\Delta x = d\sin\theta$

$\Rightarrow \Delta x = d\sin\theta = \frac{dy}{D}$

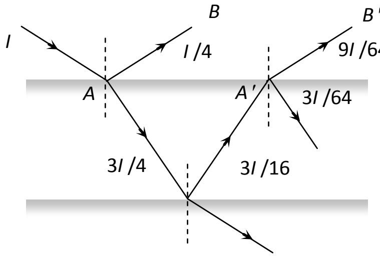
$\Rightarrow \Delta x = \frac{d}{D}\times\frac{\beta}{4} = \frac{d}{D}\times\frac{\lambda D}{4d} = \frac{\lambda}{4}$

$\therefore \Delta\phi = \frac{2\pi}{\lambda}\times\frac{\pi}{4} = \frac{\pi}{2} \quad [\Delta\phi = k\,\Delta x]$

$I' = I + I + 2\sqrt{I^2}\cos\frac{\pi}{2} = 2I = \frac{I_0}{2}$

16 **(d)**

From figure $I_1 = \frac{I}{4}$ and $I_2 = \frac{9I}{64} \Rightarrow \frac{I_2}{I_1} = \frac{9}{16}$



By using $\frac{I_{\max}}{I_{\min}} = \left(\frac{\sqrt{\frac{I_2}{I_1}}+1}{\sqrt{\frac{I_2}{I_1}}-1}\right)^2 = \left(\frac{\sqrt{\frac{9}{16}}+1}{\sqrt{\frac{9}{16}}-1}\right)^2 = \frac{49}{1}$

17 **(b)**

Angular separation is λ/d

For angular separation to be 10% greater, λ should be 10% greater

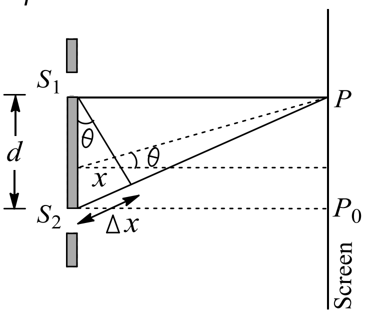
$\therefore$ New wavelength $= \left(589 + \frac{589}{10}\right)$ nm

$= (589 + 58.9)$nm $= 647.9$ nm (≈ 648 nm)

18 **(c)**

$\Delta x = d\sin\theta = \frac{\lambda}{8}\sin\theta$

$\Delta\phi$ = Phase difference at P



$\Delta\phi = \frac{2\pi}{\lambda}(\Delta x) + \Delta\phi' = \frac{2\pi}{\lambda}\left(\frac{\lambda}{8}\sin\theta\right) + \frac{\pi}{4}$

$\Delta\phi = \frac{\pi}{4}(1+\sin\theta)$

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

$= 4I_0\cos^2\left[\frac{\pi}{8}(1+\sin\theta)\right]$

19 **(a)**

When slits of equal width are taken, then intensity at maxima is $4a^2$ and at minima it is zero ($I \propto w$)

When one slit is doubled, then intensity at maxima will increase whereas intensity at minima will not equal to zero and will be finite

20 **(a)**

The experimental set-up is in a liquid, therefore the wavelength of light will change

$\lambda_{\text{liquid}} = \frac{\lambda_{\text{air}}}{\mu} = \frac{6300}{1.33} = \frac{6300\times 10^{-10}}{1.33}$ m

Fringe width,

$\beta = \frac{\lambda_{\text{liquid}} D}{d} = \frac{\lambda_{\text{air}} D}{\mu d} = \frac{6300\times 10^{-10}}{1.33}\times\frac{1.33}{10^{-3}}$

$= 6.3\times 10^{-4}$m

21 **(a)**

According to the question,

Shift = 5 fringe widths

$$\Rightarrow \frac{(\mu-1)tD}{d} = \frac{5\lambda D}{d}$$
$$\therefore t = \frac{5\lambda}{\mu-1} = \frac{25000}{1.5-1} = 50{,}000 \text{ Å}$$

22 **(c)**

The maxima is this case is obtained whenever
$$x_{\text{cm}} = \frac{n\lambda D}{d}$$
We can write for first wavelength,
$$(x_4)\lambda_1 = \frac{4\lambda_1 D}{d}$$
This must be equal to $(x_3)\lambda_2 = \frac{3\lambda_2 D}{d}$, since
$(x_4)\lambda_1 = (x_3)\lambda_2$
$$\therefore \frac{4\lambda_1 D}{d} = 3\lambda_2 \frac{D}{d} \Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{3}{4}$$
Hence, when both wavelengths are incident simultaneously, the maxima due to two will coincide at a point where the fourth maxima due to λ_1 occurred. This point will have maximum intensity and intensity will not be zero at any point

23 **(a)**

There are three and a half fringes from first maxima to fifth minima as shown
$$\beta = \frac{7 \text{ mm}}{3.5} = 2 \text{ mm} \Rightarrow \lambda = \frac{\beta D}{d} = 600 \text{ nm}$$

24 **(d)**
$$\beta_w = \frac{\lambda D}{\mu d}$$
We need to increase $\beta \Rightarrow D$ increases; d decreases

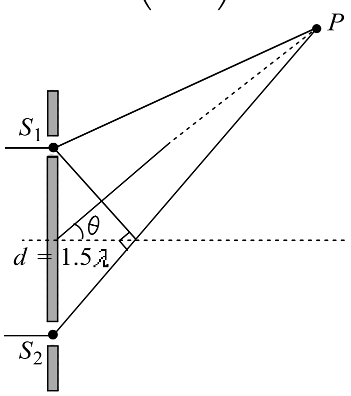
25 **(d)**

The contrast between bright and dark fringes is determined by intensity ratio

26 **(a)**

$\delta =$ phase difference between the waves from S_1 and S_2 at $P = \frac{\pi}{2} - \frac{2\pi}{2}(d \sin\theta)$

For maximum intensity at P, $\delta = n\pi$, where $n = 0, \pm1, \pm2, \dots$
$$\therefore \frac{2\pi}{2}(1.5\lambda \sin\theta)\frac{\pi}{2} = n\pi$$
$$\Rightarrow n - \frac{1}{2} = 3\sin\theta$$
$$\Rightarrow \sin\theta = \left(\frac{n-\frac{1}{2}}{3}\right)$$



For $n = 0$, $\sin\theta = -\frac{1}{6}$

For $n = \pm1, \sin\theta = \frac{1}{6}, -\frac{1}{2}$

For $n = \pm2, \sin\theta = \frac{1}{2}, -\frac{5}{6}$

27 **(d)**

Path difference $= d\sin\phi + d\sin\theta$

For maxima, $\Delta x = m\lambda$
$$\Rightarrow \sin\phi + \sin\theta = \frac{m\lambda}{d}$$

28 **(a)**
$$I = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$$
$$\Rightarrow I_0 = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$$
$$\Rightarrow \cos\left(\frac{\phi}{2}\right) = \frac{1}{2}$$
Or $\frac{\phi}{2} = \frac{\pi}{3}$

Or $\phi = \frac{2\pi}{3} = \left(\frac{2\pi}{\lambda}\right)\Delta x$

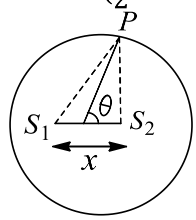
Or $\frac{1}{3} = \left(\frac{1}{\lambda}\right) y \frac{d}{D} \left(\Delta x = \frac{yd}{D}\right)$
$$\therefore y = \frac{\lambda}{3 \times \frac{d}{D}} = \frac{6 \times 10^{-7}}{3 \times 10^{-4}}$$
$= 2 \times 10^{-3}$ m $= 2$ mm

29 **(d)**

Distance between the first dark fringes on either side of central maxima = width of central maxima
$$= \frac{2\lambda D}{d} = \frac{2 \times 600 \times 10^{-9} \times 2}{1 \times 10^{-3}} = 2.4\, mm$$

30 **(a)**

Path difference at P is
$$\Delta x = 2\left(\frac{x}{2}\cos\theta\right) = x\cos\theta$$



For intensity to be maximum,

$\Delta x = n\lambda \quad (n = 0, 1, 2, 3, \dots)$

Or $x\cos\theta = n\lambda$

Or $\cos\theta = \frac{n\lambda}{x} \geq 1$
$$\therefore n \geq \frac{x}{\lambda}$$
Subtracting $x = 5\lambda$, we get

$n \geq 5$ or $n = 1, 2, 3, 4, 5, \dots$

Therefore, in all four quadrants there can be 20 maxima. There are more maxima at $\theta = 0°$ and $\theta = 180°$. But $n = 5$ corresponds to $\theta = 90°$ and $\theta = 270°$ which are coming only twice while we have multiplied it four times. Therefore, total number of maxima are still 20, i.e., $n = 1$ to 4 in four quadrants (total 16) plus more at $\theta = 0°, 90°, 180°$ and $270°$

31 **(a)**

Condition for observing bright fringe is

$$2nd = \left(m + \frac{1}{2}\right)\lambda$$

$$\therefore\ \lambda = \frac{2nd}{\left(m + \frac{1}{2}\right)} = \frac{2 \times 1.5 \times 4 \times 10^{-5}}{m + \frac{1}{2}}$$

$$= \frac{12 \times 10^{-5}}{m + \frac{1}{2}}$$

The integer m that gives the wavelength in the visible region (4000 Å to 7000 Å) is $m = 2$. In that case,

$$\lambda = \frac{12 \times 10^{-5}}{2 + \frac{1}{2}} = 4.8 \times 10^{-5} = 4800\ \text{Å}$$

32 **(a)**

$$\beta = \frac{D\lambda}{d} = \frac{f\lambda}{d} = \frac{1 \times 4890 \times 10^{-10}}{0.2 \times 10^{-3}}$$

$= 0.29 \times 10^{-2}\text{m} = 2.9\ \text{mm} \approx 3\ \text{mm}$

33 **(b)**

$$v = \frac{c\Delta\lambda}{\lambda} = \frac{3 \times 10^8 \times (706 - 656)}{656} = \frac{1500}{656} \times 10^7$$

$= 2 \times 10^7 m/s$

34 **(c)**

There can be three minima from central point to ∞ corresponding to $\frac{\lambda}{3}, \frac{3\lambda}{2}, \frac{5\lambda}{2}$ path differences

Therefore, total number of minima $= 2n_{\text{max}} = 6$

35 **(b)**

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

Here,

$I_1 = I$ and $I_2 = 4I$

At point A,

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

$\therefore I_A = I + 4I = 5I$

At point B,

$\phi = \pi$

$\therefore I_B = I + 4I - 4I = I$

$\therefore I_A - I_B = 4I$

36 **(b)**

Angular width $= \frac{\lambda}{d} = 10^{-3}$ (given)

No. of fringes width 0.12° will be

$$n = \frac{0.12 \times 2\pi}{360 \times 10^{-3}} \cong [2.09]$$

The number of bright spots will be three

37 **(d)**

The path difference introduced due to introduction of transparent sheet is given by $\Delta x = (m - 1)t$

If the central maxima occupies position of nth fringe, then

$(\mu - 1)t = n\lambda = d\sin\theta$

$$\Rightarrow \sin\theta = \frac{(\mu - 1)t}{d} = \frac{(1.17 - 1) \times 1.5 \times 10^{-7}}{3 \times 10^{-7}}$$

$= 0.085$

Hence, the angular position of central maxima is $\theta = \sin^{-1}(0.085) = 4.88°$

For small angles,

$\sin\theta = \theta = \tan\theta$

$$\Rightarrow \tan\theta = \frac{y}{D}$$

$$\therefore \frac{y}{D} = \frac{(\mu - 1)t}{d}$$

Shift of central maxima is

$$y = \frac{D(\mu - 1)t}{d}$$

This formula can be used if D is given

38 **(a)**

$y_9 =$ Position of 9th bright fringe $= 9\left(\frac{\lambda D}{d}\right)$

$y_2 =$ Position of 2nd dark fringe $= \left(2 - \frac{1}{2}\right)\frac{\lambda D}{d} = \frac{3}{2}\frac{\lambda D}{d}$

$$y_9 - y_2 = 7.5\ \text{mm} \Rightarrow \frac{\lambda D}{d}\left(9 - \frac{3}{2}\right) = 7.5 \times 10^{-3}$$

$$\therefore\ \lambda = (7.5 \times 10^{-3})\left(\frac{2}{15}\right)\left(\frac{0.5 \times 10^{-3}}{100 \times 10^{-2}}\right)$$

$$= (75)\left(\frac{2}{15}\right)(5)(10^{-4-4}) = 50 \times 10^{-8}\ \text{m}$$

$= 5000$ Å

39 **(a)**

$$y = \frac{d}{2} = \frac{2(n-1)D\lambda}{2d}$$

$$\Rightarrow\ \lambda = \frac{d^2}{D(n-1)}, n = 1, 2, 3$$

40 **(b)**

Difference wavelengths would correspond to different frequencies. Lights of different intensities can give coherence even if contrast is poor

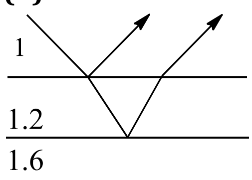
41 **(a)**

$$\mu = \frac{c}{v} = \frac{v\lambda}{v\lambda'}$$

$$\frac{3}{2} = \frac{\lambda}{\lambda'} \text{ or } \lambda' = \frac{2\lambda}{3}$$

Note that the frequency remains unchanged

42 **(b)**



$$2\mu t = n\lambda \Rightarrow t = \frac{n\lambda}{2\mu}$$

$$\Rightarrow\ t = \frac{\lambda}{2\mu} = 200\ \text{nm}$$

43 **(c)**

$I = I_0 \sin^2\theta$

Differentiating I with respect to θ,

$$\frac{dI}{d\theta} = 2I_0 \sin\theta\cos\theta$$

$$\frac{dI}{I} = \frac{2I_0 \sin\theta\cos\theta\, d\theta}{I_0 \sin^2\theta} = 2\cos\theta\, d\theta$$

Percentage error in angle is

$$\frac{d\theta}{\theta}\times 100=\left(\frac{dI}{2I\cos\theta}\right)\frac{1}{\theta}\times 100$$
$$=\frac{0.002}{2\times 5\cos 30°}\times\frac{6\times 100}{\pi}$$
$$=\frac{4}{\pi}\sqrt{3}\times 10^{-2}\%$$

44 **(a)**

As a bright fringe is formed in front of slit, therefore $d/2$ =integral multiple of fringe width

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

45 **(c)**

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

From given information,

$$I_{\max}=\frac{105}{100}I$$
$$I_{\min}=\left(\frac{95}{100}\right)I$$

Where $I=I_1+I_2$ is average intensity

$$\therefore\frac{I_{\max}}{I_{\min}}=\frac{105}{95}=\left(\frac{1+\sqrt{\frac{I_2}{I_1}}}{1-\sqrt{\frac{I_2}{I_1}}}\right)^2$$
$$\Rightarrow\sqrt{\frac{I_1}{I_2}}=0.0244$$
$$\Rightarrow\frac{I_1}{I_2}=1681$$

46 **(b)**

Velocity of light is perpendicular to the wavefront

47 **(a)**

When mica sheet of thickness t and refractive index μ is introduced in the path of one of the interferring beams, optical path increases by $(\mu-1)t$. Therefore, the shift on the screen is given by

$y_0=\frac{D}{d}(\mu-1)t$ (i)

When the distance between the plane of slits and screen is changed from D to $2D$, then

$\beta=\frac{2D}{d}\lambda$ (ii)

$$\therefore\frac{D}{d}(\mu-1)t=\frac{2D(\lambda)}{d}\Rightarrow\lambda=\frac{1}{2}(\mu-1)t$$

48 **(a)**

$$\frac{(d/2)}{D}=\frac{\theta}{2}\Rightarrow\theta=\frac{d}{D}\text{ and }\beta=\frac{D\lambda}{d}=\frac{\lambda}{\theta}$$

49 **(b)**

When slits are of unequal width, the intensity of sources S_1 and S_2 is not equal. So, position of minimum intensity will not be completely dark

50 **(c)**

A slit would give divergent; a biprism would give double; a glass slab would give a parallel wavefront. Edge is downward

