CHAPTER 9

Ray Optics and Optical Instruments

9.2 Reflection of Light by Spherical Mirrors

1. An object is placed at a distance of 40 cm from a concave mirror of focal length 15 cm. If the object is displaced through a distance of 20 cm towards the mirror, the displacement of the image will be
(a) 30 cm away from the mirror
(b) 36 cm away from the mirror
(c) 30 cm towards the mirror
(d) 36 cm towards the mirror. *(NEET 2018)*

2. A beam of light from a source L is incident normally on a plane mirror fixed at a certain distance x from the source. The beam is reflected back as a spot on a scale placed just above the source L. When the mirror is rotated through a small angle θ, the spot of the light is found to move through a distance y on the scale. The angle θ is given by
(a) $\frac{y}{x}$ (b) $\frac{x}{2y}$ (c) $\frac{x}{y}$ (d) $\frac{y}{2x}$
(NEET 2017)

3. Match the corresponding entries of Column 1 with Column 2. [Where m is the magnification produced by the mirror]

Column 1	Column 2
(A) $m = -2$	(p) Convex mirror
(B) $m = -\frac{1}{2}$	(q) Concave mirror
(C) $m = +2$	(r) Real image
(D) $m = +\frac{1}{2}$	(s) Virtual image

(a) A $\rightarrow$ p and s; B $\rightarrow$ q and r; C $\rightarrow$ q and s; D $\rightarrow$ q and r
(b) A $\rightarrow$ r and s; B $\rightarrow$ q and s; C $\rightarrow$ q and r; D $\rightarrow$ p and s
(c) A $\rightarrow$ q and r; B $\rightarrow$ q and r; C $\rightarrow$ q and s; D $\rightarrow$ p and s
(d) A $\rightarrow$ p and r; B $\rightarrow$ p and s; C $\rightarrow$ p and q; D $\rightarrow$ r and s *(NEET-I 2016)*

4. Two plane mirrors are inclined at 70°. A ray incident on one mirror at angle, θ after reflection falls on second mirror and is reflected from there parallel to first mirror. The value of θ is
(a) 45° (b) 30°
(c) 55° (d) 50°
(Karnataka NEET 2013)

5. A rod of length 10 cm lies along the principal axis of a concave mirror of focal length 10 cm in such a way that its end closer to the pole is 20 cm away from the mirror. The length of the image is
(a) 10 cm (b) 15 cm
(c) 2.5 cm (d) 5 cm. *(Mains 2012)*

6. A tall man of height 6 feet, want to see his full image. Then required minimum length of the mirror will be
(a) 12 feet (b) 3 feet
(c) 6 feet (d) any length *(2000)*

9.3 Refraction

7. An air bubble in a glass slab with refractive index 1.5 (near normal incidence) is 5 cm deep when viewed from one surface and 3 cm deep when viewed from the opposite face. The thickness (in cm) of the slab is
(a) 8 (b) 10
(c) 12 (d) 16. *(NEET-II 2016)*

8. A microscope is focussed on a mark on a piece of paper and then a slab of glass of thickness 3 cm and refractive index 1.5 is placed over the mark. How should the microscope be moved to get the mark in focus again?
(a) 2 cm upward (b) 1 cm upward
(c) 4.5 cm downward (d) 1 cm downward *(2006)*

9. A beam of light composed of red and green ray is incident obliquely at a point on the face of rectangular glass slab. When coming out on the opposite parallel face, the red and green ray emerge from

(a) two points propagating in two different non parallel directions
(b) two points propagating in two different parallel directions
(c) one point propagating in two different directions
(d) one point propagating in the same directions. *(2004)*

10. A ray of light travelling in air have wavelength λ, frequency n, velocity v and intensity I. If this ray enters into water then these parameters are λ', n', v' and I' respectively. Which relation is correct from following?
(a) $\lambda = \lambda'$ (b) $n = n'$
(c) $v = v'$ (d) $I = I'$ *(2001)*

11. A bubble in glass slab (μ = 1.5) when viewed from one side appears at 5 cm and 2 cm from other side, then thickness of slab is
(a) 3.75 cm (b) 3 cm
(c) 10.5 cm (d) 2.5 cm *(2000)*

9.4 Total Internal Reflection

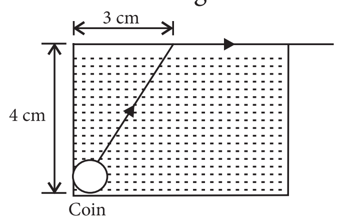
12. In total internal reflection when the angle of incidence is equal to the critical angle for the pair of media in contact, what will be angle of refraction?
(a) 90° (b) 180°
(c) 0°
(d) equal to angle of incidence *(NEET 2019)*

13. Which of the following is not due to total internal reflection?
(a) Working of optical fibre
(b) Difference between apparent and real depth of a pond
(c) Mirage on hot summer days
(d) Brilliance of diamond *(2011)*

14. A ray of light travelling in a transparent medium of refractive index μ, falls on a surface separating the medium from air at an angle of incidence of 45°. For which of the following value of μ the ray can undergo total internal reflection?
(a) μ = 1.33 (b) μ = 1.40
(c) μ = 1.50 (d) μ = 1.25 *(2010)*

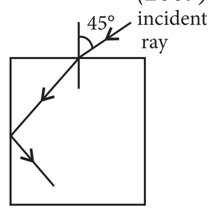
15. The speed of light in media M_1 and M_2 are 1.5×10^8 m/s and 2.0×10^8 m/s respectively. A ray of light enters from medium M_1 to M_2 at an incidence angle i. If the ray suffers total internal reflection, the value of i is
(a) equal to $\sin^{-1}\left(\frac{2}{3}\right)$
(b) equal to or less than $\sin^{-1}\left(\frac{3}{5}\right)$
(c) equal to or greater than $\sin^{-1}\left(\frac{3}{4}\right)$
(d) less than $\sin^{-1}\left(\frac{2}{3}\right)$ *(Mains 2010)*

16. A small coin is resting on the bottom of a beaker filled with liquid. A ray of light from the coin travels upto the surface of the liquid and moves along its surface. How fast is the light travelling in the liquid?



(a) 2.4×10^8 m/s
(b) 3.0×10^8 m/s
(c) 1.2×10^8 m/s
(d) 1.8×10^8 m/s. *(2007)*

17. For the given incident ray as shown in figure, the condition of total internal reflection of this ray the required refractive index of prism will be



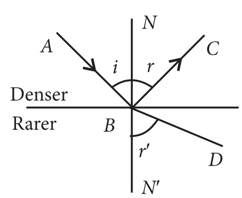
(a) $\frac{\sqrt{3}+1}{2}$ (b) $\frac{\sqrt{2}+1}{2}$
(c) $\sqrt{\frac{3}{2}}$ (d) $\sqrt{\frac{7}{6}}$ *(2002)*

18. Optical fibre are based on
(a) total internal reflection
(b) less scattering (c) refraction
(d) less absorption coefficient. *(2001)*

19. A disc is placed on a surface of pond which has refractive index 5/3. A source of light is placed 4 m below the surface of liquid. The minimum radius of disc needed so that light is not coming out is,
(a) ∞ (b) 3 m (c) 6 m (d) 4 m *(2001)*

