CHAPTER 16

Optics

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

(a) 0° (b) 30° (c) 45° (d) 60°

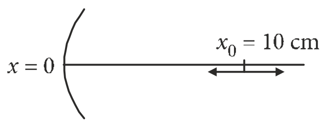
(2018)

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

(a) 25 μm (b) 50 μm (c) 75 μm (d) 100 μm

(2018)

3. A particle is oscillating on the x-axis with an amplitude 2 cm about the point x_0 = 10 cm, with a frequency ω. A concave mirror of focal length 5 cm is placed at the origin (see figure). Identify the correct statements.



(1) The image executes periodic motion.
(2) The image executes non-periodic motion.
(3) The turning points of the image are asymmetric w.r.t. the image of the point at x = 10 cm.
(4) The distance between the turning points of the oscillation of the image is $\frac{100}{21}$ cm

(a) 2, 4 (b) 2, 3 (c) 1, 3, 4 (d) 1, 4

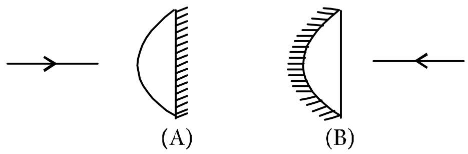
(Online 2018)

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

(a) $\frac{\pi}{8}$ (b) $\frac{\pi}{12}$ (c) $\frac{\pi}{6}$ (d) $\frac{\pi}{4}$

(Online 2018)

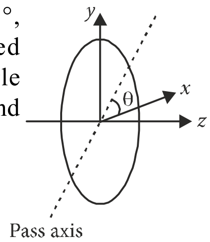
5. A planoconvex lens becomes an optical system of 28 cm focal length when its plane surface is silvered and illuminated from left to right as shown in figure (A). If the same lens is instead silvered on the curved surface and illuminated from other side as shown in figure (B), it acts like an optical system of focal length 10 cm. The refractive index of the material of lens is



(a) 1.75 (b) 1.51 (c) 1.55 (d) 1.50

(Online 2018)

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



(a) 203°
(b) 128°
(c) 98°
(d) 45°

(Online 2018)

7. A convergent doublet of separated lenses, corrected for spherical aberration, has resultant focal length of 10 cm. The separation between the two lenses is 2 cm. The focal lengths of the component lenses are

(a) 18 cm, 20 cm (b) 12 cm, 14 cm
(c) 16 cm, 18 cm (d) 10 cm, 12 cm

(Online 2018)

8. A ray of light is incident at an angle of 60° on one face of a prism of angle 30°. The emergent ray of light makes an angle of 30° with incident ray. The angle made by the emergent ray with second face of prism will be

(a) 0° (b) 45° (c) 90° (d) 30

(Online 2018)

9. Unpolarized light of intensity I is incident on a system of two polarizers, A followed by B. The intensity of emergent light is $\frac{I}{2}$. If a third polarizer C is placed between A and B, the intensity of emergent light is reduced to $\frac{I}{3}$.

The angle between the polarizers A and C is θ. Then

(a) $\cos\theta = \left(\frac{1}{3}\right)^{\frac{1}{2}}$ (b) $\cos\theta = \left(\frac{2}{3}\right)^{\frac{1}{4}}$

(c) $\cos\theta = \left(\frac{2}{3}\right)^{\frac{1}{2}}$ (d) $\cos\theta = \left(\frac{1}{3}\right)^{\frac{1}{4}}$

(Online 2018)

10. An observer is moving with half the speed of light towards a stationary microwave source emitting waves at frequency 10 GHz. What is the frequency of the microwave measured by the observer ?
(speed of light = 3×10^8 m s^{-1})
(a) 10.1 GHz (b) 12.1 GHz
(c) 17.3 GHz (d) 15.3 GHz *(2017)*

11. A diverging lens with magnitude of focal length 25 cm is placed at a distance of 15 cm from a converging lens of magnitude of focal length 20 cm. A beam of parallel light falls on the diverging lens. The final image formed is
(a) real and at a distance of 40 cm from convergent lens.
(b) virtual and at a distance of 40 cm from convergent lens.
(c) real and at a distance of 40 cm from the divergent lens.
(d) real and at a distance of 6 cm from the convergent lens.
(2017)

12. In a Young's double slit experiment, slits are separated by 0.5 mm and the screen is placed 150 cm away. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes on the screen. The least distance from the common central maximum to the point where the bright fringes due to both the wavelengths coincide is
(a) 1.56 mm (b) 7.8 mm
(c) 9.75 mm (d) 15.6 mm *(2017)*

13. Let the refractive index of a denser medium with respect to a rarer medium be n_{12} and its critical angle θ_C. At an angle of incidence A when light is travelling from denser medium to rarer medium, a part of the light is reflected and the rest is refracted and the angle between reflected and refracted rays is 90°. Angle A is given by

(a) $\frac{1}{\tan^{-1}(\sin\theta_C)}$ (b) $\frac{1}{\cos^{-1}(\sin\theta_C)}$

(c) $\tan^{-1}(\sin\theta_C)$ (d) $\cos^{-1}(\sin\theta_C)$

(Online 2017)

14. A single slit of width b is illuminated by a coherent monochromatic light of wavelength λ. If the second and fourth minima in the diffraction pattern at a distance 1 m from the slit are at 3 cm and 6 cm respectively from the central maximum, what is the width of the central maximum? (*i.e.* distance between first minimum on either side of the central maximum)
(a) 6.0 cm (b) 1.5 cm
(c) 4.5 cm (d) 3.0 cm
(Online 2017)

15. A single slit of width 0.1 mm is illuminated by a parallel beam of light of wavelength 6000 Å and diffraction bands are observed on a screen 0.5 m from the slit. The distance of the third dark band from the central bright band is
(a) 3 mm (b) 1.5 mm
(c) 9 mm (d) 4.5 mm *(Online 2017)*

16. An observer looks at a distant tree of height 10 m with a telescope of magnifying power of 20. To the observer the tree appears
(a) 10 times taller (b) 10 times nearer
(c) 20 times taller (d) 20 times nearer *(2016)*

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

(a) $= \frac{\lambda^7}{i}$ mzp y uz $= \left(\frac{7\lambda^7}{i}\right)$

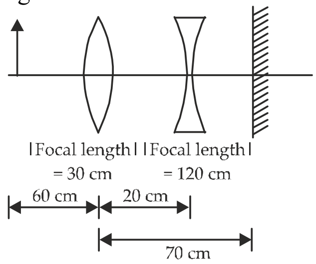
(b) $= \sqrt{\lambda i}$ mzp y uz $= \left(\frac{7\lambda^7}{i}\right)$

(c) $= \sqrt{\lambda i}$ mzp y uz $= \sqrt{9\lambda i}$

(d) $= \frac{\lambda^7}{i}$ mzp y uz $= \sqrt{9\lambda i}$ *(2016)*

18. In Young's double slit experiment, the distance between slits and the screen is 1.0 m and monochromatic light of 600 nm is being used. A person standing near the slits is looking at the fringe pattern. When the separation between the slits is varied, the interference pattern disappears for a particular distance d_0 between the slits.
If the angular resolution of the eye is $\frac{6°}{;5}$1the value of d_0 is close to
(a) 1 mm (b) 3 mm (c) 2 mm (d) 4 mm
(Online 2016)

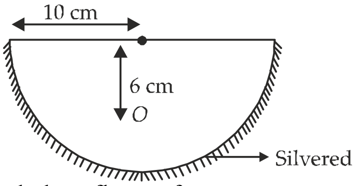
19. A convex lens, of focal length 30 cm, a concave lens of focal length 120 cm, and a plane mirror are arranged as shown. For an object kept at a distance of 60 cm from the convex lens, the final image formed by the combination is a real image at a distance of