51 **(d)**

$I=I_1+I_2+2\sqrt{I_1I_2}\cos\Delta\phi$

Here $I_1=I_0$

$I_2=I_0/2$

For maximum intensity, $\cos\Delta\phi=1$

For minimum intensity, $\cos\Delta\phi=-1$

Before painting,

$I=I_2=I_0, I_{\max}=4I_0, I_{\min}=0$

After painting,

$$I_1=I_0, I_{\max}=\left(\frac{3+2\sqrt{2}}{2}\right)I_0<4I_0$$
$$I_2=\frac{I_0}{2}, I_{\min}=\left(\frac{3-2\sqrt{2}}{2}\right)I_0>0$$

52 **(b)**

Ray N undergoes reflection at surface II with phase change of π

$\Rightarrow n_3>n_2$

Ray Q undergoes a phase change of π at surface II, but there is no phase change when it is reflected from surface I

$\Rightarrow n_1<n_2$

53 **(d)**

$\Delta x=(\mu_A-1)t_A-(\mu_B-1)t_B$

$=\mu_At_A-\mu_Bt_B-t_B+t_B$

$=t_B-t_A$

If $\Delta x>0$, the fringe pattern will shift upward

If $\Delta x<0$, the fringe pattern will shift downward

54 **(c)**

Fringe width, $\beta\propto\lambda$. Therefore, λ and hence β will decrease 1.5 times when immersed in the liquid. The distance between central maxima and 10th maxima is 3 cm in vacuum. When immersed in the liquid, it will reduce to 2 cm. Position of central maxima will not change while 10th maxima will be obtained at $y=4$ cm

55 **(b)**

$PR=d$

$PO=d\sec\theta$

And $CO=PO\cot 2\theta=d\sec\theta\cos 2\theta$

Path difference between the two rays is,

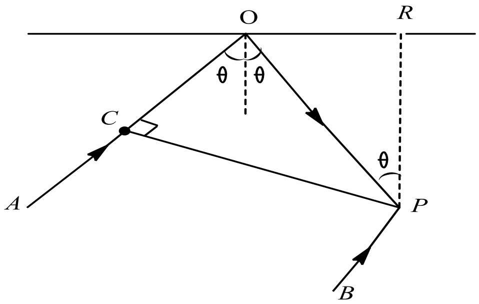
$\Delta x=CO+PO$

$=(d\sec\theta+d\sec\theta\cos 2\theta)$

Phase difference between the two rays is

$\Delta\phi=\pi$ (one is reflected, while another is direct)

Therefore condition for constructive interference should be



$$\Delta x = \frac{\lambda}{2}, \frac{3\lambda}{2} \dots$$

Or $d \sec\theta\,(1+\cos 2\theta) = \frac{\lambda}{2}$

Or $\left(\frac{d}{\cos\theta}\right)(2\cos^2\theta) = \frac{\lambda}{2}$

Or $\cos\theta = \frac{\lambda}{4d}$

56 **(c)**

$I_{\text{max}} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = \left(\sqrt{I} + \sqrt{4I}\right)^2 = 9I$

$I_{\text{min}} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2 = \left(\sqrt{I} - \sqrt{4I}\right)^2 = I$

57 **(d)**

$\beta = \frac{\lambda D}{d} \Rightarrow$ If D becomes twice and d becomes half so β becomes four times

58 **(d)**

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

$\overrightarrow{VIBGYOR}\lambda$ increases

$\lambda_R > \lambda_G > \lambda_B$

So $\beta_R > \beta_G > \beta_B$

59 **(c)**

For 100th maximum,

$d \sin\theta = 100\,\lambda$

$$\Rightarrow \sin\theta = \frac{100 \times 500 \times 10^{-9}}{1 \times 10^{-3}} = \frac{5 \times 10^{-4}}{10^{-3}} = 0.5 = \frac{1}{2}$$

$$\therefore y = D\tan\theta = 1 \times \tan 30 = \frac{1}{\sqrt{3}}$$

60 **(a)**

$\beta = 0.03$ cm, $D = 1$ m $=100$ cm

Distance between image of the source $= 0.8$ cm

Distance of image from lens, $v = 80$ cm

Distance of slit from lens $= u$

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{60} + \frac{1}{u} = \frac{1}{16} \Rightarrow u = 20\text{cm}$$

Magnification $= \frac{v}{u} = \frac{80}{20} = 4$

Magnification $= \frac{\text{distnaces between images of slits}}{\text{distance between slits}}$

$$= \frac{0.8}{d} = \frac{0.8}{d} = 4$$

$$\Rightarrow d = 0.2 \text{ cm} \Rightarrow \beta = \frac{D\lambda}{d} = \frac{100\lambda}{2} = 0.03$$

$\Rightarrow \lambda = 6000$ Å

61 **(a)**

Consider light to be incident at near normal incidence. We wish to cause destructive interference between rays r_1 and r_2 so that maximum energy passes into the glass. A phase change of $\lambda/2$ occurs in each ray because at both the upper and lower surfaces of the MgF_2 film the light is reflected by a medium of greater index of refraction. When striking a medium of lower index of refraction, the light is reflected with no phase change. Since in this problem both rays 1 and 2 experience the same phase shift, no net change of phase is introduced by these two reflections. Hence, the only way a phase change can occur is if the two rays travel through different optical path lengths. The optical path length is the product of the geometric path difference a ray travels through different media and the refractive index of the medium in which it is travelling. For destructive interference, the two rays must be out of phase by an odd number of half wavelengths. Hence, the optical path difference needed for destructive interference is

$$2\mu d = (2n+1)\frac{\lambda}{2}, n = 0, 1, 2, \dots$$

Note that $2\mu d$ is the total optical path length that the rays traverse when $n = 0$

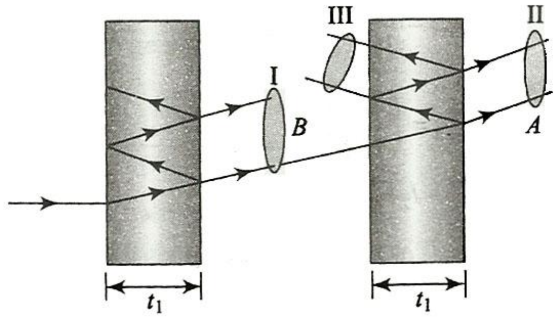
$$\therefore d = \frac{\lambda/2}{2\mu} = \frac{\lambda}{4\mu} = \frac{350 \times 10^{-9}}{4 \times 1.38} = 100 \text{ nm} = 1 \times 10^{-7}\text{m}$$

62 **(c)**

Effective path difference is $\mu_1 L_1 - \mu_2 L_2$

63 **(d)**

Path difference between waves of



I is $\rightarrow 2\mu t_1$

II is $\rightarrow 2\mu t_2$

III is $\rightarrow 2\mu t_3$

System I is used to observe film 1 from A, system II is used to observe film 2 from B, and system III is used to observe film 2 from A. It is given that $2\mu t_2 =$ odd multiple of $\lambda/2$, i.e., dark. So, from A film 2 appears dark while for I, relation between t_1 and t_2 has to be known

64 **(b)**

$\Delta x =$path difference between two light waves

$= [n_1L_1 + L_2 - L_1] - [n_2L_2]$
$\Delta\phi$ = phase difference between two waves
For longest wavelengths, $\Delta\phi$ is the smallest
For constructive interference, $\Delta\phi = 2\pi$
$l_{\max} = n_1L_1 - n_2L_2 + (L_2 - L_1)$
$= (1.7)(3.5 \times 10^{-6}) - (1.25)(5.0 \times 10^{-6}) + (5.0 - 3.5) \times 10^{-6}$
$= (5.95 - 6.25 + 1.5) \times 10^{-6} = 1.25 \times 10^{-6}$ m
$= 1.2$ μm

65 **(a)**
If after placing the plate, intensity at the position of central maxima position remains unchanged, then it means first maxima takes position of central maxima. In case of minimum thickness of plate 2, path difference created by the plate should be equal to λ
i.e., $t(\mu - 1) = \lambda$
$$t\left(\frac{3}{2} - 1\right) = \lambda \Rightarrow t = 2\lambda$$

66 **(c)**
Here, direction of light is given by normal vector $\vec{n} = \hat{\imath} + 2\hat{\jmath} + 3\hat{k}$
∴ Angle made by the $\vec{n}$ with y-axis is given by cos
$$\beta = \frac{2}{\sqrt{1^2 + 2^2 + 3^2}} = \frac{2}{\sqrt{14}}$$

67 **(b)**
When light passes through a medium of refractive index μ, the optical path it travels is μt
Path difference $= (\mu\ell + b) - (\ell + b) = (\mu - 1)\ell$
For a small element 'dx', path difference,
$\Delta x = [(1 + ax) - 1]dx = axdx$
For the whole length,
$$\Delta x = \int_0^\ell ax\,dx = \frac{a\ell^2}{2}$$
For a minima to be at 'O',
$$\Delta x = (2n + 1)\frac{\lambda}{2}$$
$$\Rightarrow \frac{a\ell^2}{2} = (2n + 1)\frac{\lambda}{2}$$
For minimum 'a', $n = 0$
$$\therefore \frac{a\ell^2}{2} = \frac{\lambda}{2} \Rightarrow a = \frac{\lambda}{\ell^2}$$

68 **(b)**
$$y_n = \left(n + \frac{1}{2}\right)\frac{D\lambda}{d}, n = 1, 2, 3$$
$$\left(3 + \frac{1}{2}\right)\frac{D\lambda_1}{d} = 2 \times \frac{D\lambda_2}{d}$$
$$\lambda_2 = \frac{7}{4} \times 400 = 700 \text{ nm}$$

69 **(a)**
Optical path difference between the waves
$= (n_3 - n_2)t$
∴ Phase difference $= 2\pi\frac{(n_3 - n_2)t}{\lambda_{(\text{vaccum})}} = 2\pi\frac{(n_3 - n_2)t}{n_1\lambda_1}$

70 **(c)**
Intensity of direct ray $= I_0 = kA_0^2$
Intensity of reflected ray $= \frac{64}{100}I_0 = k\left(\frac{8A_0}{10}\right)^2$
$$\therefore \frac{I_{\max}}{I_{\min}} = \frac{(A_0 + 0.8\,A_0)^2}{(A_0 - 0.8\,A_0)^2} = \left(\frac{1.8}{0.2}\right)^2 = \frac{81}{1}$$

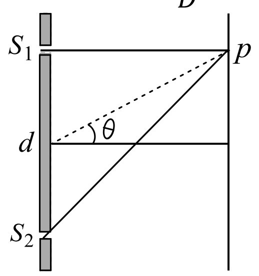
71 **(b)**
Path difference $= \mu t - \mu_0 t_0 = n\lambda_0$
Where n is the number of fringes that shift on the screen
$$\Rightarrow \frac{\mu_0(1 + \alpha_1\theta)t_0(1 + \alpha_2\theta) - \mu_0 t_0}{\lambda_0} = n$$
$$\frac{\mu_0 t_0(\alpha_1 + \alpha_2)\theta}{\lambda_0} = n$$
Given, $\mu_0 = 1.48, t_0 = 3 \times 10^{-2}$ m
$\alpha_1 = 2.5 \times 10^{-5}$ °C^{-1}
$\alpha_2 = 0.5 \times 10^{-8}$ °C^{-1}, $\theta = 5°\text{min}^{-1}$
$\lambda_0 = 589$ nm
$$\therefore n = \frac{1.48 \times 3 \times 10^{-2}(3 \times 10^{-5}) \times 5}{589 \times 10^{-9}} = 11$$

72 **(a)**
White fringe is formed at the centre of screen. Position of central fringe will remain unchanged on moving the screen

73 **(b)**
If the detector move by 0.5λ from origin, it observes 2nd maxima. So, after every 0.5λ, one maxima will be observed

74 **(a)**
Fringe width, $\beta = \lambda D/d$. When the apparatus is immersed in a liquid, λ and hence β is reduced μ (refractive index) times
$10\,\beta' = (5.5)\beta$
Or $10\lambda'\left(\frac{D}{d}\right) = (5.5)\frac{\lambda D}{d}$
Or $\frac{\lambda}{\lambda'} = \frac{10}{5.5} = \mu$
Or $\mu = 1.8$

75 **(c)**
Total number of waves $= \frac{(1.5)t}{\lambda}$ (i)
$$\begin{pmatrix}\text{Total number}\\ \text{of waves}\end{pmatrix} = \left(\frac{\text{Optical path length}}{\text{wavelength}}\right)$$
For B and C:
Total number of waves $= \frac{n_0\left(\frac{t}{3}\right)}{\lambda} + \frac{1.6\left(\frac{2t}{3}\right)}{\lambda}$ (ii)
Equating (i) and (ii), we get
$n_0 = 1.3$

76 **(c)**
$$S_2P - S_1P = \frac{dy}{D} = \frac{d \times (d/2)}{D} = \frac{d^2}{2D}$$


$$\frac{d^2}{2D} = n\lambda$$
$$\lambda = \frac{d^2}{2nD}, n = 1, 2, \ldots$$
$$\lambda = \frac{d^2}{2D}, \frac{d^2}{4D}, \frac{d^2}{6D}$$

77 **(a)**

In this case, both the rays suffer a phase change of 180° and the conditions for destructive interference is

$$2nd = \left(m + \frac{1}{2}\right)\lambda_1$$
$$2nd = \left(m + \frac{3}{2}\right)\lambda_2$$
$$\therefore \frac{m + \frac{1}{2}}{m + \frac{3}{2}} = \frac{\lambda_2}{\lambda_1} = \frac{5000}{7000} = \frac{5}{7}$$

and $d = \frac{\left(m+\frac{1}{2}\right)\lambda_1}{2n} = \frac{2.5 \times 7000}{2 \times 1.3}$

$= 6738\ \text{Å} = 6.738 \times 10^{-5}\text{cm}$

78 **(c)**

As amplitude are A and $2A$, so intensities would be in the ratio 1:4, let us say I and $4I$

$$I_{\max} = I_0 = I + I_0 + 2\sqrt{4I^2} = 9I$$
$$\Rightarrow I = \frac{I_0}{9}$$

Intensity at any point,

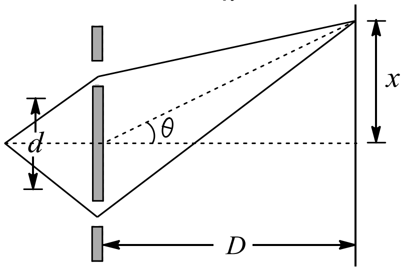
$$I' = I + 4I + 2\sqrt{4I^2}\cos\phi$$
$$\Rightarrow I' = 5I + 4I\cos\phi = \frac{I_0}{9}(5 + 4\cos\phi)$$

79 **(b)**

$$S_1 = \frac{\Delta_1 D}{d} = 11 \times 10^{-3}$$
$$S_2 = \frac{\Delta_2 D}{d} = 12 \times 10^{-3}$$
$$\Rightarrow \Delta_1/\Delta_2 = 11/12$$
$$\Rightarrow 12\Delta_1 = 11\Delta_2$$

80 **(c)**

At point P, $\Delta\phi = \frac{2\pi}{\lambda}\Delta x$ and $\Delta x = \frac{\mathrm{d}x}{\Delta}$



$$\Delta\phi = \frac{2\pi}{\lambda} \times \frac{dx}{D} = \frac{2\pi x}{\beta}$$
$$I_P = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\Delta\phi\,; I_1 = I_2 = I$$
$$I_P = 4I\cos^2\frac{\Delta d}{2}$$

Given $4I = I_0$

$$\Rightarrow I_1 = I_2 = \frac{I_0}{4}$$
$$I_P = \frac{I_0}{2} + \frac{I_0}{2}\cos\Delta\phi$$
$$I_P = I_0\cos^2\frac{\Delta\phi}{2} = I_0\cos^2\frac{\pi x}{\beta}$$

81 **(c)**

In Young's double slit experiment,

$\sin\theta = \theta = y/D$

So, $\Delta y/D$ and hence angular fringe width $\theta_0 = \Delta\theta$(with $\Delta y = \beta$) will be

$$\theta_0 = \frac{\beta}{D} = \frac{D\lambda}{d} \times \frac{1}{D} = \frac{\lambda}{d}$$