20. Light enters at an angle of incidence in a transparent rod of refractive index n. For what value of the refractive index of the material of the rod, the light once entered into it will not leave it through its lateral face whatsoever be the value of angle of incidence?
(a) n = 1.1 (b) n = 1
(c) $n > \sqrt{2}$ (d) n = 1.3 *(1998)*

21. A ray of light from a denser medium strikes a rare medium as shown in figure. The reflected and refracted rays make an angle of 90° with each other. The angles of reflection and refraction are r and r'. The critical angle would be



(a) $\sin^{-1}(\tan r)$ (b) $\sin^{-1}(\sin r)$
(c) $\cos^{-1}(\tan r)$ (d) $\tan^{-1}(\sin r)$ *(1996)*

22. A small source of light is 4 m below the surface of water of refractive index 5/3. In order to cut off all the light, coming out of water surface, minimum diameter of the disc placed on the surface of water is
(a) 6 m (b) ∞
(c) 3 m (d) 4 m *(1994)*

9.5 Refraction at Spherical Surfaces and by Lenses

23. Two similar thin equi-convex lenses, of focal length f each, are kept coaxially in contact with each other such that the focal length of the combination is F_1. When the space between the two lenses is filled with glycerin (which has the same refractive index ($\mu = 1.5$) as that of glass) then the equivalent focal length is F_2. The ratio $F_1 : F_2$ will be
(a) 3 : 4 (b) 2 : 1 (c) 1 : 2 (d) 2 : 3
(NEET 2019)

24. An equiconvex lens has power P. It is cut into two symmetrical halves by a plane containing the principal axis. The power of one part will be
(a) 0 (b) $\frac{P}{2}$ (c) $\frac{P}{4}$ (d) P
(Odisha NEET 2019)

25. Two identical glass ($\mu_g = 3/2$) equiconvex lenses of focal length f each are kept in contact. The space between the two lenses is filled with water ($\mu_w = 4/3$). The focal length of the combination is
(a) $f/3$ (b) f (c) $4f/3$ (d) $3f/4$
(NEET-II 2016)

26. A plano convex lens fits exactly into a plano concave lens. Their plane surfaces are parallel to each other. If lenses are made of different materials of refractive indices μ_1 and μ_2 and R is the radius of curvature of the curved surface of the lenses, then the focal length of the combination is
(a) $\frac{R}{(\mu_1 - \mu_2)}$ (b) $\frac{2R}{(\mu_2 - \mu_1)}$
(c) $\frac{R}{2(\mu_1 + \mu_2)}$ (d) $\frac{R}{2(\mu_1 - \mu_2)}$
(NEET 2013)

27. When a biconvex lens of glass having refractive index 1.47 is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index
(a) equal to that of glass (b) less than one
(c) greater than that of glass
(d) less than that of glass. *(2012)*

28. A concave mirror of focal length f_1 is placed at a distance of d from a convex lens of focal length f_2. A beam of light coming from infinity and falling on this convex lens – concave mirror combination returns to infinity. The distance d must equal
(a) $f_1 + f_2$ (b) $-f_1 + f_2$
(c) $2f_1 + f_2$ (d) $-2f_1 + f_2$ *(2012)*

29. A biconvex lens has a radius of curvature of magnitude 20 cm. Which one of the following options describe best the image formed of an object of height 2 cm placed 30 cm from the lens?
(a) Virtual, upright, height = 1 cm
(b) Virtual, upright, height = 0.5 cm
(c) Real, inverted, height = 4 cm
(d) Real, inverted, height = 1 cm *(2011)*

30. A converging beam of rays is incident on a diverging lens. Having passed through the lens the rays intersect at a point 15 cm from the lens on the opposite side. If the lens is removed, the point where the rays meet will move 5 cm closer to the lens. The focal length of the lens is
(a) 5 cm (b) –10 cm
(c) 20 cm (d) –30 cm *(Mains 2011)*

31. A lens having focal length f and aperture of diameter d forms an image of intensity I. Aperture of diameter $\frac{d}{2}$ in central region of lens is covered by a black paper. Focal length of lens and intensity of image now will be respectively
(a) f and $\frac{I}{4}$ (b) $\frac{3f}{4}$ and $\frac{I}{2}$
(c) f and $\frac{3I}{4}$ (d) $\frac{f}{2}$ and $\frac{I}{2}$. *(2010)*

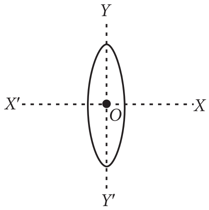
32. Two thin lenses of focal lengths f_1 and f_2 are in contact and coaxial. The power of the combination is
(a) $\frac{f_1 + f_2}{2}$ (b) $\frac{f_1 + f_2}{f_1 f_2}$
(c) $\sqrt{\frac{f_1}{f_2}}$ (d) $\sqrt{\frac{f_2}{f_1}}$ *(2008)*

33. A boy is trying to start a fire by focusing sunlight on a piece of paper using an equiconvex lens of focal length 10 cm. The diameter of the sun is 1.39×10^9 m and its mean distance from the earth is 1.5×10^{11} m. What is the diameter of the sun's image on the paper?
(a) 6.5×10^{-5} m (b) 12.4×10^{-4} m
(c) 9.2×10^{-4} m (d) 6.5×10^{-4} m *(2008)*

34. A convex lens and a concave lens, each having same focal length of 25 cm, are put in contact to form a combination of lenses. The power in diopters of the combination is

(a) zero (b) 25
(c) 50 (d) infinite. *(2006)*

35. An equiconvex lens is cut into two halves along (i) XOX' and (ii) YOY' as shown in the figure. Let f, f', f'' be the focal lengths of the complete lens, of each half in case (i), and of each half in case (ii), respectively. Choose the correct statement from the following.



(a) $f' = f, f'' = 2f$ (b) $f' = 2f, f'' = f$
(c) $f' = f, f'' = f$ (d) $f' = 2f, f'' = 2f$ *(2003)*

36. A convex lens is dipped in a liquid whose refractive index is equal to the refractive index of the lens. Then its focal length will

(a) become zero (b) become infinite
(c) become small, but non-zero
(d) remain unchanged. *(2003)*

37. A bulb is located on a wall. Its image is to be obtained on a parallel wall with the help of convex lens. The lens is placed at a distance d ahead of second wall, then required focal length will be

(a) only $\frac{d}{4}$ (b) only $\frac{d}{2}$
(c) more than $\frac{d}{4}$ but less than $\frac{d}{2}$
(d) less than $\frac{d}{4}$ *(2002)*

38. For a plano convex lens (μ = 1.5) has radius of curvature 10 cm. It is silvered on its plane surface. Find focal length after silvering.

(a) 10 cm (b) 20 cm
(c) 15 cm (d) 25 cm *(2000)*

39. A plano convex lens is made of refractive index 1.6. The radius of curvature of the curved surface is 60 cm. The focal length of the lens is

(a) 200 cm (b) 100 cm
(c) 50 cm (d) 400 cm *(1999)*

40. A luminous object is placed at a distance of 30 cm from the convex lens of focal length 20 cm. On the other side of the lens, at what distance from the lens a convex mirror of radius of curvature 10 cm be placed in order to have an upright image of the object coincident with it ?

