

RAY OPTICS AND OPTICAL INSTRUMENTS

Exercise 1: NCERT Based Topic-wise MCQs

9.1 INTRODUCTION

1. Rectilinear propagation of light means
 - (a) Light travels in straight lines
 - (b) Light travels in curved path
 - (c) Light travels in zig-zag path
 - (d) Light travels as a wave

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9.2 REFLECTION OF LIGHT BY SPHERICAL MIRRORS

2. An object is placed 40cm from a concave mirror of focal length 20cm. The image formed is
 - (a) real, inverted and same in size
 - (b) real, inverted and smaller
 - (c) virtual, erect and larger
 - (d) virtual, erect and smaller
3. In image formation from spherical mirrors, only paraxial rays are considered because they
 - (a) are easy to handle geometrically
 - (b) contain most of the intensity of the incident light
 - (c) form nearly a point image of a point source
 - (d) show minimum dispersion effect
4. For reflection through spherical surfaces, the normal at the point of incidence is
 - (a) perpendicular to the principle axis and passes through the centre of curvature.
 - (b) perpendicular to the focal plane and passes through the pole.
 - (c) perpendicular to the tangent plane at pole and passes through the focus.
 - (d) perpendicular to the tangent plane at the point of incidence and passes through the centre of curvature.

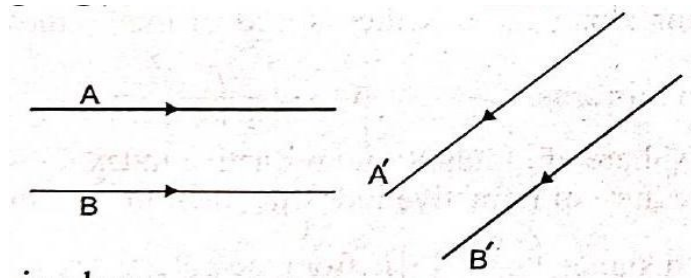
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5. Figure shows two rays A and B being reflected by a mirror and going as A' and B' . The mirror

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- (a) is plane
 (b) is convex
 (c) is concave
 (d) may be any spherical mirror

6. Which of the following is incorrect statement?

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- (a) the magnification produced by a convex mirror is always less than one
 (b) a virtual, erect, same-sized image can be obtained using a plane mirror
 (c) a virtual, erect, magnified image can be formed using a concave mirror
 (d) a real, inverted, same-sized image can be formed using a convex mirror

7. A rod of length 10cm lies along the principal axis of a concave mirror of focal length 10cm in such a way that its end closer to the pole is 20cm away from the mirror. The length of the image is

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- (a) 10cm
 (b) 15cm
 (c) 2.5cm
 (d) 5cm

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

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

9. An object is moving with speed v_0 towards a spherical mirror with radius of curvature R , along the central axis of the mirror. The speed of the image respect to the mirror is (U is the distance of the object from mirror at any given time t)

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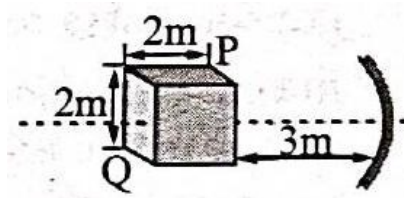
- (a) $+\left(\frac{R}{U-2R}\right)v_0^2$
 (b) $-\left(\frac{R}{R-2U}\right)^2 v_0$
 (c) $-\left(\frac{R}{2U-2R}\right)^2 v_0$
 (d) $+\left(\frac{R}{2U-2}\right)v_0^2$

10. A concave mirror is used for face viewing has focal length of 0.6m. At what distance you should hold the mirror from your face to get an upright image with a magnification of 4 ? NCERT Page-314 / N-226

- (a) 0.20m
- (b) 0.25m
- (c) 0.40m
- (d) 0.45m

11. A cube of side 2m is placed in front of a concave mirror of focal length 1m with its face P at a distance of 3m and face Q at a distance of 5m from the mirror. The distance between the image of face P and Q is NCERT Page-313 / N-225

- (a) 1m
- (b) 0.5m
- (c) 0.5m
- (d) 0.25m

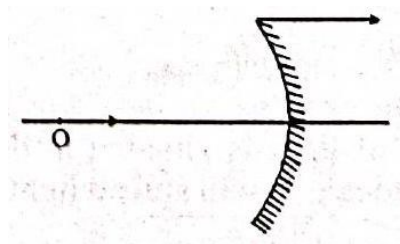


12. A short linear object of length ℓ lies along the axis of a concave mirror of focal length f at a distance u from the pole of the mirror. The size of the image is approximately equal to, NCERT Page-314 / N-225,226