$\Rightarrow \theta_0 = 1° = \left(\frac{\pi}{180}\right)$ rad, and $\lambda = 6 \times 10^{-7}$ m

or $d = \frac{\lambda}{\theta_0} = \frac{180}{\pi} \times (6 \times 10^{-7}) = 3.44 \times 10^{-5}$ m

or $d = 0.0344$ mm

82 **(b)**

$$I = I_{\max}\cos\frac{2\phi}{2}$$
$$\phi = \frac{2\pi}{\lambda}\Delta x$$
$$I = I_{\max}\cos^2\frac{\pi}{\lambda}\Delta x$$
$$\frac{I_1}{I_2} = \frac{\cos^2\frac{\pi}{\lambda}\ \Delta x_1}{\cos^2\frac{\pi}{\lambda}\Delta x_2}$$
$$\frac{I}{I/4} = \frac{\cos^2\pi}{\cos^2\frac{\pi}{\lambda}\Delta x_2}$$
$$\Rightarrow \cos^2\frac{\pi}{\lambda}\Delta x_2 = \frac{1}{4}$$
$$\Rightarrow \cos\frac{\pi}{\lambda}\Delta x = \pm\frac{1}{2}$$
$$\frac{\pi}{\lambda}\Delta x = \frac{\pi}{3}, \frac{2\pi}{3}$$
$$\Delta x = \frac{\lambda}{3}, \frac{2\lambda}{3}$$

83 **(b)**

Fringe width, $\beta = \frac{\lambda D}{d}$ i.e., $\beta \propto \lambda$

When the wavelength is decreased from 600 nm to 400 nm, fringe width will also decrease by a factor of 4/6 or 2/3 or the number of fringes in the same segment will increase by a factor of 3/2. Therefore, number of fringes observed in the same segment is $12 \times \frac{3}{2} = 18$

84 **(d)**

$$\beta' = \frac{D\lambda}{3d} = \frac{\beta}{3}$$

85 **(b)**

$\phi_0 = \frac{2\pi}{\lambda_0}$ (optical path)

$$\phi_0 = \frac{2\pi}{\lambda_0}(nx)$$

86 **(d)**

$$I = I_0\cos^2\frac{(\lambda d\sin\theta)}{\lambda} = \frac{I_0}{2}$$
$$\cos\left(\frac{\pi d\sin\theta}{\lambda}\right) = \frac{1}{\sqrt{2}}$$
$$x = \frac{\lambda D}{4d} = \frac{650 \times 10^{-9} \times 0.75}{4 \times 0.25 \times 10^{-3}}$$
$$= 487.5 \times 10^{-6}\ \text{m}$$

$= 0.4875 \text{ mm} \approx 0.5 \text{ mm}$

87 **(d)**

The phase difference (ϕ) between the wavelets from the top edge and the bottom edge of the slit is $\phi = \frac{2\pi}{\lambda}(d \sin\theta)$ where d is the slit width. The first minima of the diffraction pattern occurs at $\sin\theta = \frac{\lambda}{d}$ so $\phi = \frac{2\pi}{\lambda}\left(d \times \frac{\lambda}{d}\right) = 2\pi$

88 **(c)**

Let n_1^{th} maxima corresponding to λ_1 be overlapping with n_2^{th} maxima corresponding to λ_2. Then, the required distance,

$y = \frac{n_1\lambda_1 D}{d} = \frac{n_2\lambda_2 D}{d}$

$= \text{LCM of} \frac{\lambda_1 D}{d} \text{ and } \frac{\lambda_2 D}{d}$

89 **(d)**

The nearest white spot will be at P, the central maxima

$y = \frac{2d}{3} - \frac{d}{2} = \frac{d}{6}$

90 **(c)**

$\lambda = ?$

When mica sheet of thickness t and refractive index μ is introduced in the path of one of the interfering beams, optical path increases by $(\mu - 1)t$. Hence, the shift on the screen,

$y_0 = \frac{D}{d}(\mu - 1)t$ (i)

When the distance between the plane of slits and screen is changed from F to $2D$, then

$\beta = \frac{2D}{d}\lambda$ (ii)

$\frac{D}{d}(\mu - 1)t = \frac{2D(\lambda)}{d}$

$\Rightarrow \lambda = \frac{1}{2}(\mu - 1)t = \frac{1}{2}(1.6 - 1) \times 2.0 \times 10^{-6}\text{m}$

$= 6000 \text{ Å}$

91 **(d)**

Shift of fringe pattern $= (\mu - 1)\frac{tD}{d}$

$\Rightarrow \frac{30D(4800 \times 10^{-10})}{d} = (0.6)t\frac{D}{d}$

$\Rightarrow 30 \times 4800 \times 10^{-10} = 0.6t$

$\therefore t = \frac{30 \times 4800 \times 10^{-10}}{0.6} = \frac{1.44 \times 10^{-5}}{0.6}$

$= 24 \times 10^{-6} \text{ m}$

92 **(c)**

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

$\therefore \frac{I_{max}}{4} = I_{max} \cos^2\frac{\phi}{2}$

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

Or $\frac{\phi}{2} = \frac{\pi}{3}$

$\therefore \phi = \frac{2\pi}{3} = \left(\frac{2\pi}{\lambda}\right).\Delta x$ ... (i)

Where $\Delta x = d \sin\theta$

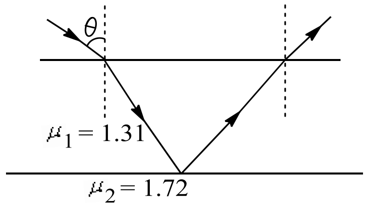
Substituting in Eq. (i) we get,

$\sin\theta = \frac{\lambda}{3d}$

Or $\theta = \sin^{-1}\left(\frac{\lambda}{3d}\right)$

93 **(c)**

There is no net change in phase produced by the two reflections. Hence,



$\frac{\lambda}{2} = 2\mu_1 d \cos\theta$

For normal incidence, $\cos\theta = 1$

$\therefore d = \frac{\lambda}{4\mu_1} = \frac{5.3 \times 10^{-7}}{4 \times 1.31} = 10^{-7} \text{ m} = 0.1 \text{ μm}$

94 **(a)**

Optical path difference at $O = \left(\frac{\mu_2}{\mu_1} - 1\right)t$

95 **(b)**

P and Q: convergence increasing : Q to R: direction changing

96 **(c)**

$30\beta = n\beta'$

$\Rightarrow 30\frac{D \times 4000}{d} = n\frac{D \times 6000}{d} \Rightarrow n = 20$

97 **(d)**

Let nth minima of 400 nm coincides with mth minima of 560 nm, then

$(2n - 1)\left(\frac{400}{2}\right) = (2m - 1)\left(\frac{560}{2}\right)$

Or $\frac{2n-1}{2m-1} = \frac{7}{2} = \frac{14}{10} = \cdots$

ie. 4^{th} minima of 400 nm coincides with 3^{rd} minima of 560 nm.

Location of this minima is,

$Y_1 = \frac{(2 \times 4 - 1)(1000)(400 \times 10^{-6})}{2 \times 0.4} = 14 \text{ mm}$

Next 11^{th} minima of 400 nm will coincide with 8^{th}

minima of 560 nm. Location of this minima is ,

$$Y_2 = \frac{(2\times 11-1)\ (1000)\ (400\times 10^{-6})}{2\times 0.1} = 42 \text{ mm}$$

$\therefore$ Required distance= $Y_2 - Y_1 = 28$ mm

98 **(b)**

$\frac{\lambda_1 D}{d} = 4.84$ mm (i)

Let required wavelength be λ_2. Then according to given information,

$\frac{\lambda_2 D}{2d} = 4.84$ mm (ii)

From (i) and (ii),

$\frac{\lambda_1}{\frac{l_2}{2}} = 1 \Rightarrow \lambda_2 = 1200$ nm

99 **(b)**

For dark fringe,

Path difference $= (2n-1)\frac{\lambda}{2}$

100 **(b)**

Intensity of central maxima, $I_u = (2A_0)^2 = 4kA_0^2 = 4I_0$

Intensity at distance x from the central maxima is half of the maximum intensity if

$I = 4I_0 \cos^2\frac{\phi}{2} = \frac{4I_0}{2} \Rightarrow \cos^2\frac{\phi}{2} = \frac{1}{2}$

$\therefore x = 1.25\times 10^{-4}$ m

$\frac{\lambda D}{4d} = \frac{500\times 10^{-9}\times 1}{4\times 10^{-3}}$

101 **(d)**

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

β becomes (1/4th) where λ is halfed and d is doubled. The separation between successive dark fringes reduces. It does not remain unchanged

102 **(a)**

$I \propto 4a^2 \cos^2\frac{\phi}{2}$

In the first case, $\phi = 2\pi$

$\therefore I' \propto 4a^2$

In the second case, $\phi = \frac{2\pi}{3}$

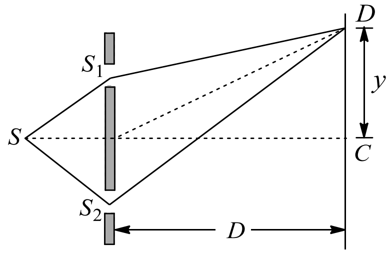
$\therefore I' \propto 4a^2\cos^2\frac{2\pi}{3}$ or $I' \propto a^2$

$\frac{I'}{I} = \frac{1}{4}$ or $I' = \frac{I}{4}$

103 **(a)**

Path difference $\Delta x = \frac{dy}{D}$

Here $d = 2\times 10^{-3}$ m, $y = \frac{1}{6}\times 10^{-3}$ m, $D = 2$ m



$\Delta x = \frac{2\times 10^{-3}\times 1\times 10^{-3}}{2\times 6} = \frac{10^{-6}}{5}$ m

Phase difference $\Delta\phi = \frac{2\pi}{\lambda}\times\Delta x$

$= \frac{2\pi}{500\times 10^{-9}}\times\frac{10^{-9}}{6} = -\frac{2\pi}{3}$

Resultant intensity at P

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\Delta\phi$

$= I_0 + 9I_0 + 2\times 3I_0\cos\frac{2\pi}{3}$

$= 10I_0 - 3I_0 = 7I_0$

104 **(a)**

$I_{\min} \propto (A_1 - A_2)^2$

$I_{\min} \propto (2a - a)^2$

Clearly, the intensity of minima increases. Again,

$I_{\max} \propto (A_1 + A_2)^2$

$I_{\max} \propto (2a + a)^2$

Clearly, the intensity of maxima increases

105 **(d)**

In case I, II, III and IV, the path differences are respectively, $\frac{\lambda}{2}, \lambda, \frac{\lambda}{4}$ and $\frac{3\lambda}{2}$

Phase difference are, respectively, $\pi, 2\pi, \frac{\pi}{2}, \frac{3\pi}{2}$, and

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

Therefore, the intensities in the four cases are $0, I_0, \frac{I_0}{2}, \frac{I_0}{2}$, respectively

106 **(c)**

Change in path difference for any point on screen is $|\mu - 1.8|t$

For central maxima, phase difference = 0

Hence, $d\sin\theta - |\mu - 1.8|t = 0$

$\Rightarrow d\theta = |\mu - 1.8|t$ [θ is very small and is in radian]

$\Rightarrow |\mu - 1.8| = \frac{10^{-3}\times 0.1}{0.5\times 10^{-3}} = 0.2$

$\Rightarrow \mu = 2$ or 1.6

107 **(a)**

Path difference due to slab should be integral multiple of λ. Hence,

$\Delta x = n\lambda$

Or $(\mu - 1)t = n\lambda,\ n = 1, 2, \dots$

Or $t = \frac{n\lambda}{\mu - 1}$

For minimum value of $t, n = 1$

$\therefore t = \frac{n\lambda}{\mu - 1} = \frac{\lambda}{1.5 - 1} = 2\lambda$

108 **(c)**

N =no. of fringes shifted

Shift of central maxima $= n\lambda = (\mu - 1)t$

$\Rightarrow t = 24$ μm

109 **(a)**

In ΔS_1PO,

$\tan\frac{\theta}{2}=\frac{d/2}{D}$

As $D\gg d,\theta$ is very small

$\therefore \tan\frac{\theta}{2}=\frac{\theta}{2} \Rightarrow \frac{\theta}{2}=\frac{d}{2D} \Rightarrow \frac{D}{d}=\frac{1}{\theta}$

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

110 **(c)**

$y_n=n\left(\frac{D\lambda}{d}\right)$ and $y_n'=n'\left(\frac{D\lambda'}{d}\right)$

Equating y_n and y_n', we get

$\frac{n}{n'}=\frac{\lambda'}{\lambda}=\frac{900}{750}=\frac{6}{5}$

Hence, the first position at which overlapping occurs is

$y_6=y_5'=\frac{6(2)(750\times10^{-9})}{2\times10^{-3}}=4.5\text{ mm}$

111 **(b)**

The wavelength missing from the reflected spectrum must satisfy the condition, $2\mu t=n\lambda$, where t is thickness of air film

$2\mu t=n\lambda_1=(n+1)\lambda_2$

Or $n\times(7200)=(n+1)5400$

$\therefore n=3$

The next wavelengths must satisfy the condition,

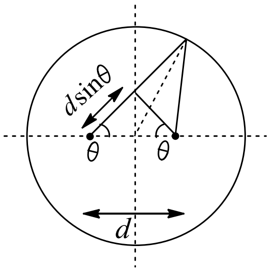
$n\lambda_1=(n+2)\lambda_2$

Or $7200\times3=(3+2)\lambda_2=5\lambda_2$

$\Rightarrow \lambda_2=4320\text{ Å}$

112 **(a)**

Condition for maxima is



$d\sin\theta=n\lambda$

$\sin\theta=\frac{n\lambda}{d}=n\left(\frac{0.50}{2.0}\right)=0.25n$

As $\sin\theta$ lies between -1 and 1, so we wish to find all values of n for which

$|0.25n|\le1$

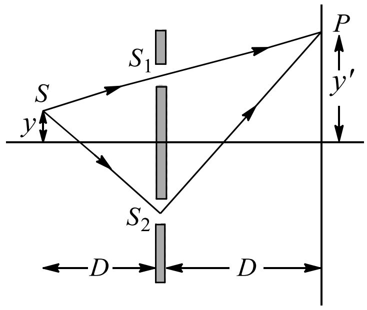
These values are

$-4,-3,-2,-1,0,+1,+2,+3,+4$. For each of these, there are two different values of θ except for -4 and $+4$. A single value of $\theta, -90°$ and $+90°$, is associated with $n=-4$ and $n=+4$, respectively. Thus, there are 16 different angles in all and therefore 16 maxima

113 **(a)**

$y'=\frac{d}{2}$, at point P exactly in front of S_1

$\Delta x=\frac{yd}{D}+\frac{d^2}{2D}$



For minimum intensity, $\Delta x=(2n-1)\frac{\lambda}{2}(n=1)$

Putting the values, we get

$(0.5\sin\pi t)\times10^{-6}+0.25\times10^{-6}=\frac{500}{2}\times10^{-9}$

$0.5\sin\pi t+0.25=\frac{0.5}{2}$

$\sin\pi t=0 \Rightarrow \pi t=0,\pi,2\pi,\dots$

$\Rightarrow t=1\text{ s}$

114 **(d)**

Because white light will give a general illumination at the central maxima

115 **(b)**

Velocity of wave in medium (μ) is less than that in air. Hence, wavefront reaches earlier at P through air

116 **(c)**

$I_p=\frac{I_{\max}}{2}[1+\cos\phi]=\frac{I_{\max}}{2}\left(1+\cos\frac{2\pi y}{\beta}\right)$

Where $\beta=D\lambda/d$

First maxima is observed at P, i.e., $\cos\frac{2\pi y}{\beta}=1$. As D incraeses β will increase and the value of $\cos\frac{2\pi y}{\beta}$ should be negative. Hence, the ratio $I_P/I_{\max}$ starts decreasing but starts increasing again as $\cos\frac{2\pi y}{\beta}$ again starts becoming positive

117 **(d)**

If $d\sin\theta=(\mu-1)t$, central fringe is obtained at O

If $d\sin\theta>(\mu-1)t$, central fringe is obtained above O

If $d\sin\theta<(\mu-1)t$, central fringe is obtained below O

118 **(c)**

At path difference $\frac{\lambda}{6}$, phase difference is $\frac{\pi}{3}$

$I=I_0+I_0+2I_0\cos\frac{\pi}{3}=3I_0$

So, the required ratio is $\frac{3I_0}{4I_0}=0.75$

119 **(d)**

Let intensity of one slit be I

For maxima,

$\Delta\phi=0$

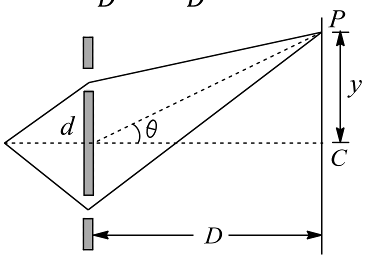
$\Rightarrow I_0=I+I+2\sqrt{II}\cos(0)$

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

120 **(b)**

$\Delta x=d\sin\theta=\frac{dy}{D}$ (approx.)