(a) 50 cm (b) 30 cm
(c) 12 cm (d) 60 cm *(1998)*

41. The focal length of converging lens is measured for violet, green and red colours. It is respectively f_v, f_g, f_r. We will get

(a) $f_v < f_r$ (b) $f_g > f_r$
(c) $f_v = f_g$ (d) $f_g < f_r$ *(1997)*

42. If a convex lens of focal length 80 cm and a concave lens of focal length 50 cm are combined together, what will be their resulting power?

(a) + 7.5 D (b) –0.75 D
(c) + 6.5 D (d) –6.5 D *(1996)*

43. If f_V and f_R are the focal lengths of a convex lens for violet and red light respectively and F_V and F_R are the focal lengths of a concave lens for violet and red light respectively, then we must have

(a) $f_V > f_R$ and $F_V > F_R$ (b) $f_V < f_R$ and $F_V > F_R$
(c) $f_V > f_R$ and $F_V < F_R$ (d) $f_V < f_R$ and $F_V < F_R$
(1996)

44. A lens is placed between a source of light and a wall. It forms images of area A_1 and A_2 on the wall, for its two different positions. The area of the source of light is

(a) $\frac{A_1 - A_2}{2}$ (b) $\frac{1}{A_1} + \frac{1}{A_2}$
(c) $\sqrt{A_1 A_2}$ (d) $\frac{A_1 + A_2}{2}$ *(1995)*

45. Focal length of a convex lens of refractive index 1.5 is 2 cm. Focal length of lens when immersed in a liquid of refractive index of 1.25 will be

(a) 10 cm (b) 2.5 cm
(c) 5 cm (d) 7.5 cm *(1988)*

9.6 Refraction through a Prism

46. A ray is incident at an angle of incidence i on one surface of a small angle prism (with angle of prism A) and emerges normally from the opposite surface. If the refractive index of the material of the prism is μ, then the angle of incidence is nearly equal to

(a) $A/2\mu$ (b) $2A/\mu$
(c) μA (d) $\mu A/2$ *(NEET 2020)*

47. The refractive index of the material of a prism is $\sqrt{2}$ and the angle of the prism is 30°. One of the two refracting surfaces of the prism is made a mirror inwards, by silver coating. A beam of monochromatic light entering the prism from the other face will retrace its path (after reflection from the silvered surface) if its angle of incidence on the prism is

(a) 60° (b) 45° (c) 30° (d) zero
(NEET 2018, 2004, 1992)

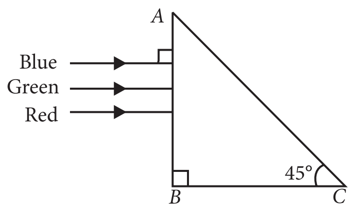
48. The angle of incidence for a ray of light at a refracting surface of a prism is 45°. The angle of prism is 60°. If the ray suffers minimum deviation through the prism, the angle of minimum deviation and refractive index of the material of the prism respectively, are

(a) $45^\circ; \sqrt{2}$ (b) $30^\circ; \frac{1}{\sqrt{2}}$

(c) $45^\circ; \frac{1}{\sqrt{2}}$ (d) $30^\circ; \sqrt{2}$

(NEET-I 2016)

49. A beam of light consisting of red, green and blue colours is incident on a right angled prism. The refractive index of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively.



The prism will

(a) not separate the three colours at all
(b) separate the red colour part from the green and blue colours
(c) separate the blue colour part from the red and green colours
(d) separate all the three colours from one another

(2015)

50. The refracting angle of a prism is A, and refractive index of the material of the prism is cot (A/2). The angle of minimum deviation is

(a) $90° - A$ (b) $180° + 2A$
(c) $180° - 3A$ (d) $180° - 2A$

(2015 Cancelled)

51. The angle of a prism is A. One of its refracting surfaces is silvered. Light rays falling at an angle of incidence $2A$ on the first surface returns back through the same path after suffering reflection at the silvered surface. The refractive index μ, of the prism is

(a) $2\sin A$ (b) $2\cos A$
(c) $\frac{1}{2}\cos A$ (d) $\tan A$ *(2014)*

52. For the angle of minimum deviation of a prism to be equal to its refracting angle, the prism must be made of a material whose refractive index

(a) lies between $\sqrt{2}$ and 1
(b) lies between 2 and $\sqrt{2}$
(c) is less than 1
(d) is greater than 2 *(Mains 2012)*

53. A ray of light is incident on a 60° prism at the minimum deviation position. The angle of refraction at the first face (*i.e.*, incident face) of the prism is

(a) zero (b) 30° (c) 45° (d) 60°

(Mains 2010)

54. If the refractive index of a material of equilateral prism is $\sqrt{3}$, then angle of minimum deviation of the prism is

(a) 60° (b) 45° (c) 30° (d) 75° *(1999)*

9.7 Some Natural Phenomena due to Sunlight

55. Pick the wrong answer in the context with rainbow.

(a) Rainbow is a combined effect of dispersion, refraction and reflection of sunlight.
(b) When the light rays undergo two internal reflections in a water drop, a secondary rainbow is formed.
(c) The order of colours is reversed in the secondary rainbow.
(d) An observer can see a rainbow when his front is towards the sun. *(NEET 2019)*

56. Which colour of the light has the longest wavelength?

(a) violet (b) red
(c) blue (d) green *(NEET 2019)*

57. A thin prism having refracting angle 10° is made of glass of refractive index 1.42. This prism is combined with another thin prism of glass of refractive index 1.7. This combination produces dispersion without deviation. The refracting angle of second prism should be

(a) 6° (b) 8° (c) 10° (d) 4°

(NEET 2017)

58. The reddish appearance of the sun at sunrise and sunset is due to

(a) the scattering of light
(b) the polarisation of light
(c) the colour of the sun
(d) the colour of the sky. *(Karnataka NEET 2013)*

59. A thin prism of angle 15° made of glass of refractive index $\mu_1 = 1.5$ is combined with another prism of glass of refractive index $\mu_2 = 1.75$. The combination of the prisms produces dispersion without deviation. The angle of the second prism should be

(a) 5° (b) 7° (c) 10° (d) 12°

(Mains 2011)

60. Rainbow is formed due to
(a) scattering and refraction
(b) internal reflection and dispersion
(c) reflection only
(d) diffraction and dispersion. *(2000)*

61. The blue colour of the sky is due to the phenomenon of
(a) scattering (b) dispersion
(c) reflection (d) refraction. *(1994)*

9.8 Optical Instruments

62. A person can see clearly objects only when they lie between 50 cm and 400 cm from his eyes. In order to increase the maximum distance of distinct vision to infinity, the type and power of the correcting lens, the person has to use, will be
(a) convex, +2.25 dioptre
(b) concave, –0.25 dioptre
(c) concave, –0.2 dioptre
(d) convex, +0.15 dioptre. *(NEET-II 2016)*

63. A astronomical telescope has objective and eyepiece of focal lengths 40 cm and 4 cm respectively. To view an object 200 cm away from the objective, the lenses must be separated by a distance
(a) 50.0 cm (b) 54.0 cm
(c) 37.3 cm (d) 46.0 cm. *(NEET-I 2016)*

64. In an astronomical telescope in normal adjustment a straight black line of length L is drawn on inside part of objective lens. The eye-piece forms a real image of this line. The length of this image is I. The magnification of the telescope is
(a) $\frac{L+I}{L-I}$ (b) $\frac{L}{I}$ (c) $\frac{L}{I}+1$ (d) $\frac{L}{I}-1$ *(2015)*