(a) 60 cm from the convex lens
(b) 60 cm from the concave lens
(c) 70 cm from the convex lens
(d) 70 cm from the concave lens *(Online 2016)*

20. To determine refractive index of glass slab using a travelling microscope, minimum number of readings required are
(a) Two (b) Four (c) Three (d) Five
(Online 2016)

21. A hemispherical glass body of radius 10 cm and refractive index 1.5 is silvered on its curved surface. A small air bubble is 6 cm below the flat surface inside it along the axis. The position of the image of the air bubble made by the mirror is seen



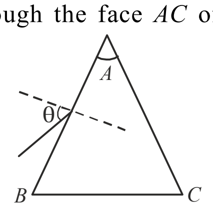
(a) 14 cm below flat surface
(b) 20 cm below flat surface
(c) 16 cm below flat surface
(d) 30 cm below flat surface *(Online 2016)*

22. Two stars are 10 light years away from the earth. They are seen through a telescope of objective diameter 30 cm. The wavelength of light is 600 nm. To see the stars just resolved by the telescope, the minimum distance between them should be (1 light year = 9.46×10^{15} m) of the order of
(a) 10^8 km (b) 10^{10} km
(c) 10^{11} km (d) 10^6 km *(Online 2016)*

23. Assuming human pupil to have a radius of 0.25 cm and a comfortable viewing distance of 25 cm, the minimum separation between two objects that human eye can resolve at 500 nm wavelength is
(a) 100 μm (b) 300 μm
(c) 1 μm (d) 30 μm *(2015)*

24. On a hot summer night, the refractive index of air is smallest near the ground and increases with height from the ground. When a light beam is directed horizontally, the Huygens' principle leads us to conclude that as it travels, the light beam
(a) bends downwards (b) bends upwards
(c) becomes narrower
(d) goes horizontally without any deflection *(2015)*

25. Monochromatic light is incident on a glass prism of angle A. If the refractive index of the material of the prism is μ, a ray, incident at an angle θ, on the face AB would get transmitted through the face AC of the prism provided



(a) $\theta > \text{o\{}^{-6}\left[\mu \text{ -ız}\left(W + \text{-ız}^{-6}\left(\frac{6}{\mu}\right)\right)\right]$

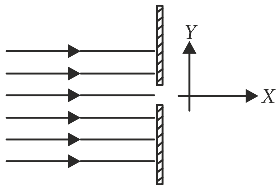
(b) $\theta < \text{o\{}^{-6}\left[\mu \text{ -ız}\left(W + \text{-ız}^{-6}\left(\frac{6}{\mu}\right)\right)\right]$

(c) $\theta > \text{-ız}^{-6}\left[\mu \text{ -ız}\left(W - \text{-ız}^{-6}\left(\frac{6}{\mu}\right)\right)\right]$

(d) $\theta < \text{-ız}^{-6}\left[\mu \text{ -ız}\left(W - \text{-ız}^{-6}\left(\frac{6}{\mu}\right)\right)\right]$ *(2015)*

26. You are asked to design a shaving mirror assuming that a person keeps it 10 cm from his face and views the magnified image of the face at the closest comfortable distance of 25 cm. The radius of curvature of the mirror would then be
(a) 30 cm (b) 24 cm (c) 60 cm (d) –24 cm
(Online 2015)

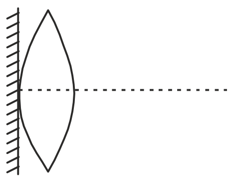
27. A parallel beam of electrons travelling in x-direction falls on a slit of width d (see figure). If after passing the slit, an electron acquires momentum p_y in the y-direction then for a majority of electrons passing through the slit (h is Planck's constant)



(a) $|p_y|d \simeq h$ (b) $|p_y|d > h$
(c) $|p_y|d < h$ (d) $|p_y|d >> h$
(Online 2015)

28. A telescope has an objective lens of focal length 150 cm and an eyepiece of focal length 5 cm. If a 50 m tall tower at a distance of 1 km is observed through this telescope in normal setting, the angle formed by the image of the tower is θ, then θ is close to
(a) 1° (b) 15° (c) 30° (d) 60°
(Online 2015)

29. A thin convex lens of focal length f is put on a plane mirror as shown in the figure. When an object is kept at a distance a from the lens - mirror combination, its image is formed at a distance $\frac{}{8}$ in front of the combination. The value of a is



(a) f (b) $2f$ (c) $3f$ (d) $\frac{8}{7}$
(Online 2015)

30. In a Young's double slit experiment with light of wavelength λ the separation of slits is d and distance of screen is D such that $D >> d >> \lambda$. If the fringe width is β, the distance from point of maximum intensity to the point where intensity falls to half of maximum intensity on either side is

(a) $\frac{\beta}{7}$ (b) $\frac{\beta}{9}$ (c) $\frac{\beta}{8}$ (d) $\frac{\beta}{;}$
(Online 2015)

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

(a) Transmitted light is partially polarized with intensity $I_0/2$.
(b) Transmitted light is completely polarized with intensity less than $I_0/2$.
(c) Reflected light is completely polarized with intensity less than $I_0/2$.
(d) Reflected light is partially polarized with intensity $I_0/2$.

(Online 2015)

32. A thin convex lens made from crown glass $\left(\mu = \frac{3}{2}\right)$ has focal length f. When it is measured in two different liquids having refractive indices $\frac{4}{3}$ and $\frac{5}{3}$, it has the focal lengths f_1 and f_2 respectively. The correct relation between the focal lengths is

(a) f_1 and f_2 both become negative
(b) $f_1 = f_2 < f$
(c) $f_1 > f$ and f_2 becomes negative
(d) $f_2 > f$ and f_1 becomes negative *(2014)*

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

(a) $\frac{1}{3}$ (b) 3 (c) $\frac{3}{2}$ (d) 1

(2014)

34. A green light is incident from the water to the air-water interface at the critical angle (θ). Select the correct statement.

(a) The entire spectrum of visible light will come out of the water at various angles to the normal.
(b) The entire spectrum of visible light will come out of the water at an angle of 90° to the normal.
(c) The spectrum of visible light whose frequency is less than that of green light will come out to the air medium.
(d) The spectrum of visible light whose frequency is more than that of green light will come out to the air medium.

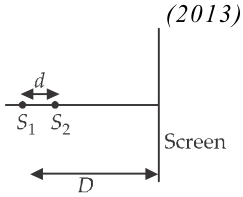
(2014)

35. Diameter of a plano-convex lens is 6 cm and thickness at the centre is 3 mm. If speed of light in material of lens is 2×10^8 m/s, the focal length of the lens is

(a) 10 cm (b) 15 cm (c) 20 cm (d) 30 cm

(2013)

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



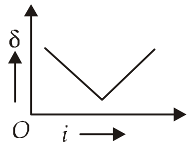
(a) concentric circles (b) points
(c) straight lines (d) semi-circles *(2013)*

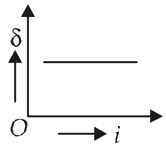
37. A beam of unpolarised light of intensity I_0 is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of A. The intensity of the emergent light is

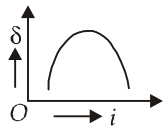
(a) $I_0/8$ (b) I_0 (c) $I_0/2$ (d) $I_0/4$

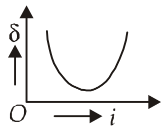
(2013)

38. The graph between angle of deviation (δ) and angle of incidence (i) for a triangular prism is represented by

(a) 

(b) 

(c) 

(d) 

(2013)

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

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

(c) $\frac{I_m}{9}\left(1 + 8\cos^2\frac{\phi}{2}\right)$ (d) $\frac{I_m}{9}(4 + 5\cos\phi)$ *(2012)*

40. An object 2.4 m in front of a lens forms a sharp image on a film 12 cm behind the lens. A glass plate 1 cm thick, of refractive index 1.50 is interposed between lens and film with its plane faces parallel to film. At what distance (from lens) should object be shifted to be in sharp focus on film?