$$\Delta x = \frac{d \times d}{D} = \frac{d^2}{D}$$



For missing wavelength, destructive interference has to be there at $y = d$

$$\frac{d^2}{D} = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}, \dots$$

$$\lambda = \frac{2d^2}{D}, \frac{2d^2}{3D}, \frac{2d^2}{5D}, \dots$$

121 **(a)**

$d \sin\theta_1 = n\lambda_1, d \sin\theta_2 = n\lambda_2$

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{\lambda_1}{\lambda_2} = \mu$$

$$\mu = \frac{\sin\theta_1}{\sin\theta_2} = \frac{\sin 45°}{\sin 30°} = \sqrt{2}$$

122 **(a)**

The detector receives direct as well as reflected waves. The distance moved between two consecutive position of maxima is $\lambda/2$

$$14 \times \frac{\lambda}{2} = 71 = 0.14 \text{ m}$$

$\Rightarrow \lambda = 0.02$ m

$c = n\lambda$

Putting $c = 3 \times 10^8$ m/s, we have

$$n = \frac{c}{\lambda} = \frac{3 \times 10^8}{0.02} = 1.5 \times 10^{10} \text{ Hz}$$

123 **(d)**

Fringe width $= \frac{\lambda_{\text{medium}} D}{d} = \frac{\lambda D}{\mu d}$

As $\mu > 1$, so fringe width decreases. Fringe pattern doesn't shift because same path length change is introduced in both the waves

124 **(c)**

(Shift)=7 (Position of central maxima)

$$\Rightarrow (\mu - 1)t\frac{D}{d} = 7\left(\frac{\lambda D}{d}\right)$$

$$\therefore t = \frac{7\lambda}{\mu - 1}$$

$$\Rightarrow t = \frac{7(600)}{0.5}$$

$\Rightarrow t = 8400$ nm

125 **(c)**

In the first case,

$I = I_0 + I_0 + 2I_0 \cos 0°$

or $I = 4I_0$

In the second case,

$I' = I_0 + I_0 = 2I_0$

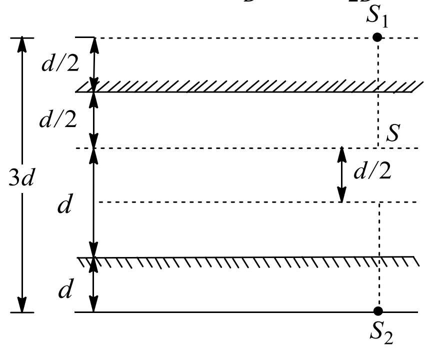
$$\therefore \frac{I}{I'} = \frac{4I_0}{2I_0} = \frac{2}{1}$$

126 **(b)**

The situation can be taken as if there are two sources S_1 and S_2 as shown in the figure in question

For 'O' to be a maxima:

Path difference $\frac{(3d)(d/2)}{D} = \frac{3d\, d}{2D} = n\lambda$



$$\Rightarrow \lambda = \frac{3d^2}{2nD} \text{ or } \lambda = \frac{3d^2}{2D}$$

127 **(c)**

Intensity at the centre will be zero if path difference is $\lambda/2$. That is,

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

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

128 **(b,c)**

$$\beta_2 = \frac{\lambda_2 D}{d} = 2\frac{\lambda_1}{d}D$$

As $\beta_1 = \frac{\lambda_1}{d}D$

nth order maxima of λ_2 coincides with $2n$th order maxima of λ_1

n^{th} order minima of λ_2 does not coincide with $2n$th order maxima of λ_1

129 **(a,c)**

Path difference at point $O = d \sin\alpha = 0.5$ mm

Corresponding phase difference,

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

$$= \frac{2\pi(0.5 \times 10^{-3})}{5000 \times 10^{-10}} = 2000\pi = 2\pi \times 1000$$

O is a point corresponding to a maxima with the point at 1 m below O corresponding to central maxima

130 **(a,c)**

If the screen is perpendicular to y-axis (line joining the sources), i.e., xz plane, the fringes will be circular (i.e., concentric circles with their centers on the point of intersection of the screen with y-axis). In this situation, central fringe will be bright if $S_1, S_2 = n\lambda$ and dark if $S_1S_2 = (2n - 1)\lambda/2$. From all this, it is clear that shape of fringes depends on the nature of sources and direction of observation, i.e., position of screen

131 **(a)**

Locus of equal thickness are lines running parallel to the axis of the cylinder. Hence straight fringes will be observed

132 **(a,c)**

For a certain point P on the screen at a distance x from the center of the screen, path difference

$\Delta = \frac{xd}{D}$

Path difference introduced due to sheet= $(\mu - 1)t$

For central maximum at P,

$$\frac{xd}{D} = t(\mu - 1)$$

Or $x = t(\mu - 1)\frac{D}{d}$

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

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

Hence, $x = t(\mu - 1)\frac{\beta}{\lambda}$

133 **(b,d)**

$$\frac{I_{\min}}{I_{\max}} = 9 \Rightarrow \left(\frac{a_1 + a_2}{a_1 - a_2}\right)^2 = 9 \Rightarrow \frac{a_1 + a_2}{a_1 - a_2} = 3$$

$\Rightarrow \frac{a_1}{a_2} = \frac{3+1}{3-1} \Rightarrow \frac{a_1}{a_2} = 2$. Therefore $I_1 : I_2 = 4 : 1$

134 **(b,d)**

We know that

$$\frac{I_{\max}}{I_{\min}} = \frac{(a+b)^2}{(a-b)^2}$$

Where $I_1 \propto a^2$ (a is amplitude of wave 1) and $I_2 \propto b^2$

Hence, $\frac{I_{\max}}{I_{\min}} = \frac{9}{1}$

$$\frac{a+b}{a-b} = \frac{3}{1} \Rightarrow \frac{a}{b} = \frac{1}{2}$$

$$\frac{I_1^2}{I_2^2} = \frac{a^2}{b^2} = \frac{1}{4}$$

135 **(b)**

In Young's double-slit experiment,

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

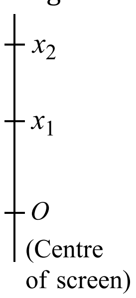
Given that

$x_2 - x_1 = 12\frac{\lambda_1 D}{d}$ (i)

Where $\lambda_1 = 600$ nm. Also,

$x_2 - x_1 = k\frac{\lambda_2 D}{d}$ (ii)

Where $\lambda_2 = 400$ nm and k is the number of fringes



Dividing Eq. (i) by Eq. (ii),

$$1 = \frac{12\lambda_1}{k\lambda_2}$$

$$\therefore k = \frac{12 \times 600}{400} = 18$$

Correct option is (b)

136 **(a,d)**

If the amplitudes due to two individual sources at point P are A_0 and $3A_0$, then the resultant amplitude at P will be

$$A = \sqrt{A_0^2 + (3A_0)^2 + 2(A_0)(3A_0)\cos \pi/3}$$

$= A_0$

Resultant intensity, $I \propto 13\,A_0^2$

137 **(a,b)**

In conventional light source, light comes from a large number of independent atoms, each atom emitting light for about $10^{-8}s$ *i.e.* light emitted by an atom is essentially a pulse lasting for only $10^{-8}s$. Light coming out from two slits will have a fixed phase relationship only for $10^{-8}s$. Hence any interference pattern formed on the screen would last only for $10^{-8}s$, and then the pattern will change. The human eye can notice intensity changes which last at least for a tenth of a second and hence we will not be able to see any interference pattern. Instead due to rapid changes in the pattern, we will only observe a uniform intensity over the screen

138 **(a)**

$$I = I_0 \cos^2 \frac{(xd \sin\theta)}{\lambda}$$

(1) Path difference, $\delta = d\sin\theta = 5 \times 10^{-7}$m

$$I_1 = I_0 \cos^2 \frac{(\pi \times 5 \times 10^{-7})}{(5 \times 10^{-7}\text{ m})} = I_0 \cos^2(\pi) = I_0$$

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

$= I_0 \cos^2\left(\frac{4\pi}{6}\right) = 0.25I_0$

(3) $I_3 = I_0 \cos^2\left(\frac{\pi \times 7.5 \times 10^{-7}\text{ m}}{5 \times 10^{-7}\text{m}}\right)$

$= I_0 \cos^2(1.5\pi\text{ rad}) = I_0 \cos^2(270°) = 0$

(4) $I_4 = I_0 \cos^2\left(\frac{\pi}{2\times 3}\right)\text{rad} = 0.75I_0$

139 **(c)**

We know that

$$I = I_0 \cos^2 \frac{\delta}{2}$$

Where

$$\delta = \frac{2\pi}{\lambda} \times \frac{Dy}{d} = \frac{2\pi \tan\theta}{\lambda}$$

$$I = I_0 \cos^2\left(\frac{\pi d \tan\theta}{\lambda}\right)$$

$= I_0 \cos^2\left(\frac{\pi \times 150 \times \tan\theta}{3 \times 10^8/10^6}\right)$

$= I_0 \cos^2\left(\frac{\pi}{2}\tan\theta\right)$

For $\theta = 30°, I = I_0 \cos^2 52$

For $\theta = 90°, I = I_0 \cos^2 \pi/2 = 0$

Hence, (c) is the correct option

140 **(b,d)**

Whenever a ray goes from one medium to another, its frequency remains same. Its wavelength changes in accordance with $\mu\lambda =$constant. i.e,

$\mu_0\lambda_0 = \mu\lambda$

$\lambda_0 = \mu\lambda \;\; (\because \mu_0 = \mu_{\text{air}} = 1)$

$\lambda = \frac{\lambda_0}{\mu}(< \lambda)$

So, λ decreases when it goes from rarer to denser medium and vice versa

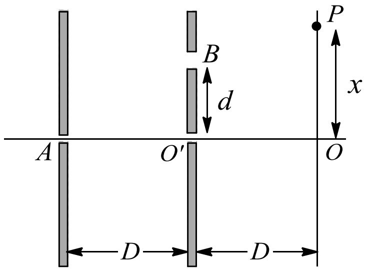
$\Delta\lambda = \lambda - \lambda_0$

$\Delta\lambda = \lambda_0\left(\frac{1}{\mu} - 1\right)$

141 **(b,d)**

There is a dark fringe at O if the path difference

$\delta = ABO - AO'O = \frac{\lambda}{2}$



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

$d_{\min} = \sqrt{\frac{\lambda D}{2}}$

The bright fringe is formed at P if the path difference

$\delta' = AO'P - ABP = \lambda$

$= D + \sqrt{D^2 + x^2} - \sqrt{D^2 + d^2} - \sqrt{D^2 + (x-d)^2}$

$= \lambda$

$= \frac{x^2}{2D} - \frac{d^2}{2D} - \frac{(s^2 + d^2 - 2xd)}{2D} = \lambda$

Given $d = d_{\min}$

On solving, $x = d_{\min} = \sqrt{\frac{\lambda D}{2}}$

142 **(a,b,c)**

Path difference, $\delta = BP - AP$

$\sqrt{x^2 + 9^2} - x = n\lambda$

$\Rightarrow x^2 + 9^2 = n^2\lambda^2 + x^2 + 2n\lambda x$

$\Rightarrow x = \frac{9^2 - n^2\lambda^2}{2n\lambda}$

$\lambda = \frac{c}{v} = \frac{3 \times 10^8}{120 \times 10^6} = 2.5 \text{ m}$

$n = 1, x = 14.95$ m; $n = 3, x = 1.65$ m ;

$n = 2, x = 5.6$ m; $n = 4$ not possible

143 **(c)**

$\beta_l = \frac{\beta_a}{{}_a\mu_l} = \frac{2}{5/3} = \frac{6}{5}\text{mm}$

144 **(a)**

When slits are of equal width:

$I_{\max} \propto (a + a)^2 (= 4a^2)$

$I_{\min} \propto (a - a)^2 (= 0)$

When one slit's width is twice that of the other:

$\frac{I_1}{I_2} = \frac{\omega_1}{\omega_2} = \frac{a^2}{b^2} \Rightarrow \frac{\omega}{2\omega} = \frac{a^2}{b^2} \Rightarrow b = \sqrt{2}a$

$\therefore I_{\max} \propto \left(a + \sqrt{2}a\right)^2 (= 5.8a^2)$

$I_{\min} \propto \left(\sqrt{2}a - a\right)^2 (= 0.17a^2)$

Hence, (a) is the correct option

145 **(b,d)**

It is better to make a chart for all the four cases which show the phase difference due to reflection at top and bottom surfaces of film

	Top surfaces	Bottom surfaces	Due to $2L$	Total
Case I	0	0	6π	6π
Case II	0	π	6π	7π
Case III	0	π	6π	7π
Case IV	π	π	6π	8π

146 **(c,d)**

$\phi_f = \frac{2\pi}{\lambda_0}\ell$

$\phi_f = \frac{2\pi}{\lambda}\ell$

$\Delta\phi = 2\pi\ell\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$

Further, by Snell's law,

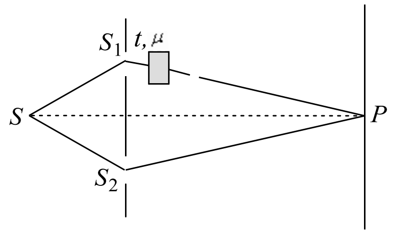
$n\lambda = (1)\lambda_0 \Rightarrow \lambda = \frac{l_0}{n}$

$\Rightarrow \Delta\phi = \frac{2\pi l}{\lambda_0}(n - 1)$

147 **(a,c,d)**

Δx (at P) after insertion of slab

$= (S_1P - t)_{\text{air}} + t_{\text{medium}} - S_2P_{\text{air}} = (\mu - 1)t$



Earlier, Δx (at P)$= S_1P - S_2P = 0$

So, change in optical path due to insertion of slab is $(\mu - 1)t$

For intensity to be zero at P, we have

$$\Delta x = \frac{(2n-1)\lambda}{2} \ (n = 1, 2, \dots)$$

$$(\mu - 1)t = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}, \dots$$

148 **(b,c)**

For maxima, path difference $\Delta = n\lambda$

So for $n = 1, \Delta = \lambda = 6320\text{Å}$

149 **(b,d)**

We know that

$$\frac{I_{\max}}{I_{\min}} = \frac{(a+b)^2}{(a-b)^2}$$

Where $I_1 \propto a^2$ (a is amplude of 1 wave) and $I_2 \propto b^2$ (b is amplitude of 2 wave). Here,

$$\frac{I_{\max}}{I_{\min}} = \frac{9}{1} \Rightarrow \frac{a+b}{a-b} = \frac{3}{1} \Rightarrow \frac{a}{b} = \frac{1}{2}$$

$$\therefore \frac{I_1^2}{I_2^2} = \frac{a^2}{b^2} = \frac{1}{4}$$

150 **(b)**

We know that the resultant amplitude of two interfering waves is given by $R^2 = a^2 + b^2 + 2ab\cos\phi$, where R is the amplitude of resultant wave, a is the amplitude of one wave, b is the amplitude of second wave, and ϕ as the phase difference between the two waves at a point

Also,

$I \propto (\text{amplitude})^2$

$\therefore I \propto I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$ (i)

Applying Eq. (i) when phase difference is $\pi/2$,

$I_{\pi/2} \propto I + 4I$

$\Rightarrow I_{\pi/2} \propto 5I$

Again, applying Eq. (i) when phase difference is π

$I_\pi \propto I + 4I + 2\sqrt{I}\sqrt{4I}\cos\pi$

$\therefore I_\pi \propto I \Rightarrow I_{\pi/2} - I_\pi \propto 4I$

Correct option is (b)

151 **(a,c,d)**

$$I_{\max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = \left(\sqrt{I_1} + \sqrt{\frac{I}{2}}\right)^2 < 4I$$

$$I_{\min} = \left(\sqrt{I_1} - \sqrt{\frac{I}{2}}\right)^2 > 0$$

152 **(a,b,c)**

Due to absorption of light by the slab, intensity of two sources would be different and hence intensity at central maxima changes. If no absorption takes place, then it will not change. Intensity of dark fringes will not be absolutely zero, if some absorption is there

153 **(b)**

$$\frac{I_{max}}{I_{min}} = \frac{(a+b)^2}{(a-b)^2} = \frac{16}{1}$$

$$\therefore \ \frac{a+b}{a-b} = \frac{4}{1}$$

$4a - 4b = a + b$ or 3a = 5b

$$\therefore \frac{a}{b} = \frac{5}{3}$$

154 **(a,b,c,d)**

Δx at $O = d$ [path difference is maximum at O]

So, if $d = \frac{7\lambda}{2}$, O will be a minima. If $d = \lambda, O$ will be a maxima. If $d = \frac{5\lambda}{2}$, O will be a minima and hence intensity is minimum

If $d = 4.8\lambda$, then total 10 minima can be observed on the screen, 5 above O and 5 below O, which correspond to

$$\Delta x = \pm\frac{\lambda}{2}, \pm\frac{3\lambda}{2}, \pm\frac{5\lambda}{2}, \pm\frac{7\lambda}{2}, \pm\frac{9\lambda}{2}$$

155 **(a,d)**

These waves are of same frequencies and they are coherent

156 **(a,b)**

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

and $n = 0,1 \ \therefore \lambda < d < 2\lambda$

157 **(a,c)**

$\lambda_a = 6000\text{Å}, v_a = \frac{c}{\lambda_a} = \frac{3\times10^8}{6000\times10^{-10}}$

$= 5 \times 10^{14}$ Hz

In water, $\lambda_m = \frac{\lambda_a}{\mu} = \frac{6000\text{Å}}{1.5} = 4000\text{Å}$

$v_m = v_a = 5 \times 10^{14}\text{Hz}$

158 **(a,c)**

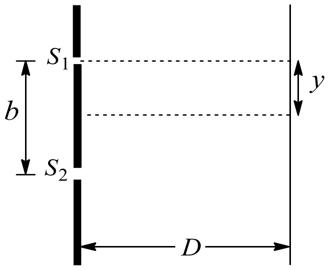
The wavefront in $Y - Z$ plane travels along X-axis. Therefore, $x = a$ and $x = a'$ represents such a wavefront.