65. If the focal length of objective lens is increased then magnifying power of
(a) microscope will increase but that of telescope decrease
(b) microscope and telescope both will increase
(c) microscope and telescope both will decrease
(d) microscope will decrease but that of telescope will increase *(2014)*

66. For a normal eye, the cornea of eye provides a converging power of 40 D and the least converging power of the eye lens behind the cornea is 20 D. Using this information, the distance between the retina and the cornea-eye lens can be estimated to be
(a) 1.67 cm (b) 1.5 cm
(c) 5 cm (d) 2.5 cm *(NEET 2013)*

67. The magnifying power of a telescope is 9. When it is adjusted for parallel rays the distance between the objective and eyepiece is 20 cm. The focal length of lenses are
(a) 10 cm, 10 cm (b) 15 cm, 5 cm
(c) 18 cm, 2 cm (d) 11 cm, 9 cm. *(2012)*

68. An astronomical telescope of tenfold angular magnification has a length of 44 cm. The focal length of the objective is
(a) 44 cm (b) 440 cm
(c) 4 cm (d) 40 cm *(1997)*

69. Exposure time of camera lens at $f/2.8$ setting is 1/200 second. The correct time of exposure at $f/5.6$ is
(a) 0.20 second (b) 0.40 second
(c) 0.02 second (d) 0.04 second. *(1995)*

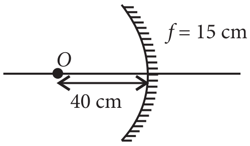
70. Four lenses of focal length ±15 cm and ±150 cm are available for making a telescope. To produce the largest magnification, the focal length of the eyepiece should be
(a) +15 cm (b) +150 cm
(c) –150 cm (d) –15 cm *(1994)*

ANSWER KEY

1. (b)	**2.** (d)	**3.** (c)	**4.** (d)	**5.** (d)	**6.** (b)	**7.** (c)	**8.** (b)	**9.** (b)	**10.** (b)
11. (c)	**12.** (a)	**13.** (b)	**14.** (c)	**15.** (c)	**16.** (d)	**17.** (c)	**18.** (a)	**19.** (b)	**20.** (c)
21. (a)	**22.** (a)	**23.** (c)	**24.** (d)	**25.** (d)	**26.** (a)	**27.** (a)	**28.** (c)	**29.** (c)	**30.** (d)
31. (c)	**32.** (b)	**33.** (c)	**34.** (a)	**35.** (a)	**36.** (b)	**37.** (b)	**38.** (a)	**39.** (b)	**40.** (a)
41. (a)	**42.** (b)	**43.** (b)	**44.** (c)	**45.** (c)	**46.** (c)	**47.** (b)	**48.** (d)	**49.** (b)	**50.** (d)
51. (b)	**52.** (b)	**53.** (b)	**54.** (a)	**55.** (d)	**56.** (b)	**57.** (a)	**58.** (a)	**59.** (c)	**60.** (b)
61. (a)	**62.** (b)	**63.** (b)	**64.** (b)	**65.** (d)	**66.** (a)	**67.** (c)	**68.** (d)	**69.** (c)	**70.** (a)

Hints & Explanations

1. (b) :



Using mirror formula,

$$\frac{1}{f}=\frac{1}{v_1}+\frac{1}{u_1};\ -\frac{1}{15}=\frac{1}{v_1}-\frac{1}{40} \Rightarrow \frac{1}{v_1}=\frac{1}{-15}+\frac{1}{40}$$

$v_1 = -24$ cm

When object is displaced by 20 cm towards mirror. Now,

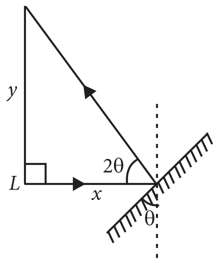
$u_2 = -20$ cm

$$\frac{1}{f}=\frac{1}{v_2}+\frac{1}{u_2};\ \frac{1}{-15}=\frac{1}{v_2}-\frac{1}{20} \Rightarrow \frac{1}{v_2}=\frac{1}{20}-\frac{1}{15};$$

$v_2 = -60$ cm

So, the image will be shift away from mirror by (60 – 24) cm = 36 cm.

2. (d) : When mirror is rotated by θ angle reflected ray will be rotated by 2θ.



For small angle θ,

$$\tan 2\theta \approx 2\theta = \frac{y}{x}$$

$$\therefore\quad \theta = \frac{y}{2x}$$

3. (c) : Magnification in the mirror, $m=-\frac{v}{u}$

$m = -2 \Rightarrow v = 2u$

As v and u have same signs so the mirror is concave and image formed is real.

$m=-\frac{1}{2} \Rightarrow v=\frac{u}{2} \Rightarrow$ Concave mirror and real image.

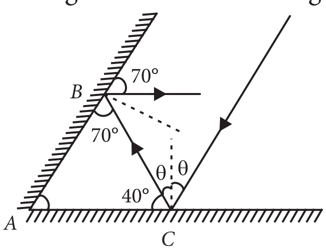
$m = +2 \Rightarrow v = -2u$

As v and u have different signs but magnification is 2 so the mirror is concave and image formed is virtual.

$$m=+\frac{1}{2} \Rightarrow v=-\frac{u}{2}$$

As v and u have different signs with magnification $\left(\frac{1}{2}\right)$ so the mirror is convex and image formed is virtual.

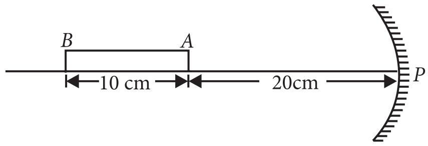
4. (d) : Different angles as shown in the figure.



$\theta + 40° = 90°$

$\therefore\quad \theta = 90° - 40° = 50°$

5. (d) :



Here, $f = -10$ cm

For end A, $u_A = -20$ cm

Image position of end A,

$$\frac{1}{v_A}+\frac{1}{u_A}=\frac{1}{f}$$

$$\frac{1}{v_A}+\frac{1}{(-20)}=\frac{1}{(-10)} \text{ or } \frac{1}{v_A}=\frac{1}{-10}+\frac{1}{20}=-\frac{1}{20}$$

$v_A = -20$ cm

For end B, $u_B = -30$ cm

Image position of end B,

$$\frac{1}{v_B}+\frac{1}{u_B}=\frac{1}{f}$$

$$\frac{1}{v_B}+\frac{1}{(-30)}=\frac{1}{(-10)} \text{ or } \frac{1}{v_B}=\frac{1}{-10}+\frac{1}{30}=-\frac{2}{30}$$

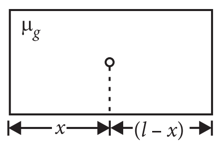
$v_B = -15$ cm

Length of the image

$= |v_A| - |v_B| = 20 \text{ cm} - 15 \text{ cm} = 5 \text{ cm}$

6. (b) : The minimum mirror length should be half of the height of man.