(a) 2.4 m (b) 3.2 m
(c) 5.6 m (d) 7.2 m *(2012)*

41. Direction : The question has a paragraph followed by two statements, Statement-1 and Statement-2. Of the given four alternatives after the statements, choose the one that describes the statements.

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

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

Statement-2 : The centre of the interference pattern is dark.

(a) Statement-1 is true, Statement-2 is false.
(b) Statement-1 is true, Statement-2 is true, Statement-2 is the correct explanation of Statement-1.
(c) Statement-1 is true, Statement-2 is true, Statement-2 is not the correct explanation of Statement-1.
(d) Statement-1 is false, Statement-2 is true. *(2011)*

42. Let the x–z plane be the boundary between two transparent media. Medium 1 in $z \geq 0$ has a refractive index of $\sqrt{2}$ and medium 2 with $z < 0$ has a refractive index of $\sqrt{3}$. A ray of light in medium 1 given by the vector $\vec{A} = 6\sqrt{3}\hat{i} + 8\sqrt{3}\hat{j} - 10\hat{k}$ is incident on the plane of separation. The angle of refraction in medium 2 is
(a) 30° (b) 45°
(c) 60° (d) 75° *(2011)*

43. A car is fitted with a convex side-view mirror of focal length 20 cm. A second car 2.8 m behind the first car is overtaking the first car at a relative speed of 15 m s^{-1}. The speed of the image of the second car as seen in the mirror of the first one is

(a) $\frac{1}{10}$ m s^{-1} (b) $\frac{1}{15}$ m s^{-1}
(c) 10 m s^{-1} (d) 15 m s^{-1} *(2011)*

Directions : Questions number 44-46 are based on the following paragraph.
An initially parallel cylindrical beam travels in a medium of refractive index $\mu(I) = \mu_0 + \mu_2 I$, where μ_0 and μ_2 are positive constants and I is the intensity of the light beam. The intensity of the beam is decreasing with increasing radius.

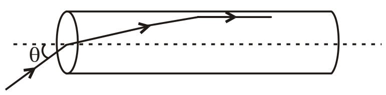
44. The initial shape of the wavefront of the beam is
(a) planar (b) convex
(c) concave
(d) convex near the axis and concave near the periphery

45. The speed of light in the medium is
(a) maximum on the axis of the beam
(b) minimum on the axis of the beam
(c) the same everywhere in the beam
(d) directly proportional to the intensity I

46. As the beam enters the medium, it will
(a) travel as a cylindrical beam
(b) diverge (c) converge
(d) diverge near the axis and converge near the periphery
(2010)

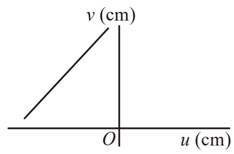
47. A mixture of light, consisting of wavelength 590 nm and an unknown wavelength, illuminates Young's double slit and gives rise to two overlapping interference patterns on the screen. The central maximum of both lights coincide. Further, it is observed that the third bright fringe of known light coincides with the 4th bright fringe of the unknown light. From this data, the wavelength of the unknown light is
(a) 393.4 nm (b) 885.0 nm
(c) 442.5 nm (d) 776.8 nm *(2009)*

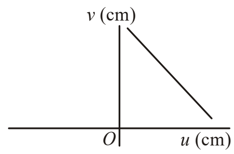
48. A transparent solid cylindrical rod has a refractive index of $\frac{2}{\sqrt{3}}$. It is surrounded by air. A light ray is incident at the mid-point of one end of the rod as shown in the figure.

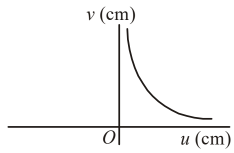


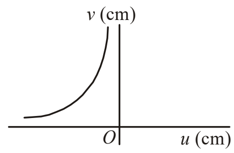
The incident angle θ for which the light ray grazes along the wall of the rod is
(a) $\sin^{-1}\left(\frac{1}{2}\right)$ (b) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$
(c) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (d) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ *(2009)*

49. A student measures the focal length of a convex lens by putting an object pin at a distance u from the lens and measuring the distance v of the image pin. The graph between u and v plotted by the student should look like

(a) 

(b) 

(c) 

(d) 

(2008)

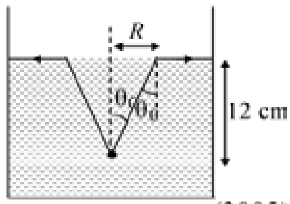
50. Two lenses of power –15 D and +5 D are in contact with each other. The focal length of the combination is
(a) + 10 cm (b) –20 cm
(c) –10 cm (d) + 20 cm *(2007)*

51. In a Young's double slit experiment the intensity at a point where the path difference is $\frac{\lambda}{6}$ (λ being the wavelength of light used) is I. If I_0 denotes the maximum intensity, $\frac{I}{I_0}$ is equal to
(a) $\frac{3}{4}$ (b) $\frac{1}{\sqrt{2}}$ (c) $\frac{\sqrt{3}}{2}$ (d) $\frac{1}{2}$
(2007)

52. The refractive index of glass is 1.520 for red light and 1.525 for blue light. Let D_1 and D_2 be angles of minimum deviation for red and blue light respectively in a prism of this glass. Then
(a) $D_1 > D_2$ (b) $D_1 < D_2$
(c) $D_1 = D_2$
(d) D_1 can be less than or greater than depending upon the angle of prism. *(2006)*

53. A thin glass (refractive index 1.5) lens has optical power of –5 D in air. Its optical power in a liquid medium with refractive index 1.6 will be
(a) 25 D (b) –25 D
(c) 1 D (d) –1 D *(2005)*

54. A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is 4/3 and the fish is 12 cm below the surface, the radius of this circle in cm is



(a) $36\sqrt{5}$
(b) $4\sqrt{5}$
(c) $36\sqrt{7}$
(d) $36/\sqrt{7}$ *(2005)*

55. Two point white dots are 1 mm apart on a black paper. They are viewed by eye of pupil diameter 3 mm. Approximately, what is the maximum distance at which these dots can be resolved by the eye? [Take wavelength of light = 500 nm]
(a) 6 m (b) 3 m (c) 5 m (d) 1 m *(2005)*

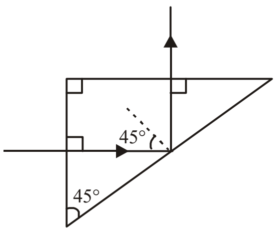
56. When an unpolarized light of intensity I_0 is incident on a polarizing sheet, the intensity of the light which does not get transmitted is
(a) zero (b) I_0
(c) $\frac{1}{2}I_0$ (d) $\frac{1}{4}I_0$ *(2005)*

57. If I_0 is the intensity of the principal maximum in the single slit diffraction pattern, then what will be its intensity when the slit width is doubled?
(a) I_0 (b) $I_0/2$ (c) $2I_0$ (d) $4I_0$ *(2005)*

58. A Young's double slit experiment uses a monochromatic source. The shape of the interference fringes formed on a screen
(a) straight line (b) parabola
(c) hyperbola (d) circle *(2005)*

59. A plano convex lens of refractive index 1.5 and radius of curvature 30 cm is silvered at the curved surface. Now this lens has been used to form the image of an object. At what distance from this lens an object be placed in order to have a real image of the size of the object?
(a) 20 cm (b) 30 cm
(c) 60 cm (d) 80 cm *(2004)*

60. A light ray is incident perpendicular to one face of a 90° prism and is totally internally reflected at the glass-air interface. If the angle of reflection is 45°, we conclude that the refractive index n