159 **(a,c)**

$y = (2n-1)\frac{\lambda D}{2d} = (2n-1)\frac{\lambda D}{2b}$

$(\because d = b)$

But $y = b/2$



$\therefore \frac{b}{2} = (2n-1)\frac{\lambda D}{2d}$

$\Rightarrow \lambda = \frac{b^2}{(2n-1)D}$

When $n = 1, 2,$

$\lambda = \frac{b^2}{D'}, \frac{b^2}{3D'}$

160 **(d)**

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

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

$= \frac{4 \times 10^{-3} \times 0.1 \times 10^{-3}}{4 \times 10^{-7}} = 1 \text{ m}$

161 **(a,c)**

Path difference $= \sqrt{D^2 + d^2} - D = 1$ m

Also,

$\left[\sqrt{D^2 + d^2} - D\right] = (2n-1)\frac{\lambda}{2}$

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

For $n = 1, 2, 3, \ldots$

$\lambda = 2 \text{ cm}, \frac{2}{3}, \frac{2}{5} \text{ cm}, \ldots$

162 **(c)**

Hertz experimentally observed that the production of spark between the detector gap is maximum when it is placed parallel to source gap. This means that the electric vector of radiation produced by the source gap is parallel to the two gaps *i.e.*, in the direction perpendicular to the direction of propagation of the radiation

163 **(d)**

If a transparent medium of thickness t and refractive index μ is introduced in the path of one of the slits, then effective path in air is increased by an amount $(\mu - 1)t$ due to introduction of plate

Therefore, the zeroth fringe shifts to a new position where the two optical paths are equal. In such case fringe width remains unchanged

The central fringe is bright or dark depends upon the initial phase difference between the two coherent sources

164 **(d)**

If maximum intensity is observed at P, then for maximum intensity to be also observed at Q, S_1 and S_2 must have phase difference of $2m\pi$ (where m is an integer)

165 **(a)**

When a Polaroid is rotated in the path of unpolarised light, the intensity of light coming out from Polaroid remains undiminished because unpolarised light have vibrations in all possible planes. While a polariod when rotated in path of plane polarized light, its intensity will vary from maximum to minimum. Thus, sing polariod, unpolarised light and polarized light can be distinguished from each other.

166 **(c)**

The beautiful colours are seen on account of interference of light reflected from the upper and the lower surfaces of the thin films. Since condition for constructive and destructive interference depends upon the wavelength of light, therefore coloured interference fringes are observed

167 **(b)**

Short wave (wavelength 30 km to 30 cm). These waves are used for radio transmission and for general communication purpose to a longer distance from ionosphere

168 **(a)**

S_1: When light reflects from denser med. (Glass) a phase shift of π is generated

S_2: Centre maxima or minima depends on thickness of the lens

169 **(c)**

In Young's experiments, fringe width for dark and white fringes are same while in Young's double-slit experiment when a white light as a source is used, the central fringe is bright around which few coloured fringes are observed on either side

170 **(c)**

The waves which consist longer wavelength have more diffraction. Since radio waves have greater wavelength than microwaves, hence, radio waves undergo more diffraction than microwaves.

171 **(b)**
Doppler's effect is observed readily in sound wave due to larger wavelengths. The same is not the case with light due to shorter wavelength in every day life

172 **(a)**
Fringe width, $\beta = \frac{\lambda D}{d}$
de Broglie wavelength, $\lambda = \frac{h}{mv}$
As speed of electrons increases, λ decreases i.e., β decreases

173 **(c)**
The beautiful colours are seen on account of interference of light reflected from the upper and the lower surfaces of the thin films. Since condition for constructive and destructive interference depends upon the wavelength of light therefore, coloured interference fringes are observed.

174 **(c)**
The waves diffracted from the edges of circular obstacle, placed in the path of light, interfere constructively at the centre of the shadow resulting in the formation of a bright spot.

175 **(c)**
The earth's atmosphere is transparent to visible light and radio waves, but absorbs X-rays. Therefore X-rays telescope cannot be used on earth surface

176 **(c)**
The clouds consists of dust particles and water droplets. Their size is very large as compared to the wavelength of the incident light from the sun. So there is very little scattering of light. Hence the light which we receive through the clouds has all the colours of light. As a result of this, we receive almost white light. Therefore, the cloud are generally white

177 **(a)**
Microwaves communication is preferred over optical communication because microwaves provide large number of channels and wider band width compared to optical signals as information carrying capacity is directly proportional to band width. So, wider the band width, greater the information carrying capacity

178 **(b)**
$\Delta x = d \sin\theta \Rightarrow \Delta x_{\max} < d$
If $d < \lambda$, then $\Delta x_{\max} < \lambda$. So, maxima can be present and interference pattern cannot be observed
Statement II is true but not explaining statement I

179 **(b)**
When intensity of light emerging from two slits is equal, the intensity of minima,
$I_{\min} = \left(\sqrt{I_a} - \sqrt{I_b}\right)^2 = 0$, or absolute dark
It provides a better contrast

180 **(a)**
As given in the expression $\beta = \frac{\lambda D}{d}$, fringe width β is independent of 'n' (position)

181 **(a)**
At the location of minima, two waves have different intensities and hence minimum intensity is not exactly zero

182 **(c)**
The television signals being of high frequency are not reflected by the ionosphere. So the T.V. signals are broadcasted by tall antenna to get large coverage, but for transmission over large distance satellites are needed. That is way, satellites are used for long distance T.V. transmission

183 **(a)**
For diffraction to occur, the size of an obstacle/aperture is comparable to the wavelength of light wave. The order of wavelength of light wave is 10^{-7}m, so diffraction occurs.

184 **(d)**
If a transparent medium of thickness t and refractive index μ is introduced in the path of one of the slits, then effective path in air is increased by an amount $(\mu - 1)t$ due to introduction of plate
Therefore, the zeroth fringe shifts to a new position where the two optical paths are equal. In such case fringe width remains unchanged
The central fringe is bright or dark depends upon the initial phase difference between the two coherent sources

185 **(a)**
Average value of $\cos\delta$ is
$$\frac{\int_t^{t=T} \cos(\phi_1 - \phi_2)\, dt}{T} = 0$$
Here, ϕ_1 and ϕ_2 are constantly, randomly fluctuating phases of the two wave trains and

integral is taken over a long time (relative to periods of the individual waves)

187 **(b)**

Radio waves can be polarized because they are transverse in nature. Sound waves in air are longitudinal in nature

188 **(a)**

According to Newton's to corpuscular theory of light, the light should travel faster in denser media than in rarer media. It is contrary to present theory of light which explains the light travels faster in air (rarer) and in water (Denser).

189 **(b)**

Wavelength in a medium of refractive index μ is $\lambda' = \lambda/\mu$, where λ is the wavelength in air. Fringe width,

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

190 **(a)**

When we seen the painting which is painted by a myriad of small colour dots near our eyes, scientillating colour of dots are visible due to diffraction of light and when we go away from the painting our eyes blend the dots and we see the different colours. This is due to the change is angular separation of adjacent dots as the distance of the object changes.

191 **(a)**

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

192 **(a)**

The diffraction of sound is only possible when the size of opening should be of the same order as its wavelength and the wavelength of sound is of the order of 1.0 m, hence, for a very small opening no diffraction is produced in sound waves.

193 **(d)**

When a light wave travel from a rarer to a denser medium it loses speed, but energy carried by the wave does not depend on its speed. Instead, it depends on the amplitude of wave

194 **(b)**

For two coherent sources.

$$I = I_1 + I_2 + \sqrt{I_1 I_2}\cos\phi$$

Putting, $I_1 = I_2 = I_0$

We have, $I = I_0 + I_0 + 2\sqrt{I_0 \times I_0}\cos\phi$

Simplifying the above expression

$$I = 2I_0(1 + \cos\phi)$$

$$= 2I_0\left(1 + 2\cos^2\frac{\phi}{2} - 1\right)$$

$$= 2I_0 \times 2\cos^2\frac{\phi}{2}$$

$$= 4I_0\cos^2\frac{\phi}{2}$$

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

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

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

195 **(d)**

Statement I is false because constructive interference can be obtained if phase difference of source is $2\pi, 4\pi, 6\pi$, etc

196 **(a)**

Diffraction (bending of waves) occurs when obstacle size is comparable to wavelength

197 **(a)**

When a polaroid is rotated in the path of unpolarised light, the intensity of light transmitted from polaroid remains undiminished (because unpolarised light contains wave vibrating in all possible planes with equal probability). However, when the polaroid is rotated in path of plane polarised light, its intensity will vary from maximum (when the vibrations of the plane polarized light are parallel to the axis of the polaroid) to minimum (when the direction of the vibrations becomes perpendicular to the axis of the crystal). Thus using polaroid we can easily verify that whether the light is polarized or not

198 **(b)**

Light radiations and thermal radiations both belong to electromagnetic spectrum. Light radiation belongs to visible while thermal radiation belongs to infrared region of EM spectrum

Also EM radiations require no medium for propagation

199 **(d)**

In sky wave propagation, the ratio waves having frequency range 2 MHz to 30 MHz are reflected back by the ionosphere. Radio waves having frequency nearly greater than 30 MHz penetrates the ionosphere and is not reflected back by the ionosphere. The TV signal having frequency greater than 30 MHz therefore cannot be propagated through sky wave propagation

In case of sky wave propagation, critical frequency is defined as the highest frequency is returned to the earth by the considered layer of the ionosphere after having sent straight to it. Above this frequency, a wave will penetrate the ionosphere and is not reflected by it

200 **(d)**

When the medium between plane-convex lens and plane glass is rarer than the medium of lens and glass, the central spot of Newton's ring is dark. The darkness of central spot is due to the phase change of π which is introduced between the rays reflected from denser to rarer and rarer to denser medium.

201 **(b)**

For two coherent sources,

$I = I_1 + I_2 + \sqrt{I_1 I_2}\cos\theta$

Putting $I_1 = I_2 = I_0$, we have

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

Simplifying the above expression,

$I = 2I_0(1+\cos\phi)$

$= 2I_0\left(1 + 2\ \cos^2\frac{\phi}{2} - 1\right)$

$= 2I_0 \times \cos^2\frac{\phi}{2} = 4I_0\cos^2\frac{\phi}{2}$

Also,

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

$I_{\min} = \left(\sqrt{I_1} + \sqrt{I_2}\right)$

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

202 **(d)**

The central spot of Newton's rings is dark when the medium between plano convex lens and plane glass is rarer than the medium of lens and glass. The central spot is dark because the phase change of π is introduced between the rays reflected from surfaces of denser to rarer to denser medium

203 **(d)**

Ozone layer in the stratosphere helps in protecting life of organism from ultraviolet radiation on earth. Ozone layer is depleted due to of several factors like use of chlorofluoro carbon (CFC) which is the cause of environmental damages

204 **(e)**

We know, with increase in altitude, the atmospheric pressure decreases. The high energy particles ($i.e. \gamma$-rays and cosmic rays) coming from outer space and entering out earth's atmosphere cause ionization of the atoms of the gases present there. The ionosing power of these radiation decreases rapidly as they approach to earth, due to increase in number of collisions with the gas atoms. It is due to this reason the electrical conductivity of earth's atmosphere increase with altitude

205 **(b)**

When dark fringe is obtained at the point opposite to one of the slits, then

$S_1P = D$

$S_2P = \sqrt{D^2 + d^2}$

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

Path difference $= S_2P - S_1P$

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

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

Now, intensity of a dark fringe is zero

206 **(c)**

When one of slits is covered with cellophane paper, the intensity of light emerging from the slit is decreased (because this medium is translucent). Now the two interfering beam have different intensities or amplitudes. Hence intensity at minima will not be zero and fringes will become indistinct

207 **(a)**

For reflected system of the film, the maxima or constructive interference is $2\mu t\cos r = \frac{(2n-1)\lambda}{2}$ while the maxima for transmitted system of film is given by equation $2\mu t\cos r = n\lambda$

Where t is thickness of the film and r is angle of reflection. From these two equations we can see that condition for maxima in reflected system and transmitted system are just opposite

208 **(a)**

It is quite clear that the coloured spectrum is seen due to diffraction of white light on passing through fine slits made by fine threads in the muslin cloth

209 **(a)**

For two coherent sources,

$I = I_1 + I_2 + \sqrt{I_1 I_2} \cos \phi$

Putting $I_1 = I_2 = 0$

We have, $I = I_0 + I_0 + 2\sqrt{I_0 \times I_0} \cos \phi$

Simplifying the above expression

$I = 2I_0(1 + \cos \phi)$

$= 2I_0 \left(1 + 2\cos^2 \frac{\phi}{2} - 1\right)$

$= 2I_0 \times 2\cos^2 \frac{\phi}{2}$

$= 4I_0 \cos^2 \frac{\phi}{2}$

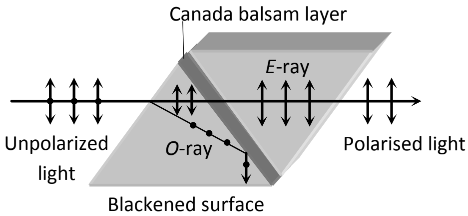
Also, $I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

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

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

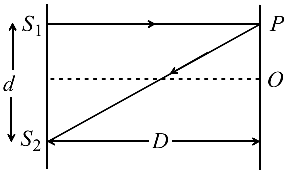
210 **(e)**
A narrow pulse is made of harmonic waves with a large range of wavelength. As speed of propagation is different for different wavelengths, the pulse cannot retain its shape while travelling through the medium

211 **(c)**
The nicol prism is made of calcite crystal. When light is passed through calcite crystal, it breaks up into two rays (i) the ordinary ray which has its electric vector perpendicular to the principal section of the crystal and (ii) the extra ordinary ray which has its electric vector parallel to the principal section. The nicol prism is made in such a way that it eliminates one of the two rays by total internal reflection, thus produces plane polarized light. It is generally found that the ordinary ray is eliminated and only the extra ordinary ray is transmitted through the prism. The nicol prism consists of two calcite crystal cut at $-68°$ with its principal axis joined by a glue called Canada balsam



212 **(b)**
The wavelength of these waves ranges between 4000 Å to 100 Å that is smaller wavelength and higher frequency. They are absorbed by atmosphere and convert oxygen into ozone. They cause skin diseases and they are harmful to eye and cause permanent blindness

213 **(b)**
When dark fringe is obtained at the point opposite to one of the slits then



$S_1 p = D$

and $S_2 p = \sqrt{D^2 + d^2}$

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

Path difference $= S_2 p - S_1 p$

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

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

Now, intensity of a dark fringe is zero

214 **(d)**
Intensity $\propto$ (amplitude)^2 and hence a non-linear physical quantity. So, we cannot add intensities directly, as principle of superposition is valid for linear waves only

215 **(d)**
In Young's experiment, fringe width for dark and white fringes is same while in the same experiment. When a white light as a source is used, the central fringe is white around which few colored fringes are observed on either side

216 **(c)**
In Young's experiment fringe width for dark and white fringe are same while in the same experiment, when a white light as a source is used, the central fringe is white around which few coloured fringes are observed on either side.