7. (c) : Here $\mu = 1.5$



l = length of the slab

x = position of air bubble from one side

As per question, total apparent length of slab = 5 + 3

$$\text{or } \frac{x}{\mu}+\frac{(l-x)}{\mu}=8 \text{ or } \frac{l}{\mu}=8$$

$$\therefore\quad l = 8\mu = 8\times 1.5 = 12 \text{ cm}$$

8. (b) : Apparent depth $=\dfrac{\text{real depth}}{\mu}=\dfrac{3}{1.5}$

$= 2$ cm

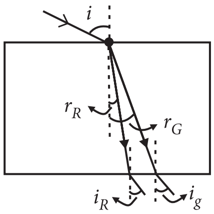
As image appears to be raised by 1 cm, therefore, microscope must be moved upwards by 1 cm.

9. (b) : The velocities of different colours is different in a given medium. Red and green are refracted at different angle of refraction.

$$\frac{\sin i}{\sin r_R} = \mu \qquad \text{...(i)}$$

$$\frac{\sin i}{\sin r_G} = \mu \qquad \text{...(ii)}$$

$$\frac{\sin r_p}{\sin i_p} = \mu \qquad \text{...(iii)}$$



From equations (i), (ii) and (iii), we get

$$i = i_R = i_G$$

Thus two point propagation in two different parallel direction.

10. (b) : Frequency remains same.

11. (c) : Total apparent depth,

$$y = y_1 + y_2 = 5 + 2 = 7 \text{ cm.}$$

If x is real depth = thickness of slab, then as

$$\mu = \frac{\text{real depth}}{\text{apparent depth}} = \frac{x}{y}$$

or, $x = \mu y = 1.5 \times 7 = 10.5$ cm.

12. (a) : When the angle of refraction is equal to 90°, the angle of incidence is called the critical angle.

13. (b) : Difference between apparent and real depth of a pond is due to refraction. Other three are due to total internal reflection.

14. (c) : For total internal reflection, $\sin i > \sin C$

where, i = angle of incidence, C = critical angle

But, $\sin C = \dfrac{1}{\mu}$ $\quad\therefore\quad \sin i > \dfrac{1}{\mu}$ or $\mu > \dfrac{1}{\sin i}$

$$\mu > \frac{1}{\sin 45^\circ} \qquad (i = 45^\circ \text{ (Given)})$$

$$\mu > \sqrt{2}$$

Hence, option (c) is correct.

15. (c) : Refractive index for medium M_1 is

$$\mu_1 = \frac{c}{v_1} = \frac{3\times10^8}{1.5\times10^8} = 2$$

Refractive index for medium M_2 is

$$\mu_2 = \frac{c}{v_2} = \frac{3\times10^8}{2.0\times10^8} = \frac{3}{2}$$

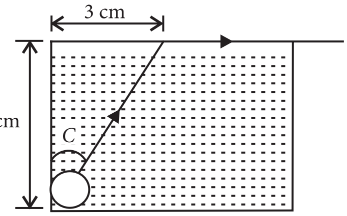
For total internal reflection, $\sin i \geq \sin C$

where i = angle of incidence, C = critical angle

But $\sin C = \dfrac{\mu_2}{\mu_1}$

$$\therefore\ \sin i \geq \frac{\mu_2}{\mu_1} \geq \frac{3/2}{2} \ \Rightarrow\ i \geq \sin^{-1}\left(\frac{3}{4}\right)$$

16. (d) :



From figure, $\sin C = \dfrac{3}{\sqrt{(4)^2 + (3)^2}} = \dfrac{3}{5}$

where C is the critical angle.

Also, $\sin C = {}^{l}\mu_a$

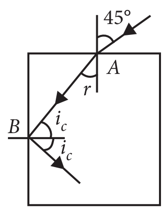
$$\sin C = \frac{1}{{}^{a}\mu_l} \quad \left[\text{since } {}^{l}\mu_a = \frac{1}{{}^{a}\mu_l}\right]$$

$$\text{Also } {}^{a}\mu_l = \frac{\text{velocity of light in air } (c)}{\text{velocity of light in liquid } (v)}$$

$$\therefore\ \sin C = \frac{v}{c} = \frac{v}{3\times10^8}$$

$$\text{or, } v = 3\times10^8 \times \frac{3}{5} = 1.8\times10^8 \text{ m s}^{-1}.$$

17. (c) : Applying Snell's law of refraction at A, we get



$$\mu = \frac{\sin i}{\sin r} = \frac{\sin 45^\circ}{\sin r}$$

$$\therefore\ \sin r = 1/\sqrt{2}\,\mu$$

$$\therefore\ r = \sin^{-1}\left(\frac{1}{\sqrt{2}\,\mu}\right) \qquad \text{...(i)}$$

Applying the condition of total internal reflection at B, we get

$$i_c = \sin^{-1}(1/\mu) \qquad \text{... (ii)}$$

where i_c is the critical angle.

Now, $r + i_c = 90^\circ = \pi/2$

$$\therefore\ \sin^{-1}\frac{1}{\sqrt{2}\,\mu} = \frac{\pi}{2} - \sin^{-1}\frac{1}{\mu}$$

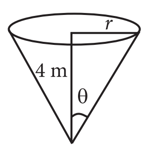
$$\text{or, } \sin^{-1}\frac{1}{\sqrt{2}\,\mu} = \cos^{-1}\frac{1}{\mu}$$

$$\therefore\ \frac{1}{\sqrt{2}\,\mu} = \frac{\sqrt{\mu^2 - 1}}{\mu} \text{ or } \frac{1}{2} = \mu^2 - 1$$

$$\therefore\ \mu = \sqrt{3/2}$$

18. (a)

19. (b) : θ is the critical angle.



$\therefore\ \theta = \sin^{-1}(1/\mu) = \sin^{-1}(3/5)$

or, $\sin\theta = 3/5$

$\therefore\ \tan\theta = 3/4 = r/4$

or, $r = 3$ m.

20. (c) : $n > \dfrac{\sin r}{\sin i}$

i.e., $n > \dfrac{\sin 90^\circ}{\sin 45^\circ} \Rightarrow n > \sqrt{2}$

21. (a) : According to Snell's law,

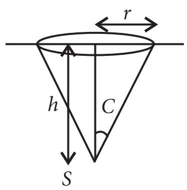
$$\mu = \frac{\sin i}{\sin r'} = \frac{\sin i}{\sin(90^\circ - r)} = \frac{\sin i}{\cos r}$$

From law of reflection, $i = r$

$$\therefore \quad \mu = \frac{\sin r}{\cos r} = \tan r$$

Critical angle = $\sin^{-1}(\mu) = \sin^{-1}(\tan r)$.

22. (a) : In order to cut off all the light coming out of water surface, angle C should be equal to critical angle.



i.e. $\sin C = \dfrac{1}{\mu} = \dfrac{1}{5/3} = \dfrac{3}{5}$

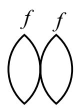
$\therefore \quad \tan C = 3/4.$

Now, $\tan C = \dfrac{r}{h}$;

$r = h \tan C = 4 \times \dfrac{3}{4} = 3$ m

Diameter of disc = $2r$ = 6 m.

23. (c) : According to lens maker's formula



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

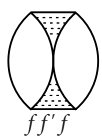
$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R} - \frac{1}{-R}\right) = (1.5 - 1)\left(\frac{2}{R}\right) = \frac{1}{R}$$

Two similar equi-convex lenses of focal length f each are held in contact with each other.