- (a) $\ell \left(\frac{u-f}{f}\right)^{1/2}$
- (b) $\ell \left(\frac{u-f}{f}\right)^2$
- (c) $\ell \left(\frac{f}{u-f}\right)^{1/2}$
- (d) $\ell \left(\frac{f}{u-f}\right)^2$

13. An object kept on the principle axis is moving in the same direction as that of mirror as shown in figure. Speed of object and mirror is 10m/s and 40/12m/s. Radius of the curvature of the mirror is 20cm. What should be the distance of object from the mirror at this instant so that the image is stationary? NCERT Page-314/ N-225

- (a) 25cm
- (b) 45cm
- (c) 37.5cm
- (d) 15cm



14. You are asked to design a shaving mirror assuming that a person keeps it 10cm 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:

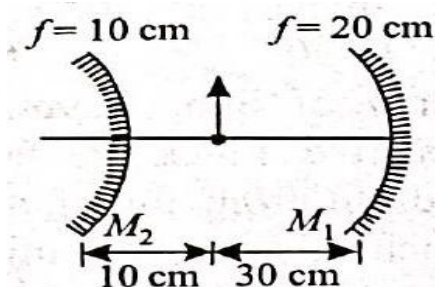
- (a) 60cm

- (b) -24cm
- (c) -60cm
- (d) 24cm

15. In figure find the total magnification after two successive reflections first on M_1 and then on M_2 .
if

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- (a) +1
- (b) -2
- (c) +2
- (d) -1

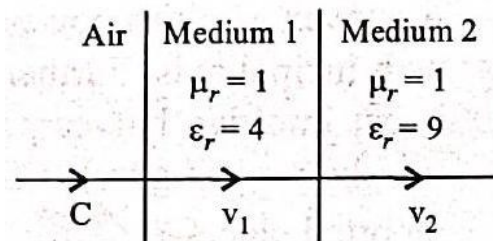


9.3 REFRACTION

16. As shown in the figure, after passing through the medium 1. The speed of light v_2 in medium 2 will be :
(Given $c = 3 \times 10^8 \text{ms}^{-1}$)

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- (a) $1.0 \times 10^8 \text{ms}^{-1}$
- (b) $0.5 \times 10^8 \text{ms}^{-1}$
- (c) $1.5 \times 10^8 \text{ms}^{-1}$
- (d) $3.0 \times 10^8 \text{ms}^{-1}$



18. Light travels through a glass plate of thickness t and refractive index μ . If c is the speed of light in vacuum, the time taken by light to travel this thickness of glass is

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- (a) $\mu t c$
- (b) $\frac{t c}{\mu}$
- (c) $\frac{t}{\mu c}$
- (d) $\frac{\mu t}{c}$

One face of a rectangular glass plate 6cm thick is silvered. An object held 8cm in front of the first face, forms an image 12cm behind the silvered face. The refractive index of the glass is

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- (a) 0.4
- (b) 0.8
- (c) 1.2
- (d) 1.6