217 **(c)**
As the waves diffracted from the edges of circular

obstacle, placed in the path of light interfere constructively at the centre of the shadow resulting in the formation of a bright spot

218 **(a)**

In the absence of atmosphere, all the heat will escape from earth's surface which will make earth in hospitably cold

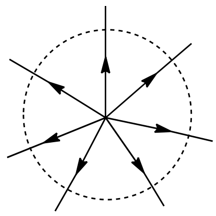
220 **(a)**

Depending on the value of refractive index, the path travelled by light would be decided, which in turn decides the shapes of wavefronts

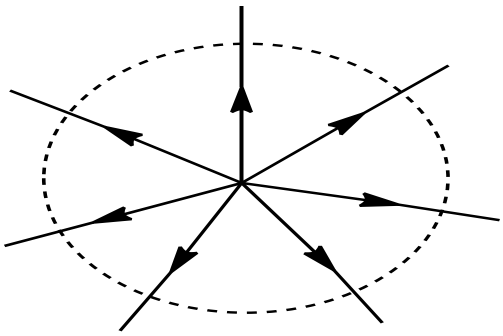
For more refractive index, speed of light is less and hence wavefront location would be somewhat located back side

221 **(d)**

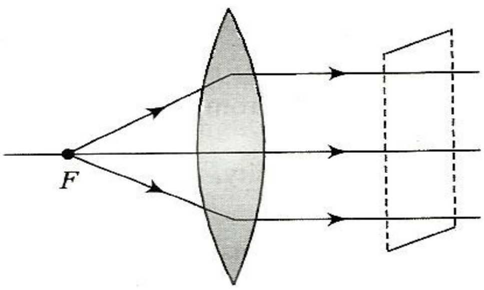
To draw the shape of wavefront, draw the ray diagram. The light will propagate in a direction perpendicular to the wavefronts



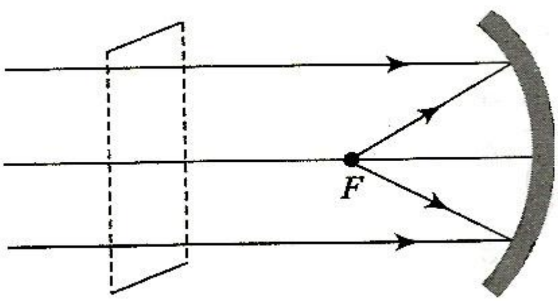
a.



b.



c.



d.

222 **(a)**

By using $(\mu - 1)t = n\lambda$, we can find value of n, that is order of fringe produced at P, if that particular strip has been placed over any of the slit. If two strips are used in conjuction (over each other), path difference due to each is added to get net path difference created. If two strips are used over different slits, their path differences are subtracted to get net path difference. Now,

$$n_1 = \frac{(\mu_1 - 1)t_1}{\lambda} = 5$$

$n = 4.5$

$n_3 = 0.5$

For (a), order of the fringe is 4.5, i.e., fifth dark

For (b), net order is $5 - 0.5 = 4.5$, i.e., fifth dark

For (c), net order is $5 - (0.5 + 4.5) = 0$, i.e., it is central bright again at P

For (d), net order is $(5 + 0.5) - (4.5) = 1$ i.e., first bright

223 **(b)**

Intensity at a distance x from central maxima on screen is

$$I = I_0 + 4I_0 + 2\sqrt{I_0}\sqrt{4I_0}\cos\frac{2\pi x}{\beta}$$

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

$I_{\max} = 9I_0$ and $I_{\min} = I_0$

a. At points where intensity is (1/9)th of maximum intensity, minima is formed. Therefore, distance between such points is $\beta, 2\beta, 3\beta, 4\beta, \ldots$

b. At points where intensity is (3/9)th of maximum intensity,

$$\cos\frac{2\pi x}{\beta} = -\frac{1}{2} \text{ or } x = \frac{\beta}{3}$$

Hence, distance between such points is

$$\frac{\beta}{3}, \frac{2\beta}{3}, \beta, \beta + \frac{\beta}{3}, \beta + \frac{2\beta}{3}, 2\beta, \ldots$$

c. $\cos\frac{2\pi x}{\beta} = 0$ or $x = \frac{\beta}{4}$

Hence, distance between such points is $\frac{\beta}{2}, \beta, \beta + \frac{\beta}{2}, 2\beta, \ldots$

d. $\cos\frac{2\pi x}{\beta} = \frac{1}{2}$ or $x = \frac{\beta}{6}$

Hence, distance between such points is

$\frac{\beta}{3}, \frac{2\beta}{3}, \beta, \beta + \frac{\beta}{3}, \beta + \frac{2\beta}{3}, 2\beta, \ldots.$

224 **(c)**

For $\mu_1 = \mu_2$, the two waves in the reflected system differ by optical phase difference of π and hence due to destructive interference, the film appears to be dark. In transmitted system, the two waves are in phase and hence film appears to be shiny. Similarly, we can go for the other conditions

225 **(b)**

$\mu = \frac{c}{v}$

$\Rightarrow \ \mu \propto \frac{1}{v}$

and

$\mu \propto \frac{1}{\lambda}$

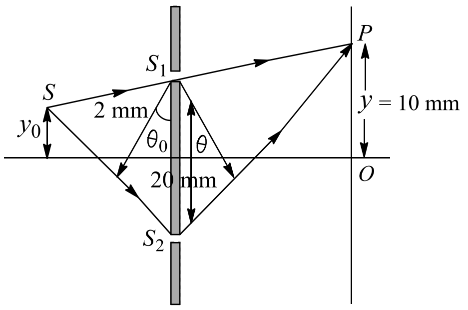
226 **(c)**

The optical path difference between the two waves arriving at P is

$\delta = (SS_2 + S_2P) - (SS_1 + S_1P)$

$= (SS_2 - SS_1) + (S_2P - S_1P)$

$= d\sin\theta_0 + d\sin\theta = \frac{dy_0}{D_1} + \frac{dy}{D_2}$



$D = 20$ mm, $y_0 = 2$ mm, $D_2 = 2$ m, $D_1 = 1$ m, $y = 10$ mm

$\therefore \ \delta = \frac{20 \times 2}{1000} + \frac{20 \times 10}{2000} = 0.14$ mm

For a bright fringe, $\delta = n\lambda$

$\Rightarrow n = \frac{\delta}{\lambda} = \frac{0.14}{0.5 \times 10^{-3}} = 280$

At the origin O, $\delta' = \frac{dy_0}{D_1} = 0.04$ mm

$n' = \frac{\delta'}{\lambda} = \frac{0.04}{0.5 \times 10^{-3}} = 80$

Due to transparent paper, the change in optical path is

$(\mu - 1)t = (1.45 - 1)(0.02)\text{mm} = 0.009$ mm

$\delta'' = 0.14 \text{ mm} - 0.009 \text{ mm} = 0.131$ mm

$\Rightarrow n = \frac{0.131}{0.5 \times 10^{-3}} = 262$

Due to transparent paper, the path difference at O,

$\delta = \delta' - (\mu - 1)t = (0.04 - 0.009)\text{mm}$

$= 0.031$ mm

$\Rightarrow \ n = \frac{0.031}{0.5 \times 10^{-3}} = 62$

227 **(a)**

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

(A) Phase difference at P_0, $\delta(P_0) = \frac{2\pi}{\lambda} \times 0 = 0$

$\delta(P_1) = \frac{2\pi}{\lambda} \times \frac{\lambda}{4} = \frac{\pi}{2}$

$\delta(P_2) = \frac{2\pi}{\lambda} \times \frac{\lambda}{3} = \frac{2\pi}{3}$

Intensity at P_0 is $I(P_0) = 4I_0\cos^2 0 = 4I_0$

$\left[\because I_R = 4I_0\cos^2\frac{\phi}{2}\right]$

Similarly, $I(P_1) = 4I_0\cos^2\left(\frac{\pi/2}{2}\right) = 2I_0$

$I(P_2) = 4I_0\cos^2\left(\frac{2\pi/3}{2}\right) = I_0$

Here $A \rightarrow p, s$

(B) Phase difference at P_0, $\delta(P_0) = \frac{2\pi}{\lambda} \times$ path difference

$= \frac{2\pi}{\lambda}[(\mu - 1)t - 0]$

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

$\delta(P_1) = \frac{2\pi}{\lambda}[\lambda/4 - \lambda/4] = 0$

$\delta(P_2) = \frac{2\pi}{\lambda}[\lambda/4 - \lambda/3] = -\pi/6$

Intensity at P_0 is $I(P_0) = 4I_0\cos^2\left(\frac{\pi/2}{2}\right) = 2I_0$

Similarly, $I(P_1) = 4I_0\cos^2(0) = 4I_0$

$I(P_2) = 4I_0\cos^2\left(\frac{-\pi/6}{2}\right) = 3.724I_0$

Hence $B \rightarrow q$

(C) Phase difference at P_0, $\delta(P_0) = \frac{2\pi}{\lambda}[(\mu - 1)t - 0$

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

$\delta(P_1) = \frac{2\pi}{\lambda}[\lambda/2 - \lambda/4] = \pi/2$

$\delta(P_2) = \frac{2\pi}{\lambda}[\lambda/2 - \lambda/3] = \pi/3$

Intensity at P_0 is $I(P_0) = 4I_0\cos^2(\pi/2) = 0$

$I(P_1) = 4I_0\cos^2\left(\frac{\pi/2}{2}\right) = 2I_0$

$I(P_2) = 4I_0\cos^2\left(\frac{\pi/3}{2}\right) = 3I_0$

Hence $C \rightarrow t$

(D) Phase difference at P_0, $\delta(P_0) = \frac{2\pi}{\lambda}[(\mu - 1)t - 0$

$= \frac{2\pi}{\lambda} \times \frac{3\lambda}{4} = \frac{3\pi}{2}$

$\delta(P_1) = \frac{2\pi}{\lambda}\left[\frac{3\lambda}{4} - \frac{\lambda}{4}\right] = \pi$

$\delta(P_2) = \frac{2\pi}{\lambda}\left[\frac{3\lambda}{4} - \frac{\lambda}{3}\right] = \frac{5\pi}{6}$

Intensity at P_0 is $I(P_0) = 4I_0\cos^2\left(\frac{3\pi/2}{2}\right) = 2\pi$

$I(P_1) = 4I_0\cos^2\left(\frac{\pi}{2}\right) = 0$

$I(P_2) = 4I_0\cos^2\left(\frac{5\pi/6}{2}\right) = 0.26I_0$

Hence $D \rightarrow r, s, t$

228 **(b)**

For constructive interference, $2d\cos i = n\lambda = \sqrt{2meV}$ on

Substituting values we get, $V \approx 50$ Volt.

229 **(d)**

$R = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\pi/2} = \sqrt{a_1^2 + a_2^2}$

230 **(d)**

Path difference produced is $\Delta x = \frac{3}{2}\pi R - \frac{\pi}{2}R = \pi R$

For maxima: $\Delta x = n\lambda$

$\therefore n\lambda = \pi R$

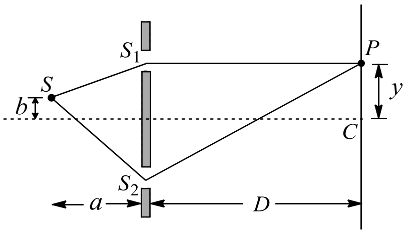
$\Rightarrow \lambda = \frac{\pi R}{n}, n = 1, 2, 3, \ldots$

Thus, the possible values of λ are $\pi R, \frac{\pi R}{2}, \frac{\pi R}{3}, \ldots$

231 **(a)**

Optical path difference $= 2n_1 t$

232 **(b)**



Path difference at any point on the screen

$\Delta x = \frac{bd}{a} + \frac{y'd}{D}$

For central maxima. $\Delta x = 0$

$\Rightarrow y' = -\frac{bD}{a} = -\frac{(1+\cos\pi t)2}{1}$

$y' = -2(1+\cos\pi t)$

Position of central maxima at any time is

$y' = -2(1 + \text{con}\,\pi t)$ mm

At $t = 2$ s, $y' = -4$ mm

At $t = 1$ s, central maxima is at $y' = 0$

But when a plate is inserted central maxima is at

$y_1 = \frac{D}{d}(\mu - 1)t = 1$ mm

233 **(b)**

(a) The path difference at any point on the screen is

$d\sin\theta = n\lambda$

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

n is maximum when $\sin\theta$ is maximum; thus maximum value of n is

$n = \frac{d}{\lambda} = 4$

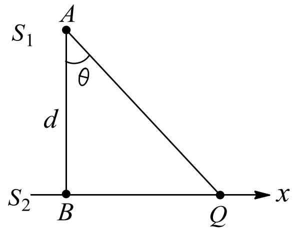
Hence, number of minima are four approximately corresponding to path difference

$\Delta x = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}, \frac{7\lambda}{2}$

Thus, apart from central maxima at $\theta = 0$, eight other maxima, 4 on either side of central maxima are registered. Total maxima registered are 9 and 8 minima lie between them

(b) The path difference at any point Q on the x-axis is

$\Delta X = AQ - BQ = \frac{AB}{\cos\theta}(1 - \sin\theta)$



Condition for maxima is

$\frac{d}{\cos\theta}(1 - \sin\theta) = n\lambda$

$n = \frac{4(1 - \sin\theta)}{\cos\theta}$

At point $B, \theta = 0 \Rightarrow n = 4$, i.e, we get fourth-order maxima. At $x = \infty, \theta = \pi/2$, path difference is zero

Thus, at $\theta = \pi/2$, we have $n = 0$, i.e., zeroth-oder maxima is formed at $x = \infty$

Hence, along x-axis, beginning from slit B fifth-order maxima are registered

234 **(b)**

Position of a point on a screen is

$y = D\tan\theta = 1\tan\theta$

For first minima,

$n = 1, \sin\theta_1 = \frac{1}{4}, \tan\theta_1 = \frac{1}{\sqrt{15}}$

For second minima,

$n = 2, \sin\theta_2 = \frac{3}{4}, \tan\theta_2 = \frac{3}{\sqrt{7}}$

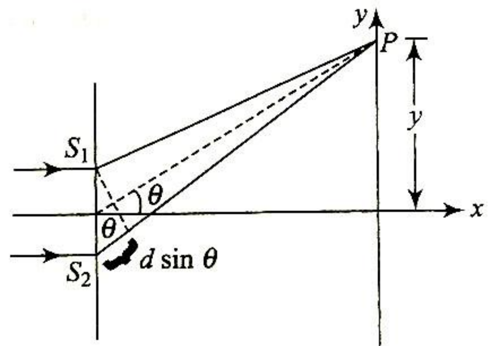
So, the positions of minima are

$y_1 = \tan\theta_1 = \frac{1}{\sqrt{15}} = 0.258$ m

$y_2 = \tan\theta_2 = \frac{3}{\sqrt{7}} = 1.13$ m

The minima are symmetrically placed on either side of central maxima; therefore there will be 4 minima at positions ± 0.258 m and ± 1.13 m on the screen

(a) When incident rays are incident normally, the waves arriving at slits are in phase, zero path difference before slits. Path difference after slits, at point P, is $d\sin\theta$



Condition for minima at y-axis is

$$d\sin\theta = (2n-1)\frac{\lambda}{2}$$

$$\sin\theta = \frac{(2n-1)\lambda}{2d} = \frac{(2n-1)(0.5)}{2\times 1} = \frac{(2n-1)}{4}$$