(a) $n < \frac{1}{\sqrt{2}}$
(b) $n > \sqrt{2}$
(c) $n > \frac{1}{\sqrt{2}}$
(d) $n < \sqrt{2}$ *(2004)*

61. The angle of incidence at which reflected light in totally polarized for reflection from air to glass (refractive index n), is
(a) $\sin^{-1}(n)$ (b) $\sin^{-1}(1/n)$
(c) $\tan^{-1}(1/n)$ (d) $\tan^{-1}(n)$ *(2004)*

62. The maximum number of possible interference maxima for slit-separation equal to twice the wavelength in Young's double-slit experiment is
(a) infinite (b) five
(c) three (d) zero *(2004)*

63. To get three images of a single object, one should have two plane mirrors at an angle of
(a) 60° (b) 90°
(c) 120° (d) 30° *(2003)*

64. The image formed by an objective of a compound microscope is
(a) virtual and diminished (b) real and diminished
(c) real and enlarged (d) virtual and enlarged. *(2003)*

65. To demonstrate the phenomenon of interference we require two sources which emit radiation of
(a) nearly the same frequency
(b) the same frequency
(c) different wavelength
(d) the same frequency and having a definite phase relationship. *(2003)*

66. An astronomical telescope has a large aperture to
(a) reduce spherical aberration
(b) have high resolution
(c) increase span of observation
(d) have low dispersion. *(2002)*

67. Which of the following is used in optical fibres?
(a) total internal reflection (b) scattering
(c) diffraction (d) refraction *(2002)*

68. Wavelength of light used in an optical instrument are $\lambda_1 = 4000$ Å and $\lambda_2 = 5000$ Å, then ratio of their respective resolving powers (corresponding to λ_1 and λ_2) is
(a) 16 : 25 (b) 9 : 1
(c) 4 : 5 (d) 5 : 4 *(2002)*

69. If two mirrors are kept at 60° to each other, then the number of images formed by them is
(a) 5 (b) 6
(c) 7 (d) 8 *(2002)*

ANSWER KEY

1. (c)	**2.** (a)	**3.** (c)	**4.** (c)	**5.** (c)	**6.** (a)	**7.** (a)	**8.** (c)	**9.** (b)	**10.** (c)	**11.** (a)	**12.** (b)
13. (c)	**14.** (d)	**15.** (c)	**16.** (d)	**17.** (c)	**18.** (c)	**19.** (a)	**20.** (c)	**21.** (b)	**22.** (a)	**23.** (d)	**24.** (b)
25. (c)	**26.** (c)	**27.** (c)	**28.** (d)	**29.** (b)	**30.** (b)	**31.** (c)	**32.** (c)	**33.** (a)	**34.** (c)	**35.** (d)	**36.** (a)
37. (d)	**38.** (d)	**39.** (c)	**40.** (c)	**41.** (c)	**42.** (b)	**43.** (b)	**44.** (a)	**45.** (b)	**46.** (c)	**47.** (c)	**48.** (d)
49. (d)	**50.** (c)	**51.** (a)	**52.** (b)	**53.** (*)	**54.** (d)	**55.** (c)	**56.** (c)	**57.** (a)	**58.** (a)	**59.** (a)	**60.** (b)
61. (d)	**62.** (b)	**63.** (b)	**64.** (c)	**65.** (d)	**66.** (b)	**67.** (a)	**68.** (d)	**69.** (a)			

Explanations

1. (c) : Polarizers A and B are oriented with parallel pass axis. Suppose polarizer C is at angle θ with A then it also makes angle θ with B,

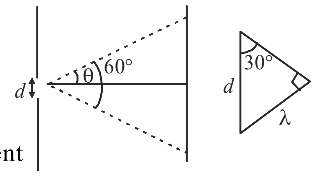
Using Malus' law, $I_C = \left(\frac{I}{2}\cos^2\theta\right)$ and $I_B = I_C \cos^2\theta = \frac{I}{2}\cos^4\theta$

$$\frac{I}{8} = \frac{I}{2}\cos^4\theta \qquad \left(\because \; I_B = \frac{I}{8}\right)$$

$$\cos^4\theta = \frac{1}{4} = \frac{1}{(\sqrt{2})^4}; \cos\theta = \frac{1}{\sqrt{2}} = \cos 45°$$

So, $\theta = 45°$

2. (a) : In a single slit diffraction, $a \sin\theta = \lambda$.



$$\lambda = \frac{a}{2} = \frac{1\times10^{-6}\text{ m}}{2}$$

$\therefore \lambda = 5000$ Å

In Young's double slit experiment

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

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

$d = 25 \times 10^{-6}$ m $= 25$ μm

3. (c) : When object is at 8 cm, image distance

$$v_1 = \frac{f\times u}{u-f} = \frac{(-5)(-8)}{-8+5} = -\frac{40}{3}\text{ cm}$$

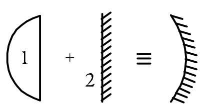
When object is at 12 cm, image distance $v_2 = -\frac{60}{7}$ cm

Separation $= |v_1 - v_2| = \frac{100}{21}$ cm

4. (c) : If the angular position of second minima from central maxima is θ then, $\sin\theta = \frac{2\lambda}{a} = \frac{2\times550\times10^{-9}}{22\times10^{-7}} = \frac{1}{2}$

$$\theta = \frac{\pi}{6}\text{ rad}$$

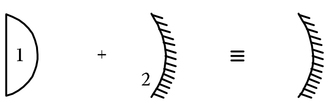
5. (c) : For figure (A)



$$\frac{1}{f_1} = \left(\frac{\mu-1}{R}\right); f = -28\text{ cm}$$

$P = 2P_1 + P_2 = 2P_1 + 0$ or $-\frac{1}{28} = -2\left(\frac{\mu-1}{R}\right)$ ...(i)

For figure (B),



$$\frac{1}{f_1} = \left(\frac{\mu-1}{R}\right) \qquad f_2 = -\frac{R}{2} \qquad f = -10\text{ cm}$$

$$P = 2P_1 + P_2 \Rightarrow -\frac{1}{10} = -2\left(\frac{\mu-1}{R}\right) - \frac{2}{R}$$

$$\frac{1}{10} = \frac{1}{28} + \frac{2}{R}$$

$$\frac{2}{R} = \frac{1}{10} - \frac{1}{28} = \frac{18}{280};\; R = \frac{280}{9}\text{ cm}$$

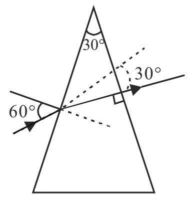
Substituting R in eqn. (i)

$$\frac{1}{28} = 2\left(\frac{\mu-1}{280}\right)9;\; \mu - 1 = \frac{5}{9}$$

$$\mu = 1 + \frac{5}{9} = \frac{14}{9} = 1.55$$

6. (a) **7. (a)**

8. (c) : As $\delta = i + e - A$



$30° = 60° + e - 30°$

$\Rightarrow \; e = 0$

So required angle with face of prism $= 90°$

9. (b) : Polarizers A and B are oriented with parallel pass axis. Suppose polarizer C is at angle θ with A then it also makes angle θ with B.