19. A glass slab of thickness 4cm contains the same number of waves as 5cm of water when both are traversed by the same monochromatic light. If the refractive index of water is $\frac{4}{3}$, what is that of glass? NCERT Page-317 / N-229
- (a) $\frac{5}{3}$
 (b) $\frac{5}{4}$
 (c) $\frac{16}{15}$
 (d) 1.5
20. A ray of light is travelling from glass to air. (Refractive index of glass = 1.5). The angle of incidence is 50° . The deviation of the ray is NCERT Page-317 / N-229
- (a) 0°
 (b) 80°
 (c) $50^\circ - \sin^{-1} \left[\frac{\sin 50^\circ}{1.5} \right]$
 (d) $\sin^{-1} \left[\frac{\sin 50^\circ}{1.5} \right] - 50^\circ$
21. A ray of light passes from vacuum into a medium of refractive index μ , the angle of incidence is found to be twice the angle of refraction. Then the angle of incidence is NCERT Page-317 / N-228
- (a) $2\cos^{-1} \left(\frac{\mu}{2} \right)$
 (b) $\sin^{-1} (\mu)$
 (c) $\sin^{-1} \left(\frac{\mu}{2} \right)$
 (d) $\cos^{-1} \left(\frac{\mu}{2} \right)$
22. When light passes from denser to rarer medium, then which of the following combination is correct? NCERT Page-317 / N-228
- (a) $\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}, r > i$
 (b) $\frac{\sin i}{\sin r} = \frac{\mu_1}{\mu_2}, i = r$
 (c) $\frac{\sin i}{\sin r} = \frac{\mu_1}{\mu_2}, i > r$
 (d) $\frac{\sin i}{\sin r} = 2, i = r$
23. A vessel of depth x is half filled with oil of refractive index μ_1 and the other half is filled with water of refractive index μ_2 . The apparent depth of the vessel when viewed from above is NCERT Page-317 / N-229
- (a) $\frac{x(\mu_1 + \mu_2)}{2\mu_1\mu_2}$
 (b) $\frac{x\mu_1\mu_2}{2(\mu_1 + \mu_2)}$
 (c) $\frac{x\mu_1\mu_2}{(\mu_1 + \mu_2)}$
 (d) $\frac{2x(\mu_1 + \mu_2)}{\mu_1\mu_2}$
24. Light travels in two media M_1 and M_2 with speeds $1.5 \times 10^8 \text{ms}^{-1}$ and $2.0 \times 10^8 \text{ms}^{-1}$ respectively. The critical angle between them is: NCERT Page-317 / N-229
- (a) $\tan^{-1} \left(\frac{3}{\sqrt{7}} \right)$
 (b) $\tan^{-1} \left(\frac{2}{3} \right)$
 (c) $\cos^{-1} \left(\frac{3}{4} \right)$
 (d) $\sin^{-1} \left(\frac{2}{3} \right)$

25. Two transparent slabs of thickness (t_1, t_2) and refractive index (μ_1, μ_2) are arranged one over another. An object is seen through this combination. Find equivalent refractive index of the system which will allow the image to be formed at the same place.

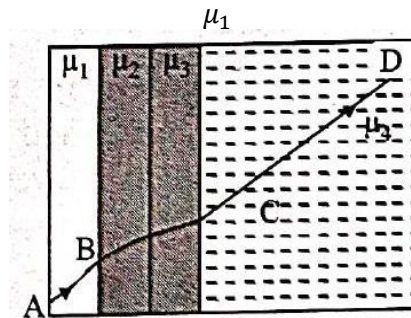
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- (a) $\frac{(t_1+t_2)\mu_1\mu_2}{t_1\mu_2+t_2\mu_1}$
 (b) $\frac{t_1+t_2}{\mu_1+\mu_2}$
 (c) $\frac{t_1t_2\mu_1\mu_2}{(t_1+t_2)}$
 (d) $\frac{t_1\mu_1}{t_2\mu_2}$

26. A ray of light passes through four transparent media with refractive indices μ_1, μ_2, μ_3 and μ_4 as shown in the figure. The thicknesses of all media are parallel. If the emergent ray CD is parallel to the incident ray AB , we must have

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- (a) $\mu_1 = \mu_2$
 (b) $\mu_2 = \mu_3$
 (c) $\mu_3 = \mu_4$
 (d) $\mu_4 =$



27. An electromagnetic radiation of frequency n , wavelength λ , travelling with velocity v in air, enters a glass slab of refractive index μ . The frequency, wavelength and velocity of light in the glass slab will be respectively

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- (a) $\frac{n}{\mu}, \frac{\lambda}{\mu}$ and $\frac{v}{\mu}$
 (b) $n, \frac{\lambda}{\mu}$ and $\frac{v}{\mu}$
 (c) $n, 2\lambda$ and $\frac{v}{\mu}$
 (d) $\frac{2n}{\mu}, \frac{\lambda}{\mu}$ and v

28. Consider a light ray travelling in air is incident into a medium of refractive index $\sqrt{2n}$. The incident angle is twice that of refracting angle. Then, the angle of incidence will be :

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- (a) $\sin^{-1}(\sqrt{n})$
 (b) $\cos^{-1}\left(\sqrt{\frac{n}{2}}\right)$
 (c) $\sin^{-1}(\sqrt{2n})$
 (d) $2\cos^{-1}\left(\sqrt{\frac{n}{2}}\right)$

29. A printed page is pressed by a glass of water. The refractive index of the glass and water is 1.5 and 1.33 , respectively. If the thickness of the bottom of glass is 1cm and depth of water is 5cm, how much the page will appear to be shifted if viewed from the top?