The focal length F_1 of the combination is given by

$$\frac{1}{F_1} = \frac{1}{f} + \frac{1}{f} = \frac{2}{f} \ ; \ F_1 = \frac{f}{2} = \frac{R}{2} \quad \text{... (i)}$$

For glycerin in between lenses, there are three lenses, one concave and two convex.



Focal length of the concave lens is given by

$$\frac{1}{f'} = (1.5 - 1)\left(\frac{-2}{R}\right) = -\frac{1}{R}$$

Now, equivalent focal length of the combination is,

$$\frac{1}{F_2} = \frac{1}{f} + \frac{1}{f'} + \frac{1}{f} \ ; \ \frac{1}{F_2} = \frac{1}{R} - \frac{1}{R} + \frac{1}{R} = \frac{1}{R}$$

$F_2 = R$ ... (ii)

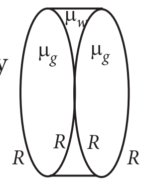
Dividing equation (i) by (ii), we get $\dfrac{F_1}{F_2} = \dfrac{1}{2}$

24. (d) : When an equiconvex lens is cut into two symmetrical halves along the principal axis, then there will be no change in focal length of the lens.

$\therefore \quad$ Power of lens, $P = \dfrac{1}{f}$

So, the power of each part will be P.

25. (d) : Here, $\mu_g = \dfrac{3}{2}$, $\mu_w = \dfrac{4}{3}$



Focal length (f) of glass convex lens is given by

$$\frac{1}{f} = (\mu_g - 1)\left(\frac{2}{R}\right)$$

or $\dfrac{1}{f} = \left(\dfrac{3}{2} - 1\right)\dfrac{2}{R} = \dfrac{1}{R}$ or $f = R$ ...(i)

Focal length (f') of water filled concave lens is given by

$$\frac{1}{f'} = (\mu_w - 1)\left(-\frac{2}{R}\right) \text{ or } \frac{1}{f'} = \left(\frac{4}{3} - 1\right)\left(-\frac{2}{R}\right)$$

$$= -\frac{2}{3R} = -\frac{2}{3f} \qquad \text{[Using eqn. (i)]}$$

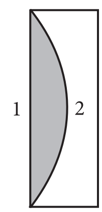
Equivalent focal length (f_{eq}) of lens system

$$\frac{1}{f_{eq}} = \frac{1}{f} - \frac{2}{3f} + \frac{1}{f} = \frac{3 - 2 + 3}{3f} = \frac{4}{3f}$$

$$\therefore \quad f_{eq} = \frac{3f}{4}$$

26. (a) : The combination of two lenses 1 and 2 is as shown in figure.

$$\therefore \quad \frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$



According to lens maker's formula

$$\frac{1}{f_1} = (\mu_1 - 1)\left(\frac{1}{\infty} - \frac{1}{-R}\right) = \frac{(\mu_1 - 1)}{R}$$

$$\frac{1}{f_2} = (\mu_2 - 1)\left(\frac{1}{-R} - \frac{1}{\infty}\right)$$

$$= (\mu_2 - 1)\left(-\frac{1}{R}\right) = -\frac{(\mu_2 - 1)}{R}$$

$$\therefore \quad \frac{1}{f} = \frac{(\mu_1 - 1)}{R} - \frac{(\mu_2 - 1)}{R}$$

$$\frac{1}{f} = \frac{(\mu_1 - \mu_2)}{R}; \ f = \frac{R}{(\mu_1 - \mu_2)}$$

27. (a) : According to lens maker's formula

$$\frac{1}{f} = \left(\frac{\mu_g}{\mu_L} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

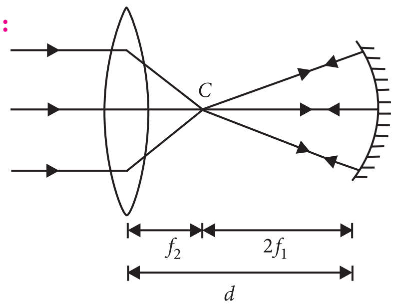
where μ_g is the refractive index of the material of the lens and μ_L is the refractive index of the liquid in which lens is dipped.

As the biconvex lens dipped in a liquid acts as a plane sheet of glass, therefore

$$f = \infty \ \Rightarrow \ \frac{1}{f} = 0$$

$$\therefore \quad \frac{\mu_g}{\mu_L} - 1 = 0 \ \text{ or } \ \mu_g = \mu_L$$

28. (c) :



$\therefore \quad d = 2f_1 + f_2$

29. (c)

30. (d) : Here, $v = +15$ cm, $u = +(15 - 5) = +10$ cm

According to lens formula

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{15} - \frac{1}{10} = \frac{1}{f} \Rightarrow f = -30 \text{ cm}$$

31. (c) : Focal length of the lens remains same.

Intensity of image formed by lens is proportional to area exposed to incident light from object.

i.e., Intensity $\propto$ area

or $\frac{I_2}{I_1} = \frac{A_2}{A_1}$

Initial area, $A_1 = \pi\left(\frac{d}{2}\right)^2 = \frac{\pi d^2}{4}$

After blocking, exposed area,

$$A_2 = \frac{\pi d^2}{4} - \frac{\pi(d/2)^2}{4} = \frac{\pi d^2}{4} - \frac{\pi d^2}{16} = \frac{3\pi d^2}{16}$$

$$\therefore \quad \frac{I_2}{I_1} = \frac{A_2}{A_1} = \frac{\frac{3\pi d^2}{16}}{\frac{\pi d^2}{4}} = \frac{3}{4} \quad \text{or} \quad I_2 = \frac{3}{4} I_1 = \frac{3}{4} I$$

$(\because \ I_1 = I)$

Hence, focal length of a lens $= f$, intensity of the image $= \frac{3I}{4}$

32. (b) : $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$; $\therefore$ Power $P = \frac{f_1 + f_2}{f_1 f_2}$

33. (c) : $\frac{\text{size of image}}{\text{size of object}} = \left|\frac{v}{u}\right|$

$$\Rightarrow \text{size of the image} = \frac{1.39 \times 10^9 \times 10^{-1}}{1.5 \times 10^{11}} = 0.92 \times 10^{-3} \text{ m}$$

size of the image $= 9.2 \times 10^{-4}$ m

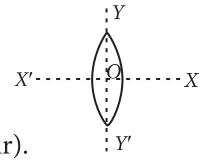
34. (a) : Focal length of convex lens $f_1 = 25$ cm

Focal length of concave lens $f_2 = -25$ cm

Power of combination in dioptres,

$$P = P_1 + P_2 = \frac{100}{f_1} + \frac{100}{f_2} = \frac{100}{25} - \frac{100}{25} = 0.$$

35. (a) : Since the lens is equiconvex, the radius of curvature of each half is same, say R. We know from Lens maker's formula



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

(considering the lens to be placed in air).