Using Malus' law,

$I_C = \left(\frac{I}{2}\cos^2\theta\right)$ and $I_B = I_C \cos^2\theta = \frac{I}{2}\cos^4\theta$

$$\frac{I}{3} = \frac{I}{2}\cos^4\theta \qquad \left(\because \; I_B = \frac{I}{3}\right)$$

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

10. (c) : Frequency of the microwave measured by the observer will be given by Doppler's effect of light.

$$\frac{\upsilon'}{\upsilon} = \sqrt{\frac{1+\beta}{1-\beta}} \qquad \left(\text{Here } \beta = \frac{v}{c}\right)$$

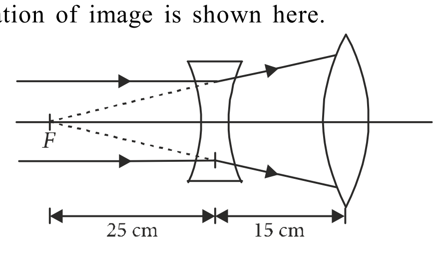
$$\Rightarrow \frac{\upsilon'}{\upsilon} = \sqrt{\frac{1+v/c}{1-v/c}} = \sqrt{\frac{c+v}{c-v}}$$

$$\upsilon' = \upsilon\sqrt{\frac{\left(c+\frac{c}{2}\right)}{\left(c-\frac{c}{2}\right)}} = 10\sqrt{3}\text{ GHz} \quad \text{or} \quad \upsilon' = 17.3\text{ GHz}$$

11. (a) : Given : focal length of concave lens, $f = -25$ cm

Focal length of convex lens, $f' = 20$ cm

The formation of image is shown here.



The image for diverging lens will form at F. *i.e.* at focal length of concave lens.

Now, this image will serve as the object for convex lens. It is at twice the focal length of the convex lens (*i.e.* $2f$). Hence, the final image will also form at $2f$, which is at a distance of 40 cm from the convergent lens. Also, the image formed is real.

12. (b) : Let y be the distance from the central maximum to the point where the bright fringes due to both the wavelengths coincides.

Now, for λ_1, $y = \frac{m\lambda_1 D}{d}$

For λ_2, $y = \frac{n\lambda_2 D}{d}$ $\therefore m\lambda_1 = n\lambda_2 \Rightarrow \frac{m}{n} = \frac{\lambda_2}{\lambda_1} = \frac{520}{650} = \frac{4}{5}$

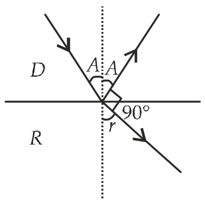
i.e. with respect to central maximum 4th bright fringe of λ_1 coincides with 5th bright fringe of λ_2

Now, $y = \frac{4 \times 650 \times 10^{-9} \times 1.5}{0.5 \times 10^{-3}}$ m

$\Rightarrow$ $y = 7.8 \times 10^{-3}$ m or $y = 7.8$ mm

13. (c) : Refractive index of denser medium with respect to rarer medium, $n_{12} = \frac{n_D}{n_R} = \frac{1}{\sin\theta_C}$

or $\frac{n_R}{n_D} = \sin\theta_C$ ...(i)



Using Snell's law at the interface of two media,

$n_D \sin A = n_R \sin r$

$\frac{n_R}{n_D} = \frac{\sin A}{\sin(90 - A)} = \frac{\sin A}{\cos A} = \tan A$

$\tan A = \sin\theta_C$; $A = \tan^{-1}(\sin\theta_C)$ [from eqn. (i)]

14. (d) : For single slit diffraction, $\sin\theta = \frac{n\lambda}{b}$

Position of n^{th} minima from central maxima $= \frac{n\lambda D}{b}$

When $n = 2$, then $x_2 = \frac{2\lambda D}{b} = 0.03$ ...(i)

When $n = 4$, then $x_4 = \frac{4\lambda D}{b} = 0.06$ ...(ii)

Eqn. (ii) – Eqn. (i)

$x_4 - x_2 = \frac{4\lambda D}{b} - \frac{2\lambda D}{b} = 0.03$ or $\frac{\lambda D}{b} = \frac{0.03}{2}$

then width of central maximum $= \frac{2\lambda D}{b}$

$= 2 \times \frac{0.03}{2} = 0.03 \text{ m} = 3 \text{ cm}$

15. (c) : Here, $d = 0.1$ mm, $\lambda = 6000$ Å, $D = 0.5$ m

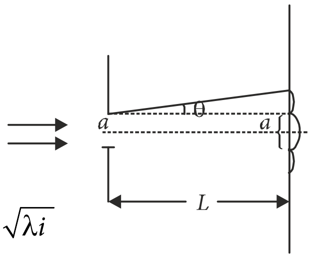
For third dark band, $d\sin\theta = 3\lambda$; $\sin\theta = \frac{3\lambda}{d} = \frac{y}{D}$

$y = \frac{3D\lambda}{d} = \frac{3 \times 0.5 \times 6 \times 10^{-7}}{0.1 \times 10^{-3}} = 9 \times 10^{-3}$ m $= 9$ mm

16. (d) : Telescope resolves and brings the objects closer which is far away from the telescope. Hence for telescope with magnifying power 20, the tree appears 20 times nearer.

17. (c) : Size of spot, b = Geometrical spread + diffraction spread

$\therefore \quad = \quad + i\,\frac{\lambda}{\;}$



Now, value of b would be

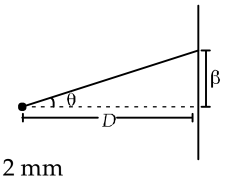
minimum if $\frac{\;}{\;} = 5$

$6 + i\left(\frac{-\lambda}{7}\right) = 5 \Rightarrow {}^{7} = \lambda i \Rightarrow \; = \sqrt{\lambda i}$

$\therefore$ y ɪɛ $= \sqrt{\lambda i} + \frac{\lambda i}{\sqrt{\lambda i}} = 7\sqrt{\lambda i} = \sqrt{9\lambda i}$

18. (c) : For a particular distance d_0 between the slits, the eye is not able to resolve two consecutive bright fringes.

Now, $\theta = \frac{\beta}{D}$ but $\beta = \frac{\lambda D}{d_0}$



$\therefore \quad \theta = \frac{\lambda}{d_0}$

or $d_0 = \frac{\lambda}{\theta} = \frac{600 \times 10^{-9} \text{m}}{\frac{1}{60} \times \frac{\pi}{180} \text{rad}} = 2.06 \times 10^{-3} \text{m} \approx 2 \text{ mm}$

19. (a) : For convex lens, $u_1 = -60$ cm, $f_1 = 30$ cm

$\frac{1}{v_1} = \frac{1}{f_1} + \frac{1}{u_1} = \frac{1}{30} - \frac{1}{60} = \frac{1}{60}$ or $v_1 = 60$ cm

For concave lens

$u_2 = 60 - 20 = 40$ cm, $f_2 = -120$ cm

$\frac{1}{v_2} = \frac{1}{f_2} + \frac{1}{u_2} = -\frac{1}{120} + \frac{1}{40} = \frac{2}{120}$ or $v_2 = 60$ cm

For plane mirror, virtual object 10 cm behind the mirror.

Hence, real image 10 cm in front of the mirror.

Now, again for concave lens, $u_2 = 40$ cm *i.e.*, light rays from the object retrace their path after striking the plane mirror, Hence the final image is formed at the object itself.

20. (c)

21. (b) : Here, $R = -10$ cm

Object distance from mirror, $u = -(10 - 6) = -4$ cm

Focal length of mirror, $f = -\frac{R}{2} = -\frac{10}{2} = -5 \text{ cm}$

Image distance $= v = ?$

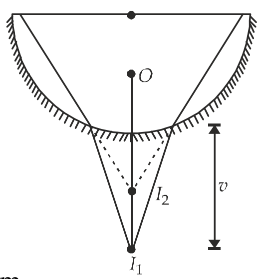
Using mirror formula,

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\Rightarrow \quad \frac{1}{v} + \frac{1}{-4} = \frac{1}{-5}$

$\Rightarrow \quad \frac{1}{v} = \frac{1}{4} - \frac{1}{5} = \frac{1}{20}$

$v = 20$ cm



Now, I_1 acts as object for plane glass surface,

$\therefore$ Apparent depth $= \frac{R + v}{\mu} = \frac{30}{1.5} = 20 \text{ cm}$

Hence, the position of the image of the air bubble made by the mirror is seen 20 cm below the flat surface.