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- (a) 1.033cm
 (b) 3.581cm

- (c) 1.574cm
- (d) 1.90cm

9.4 TOTAL INTERNAL REFLECTION

30. When the angle of incidence of a light ray is greater than the critical angle it gets NCERT Page-322 / N-230
- (a) critically refracted
 - (c) total internally reflected
 - (b) totally reflected
 - (d) totally refracted
31. Critical angle of light passing from glass to water is minimum for NCERT Page-320 / N-230
- (a) red colour
 - (b) green colour
 - (c) yellow colour
 - (d) violet colour
32. The speed of light in media 'A' and 'B' are 2.0×10^{10} cm/s and 1.5×10^{10} cm/s respectively. A ray of light enters from the medium B to A at an incident angle ' θ '. If the ray suffers total internal reflection, then NCERT Page-322 / N-230
- (a) $\theta = \sin^{-1} \left(\frac{3}{4} \right)$
 - (b) $\theta > \sin^{-1} \left(\frac{2}{3} \right)$
 - (c) $\theta < \sin^{-1} \left(\frac{3}{4} \right)$
 - (d) $\theta > \sin^{-1} \left(\frac{3}{4} \right)$
33. Light travels in two media A and B with speeds 1.8×10^8 ms⁻¹ and 2.4×10^8 ms⁻¹ respectively. Then the critical angle between them is NCERT Page-320 / N-230
- (a) $\sin^{-1} \left(\frac{2}{3} \right)$
 - (b) $\tan^{-1} \left(\frac{3}{4} \right)$
 - (c) $\tan^{-1} \left(\frac{2}{3} \right)$
 - (d) $\sin^{-1} \left(\frac{3}{4} \right)$
34. A green light is incident from the water to the air - water interface at the critical angle (θ). Select the correct statement. NCERT Page-321 / N-230
- (a) The entire spectrum of visible light will come out of the water at an angle of 90° to the normal.
 - (b) The spectrum of visible light whose frequency is less than that of green light will come out to the air medium.
 - (c) The spectrum of visible light whose frequency is more than that of green light will come out to the air medium.
 - (d) The entire spectrum of visible light will come out of the water at various angles to the normal.
35. A ray of light travelling inside a rectangular glass block of refractive index $\sqrt{2}$ is incident on the glass-air surface at an angle of incidence of 45° . The refractive index of air is one. Under these conditions the ray will NCERT Page-320 / N-230
- (a) emerge into the air without any deviation
 - (b) be reflected back into the glass
 - (c) be absorbed
 - (d) emerge into the air with an angle of refraction equal to 90°

36. 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?

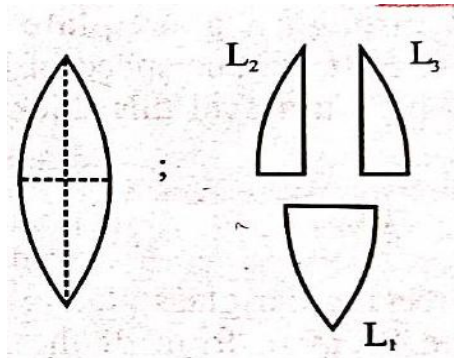
- (a) $\mu = 1.33$
- (c) $\mu = 1.50$
- (b) $\mu = 1.40$
- (d) $\mu = 1.25$

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9.5 REFRACTION AT SPHERICAL SURFACES AND BY LENSES

37. A convex lens has power P . It is cut into two halves along its principal axis. Further one piece (out of the two halves) is cut into two halves perpendicular to the principal axis (as shown in figure). Choose the incorrect option for the reported pieces.

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- (a) Power of $L_1 = \frac{P}{2}$
- (b) Power of $L_2 = \frac{P}{2}$
- (c) Power of $L_3 = \frac{P}{2}$
- (d) Power of $L_1 = P$.