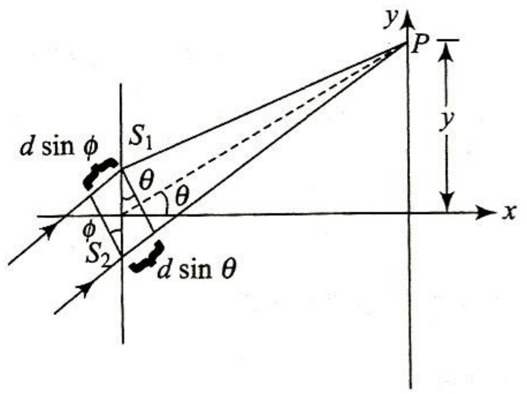
As $\sin\theta \le 1, \left(\frac{2n-1}{4}\right) \le 1$ or $n \le 2.5$

Hence, only first-order and second-order minima are possible

(b) Path difference before slits $= d\sin\phi$

Path difference after slits $= d\sin\theta$

As path of rays before slits is longer at S_1 and $S_2P > S_1P$ after slits, so net path difference for first minima is



$$d\sin\theta - d\sin\phi = \pm\frac{\lambda}{2}$$

$$\sin\theta = \sin\phi \pm \frac{\lambda}{2}$$

$$= \sin 30° \pm \frac{0.5}{2\times 1} = \frac{3}{4} \text{ or } \frac{1}{4}$$

$$\tan\theta = \frac{3}{\sqrt{7}} \text{ and } \frac{1}{\sqrt{15}}$$

So, the position of first minima on either side of central maxima is

$$y = D\tan\theta = \frac{3}{\sqrt{7}} \text{ and } \frac{1}{\sqrt{15}} \text{ m}$$

235 **(b)**

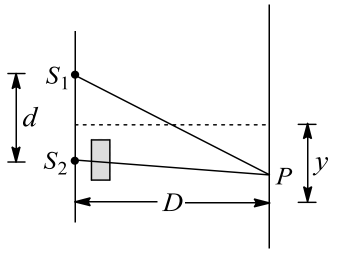
(a) Path difference at point P on the screen,

$\Delta x = \frac{yd}{D}$

At the position of central maxima, the optical path lengths S_2P and S_1P are equal

$$\frac{(S_2P - t)}{c/\mu_1} + \frac{t}{c/\mu_2} = \frac{S_1P}{c/\mu_1}$$

Where $\mu_1 = 4/3, \mu_2 = 3/2$



$$\mu_1(S_1P - S_2P) = (\mu_2 - \mu)t$$

$$\mu_1\left(\frac{yd}{D}\right) = (\mu_2 - \mu_1)t$$

$$y = \frac{(\mu_2 - \mu_1)tD}{\mu_1 d}$$

$$= \frac{[(3/2) - (4/3)] \times 10.4 \times 1.5}{(4/3) \times 0.45 \times 10^{-3}} = 4.33 \text{ mm}$$

(b) At point O, net path difference,

$$\Delta x = \left(\frac{\mu_2}{\mu_1} - 1\right)t$$

Net phase difference,

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

Net phase difference,

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

$$= \frac{2\pi}{6\times 10^{-7}}\left(\frac{1.5}{4/3} - 1\right)(10.4 \times 10^{-6}) = \left(\frac{13}{3}\right)\pi$$

Thus, intensity

$$I = I_{\max}\cos^2(\phi/2)$$

$$= I_{\max}\cos^2\left(\frac{13\pi}{6}\right) = \frac{3}{4}I_{\max}$$

(c) For maximum intensity at point O,

$\Delta x = n\lambda$ (where $n = 1, 2, 3, \ldots$)

Path difference at point O,

$$\Delta x = \left(\frac{1.5}{4/3} - 1\right)(10.4 \times 10^{-6}) = 1300 \text{ nm}$$

Thus, maximum intensity will correspond to $\frac{1300}{2}$ nm, $\frac{1300}{3}$ nm, ...

In the given range, required values are 650 nm and 433.33 nm

236 **(b)**

The angular fringe width i.e., the angle subtended by a fringe at the centre of slits is given by

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

According to the given condition,

$$\beta_\theta = \frac{\lambda}{d} \ge \frac{\pi}{180 \times 60}$$

$$d \le \frac{6\times 10^{-7} \times 180 \times 60}{\pi}$$

$$d \le 2.06 \times 10^{-3} \text{ m}$$

Thus, $d_{max} = 2.06 \times 10^{-3}$ m $= 2.06$ mm

Position of 3rd bright fringe,

$$y_3 = \frac{3\lambda D}{d} = \frac{3 \times 6 \times 10^{-7} \times 1}{2.06 \times 10^{-3}} = 8.74 \times 10^{-4} \text{ m}$$

Position of 5th dark fringe,

$$y_5 = \frac{\left(n - \frac{1}{2}\right)\lambda D}{d} = \frac{9\lambda D}{2d}$$

$$= \frac{9 \times 6 \times 10^{-7} \times 1}{2 \times 2.06 \times 10^{-3}} = 13.1 \times 10^{-4} \text{ m} = 1.31 \text{ mm}$$

237 **(b)**

While calculating path difference, it must be remembered that it is equal to difference of optical path lengths from source S to point on the screen

$\therefore \Delta x_{total} = [\Delta x]_{\text{before slits}} + [\Delta x]_{\text{after slits}}$

$= (SS_2 - SS_1) + (S_2P - S_1P)$

(a) When liquid is filled between the slits and screen, then

$[S_2P]_{\text{liquid}} = [\mu S_2P]_{\text{air}}$

$[S_1P]_{\text{liquid}} = [\mu S_1P]_{\text{air}}$

At point O: $\mu S_2O = \mu S_1O$

No path difference is introduced after slits. So,

$$\Delta x_{total} = SS_2 - SS_1 = \sqrt{d^2 + X_0^2} - x_0$$

Thus, phase difference,

$$\Delta\phi = \frac{2\pi}{\lambda}\left(\sqrt{d^2 + X_0^2} - x_0\right)$$

At point P: $[\Delta x]_{\text{before slits}} = \sqrt{d^2 + X_0^2} - x_0$

$[\Delta x]_{\text{after slits}} = \mu S_2P - \mu S_1P = \mu(S_2P - S_1P)$

$$= \frac{\mu y d}{D} = \frac{\mu d^2}{2D} \quad \left(\text{as } y = \frac{d}{2}\right)$$

Therefore,

$$[\Delta x]_{total} = \left[\sqrt{d^2 + x_0^2} - x_0\right] + \frac{\mu d^2}{2D}$$

Thus, phase difference,

$$\Delta\phi = \frac{2\pi}{\lambda}\left[\left(\sqrt{d^2 + x_0^2} - x_0\right) + \frac{\mu d^2}{2D}\right]$$

(b) When liquid is filled between the source and slits:

At point O: $(\Delta x)_{\text{before slits}} = (SS_2 + SS_1)_{\text{liquid}}$

$= (\mu SS_2 + \mu SS_1)_{\text{air}}$

$$= \mu\left(\sqrt{d^2 + x_0^2} - x_0\right)$$

$(\Delta x)_{\text{after slits}} = S_2O + S_1O = 0$

$$(\Delta x)_{total} = \mu\left(\sqrt{d^2 + x_0^2} - x_0\right)$$

Thus, phase difference at P,

$$\Delta\phi = \frac{2\pi}{\lambda}\left(\mu\sqrt{d^2 + x_0^2} - x_0\right)$$

At point P: $(\Delta x)_{\text{before slits}} = (SS_2 + SS_1)_{\text{liquid}} = (\mu SS_2 + \mu SS_1)_{\text{air}}$

$$(\Delta x)_{\text{after slits}} = (S_2P - S_1P)_{\text{air}} = \frac{yd}{D} = \frac{d^2}{2D}$$

$$(\Delta x)_{total} = \left[\left(\mu\sqrt{d^2 + x_0^2} - x_0\right) + \frac{d^2}{2D}\right]$$

Thus, phase difference at P,

$$\Delta\phi = \frac{2\pi}{\lambda}\left[\mu\sqrt{d^2 + x_0^2} - x_0 + \frac{d^2}{2D}\right]$$

238 **(b)**

We consider a point P on the screen

Optical path length,

$[S_1P]_{\text{liquid}} = [\mu_1 S_1P]_{\text{air}}$

$[S_1P - t]_{\text{liquid}} + t_{\text{glass}} = \mu_1[S_2P - t]_{\text{air}} + [\mu_g t]_{\text{air}}$

$= [\mu_1 S_2P + (\mu_g - \mu_1)t]_{\text{air}}$

Hence, optical path difference at P,

$\Delta x = [\mu_1 S_2P + (\mu_g - \mu_1)t] - \mu_1 S_1P$

$= \mu_1(S_2P - S_1P) + (\mu_g + \mu_1)t$

For a point P at the screen in the absence of liquid,

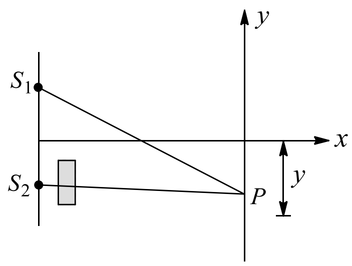
$$S_2P = S_1P = \frac{yd}{D}$$

If a liquid is filled,

$$[S_2P - S_1P]_{\text{liquid}} = \frac{\mu_1 yd}{D}$$

Thus,

$$\Delta x = \frac{\mu_1 yd}{D} + [\mu_g - \mu_1]t$$



(a) For central maxima,

$\Delta x = 0$

$$y = \left[\frac{\mu_g - \mu_1}{\mu_1}\right]\frac{tD}{d} = \frac{(4 - T)tD}{(10 - T)d}$$

At point $O, y = 0$

(b) Speed of central maxima,

$$v = \left|\frac{dy}{dt}\right| = \frac{6Dt}{(10 - T)^2 d}$$

Central maxima is at O at time $t = 4$ s

$$\therefore v = \frac{6Dt}{36d} = \frac{1 \times 36 \times 10^{-6}}{6 \times 2 \times 10^{-3}} = 3 \times 10^{-3} \text{ ms}^{-1}$$

239 **(c)**

(a) For point P in front of upper slit, $y = d/2$

Initially path difference,

$\frac{(d/2)d}{D} = n\lambda \quad$ (i)

Intensity at any point on the screen is

$$I = I_{\max}\left(\frac{1-\cos\phi}{2}\right)$$

(ϕ being the phase difference)

When the screen is displaced, $I = \frac{I_{\max}}{4}$

Hence, $\cos\phi = \frac{1}{2} \Rightarrow \phi = 2n\pi \pm \frac{\pi}{3}$ (ii)

Also, as P lies between third and fourth minima,

$5\pi < \phi < 7\pi$ (iii)

From Eqs. (ii) and (iii), we get

$$\phi = \frac{17\pi}{3} \text{ or } \frac{19\pi}{3}$$

$$\phi = \frac{(d/2)d}{D'}\frac{2\pi}{\lambda} = \frac{(n\lambda D)}{D'}\frac{2\pi}{\lambda} = \frac{2n\pi D}{D'}$$

$= \frac{17n\pi}{6}$ (putting the values of D and D')

$\therefore n = 2$ or $(38/17)$

But n is an integer, therefore $n = 2$ is the only valid answer

(b) Putting the value of n and d in Eq. (i), we get

$\lambda = 5.9 \times 10^{-7}$ m

240 **(b)**

The optical path difference at P is

$\Delta x = S_1P - S_2P = d\cos\theta$

$\because \cos\theta = 1 - \frac{\theta^2}{2}$ for small θ

$$\therefore \Delta x = d\left(1 - \frac{\theta^2}{2}\right)$$

$= d\left[1 - \frac{y^2}{2D^2}\right]$, where $D + d = D$

For nth maxima,

$\Rightarrow \Delta x = n\lambda$

$$d\left[1 - \frac{y^2}{2D^2}\right] = n\lambda$$

y =radius of the nth bright ring

$$= D\sqrt{2\left(1 - \frac{n\lambda}{d}\right)}$$

At the central maxima, $\theta = 0$

$\Delta x = d = n\lambda$

$$\Rightarrow n = \frac{d}{\lambda} = \frac{0.5}{0.5 \times 10^{-3}} = 1000$$

Hence, for the closest second bright ring, $n = 998$

Putting values, $r = 6.32$ cm

241 **(b)**

From the given condition,

$$OS_3 = \frac{D\lambda}{d} = \frac{1 \times 6 \times 10^{-7}}{3 \times 10^{-3}} = 2 \times 10^{-4} \text{ m}$$

Let light reaching from S_1 and S_2 to S_4 has phase difference ϕ and intensity of incident light is I_0.

Resultant intensity at S_4 is

$$I = 4I_0\cos^2\frac{\phi}{2}$$

As $I = I_0$, hence

$$\frac{I_0}{4I_0} = \cos^2\frac{\phi}{2}$$

$$\Rightarrow \cos\frac{\phi}{2} = \frac{1}{2}\cos 60°$$

$$\phi = \frac{2\pi}{3}, \phi = \frac{2\pi}{3}\Delta x \Rightarrow \Delta x = \frac{\lambda}{3}$$

As $\Delta x = \frac{\lambda}{3}$, using $\frac{\Delta x}{d} = \frac{y}{D}$

$$y = \frac{\Delta x D}{d} \Rightarrow OS_4 = \frac{D\lambda}{3d}$$

Therefore, $S_3S_4 = OS_3 + OS_4 = \frac{4}{3}\frac{d\lambda}{d} = \frac{8}{3} \times 10^{-4}$ m

Now, resultant wave coming out of S_3 has intensity $4I_0$ and waves coming out of S_4 have intensity I_0

Phase difference at $S_3 = 2\pi$

Phase difference at $S_4 = 2\pi/3$

These phase differences are relative to the light incident on slits S_1 and S_2

Now, S_3 and S_4 are secondary sources of light

Phase difference at $O' = 4\pi/3$, equal to initial phase difference between the light reaching at O', i.e.,

$$2\pi - \frac{2\pi}{3} = \frac{4\pi}{3}$$

Let intensity at O' be I'. Then

$$I' = I_0 + 4I_0 + 2\sqrt{I_0}\sqrt{4I_0}\cos\frac{4\pi}{3}$$

$$= 5I_0 + 4I_0\cos\left(\pi + \frac{\pi}{3}\right) = 3I_0$$

For the brightest fringe,

Phase difference $= 2np, n = 0, \pm1, \pm2, \ldots$

Let I'' be the intensity of the brightest fringe

$I'' = I_0 + 4I_0 + 2\sqrt{I_0}\sqrt{4I_0}\cos\phi$ (where $\cos\phi = 1$)

$= 9I_0$

242 **(b)**

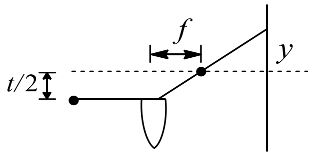
From lens equation, we have

$v = \frac{uf}{f-u}$ (v lies on the left side)

$$d = 2\left(\frac{1}{2}\right)\left[\frac{v}{u} - 1\right] = t\left[\frac{u}{f-u}\right]$$

$$D = L + v = L + \frac{uf}{f-u}$$

Fringe width,



$$\beta = \frac{\lambda D}{d} = \frac{\lambda\left[L + \frac{uf}{f-u}\right]}{t\left[\frac{u}{f-u}\right]}$$

$\beta = \frac{\lambda}{t}\left[f + \frac{L(f-u)}{u}\right]$

When $u \to f, \beta = \frac{\lambda f}{t}$

From the figure,

$\frac{y}{L-f} = \frac{t/2}{f} \Rightarrow y = \frac{t/2}{f}(L-f)$

Distance of the point up to which interferences occurs,

$y_0 = \frac{t/2}{f}(L-f) + \frac{t}{2} = \frac{tL}{2f}$

Number of visible maxima $= \frac{tLt}{2f \times \lambda f} = \frac{Lt^2}{2\lambda f^2}$

243 **(a)**

For dark spot at O,

$\Delta x = (AB + BO) - AO$

$= 2(D^2 + d^2)^{1/2} - 2D = 2D\left[\left(1 + \frac{d^2}{D^2}\right)^{1/2} - 1\right]$

$\Rightarrow \Delta x = \frac{d^2}{D}$

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

Δx at P:

$\Delta x = (AB + BP) - (AC + PC)$

$= (AB - AC) + (BP - PC)$

Δx at O: $\Delta x = \frac{\lambda}{2}$

The path difference at P will be zero if $x = d$.