22. (a): Here, $\lambda = 600$ nm $= 6 \times 10^{-7}$ m
$D = 30$ cm $= 30 \times 10^{-2}$ m $= 0.3$ m
$R = 10$ ly $= 10 \times 9.46 \times 10^{15}$ m
$l = ?$

The limit of resolution of a telescope $\Delta\theta = \frac{1.22\lambda}{D} = \frac{l}{R}$

$l = \frac{1.22\lambda R}{D} = \frac{1.22 \times 6 \times 10^{-7} \times 10 \times 9.46 \times 10^{15}}{0.3} = 2.31 \times 10^{8}$ km

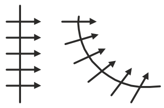
23. (d): Given, wavelength of light, $\lambda = 500$ nm $= 500 \times 10^{-9}$ m
Least distance of distinct vision, $D = 25$ cm $= 25 \times 10^{-2}$ m
Radius of pupil, $r = 0.25$ cm
$\therefore$ Diameter of pupil, $d = 2r = 0.50$ cm $= 0.50 \times 10^{-2}$ m

Resolving power of eye, $\Delta\theta = \frac{6377\,\lambda}{}$

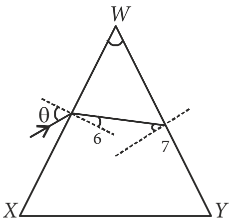
$= \frac{6377 \times :55 \times 65^{->}}{53\,5 \times 65^{-7}} = 6377 \times 65^{-9}$ ~np

$\therefore$ Minimum separation that eye can resolve,
$x = \Delta\theta D = 1.22 \times 10^{-4} \times 25 \times 10^{-2} = 30.5 \times 10^{-6}$ m $\simeq 30$ µm

24. (b): Consider a plane wavefront travelling horizontally. As refractive index of air increases with height, so speed of wavefront decreases with height. Hence, the light beam bends upwards.



25. (c): According to Snell's law
$\sin\theta = \mu \sin r_1$



$\Rightarrow \sin r_1 = \frac{\text{-uz}\,\theta}{\mu}$

or $r_1 = \sin^{-1}\left(\frac{\text{-uz}\,\theta}{\mu}\right)$

Now, $A = r_1 + r_2 \therefore r_2 = A - r_1 = A - \sin^{-1}\left(\frac{\text{-uz}\,\theta}{\mu}\right)$ ...(i)

For the ray to get transmitted through the face AC, r_2 must be less than critical angle, *i.e.*, $r_2 < \sin^{-1}\left(\frac{6}{\mu}\right)$

or $A - \sin^{-1}\left(\frac{\text{-uz}\,\theta}{\mu}\right) < \sin^{-1}\left(\frac{6}{\mu}\right)$ (using (i))

$\Rightarrow \sin^{-1}\left(\frac{\text{-uz}\,\theta}{\mu}\right) > A - \sin^{-1}\left(\frac{6}{\mu}\right)$

$\Rightarrow \frac{\text{-uz}\,\theta}{\mu} > \text{-uz}\left(W - \text{-uz}^{-6}\left(\frac{6}{\mu}\right)\right)$

$\Rightarrow \theta > \sin^{-1}\left[\mu\,\text{-uz}\left(W - \text{-uz}^{-6}\left(\frac{6}{\mu}\right)\right)\right]$

26. (c): Here, $u = -10$ cm, $v = +15$ cm

$\frac{6}{} + \frac{6}{} = \frac{6}{}$ {~ $\frac{6}{6:} - \frac{6}{65} = \frac{6}{} = \frac{7}{o}$ {~ $-\frac{:}{6:5} = \frac{7}{o}$

$o = -\frac{855}{:} = -;5$ oy

27. (c)

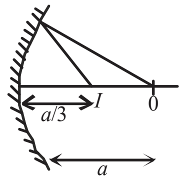
28. (d): Angular magnification $m = \frac{5}{} = \frac{6:5}{:} = 85$

so, $\frac{\text{µnz}\,\beta}{\text{µnz}\,\alpha} = 85$

$\tan\beta = \tan\alpha \times 30 = \left(\frac{:5}{6555}\right) \times 85 = \frac{15}{10} = \frac{3}{2}$; $\beta = \tan^{-1}\left(\frac{3}{2}\right)$

$\therefore \theta = \beta \approx 60°$

29. (b): This combination will behave like a mirror of power, $P_{eq} = 2P_L + P_M$



$m = 7\frac{6}{} + 5$

$= \frac{}{7}$

So the behaviour of the system, will be like a mirror of focal length $-\frac{}{7}$

Using mirror equation $\frac{6}{} + \frac{6}{} = \frac{6}{}$

Here, $u = -a$, $v = -a/3$, $f_{eq} = -f/2$

$\frac{6}{-\,48} + \frac{6}{-} = \frac{-6}{47}$ B $\frac{9}{} = \frac{7}{}$ or $a = 2f$

30. (b): Intensity at any point on the screen is given by

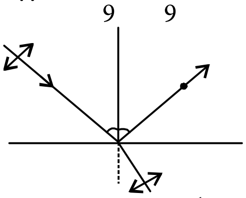
$f = 9f_5\,\text{o\{}^{7}\left(\frac{\phi}{7}\right)$

$I_{max} = 4I_0$ V{ $1\,\frac{f_{y\,m}}{7} = 7f_5 = 9f_5\,\text{o\{}^{7}\left(\frac{\phi}{7}\right)$

$\text{o\{}\left(\frac{\phi}{7}\right) = \frac{6}{\sqrt{7}}$ $\therefore \frac{\phi}{7} = \frac{\pi}{9}$ B$\phi = \frac{\pi}{7}$ Hx{ $\frac{7\pi}{\lambda}\Delta = \frac{\pi}{7}$ B $\Delta = \frac{\lambda}{9}$

$\frac{}{a} = \frac{\lambda}{9}$ $\therefore$ $= \frac{\lambda a}{9} = \frac{\beta}{9}$

31. (c):



At Brewster's angle, $i = \tan^{-1}(\mu)$, the reflected light is completely polarized, whereas refracted light is partially polarized. Thus, the reflected ray will have lesser intensity compared to refracted ray.

$\therefore f_{\text{~qrxqoqp}} < \frac{f_5}{7}$

32. (c): Given $\mu = \frac{3}{2}$ (crown glass) and focal length $= f$

Focal length $= f_1$ when lens is placed in liquid of refractive index $\mu_1 = \frac{4}{3}$

Focal length $= f_2$ when lens is placed in liquid of refractive index $\mu_2 = \frac{5}{3}$

Using Lens maker's formula $\frac{1}{f_1} = \left(\frac{\mu}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$\Rightarrow \frac{1}{f_1} = \left(\frac{3/2}{4/3} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{8}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Similarly, $\frac{1}{f_2} = \left(\frac{\mu}{\mu_2} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$\Rightarrow \frac{1}{f_2} = \left(\frac{3/2}{5/3} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{-1}{10}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

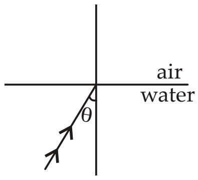
and $\frac{1}{f} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{2}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Hence, $f_1 = 4f$ and $f_2 = -5f$

33. (a): When a polaroid rotated through 30° with respect to beam A, then beam B is at 60° with it.

So, $I_A \cos^2 30° = I_B \cos^2 60° \Rightarrow I_A\left(\frac{3}{4}\right) = I_B\left(\frac{1}{4}\right) \Rightarrow \frac{I_A}{I_B} = \frac{1}{3}$

34. (c): As, $\sin\theta = \frac{1}{\mu}$



Also refractive index (μ) of the medium depends on the wavelength of the light. μ is less for the greater wavelength (*i.e.* lesser frequency).