38. A point object is placed at the centre of a glass sphere of radius 6cm and refractive index 1.5. The distance of the virtual image from the surface of the sphere is

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- (a) 2cm
- (b) 4cm
- (c) 6cm
- (d) 12cm

39. A planoconvex lens of focal length 16cm, is to be made of glass of refractive index 1.5. The radius of curvature of the curved surface should be

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- (a) 8cm
- (b) 12cm
- (c) 16cm
- (d) 24cm

40. Two thin lenses are in contact and the focal length of the combination is 80cm. If the focal length of one lens is 20 cm, then the power of the other lens will be

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- (a) 1.66D

- (b) 4.00 D
- (c) -100D
- (d) -3.75 D

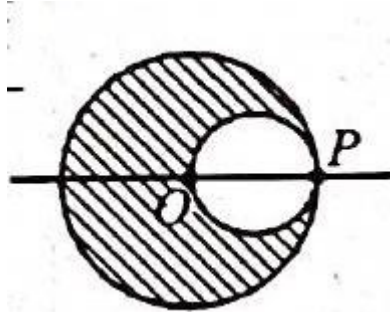
41. A plano-convex lens is made of material of refractive index 1.6. The radius of curvature of the curved surface is 60 cm. The focal length of the lens is NCERT Page-328 / N-234
- (a) 50cm
 - (b) 100cm
 - (c) 200cm
 - (d) 400cm
42. The power of a lens (biconvex) is 1.25m^{-1} in particular medium. Refractive index of the lens is 1.5 and radii of curvature are 20cm and 40cm respectively. The refractive index of surrounding medium: NCERT Page-328 / N-234
- (a) 1.0
 - (b) $\frac{9}{7}$
 - (c) $\frac{3}{2}$
 - (d) $\frac{4}{3}$
43. A lens made of glass whose index of refraction is 1.60 has a focal length of +20cm in air. Its focal length in water, whose refractive index is 1.33, will be NCERT Page-326/N-234
- (a) three times longer than in air
 - (b) two times longer than in air
 - (c) same as in air
 - (d) None of these
44. A convex lens is in contact with concave lens. The magnitude of the ratio of their powers is $\frac{2}{3}$. Their equivalent focal length is 30cm. What are their individual focal lengths (in cm)? NCERT Page-326 / N-238
- (a) -15,10
 - (b) -10,15
 - (c) 75,50
 - (d) -75,50
45. A bi-convex lens made of glass (refractive index 1.5) is put in a liquid of refractive index 1.7. Its focal length will NCERT Page-326 / N-234
- (a) decrease and change sign
 - (b) increase and change sign
 - (c) decrease and remain of the same sign
 - (d) increase and remain of the same sign
46. If two +5 diopter lenses are mounted at some distance apart, the equivalent power will always be negative if the distance is NCERT Page-328 / N-236
- (a) greater than 40cm
 - (c) equal to 10cm
 - (b) equal to 40cm
 - (d) less than 10cm
47. A transparent sphere of radius R has a cavity of radius $R/2$ as shown in figure. Find the refractive index of the sphere if a parallel beam of light falling on left surface focuses at point P NCERT Page-323 / N-234
- (a) $\mu = \frac{3+\sqrt{5}}{2}$

(b)

$$\mu = \frac{3 - \sqrt{5}}{2}$$

(c) $\mu = 3 + \sqrt{5}$

(d) $\mu = \frac{1 + \sqrt{5}}{2}$



48. A convex lens is made of 3 layers of glass of 3 different materials as in the figure. A point object is placed on its axis. The number of images of the object are

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

49. Two point source S_1 and S_2 are 24cm apart. Where should a convex lens of focal length 9cm be placed in between them so that the images of both sources are formed at the same place?

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- (a) 6cm from S_1
- (c) 10cm from S_1
- (b) 15cm from S_1
- (d) 12cm from S_1

50. A parallel beam of light is incident on a converging lens parallel to its principal axis. As one moves away from the lens on the other side on its principal axis, the intensity of light

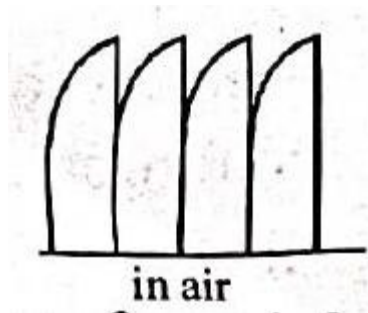
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- (a) remains constant
- (b) continuously increases
- (c) continuously decreases
- (d) first increases then decreases

51. The given lens is broken into four parts rearranged as shown. If the initial focal length is f , then after rearrangement the equivalent focal length is

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- (a) f
- (b) $f/2$
- (b) $f/4$
- (d) $4f$



52. The focal length of a converging lens are f_V and f_R for violet and red light respectively. Then

(a) $f_V > f_R$

(b) $f_V = f_R$

(c) $f_V < f_R$

(d) any of the three is possible depending on the value of the average refractive index m