Hence next maxima will form at P

Fringe width = distance between two consecutive dark or bright fringes

$= 2 \times$ distance between two consecutive bright dark fringes

$= 2 \times d$

244 **(a)**

$z = \frac{\lambda S}{2d}$

At S_4: $\frac{\Delta x}{d} = \frac{z}{D}$

$\Rightarrow \Delta x = \frac{\lambda D}{2d}\frac{d}{D} = \frac{\lambda}{2}$

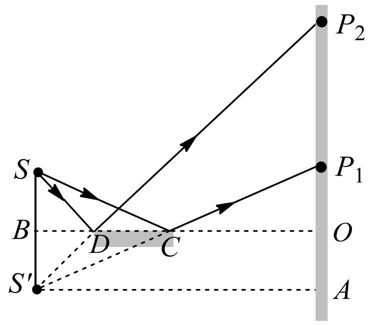
Hence, minima at S_4 and maxima at S_3 (intensity $4I_0$)

Hence,

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

245 **(c)**

Fringes will be observed in the region between P_1 and P_2 because the reflected rays lie only in this region



From similar triangles BDS' and $S'P_2A$

$\frac{AP_2}{BS'} = \frac{AS'}{BD}$

$\therefore AP_2 = \frac{(AS')(BS')}{BD}$

$= \frac{(190 + 5 + 5)(0.1)}{5} = 4$ cm

Similarly, in triangles BCS' and $S'P_1A$

$\frac{AP_1}{BS'} = \frac{AS'}{BD}$

$\therefore \frac{(AS')(BS')}{BC} = \frac{(190 + 5 + 5)(0.1)}{10} = 2$ cm

$\therefore P_1P_2 = AP_2 - AP_1 = 2$ cm

Wavelength of the light,

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

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

Here, $D = S'A = 190 + 5 + 5 = 200$ cm $=$ 2.0 m, $d = SS' = 2$ mm $= 2 \times 10^{-3}$ m

$\therefore \beta = \frac{(5 \times 10^{-7})(2.0)}{2 \times 10^{-3}} = 5 \times 10^{-4}$ m

$= 0.05$ cm

Therefore, number of fringes $= \frac{P_1P_2}{\beta} = 40$

246 **(c)**

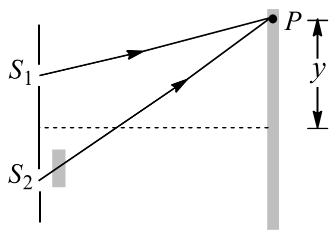
Without inserting the slab, path difference at P,

$\Delta x = \frac{yd}{D} = \frac{0.15 \times 10^{-3} \times 2 \times 10^{-3}}{2}$

$= 1.5 \times 10^{-7}$ m

Corresponding phase difference at P,

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



$= \left(\frac{2\pi}{6000 \times 10^{-10}}\right)(1.5 \times 10^{-7}) = \frac{\pi}{2}$

$\frac{\phi}{2} = \frac{\pi}{4}$

Therefore, intensity at P, $I = 4I_0\cos^2(\phi/2) = 2I_0$

Phase difference after placing the glass sheet,

$$\phi' = \phi + \frac{2\pi}{\lambda}(\mu - 1)t$$
$$= \frac{\pi}{2} + \frac{2\pi}{6000 \times 10^{-10}}(1.5 - 1)(8000 \times 10^{-19})$$
$$= \frac{11\pi}{6}$$
Now, the intensity at P is,
$$I' = I_0 + \eta I_0 + 2\sqrt{\eta I_0^2}\cos\frac{11\pi}{6} = 2I_0 \text{ (given)}$$
Solving this equation, we get $\eta = 0.21$

247 **(b)**

At $x = 0$, path difference is 3λ. Hence, third-order maxima will be obtained. At $x = \infty$, path difference is zero. Hence, zero-order maxima is obtained. In between, first and second-order maxima will be obtained

First-order maxima:
$$S_2P - S_1P = \lambda \text{ or } \sqrt{x^2 + 9\lambda^2} - x = \lambda$$
or $\sqrt{x^2 + 9\lambda^2} = x + \lambda$

Squaring this, we get $x^2 + 9\lambda^2 = x^2 + \lambda^2 + 2x\lambda$

Solving this, we get $x = 4\lambda$

Second-order maxima:
$$S_2P - S_1P = 2\lambda \text{ or } \sqrt{x^2 + 9\lambda^2} - x = 2\lambda$$
or $\sqrt{x^2 + 9\lambda^2} = (x + 2\lambda)$

Squaring both sides, we get
$$x^2 + 9\lambda^2 = x^2 + 4\lambda^2 + 4x\lambda$$
Solving this, we get $x = \frac{5}{4}\lambda = 1.25\lambda$

Hence, the desired x-coordinates are

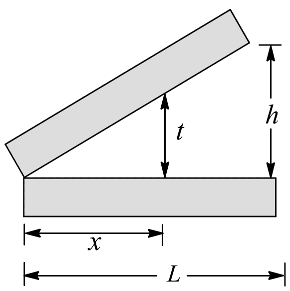
$x = 1.25\,\lambda$ and $x = 4\lambda$

248 **(d)**

Order of the fringe can be counted on either side of the central maximum. For example, fringe no. 3 is first-order bright fringe

249 **(b)**

For constructive interference, $2t = (2n - 1)\frac{\lambda_{air}}{2}$

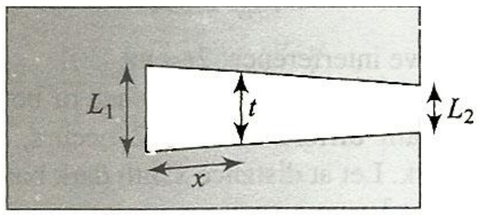


For destructive interference, $2t = n\lambda_{air}$

As due to reflection at the top surface bottom layer, an additional path difference of $\lambda/2$ occurs, contact point would be dark. Let at distance x, nth dark band forms
$$\therefore 2t = n\lambda_{air}$$
$$\frac{t}{x} = \frac{h}{L}$$
$$\frac{2hx}{L} = n\lambda_{air}$$
$$\Rightarrow x = n\left[\frac{\lambda_{air} \times L}{2h}\right]$$
$$\Rightarrow x = n\left[\frac{400 \times 10^{-9} \times 5 \times 10^{-2}}{2 \times 20 \times 10^{-6}}\right]$$
$$= (5 \times 10^{-4}\text{ n})$$
Maximum value of n would be for $x = L$
$$\therefore n_{max} = \frac{5 \times 10^{-2}}{5 \times 10^{-4}} = 100$$

250 **(b)**

From the theory mentioned in passage, at the ends of cavity fringes will form, and as number of dark fringes is greater than the number of bright fringes so the ends will be location of dark fringes. Thickness of the cavity at a distance x from the left end would be
$$t = L_2 + \frac{L_1 - L_2}{L}x$$



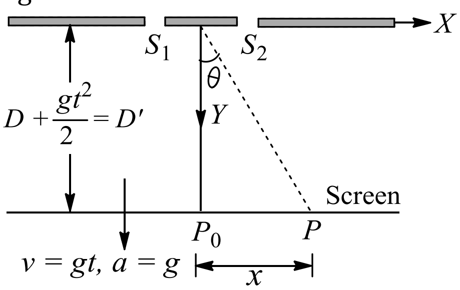
For left end,

$2\mu L_1 = n\lambda_0$ (for dark fringe)

For right end,
$$2\mu L_2 = (n - 7)\lambda_0$$
$$L_1 - L_2 = \frac{7\lambda_0}{2\mu}$$

251 **(a)**

At any time t, the situation is as shown in the figure below



Central maxima is always lying on Y-axis at P_0. Its velocity at any time t is given by $v = gt$ along positive Y axis. So, required velocity is 50 m s^{-1}

252 **(d)**
$$I_{av} = \frac{I_{max} + I_{min}}{2}$$
$$= \frac{(A_1 + A_2)^2 + (A_1 - A_2)^2}{2}$$
$$= A_1^2 + A_2^2 = I_1 + I_2$$
$$I_{av} = I_1 + I_2$$

So, choice (d) is correct

Neither loss nor gain of energy is observed, but only redistribution of energy takes place

253 **(b,c)**

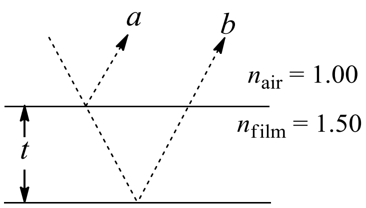
Broad sources provide wide angular incidence of light. The thickness should be small, since the path difference should be comparable with the wavelength. Thick slabs cannot bring wavelength comparable path differences. So, choices (a) and (d) are wrong. Choices (b) and (c) are correct

254 **(a)**

Net path difference to the central fringe position is $\lambda/2$. Since it is an old multiple of $(\lambda/2)$, the fringe formed is dark. So, choice (a) is correct and the others are wrong

255 **(b)**

$n_{\text{air}} < n_{\text{film}} < n_{\text{glass}}$. Reflection with phase change of $\lambda/2$ occurs for ray a at the air-film interface and for ray b at the film-glass interface. Therefore, reflections keep both rays in phase



Constructive interference then depends on making the path length difference, $2t$, within the film a multiple of λ

$2t = m\lambda/nt = m(600\text{ nm})/2(1.50)$

$= m \times 200\text{ nm}$

For $m = 1, t = 200$

256 **(b)**

$$I \propto \frac{1}{(\text{distance})^2}$$

$$\therefore \frac{\Delta I}{I_0} = \frac{L^2 - (L-x)^2}{L^2} \approx \frac{2A\sin\omega t}{L}$$

257 **(b)**

Intensity at O is proportional to intensity at S_3 and at S_4

$I = k\cos^2\frac{\delta}{2}$, where k is constant and δ is the phase difference

$\delta = \frac{2\pi}{\beta} \times \frac{Z}{2} = \frac{\pi Z}{\beta}$ where β is fringe width

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

When $Z = \lambda D/2d$:

$$\delta = \frac{\pi d}{\lambda D} \times \frac{\lambda D}{2d} = \frac{\pi}{2}$$

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

$$k = 2I_0$$

When $Z' = \frac{2\lambda D}{d}$:

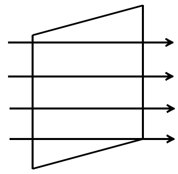
Path difference $\delta' = \frac{2\pi}{\beta}\frac{Z'}{2} = \frac{2\pi d}{\lambda d} \times \frac{2\pi D}{\lambda d} = 2\pi$

Required intensity at O is

$$I' = k\cos^2\frac{\delta}{2} = 2I_0\cos^2(\pi) = 2I_0$$

258 **(a)**

Parallel cylindrical beam gives planar wavefront



259 **(b)**

Obviously (2) is denser because ray bends towards normal

260 **(0)**

Take a point at a distance y from the centre of the slit. Path difference between waves reaching this point:

$$\Delta x = \frac{dy}{D} - (\mu - 1)t$$

For centre of slit: $y = 0$

So $\Delta x = -(\mu - 1)t$

Phase difference: $\phi = \frac{2\pi}{\lambda}\Delta x = -\frac{2\pi}{\lambda}(\mu - 1)t$

$$I = 4I_0\cos^2\left(\frac{\phi}{2}\right) = 4I_0\cos^2\left(\frac{\pi}{\lambda}(\mu - 1)t\right)$$

$$= 4I_0\cos^2\left[\frac{\pi(1.5-1)1.5 \times 10^{-6}}{500 \times 10^{-10}}\right] = 4I_0\cos^2\left(\frac{3\pi}{2}\right)$$

$$= 0$$

261 **(7)**

The powers of sources A and B are

$$P_A = \left(\frac{10}{\pi}\right) \times \pi r_A^2 = 10 \times (0.001)2 = 10^{-5}\text{ W}$$

$$P_B = \left(\frac{10}{\pi}\right) \times \pi r_B^2 = 10 \times (0.002)2 = 4 \times 10^{-5}\text{ W}$$

Powers of sources A and B received along F are

$$P_A = \frac{10}{100}(4 \times 10^{-5}) = 10^{-6}\text{ W}$$

$$P_B = \frac{10}{100}(4 \times 10^{-5}) = 4 \times 10^{-6}\text{ W}$$

Path difference

$\Delta = (\mu - 1)t = (1.5 - 1) \times 2000\text{Å} = 1000\text{Å}$

Phase difference

$$\delta = \frac{2\pi}{\lambda} \times \Delta = \frac{2\pi}{6000} \times 1000 = \frac{\pi}{3}$$

Power at point F is given by

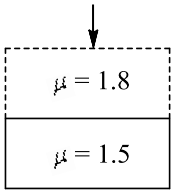
$$P_F = P_A + P_B + 2\sqrt{P_A P_B}\cos\delta$$

$$= 10^{-6} + 4 \times 10^{-6} + 2\sqrt{10^{-6} \times 4 \times 10^{-6}}\cos\frac{\pi}{3}$$

$$= 7 \times 10^{-6}\text{ W}$$

262 **(a)**

Path difference between rays reflected from upper and lower faces of layer $= 2\mu t \cos r = 2\ \mu t$ (for normal incidence). But there is abrupt change in path of $\lambda/2$ of light at upper surface. So actual path difference is $2\ \mu t - \lambda/2$



For constructive interference $2\ \mu t - \frac{\lambda}{2} = n\lambda$

$t = \frac{(2n+1)\lambda}{4\mu}$. For least thickness $n = 0$

$$\therefore t_{\min} = \frac{\lambda}{4\mu} = \frac{648}{4 \times 1.8}\text{nm} = 90\text{ nm}$$

263 **(3)**

Path difference at C,

$$\Delta x = t_1(\mu - 1) - t_2(\mu - 1)$$
$$= \mu(t_1 - t_2) - (t_1 - t_2) = (t_1 - t_2)(\mu - 1)$$
$$= (2.5 - 1.25)\left(\frac{1.4 \times 3}{4 \times 10} - 1\right)$$
$$= 1.25 \times \frac{2}{40} = \frac{2.5}{400} \Rightarrow \Delta x = \frac{1}{16}\mu\text{m}$$
$$\phi = \frac{2\pi}{\lambda} \cdot \Delta x = \frac{2\pi \times 4}{5000 \times 3 \times 10^{-10}} \cdot \frac{1}{16} \times 10^{-6}$$
$$\Rightarrow I_{\max} = 4I_0$$

I at $C, I_c = 2I_0\left(1 + \cos\frac{\pi}{3}\right) = 3I_0$

Required ratio $= I_c/I_0 = 3$

264 **(7)**

Number of fringes is

$$t\frac{(\mu - 1)D/d}{D\lambda/d} = \frac{(\mu - 1)t}{\lambda} = 7$$

265 **(5)**

Let intensity of individual slit be I_0, then intensity of central maxima is $4I_0$

Intensity at distance y from the central maxima is

$I = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$ where $\phi = \frac{2\pi}{\lambda}\frac{dy}{D}$

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

$$\Rightarrow \cos\left(\frac{\phi}{2}\right) = \frac{1}{\sqrt{2}} \Rightarrow \frac{\phi}{2} = \frac{\pi}{4} \Rightarrow \phi = \frac{\pi}{2}$$

$$\Rightarrow \frac{2\pi}{\lambda}\frac{dy}{D} = \frac{\pi}{2} \Rightarrow y = \frac{D\lambda}{4d}$$
$$\Rightarrow = \frac{500 \times 10^{-9} \times 4}{4 \times 10^{-3}} = 5 \times 10^{-4}\text{ m}$$

266 **(5)**

According to the question, shift $= 5$ (fringe width)

$$\therefore \frac{(\mu - 1)tD}{d} = \frac{5\lambda D}{d}$$
$$\therefore t = \frac{5\lambda}{\mu - 1} = \frac{25000}{1.5 - 1} = 50{,}000\text{ Å} = 5 \times 10^{-6}\text{ m}$$

267 **(7)**

I is the intensity of incident beam ab. The interfering waves are bc and ef, reflected from surface of I and II plate, respectively

Reflection coefficient of intensity,

$r = 25\% = 0.25$

Transmission coefficient of intensity,

$t = 75\% = 0.75$

The intensity of beam $bc, I_1 = 0.25\ I = \frac{1}{4}\ I$

The intensity of beam $bd = 0.75I$

The intensity of beam $de = 0.25 \times 0.75I$

The intensity of beam ef,

$$I_2 = 0.75 \times 0.25 \times 0.75I = \frac{9}{64}I$$

Ratio of maximum and minimum intensities

$$\frac{\sqrt{I_{\max}}}{\sqrt{I_{\min}}} = \frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}} = 7$$