So, θ will be more for lesser frequency of light. Hence, the spectrum of visible light whose frequency is less than that of green light will come out to the air medium.

35. (d): According to lens maker's formula

$$\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

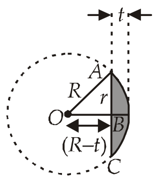
As the lens is plano-convex $\therefore$ $R_1 = R$, $R_2 = \infty$

$$\therefore \frac{1}{f} = \frac{(\mu - 1)}{R} \text{ or } f = \frac{R}{(\mu - 1)} \quad ...(i)$$

As speed of light in the medium of lens is 2×10^8 m/s

$$\therefore \mu = \frac{c}{v} = \frac{3\times10^8 \text{ m/s}}{2\times10^8 \text{ m/s}} = \frac{3}{2} \quad ...(ii)$$

If r is the radius and t is the thickness of lens (at the centre), the radius of curvature R of its curved surface in accordance with figure will be given by



$$R^2 = r^2 + (R - t)^2$$

$$R^2 = r^2 + R^2 + t^2 - 2Rt$$

$$2Rt = r^2 + t^2$$

$$R = \frac{r^2}{2t} \quad (\because r >> t)$$

Here, $r = 3$ cm, $t = 3$ mm $= 0.3$ cm $\therefore$ $R = \frac{(3)^2}{2\times0.3} = 15\text{ cm}$

On substituting the values of μ and R from Eqs. (ii) and (iii) in (i), we get $f = \frac{15\text{ cm}}{(1.5 - 1)} = 30\text{ cm}$

36. (a) : When the screen is placed perpendicular to the line joining the sources, the fringes will be concentric circles.

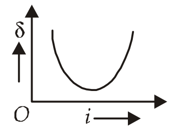
37. (d) : Intensity of light after passing polaroid A is

$$I_1 = \frac{I_0}{2}$$

Now this light will pass through the second polaroid B whose axis is inclined at an angle of 45° to the axis of polaroid A. So in accordance with Malus law, the intensity of light emerging from polaroid B is

$$I_2 = I_1 \cos^2 45° = \left(\frac{I_0}{2}\right)\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{I_0}{4}$$

38. (d) : The graph between angle of deviation(δ) and angle of incidence (i) for a triangular prism is as shown in the adjacent figure.



39. (c): Here, $A_2 = 2A_1$ $\because$ Intensity $\propto$ (Amplitude)^2

$$\therefore \frac{I_2}{I_1} = \left(\frac{A_2}{A_1}\right)^2 = \left(\frac{2A_1}{A_1}\right)^2 = 4 \Rightarrow I_2 = 4I_1$$

Maximum intensity, $I_m = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

$$= \left(\sqrt{I_1} + \sqrt{4I_1}\right)^2 = \left(3\sqrt{I_1}\right)^2 = 9I_1 \text{ or } I_1 = \frac{I_m}{9} \quad ...(i)$$

Resultant intensity, $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

$$= I_1 + 4I_1 + 2\sqrt{I_1(4I_1)}\cos\phi$$

$= 5I_1 + 4I_1\cos\phi = I_1 + 4I_1 + 4I_1\cos\phi = I_1 + 4I_1(1 + \cos\phi)$

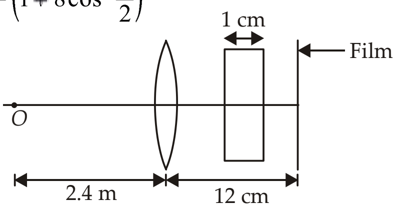
$$= I_1 + 8I_1\cos^2\frac{\phi}{2} \quad \left(\because 1 + \cos\phi = 2\cos^2\frac{\phi}{2}\right)$$

$$= I_1\left(1 + 8\cos^2\frac{\phi}{2}\right)$$

Putting the value of I_1 from eqn. (i), we get

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

40. (c) :



According to thin lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

Here, $u = -2.4$ m $= -240$ cm, $v = 12$ cm

$$\therefore \frac{1}{f} = \frac{1}{12} - \frac{1}{(-240)} = \frac{1}{12} + \frac{1}{240}$$

$$\frac{1}{f} = \frac{21}{240} \text{ or } f = \frac{240}{21}\text{ cm}$$

When a glass plate is interposed between lens and film, so shift produced by it will be

$$\text{Shift} = t\left(1 - \frac{1}{\mu}\right) = 1\left(1 - \frac{1}{1.5}\right) = 1\left(1 - \frac{2}{3}\right) = \frac{1}{3}\text{ cm}$$

To get image at film, lens should form image at distance

$$v' = 12 - \frac{1}{3} = \frac{35}{3}\text{ cm}$$

Again using lens formula

$$\therefore \frac{21}{240} = \frac{3}{35} - \frac{1}{u'} \text{ or } \frac{1}{u'} = \frac{3}{35} - \frac{21}{240} = \frac{1}{5}\left[\frac{3}{7} - \frac{21}{48}\right]$$

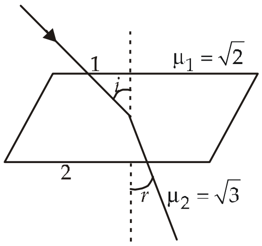
$$\frac{1}{u'} = \frac{1}{5}\left[\frac{144 - 147}{336}\right] \text{ or } \frac{1}{u'} = -\frac{3}{1680}$$

$u' = -560$ cm $= -5.6$ m

$|u'| = 5.6$ m

41. **(c)**

42. **(b)** :



Here, $\vec{A} = 6\sqrt{3}\,\hat{i} + 8\sqrt{3}\,\hat{j} - 10\,\hat{k}$

$$\cos i = \frac{10}{\sqrt{(6\sqrt{3})^2 + (8\sqrt{3})^2 + (-10)^2}} = \frac{10}{20}$$

$$\cos i = \frac{1}{2} \quad \text{or} \quad i = \cos^{-1}\left(\frac{1}{2}\right) = 60°$$

Using Snell's law, $\mu_1 \sin i = \mu_2 \sin r$

$\sqrt{2}\sin 60° = \sqrt{3}\sin r \Rightarrow r = 45°$

43. **(b)**

44. (a) : As the beam is initially parallel, the shape of wavefront is planar.

45. (b) : Given $\mu = \mu_0 + \mu_2 I$

As $\mu = \dfrac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}}$

$$\mu = \frac{c}{v} \quad \text{or} \quad v = \frac{c}{\mu} = \frac{c}{\mu_0 + \mu_2 I}$$

As the intensity is maximum on the axis of the beam, therefore v is minimum on the axis of the beam.

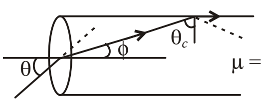
46. (c)

47. **(c)** **:** For interference, by Young's double slits, the path difference $\dfrac{xd}{D} = n\lambda$ for bright fringes and $\dfrac{xd}{D} = (2n+1)\dfrac{\lambda}{2}$ for getting dark fringes.

The central fringes when $x = 0$, coincide for all wavelengths. The third fringe of $\lambda_1 = 590$ nm coincides with the fourth bright fringe of unknown wavelength λ.

$\therefore \dfrac{xd}{D} = 3 \times 590 \text{ nm} = 4 \times 1 \text{ nm} \therefore \lambda = \dfrac{3 \times 590}{4} = 442.5 \text{ nm}$

48. **(d)** **:**

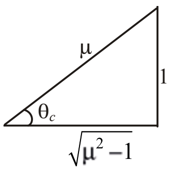


If θ_c has to be the critical angle, $\theta_c = \sin^{-1}\dfrac{1}{\mu}$

But $\theta_c = 90° - \phi$, $\theta_i = \theta$

$$\frac{\sin\theta_i}{\sin\phi} = \mu = \frac{2}{\sqrt{3}}$$

$$\Rightarrow \frac{\sin\theta}{\cos\theta_c} = \mu$$

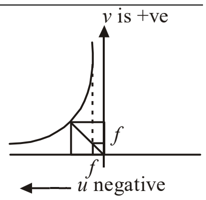


But, $\cos\theta_c = \dfrac{\sqrt{\mu^2 - 1}}{\mu}$ $\quad\therefore\quad \sin\theta = \mu\dfrac{\sqrt{\mu^2 - 1}}{\mu} = \sqrt{\mu^2 - 1}$

$$\therefore \theta = \sin^{-1}\sqrt{\frac{4}{3} - 1} = \sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$$

So that θ_c is making total internal reflection.