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53. The layered lens as shown is made of two types of transparent materials one indicated by horizontal lines and the other by vertical lines. The number of images formed of an object will be

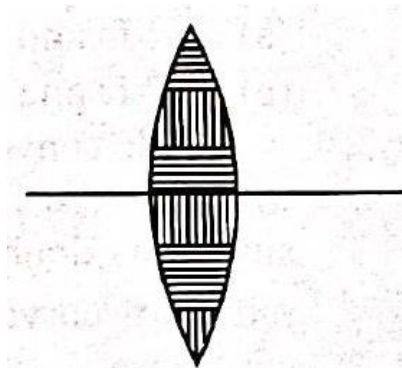
(a) 1

(b) 2

(c) 3

(d) 6

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54. Two identical thin plano-convex glass lenses (refractive index 1.5) each having radius of curvature of 20cm are placed with their convex surfaces in contact at the centre. The intervening space is filled with oil of refractive index 1.7. The focal length of the combination is

(a) -25cm

(b) -50cm

(c) 50cm

(d) -20cm

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55. A plano convex lens of refractive index 1.5 and radius of curvature 30cm. 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 size of the object

(a) 60cm

(b) 30cm

(c) 20cm

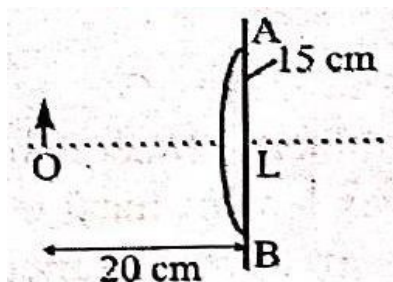
(d) 80cm

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56. A point object is placed at a distance of 20cm from a thin plano-convex lens of focal length 15cm, if the plane surface is silvered. The image will form at:

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- (a) 60cm left of AB
- (b) 30cm left of AB
- (c) 12cm left of AB
- (d) 60cm right of AB



57. An achromatic convergent doublet of two lenses in contact has a power of +2D. The convex lens has power +5D.

What is the ratio of dispersive powers of convergent and divergent lenses?

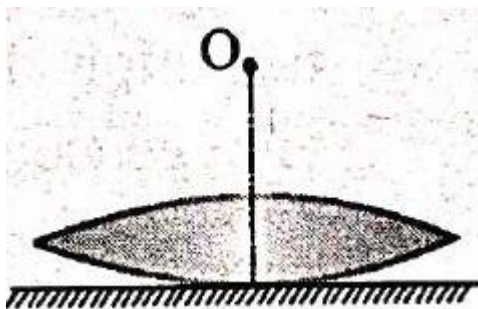
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- (a) 2: 5
- (b) 3: 5
- (c) 5: 2
- (d) 5: 3

58. A convex lens of focal length 12cm is placed in contact with a plane mirror. If the object is placed at 20cm from the lens, the position of final image is

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- (a) 30cm above lens
- (b) 30cm below lens
- (c) 20cm above lens
- (d) 8.6cm below lens



59. A thin convergent glass lens ($\mu_g = 1.5$) has a power of +5.0D. When this lens is immersed in a liquid of refractive index μ , it acts as a divergent lens of focal length 100cm.

The value of μ must be

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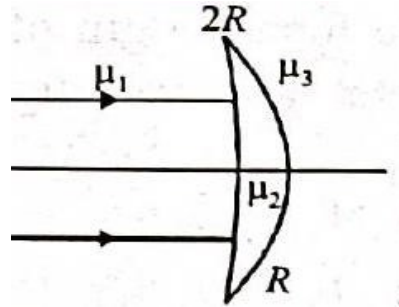
- (a) 4/3
- (b) 5/3
- (c) 5/4
- (d) 6/5

60. Figure shows a concavo - convex lens μ_2 . What is the condition on the reflective indices so that the lens is diverging?