Here $R_1 = R$, $R_2 = -R$ by convention

$$\therefore \quad \frac{1}{f} = (\mu - 1)\frac{2}{R} \Rightarrow (\mu - 1)\frac{1}{R} = \frac{1}{2f} \quad \text{...(i)}$$

If we cut the lens along XOX' then the two halves of the lens will be having the same radii of curvature and so, focal length $f' = f$

But when we cut it along YOY' then, we will have

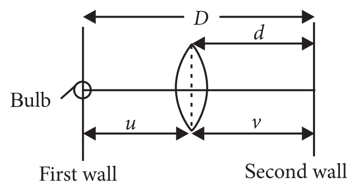
$R_1 = R$ but $R_2 = \infty$

$$\therefore \quad \frac{1}{f''} = (\mu - 1)\left(\frac{1}{R} - \frac{1}{\infty}\right) = (\mu - 1)\frac{1}{R} = \frac{1}{2f}$$

$\Rightarrow \quad f'' = 2f$

36. (b) : When refractive index of lens is equal to the refractive index of liquid, the lens behave like a plane surface with focal length infinity.

37. (b) : A real image is to be formed on the 2nd wall of the bulb placed on the first wall by the convex lens. The lens is placed at a distance of d from the 2nd wall.



Now, we know that to form a real image of an object on a screen by a convex lens, the distance between the source and the screen (D) should be equal to $4f$, where f is the focal length of the lens.

In that case, $u = v = D/2 = d$.

$\therefore \quad f = D/4 = d/2$

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

$$= (1.5 - 1)\left[\frac{1}{\infty} - \frac{1}{(-10)}\right] = 0.5\left[\frac{1}{10}\right] \Rightarrow f = 20 \text{ cm}$$

When plane surface is silvered,

$$F = \frac{f}{2} = \frac{20}{2} = 10 \text{ cm}$$

39. (b) : $R_1 = +\infty$, $R_2 = -60$ cm

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = (1.6 - 1)\left(\frac{1}{\infty} - \frac{1}{-60}\right)$$

or $\quad f = 100$ cm

40. (a) : For lens, $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$u = -30, f = 20, v = 60$ cm

To have an upright image of the object, coincide with it, image should tend to form at centre of curvature of convex mirror. Therefore, the distance of convex mirror from the lens

= 60 – 10 = 50 cm.

41. (a) : $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

Since the refractive index of violet colour (μ_v) is greater than the refractive index of red colour (μ_r), therefore focal length of violet colour is less than the focal length of red colour or in other words, $f_v < f_r$.

42. (b) : Focal length f_1 = 80 cm and f_2 = –50 cm (Minus sign due to concave lens)

Power of the combination (P)

$$=P_1+P_2=\frac{100}{f_1}+\frac{100}{f_2}=\frac{100}{80}-\frac{100}{50}=-0.75\text{ D}$$

43. (b) : For a convex lens, $f_R > f_V$ or $f_V < f_R$. For a concave lens, focal length is negative.

$\therefore$ $|F_V| < |F_R|$ or $F_V > F_R$ as the smaller negative value is bigger.

44. (c) : By displacement method, size of object

$(O)=\sqrt{I_1 \times I_2}$.

Therefore area of source of light $(A)=\sqrt{A_1 A_2}$

45. (c) : $\frac{f_a}{f_e}=\frac{\left(\frac{\mu_g}{\mu_l}-1\right)}{(\mu_g-1)}=\frac{\left(\frac{1.5}{1.25}-1\right)}{1.5-1}=\frac{1/5}{1/2}=\frac{2}{5}$

$$f_e=\frac{5}{2}f_a=\frac{5}{2}\times 2=5\text{ cm}$$

46. (c) : Light ray emerges normally from another surface so angle of emergence (e) = 0

$r_2 = 0$

$r_1 + r_2 = A \Rightarrow r_1 = A$

Using Snell's law on first surface,

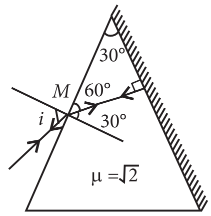
$1 \times \sin i = \mu \sin r_1$

$\sin i = \mu \sin A$

For small angles, $\sin A \approx A$

Hence, $i = \mu A$

47. (b) : For retracing the path shown in figure, light ray should be incident normally on the silvered face. Applying Snell's law at point M,



$$\frac{\sin i}{\sin 30^\circ}=\frac{\sqrt{2}}{1} \Rightarrow \sin i=\sqrt{2}\times\frac{1}{2}$$

$\sin i=\frac{1}{\sqrt{2}}$ *i.e.*, $i=45^\circ$

48. (d) : Given, $i = 45°$, $A = 60°$

Since the ray undergoes minimum deviation, therefore, angle of emergence from second face, $e = i = 45°$

$\therefore$ $\delta_m = i + e - A = 45° + 45° - 60° = 30°$

$$\mu=\frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}=\frac{\sin\left(\frac{60^\circ+30^\circ}{2}\right)}{\sin\left(\frac{60^\circ}{2}\right)}$$

$$=\frac{\sin 45^\circ}{\sin 30^\circ}=\frac{1}{\sqrt{2}}\times\frac{2}{1}=\sqrt{2}$$

49. (b) : As beam of light is incident normally on the face AB of the right angled prism ABC, so no deviation occurs at face AB and it passes straight and strikes the face AC at an angle of incidence, i = 45°.

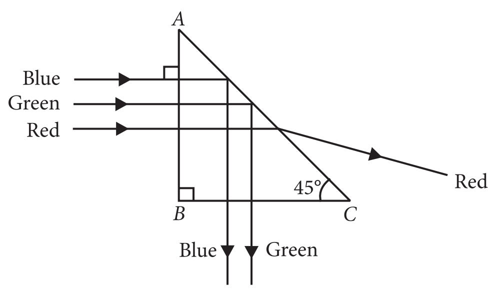
For total reflection to take place at face AC,

$i > i_c$ or $\sin i > \sin i_c$

where i_c is the critical angle.

But as here $i = 45°$ and $\sin i_c = \frac{i}{\mu}$

$\therefore$ $\sin 45^\circ > \frac{1}{\mu}$ or $\frac{1}{\sqrt{2}} > \frac{1}{\mu}$ or $\mu > \sqrt{2} = 1.414$



As μ_{red} (= 1.39) < μ(= 1.414) while μ_{green}(= 1.44) and μ_{blue} (= 1.47) > μ (= 1.414), so only red colour will be transmitted through face AC while green and blue colours will suffer total internal reflection.

So the prism will separate red colour from the green and blue colours as shown in the given figure.

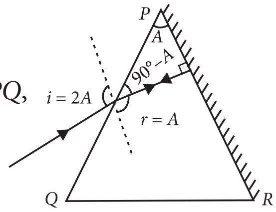
50. (d) : As $\mu = \dfrac{\sin\left(\frac{A+\delta}{2}\right)}{\sin\left(\frac{A}{2}\right)}$ or $\cot\frac{A}{2} = \dfrac{\sin\left(\frac{A+\delta}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$$\frac{\cos\left(\frac{A}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(\frac{A+\delta}{2}\right)}{\sin\left(\frac{A}{2}\right)} \text{ or } \sin\left(\frac{\pi}{2}-\frac{A}{2}\right) = \sin\left(\frac{A}{2}+\frac{\delta}{2}\right);$$

$$\frac{\pi}{2}-\frac{A}{2} = \frac{A}{2}+\frac{\delta}{2}$$

$\therefore \quad \delta = \pi - 2A = 180° - 2A$

51. (b) : On reflection from the silvered surface, the incident ray will retrace its path, if it falls normally on the surface.