49. **(d)** **:** According to the new cartesian system used in schools, $\dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}$ for a convex lens.



u has to be negative.

If $v = \infty$, $u = f$ and if $u = \infty$, $v = f$

A parallel beam ($u = \infty$) is focussed at f and if the object is at f, the rays are parallel. The point which meets the curve at $u = v$ gives $2f$. Therefore v is +ve, u is negative, both are symmetrical and this curve satisfies all the conditions for a convex lens.

50. **(c) :** Power of combination $= P_1 + P_2 = -15\text{ D} + 5\text{ D} = -10\text{ D}$

Focal length of combination $F = \dfrac{1}{P} = \dfrac{1}{-10\text{ D}} = -0.1\text{ m} = -10\text{ cm}$

51. **(a) :** In Young's double slit experiment intensity at a point is given by $I = I_0\cos^2\left(\dfrac{\phi}{2}\right)$

where ϕ = phase difference, I_0 = maximum intensity

$$\text{or} \quad \frac{I}{I_0} = \cos^2\left(\frac{\phi}{2}\right) \qquad \text{... (i)}$$

Phase difference $\phi = \dfrac{2\pi}{\lambda} \times \text{path difference}$

$$\therefore \quad \phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{6} \quad \text{or} \quad \phi = \frac{\pi}{3} \qquad \text{... (ii)}$$

Substitute eqn. (ii) in eqn. (i), we get

$$\frac{I}{I_0} = \cos^2\left(\frac{\pi}{6}\right) \quad \text{or} \quad \frac{I}{I_0} = \frac{3}{4}$$

52. **(b)** **:** Angle of minimum deviation $D = A(\mu - 1)$

$$\frac{D_1 \text{ for red}}{D_2 \text{ for blue}} = \frac{\mu_R - 1}{\mu_B - 1}.$$

Since $\mu_B > \mu_R$,

$$\therefore \quad \frac{D_1}{D_2} < 1 \quad \therefore \quad D_1 < D_2$$

53. **(*)** **:** $\dfrac{1}{f_a} = ({}^a\mu_g - 1)\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$

$$\frac{1}{f_l} = ({}^l\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \therefore \quad \frac{f_a}{f_l} = \frac{({}^l\mu_g - 1)}{({}^a\mu_g - 1)} = \frac{(\mu_g/\mu_l) - 1}{(\mu_g - 1)}$$

$$= \frac{\mu_g - \mu_l}{\mu_l(\mu_g - 1)} = \frac{1.5 - 1.6}{1.6\,(1.5 - 1)}$$

$$\text{or} \quad \frac{P_l}{P_a} = -\frac{0.1}{1.6 \times 0.5} = \frac{-1}{8} \quad \Rightarrow \quad P_l = -\frac{P_a}{8} = -\frac{(-5)}{8} = \frac{5}{8}$$

or Optical power in liquid medium $= \dfrac{5}{8}$ Dipotre.

Note : This answer is not given in the four options provided in the question.

54. **(d)** **:** For total internal reflection,

$$\mu = \frac{1}{\sin\theta_C} \Rightarrow \sin\theta_C = \frac{1}{\mu} = \frac{3}{4}$$

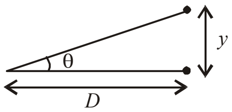
$$\therefore \quad \tan\theta_c = \frac{\sin\theta_c}{\sqrt{1 - \sin^2\theta_c}} = \frac{3/4}{\sqrt{1 - \frac{9}{16}}} = \frac{3}{4} \times \frac{4}{\sqrt{7}} = \frac{3}{\sqrt{7}}$$

$$\therefore \quad \frac{R}{12} = \frac{3}{\sqrt{7}} \Rightarrow R = \frac{36}{\sqrt{7}} \text{ cm}$$

55. (c) : Resolution limit $= \dfrac{1.22\lambda}{d}$

Again resolution limit $= \sin\theta = \theta = \dfrac{y}{D}$

$\therefore \quad \dfrac{y}{D} = \dfrac{1.22\lambda}{d}$



or $\quad D = \dfrac{yd}{1.22\lambda}$

or $\quad D = \dfrac{(10^{-3}) \times (3 \times 10^{-3})}{(1.22) \times (5 \times 10^{-7})} = \dfrac{30}{6.1} \approx 5$ m

56. (c) : Intensity of polarized light = $I_0/2$

$\therefore$ Intensity of light not transmitted

$= I_0 - \dfrac{I_0}{2} = \dfrac{I_0}{2}$

57. (a) : For diffraction pattern

$I = I_0\left(\dfrac{\sin\phi}{\phi}\right)^2$ where ϕ denotes path difference

For principal maxima, $\phi = 0$. Hence $\left(\dfrac{\sin\phi}{\phi}\right) = 1$

Hence intensity remains constant at I_0

$I = I_0\,(1) = I_0$

58. (a) : Straight line fringes are formed on screen.

59. (a) : A plano-convex lens behaves like a concave mirror when its curved surface is silvered.

$\therefore \quad F$ of concave mirror so formed $= \dfrac{R}{2\mu} = \dfrac{30}{2 \times 1.5} = 10$ cm

To form an image of object size, the object should be placed at $(2F)$ of the concave mirror.

$\therefore$ Distance of object from lens = $2 \times F = 2 \times 10 = 20$ cm

60. (b) : Total internal reflection occurs in a denser medium when light is incident at surface of separation at angle exceeding critical angle of the medium.

Given : $i = 45°$ in the medium and total internal reflection occurs at the glass air interface

$\therefore \quad n > \dfrac{1}{\sin C} > \dfrac{1}{\sin 45°} > \sqrt{2}$

61. (d) : According to Brewster's law of polarization, $n = \tan i_p$ where i_p is angle of incidence

$\therefore \quad i_p = \tan^{-1}(n)$

62. (b) : For interference maxima, $d\sin\theta = n\lambda$

$\therefore \quad 2\lambda\sin\theta = n\lambda \quad$ or $\quad \sin\theta = \dfrac{n}{2}$

This equation is satisfied if $n = -2, -1, 0, 1, 2$

$\sin\theta$ is never greater than $(+1)$, less than (-1)

$\therefore$ Maximum number of maxima can be five.

63. (b) : $n = \dfrac{360°}{\theta°} - 1$

$\therefore \quad 3 = \dfrac{360°}{\theta°} - 1 \Rightarrow 4\theta° = 360° \Rightarrow \theta° = 90°$

64. (c) : The objective of compound microscope forms a real and enlarged image.

65. (d) : For interference phenomenon, two sources should emit radiation of the same frequency and having a definite phase relationship.

66. (b) : Large aperture leads to high resolution of telescope.

67. (a) : Total internal reflection is used in optical fibres.

68. (d) : Resolving power is proportional to λ^{-1}

$\therefore \quad \dfrac{R.P. \text{ for } \lambda_1}{R.P. \text{ for } \lambda_2} = \dfrac{\lambda_2}{\lambda_1} = \dfrac{5000}{4000} = \dfrac{5}{4}$

69. (a) : $n = \dfrac{360°}{\theta°} - 1 = \dfrac{360°}{60°} - 1 = 5$