- (a) $2\mu_3 < \mu_1 + \mu_2$

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- (b) $2\mu_3 > \mu_1 + \mu_2$
- (c) $\mu_3 > 2(\mu_1 - \mu_2)$
- (d) none of these



61. A man's near point is 0.5m and far point is 3m. Power of spectacle lenses required for (i) reading purposes, (ii) seeing distant objects, respectively, are NCERT Page-326 / N-238

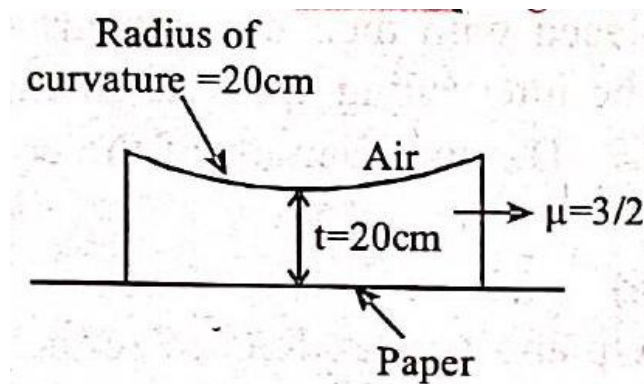
- (a) $-2D$ and $+3D$
- (b) $+2D$ and $-3D$
- (c) $+2D$ and $-0.33D$
- (d) $-2D$ and $+0.33D$

62. A double convex lens of focal length 6cm is made of glass of refractive index 1.5. The radius of curvature of one surface is double that of other surface. The value of small radius of curvature is NCERT Page-327 / N-234

- (a) 6cm
- (b) 4.5cm
- (c) 9cm
- (d) 4cm

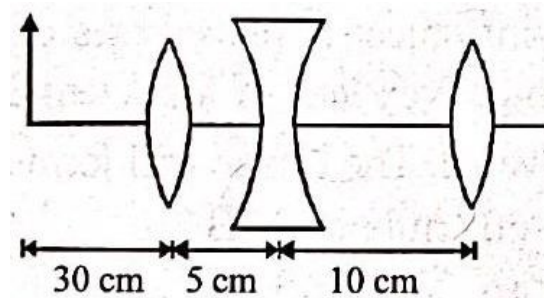
63. A planoconcave lens is placed on a paper on which a flower is drawn. How far above its actual position does the flower appear to be? NCERT Page-327 / N-234

- (a) 10cm
- (b) 15cm
- (c) 50cm
- (d) None of these



64. The position of final image formed by the given lens combination from the third lens will be at a distance of ($f_1 = +10\text{cm}$, $f_2 = -10\text{cm}^2$ and $f_3 = +30\text{cm}$). NCERT Page-329 / N-238

- (a) 15cm
- (b) infinity
- (c) 45cm
- (d) 30cm



65. A luminous object is placed at a distance of 30cm from the convex lens of focal length 20cm. On the other side of the lens, at what distance from the lens a convex mirror of radius of curvature 10cm be placed in order to have an upright image of the object coincident with it? NCERT Page-326 / N-234

- (a) 12cm
- (b) 30cm
- (c) 50cm
- (d) 60cm

9.6 REFRACTION THROUGH A PRISM

66. Yellow light is refracted through a prism producing minimum deviation. If i_1 and i_2 denote the angle of incidence and emergence for this prism, then NCERT Page-331 / N-239

- (a) $i_1 = i_2$
- (b) $i_1 > i_2$
- (c) $i_1 < i_2$
- (d) $i_1 + i_2 = 90^\circ$

67. The angle of prism is 60° and angle of deviation is 30° . In the position of minimum deviation, the values of angle of incidence and angle of emergence are: NCERT Page-331 / N-240

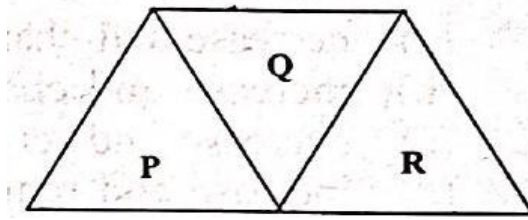
- (a) $i = 45^\circ; e = 50^\circ$
- (b) $i = 30^\circ; e = 45^\circ$
- (c) $i = 45^\circ; e = 45^\circ$
- (d) $i = 30^\circ; e = 30^\circ$

68. When the incidence angle is equal to the angle of emergence of light from the prism the refracted ray inside the prism NCERT Page-331 / N-240

- (a) becomes parallel to the right face of prism
- (b) becomes perpendicular to the base of prism
- (c) becomes parallel to the base of prism
- (d) becomes perpendicular to the left face of prism

69. A given ray of light suffers minimum deviation in an equilateral prism P . Additional prism Q and R of identical shape and of the same material as P are now added as shown in the figure. The ray will now suffer NCERT Page-331 / N-240