By geometry, $r = A$

Applying Snell's law at surface PQ,

$1 \sin i = \mu \sin r$

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin 2A}{\sin A} = 2\cos A$$

52. (b) : As $\mu = \dfrac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$$\mu = \frac{\sin\left(\frac{A+A}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin A}{\sin\left(\frac{A}{2}\right)} = \frac{2\sin\left(\frac{A}{2}\right)\cos\left(\frac{A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$= 2\cos\left(\frac{A}{2}\right)$$

As $\delta = i + e - A$

At minimum deviation, $\delta = \delta_m$, $i = e$

$\therefore \quad \delta_m = 2i - A$ or $2i = \delta_m + A$

$$i = \frac{\delta_m + A}{2} = \frac{A+A}{2} = A \qquad (\because \delta_m = A \text{ (given)})$$

$i_{\min} = 0° \Rightarrow A_{\min} = 0°$

Then, $\mu_{\max} = 2\cos 0° = 2$

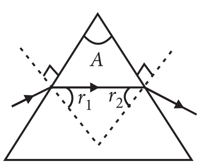
$\because \quad i_{\max} = \dfrac{\pi}{2} \Rightarrow A_{\max} = \dfrac{\pi}{2}$

Then, $\mu_{\min} = 2\cos 45° = 2 \times \dfrac{1}{\sqrt{2}} = \sqrt{2}$

So refractive index lies between 2 and $\sqrt{2}$.

53. (b) : Angle of prism,

$A = r_1 + r_2$



For minimum deviation

$r_1 = r_2 = r \quad \therefore \ A = 2r$

Given, $A = 60°$

Hence, $r = \dfrac{A}{2} = \dfrac{60°}{2} = 30°$

54. (a) : $A = 60°$, $\mu = \sqrt{3}$, $\delta_m = ?$

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}} \quad \therefore \quad \delta_m = 60°$$

55. (d) : An observer can see a rainbow only when his back is towards the sun.

56. (b) : Red light of the visible spectrum is having a maximum wavelength of about 650 nm.

57. (a) : The condition for dispersion without deviation is given as $(\mu - 1)A = (\mu' - 1)A'$

Given $\mu = 1.42$, $A = 10°$, $\mu' = 1.7$, $A' = ?$

$\therefore \quad (1.42 - 1) \times 10 = (1.7 - 1)A'$

$(0.42) \times 10 = 0.7 \times A'$

or $\quad A' = \dfrac{0.42 \times 10}{0.7} = 6°$

58. (a) : The reddish appearance of the sun at sunrise and sunset is due to the scattering of light.

59. (c) : For dispersion without deviation

$\delta_1 + \delta_2 = 0$

$(\mu_1 - 1)A_1 + (\mu_2 - 1)A_2 = 0$

$$A_2 = -\frac{(\mu_1 - 1)A_1}{(\mu_2 - 1)}$$

Substituting the given values, we get

$$A_2 = -\frac{(1.5-1)15°}{(1.75-1)} = -10°$$

Negative sign shows that two prisms must be joined in opposition.

60. (b) : The rainbow is an example of the dispersion of sunlight by the water drops in the atmosphere. This is a phenomenon due to a combination of the refraction of sunlight by spherical water droplets and of internal (not total) reflection.

61. (a) : According to Rayleigh, the amount of scattering is inversely proportional to the fourth power of the wavelength.

62. (b) : Here, $v = -400$ cm $= -4$ m, $u = \infty$, $f = ?$

Using lens formula, $\dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}$

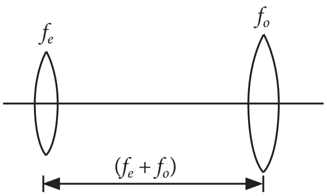
or $\dfrac{1}{-4} - \dfrac{1}{\infty} = \dfrac{1}{f}$ or $f = -4$ m

Lens should be concave.

Power of lens $= \dfrac{1}{f} = \dfrac{1}{-4} = -0.25$ D

63. (b) : Here $f_o = 40$ cm, $f_e = 4$ cm
Tube length(l) = Distance between lenses
$= v_o + f_e$
For objective lens,
$u_o = -200$ cm, $v_o = ?$
$$\frac{1}{v_0}-\frac{1}{u_0}=\frac{1}{f_0} \text{ or } \frac{1}{v_0}-\frac{1}{-200}=\frac{1}{40}$$
$$\text{or } \frac{1}{v_0}=\frac{1}{40}-\frac{1}{200}=\frac{4}{200} \quad \therefore v_0 = 50 \text{ cm}$$
$\therefore \quad l = 50 + 4 = 54$ cm

64. (b) :



For eye-piece lens,
$$m=\frac{f}{f+u}=\frac{h_1}{h_0} \Rightarrow \frac{f_e}{f_e-(f_o+f_e)}=\frac{I}{L}$$
$$\Rightarrow \frac{f_o}{f_e}=-\frac{L}{I}=\text{Magnification of the telescope}$$

65. (d) : Magnifying power of a microscope,
$$m=\left(\frac{L}{f_o}\right)\left(\frac{D}{f_e}\right)$$
where f_o and f_e are the focal lengths of the objective and eyepiece respectively and L is the distance between their focal points and D is the least distance of distinct vision.
If f_o increases, then m will decrease.
Magnifying power of a telescope, $m=\dfrac{f_o}{f_e}$
where f_o and f_e are the focal lengths of the objective and eyepiece respectively.
If f_o increases, then m will increase.

66. (a) : Converging power of cornea,
$P_c = +40$ D
Least converging power of eye lens, $P_e = +20$ D
Power of the eye-lens, $P = P_c + P_e$
$= 40$ D $+ 20$ D $= 60$ D
Power of the eye lens
$$P=\frac{1}{\text{Focal length of the eye lens } (f)}$$
$$f=\frac{1}{P}=\frac{1}{60\text{ D}}=\frac{1}{60}\text{ m}=\frac{100}{60}\text{ cm}=\frac{5}{3}\text{ cm}$$
Distance between the retina and cornea-eye lens = Focal length of the eye lens
$$=\frac{5}{3}\text{ cm}=1.67\text{ cm}$$

67. (c) : Magnifying power, $m=\dfrac{f_o}{f_e}=9$ ...(i)
where f_o and f_e are the focal lengths of the objective and eyepiece respectively
Also, $f_o + f_e = 20$ cm ...(ii)
On solving (i) and (ii), we get
$f_o = 18$ cm, $f_e = 2$ cm

68. (d) : Length of astronomical telescope $(f_o + f_e) = 44$ cm and ratio of focal length of the objective lens to that of the eye piece $\dfrac{f_o}{f_e}=10$
From the given ratio, we find that $f_o = 10\,f_e$.
Therefore $10f_e + f_e = 44$ or $f_e = 4$ cm
and focal length of the objective (f_o)
$= 44 - f_e = 44 - 4 = 40$ cm

69. (c) : Time of exposure $t \propto (f - \text{number})^2$
$$\therefore \quad \frac{t}{\left(\frac{1}{200}\right)}=\left(\frac{5.6}{2.8}\right)^2=4 \quad \text{or} \quad t=0.02\text{ s}$$

70. (a) : Magnifying power of telescope,
$M = f_o / f_e$
To produce largest magnifications $f_o > f_e$ and f_o and f_e both should be positive (convex lens).
Therefore $f_e = +15$ cm.

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