- (a) greater deviation
- (b) no deviation
- (c) same deviation as before
- (d) total internal reflection



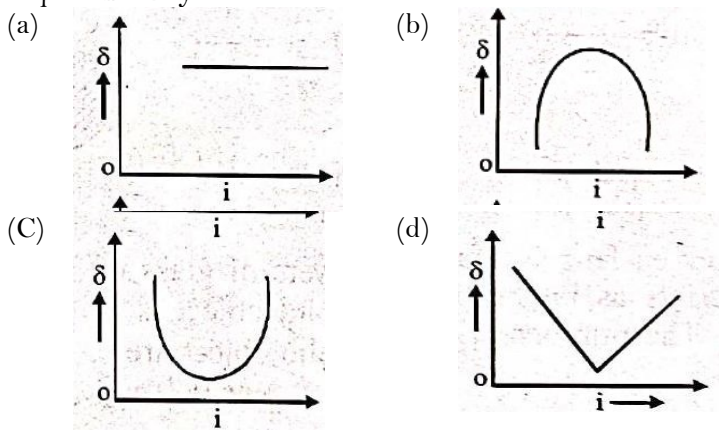
70. The refracting angle of a prism is A and refractive index of the material of the prism is $\cot(A/2)$. Then the angle of minimum deviation will be

NCERT Page-331 / N-240

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

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

NCERT Page-331 / N-240



72. A triangular prism of glass is inside water. A ray, incident normally, on one of the faces, is totally reflected from face BC . Then the minimum refractive index of glass is -

NCERT Page-331 / N-240

- (a) $\frac{\sqrt{3}}{2}$
- (b) $\frac{5}{3}$
- (c) $\frac{2\sqrt{2}}{5}$
- (d) $\frac{4\sqrt{2}}{3}$

73. A ray of light is incident normally on one refracting surface of an equilateral prism. If the refractive index of the material of the prism is 1.5, then

NCERT Page-331 / N-240

- (a) the emergent ray is deviated by 30°
- (b) the emergent ray is deviated by 60°
- (c) the emergent ray just graces the second reflecting surface
- (d) the ray undergoes total internal reflection at second refracting surface

74. A prism has a refracting angle of 60° . When placed in the position of minimum deviation, it produces a deviation of 30° . The angle of incidence is

NCERT Page-331 / N-240

- (a) 30°
- (b) 45°

- (c) 15°
- (d) 60°

75. A ray of light passes through an equilateral prism such that the angle of incidence is equal to the angle of emergence and the latter is equal to $3/4$ th of the angle of prism. The angle of deviation is NCERT Page-331 / N-240

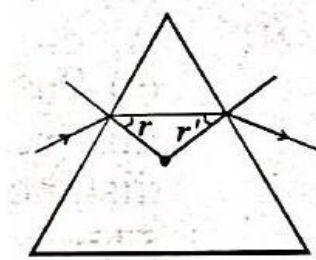
- (a) 45°
- (b) 39°
- (c) 20°
- (d) 30°

76. The refractive index of a 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, NCERT Page-331 / N-240

- (a) $D_1 < D_2$
- (b) $D_1 = D_2$
- (c) D_1 can be less than or greater than D_2 depending upon the angle of prism
- (d) $D_1 > D_2$

77. r and r' denote the angles inside an equilateral prism, as usual, in degrees. NCERT Page-331 / N-240

Consider that during some time interval from $t = 0$ to $t = t$, r' varies with time as $r' = 10 + t^2$. During this time r will vary as (assume that r and r' are in degree)



- (a) $50 - t^2$
- (b) $50 + t^2$
- (c) $60 - t^2$
- (d) $60 + t^2$

78. Find the refractive index of the material of the prism, if the angle of minimum deviation from the prism is 37° and angle of prism is 53° [take $\sin 26.5^\circ = 1/2.234$] NCERT Page-331 / N-240

- (a) 1.58
- (b) 1.99
- (c) 2.88
- (d) 3.1

9.7 OPTICAL INSTRUMENTS

79. In normal adjustment, for a refracting telescope, the distance between objective and eye piece is 30cm. The focal length of the objective, when the angular magnification of the telescope is 2, will be: NCERT Page-339 / N-245

- (a) 20cm
- (b) 30cm

- (c) 10cm
- (d) 15cm

80. An astronomical telescope has a large aperture to

NCERT Page-339 / N-245

- (a) reduce spherical aberration
- (b) have high resolution
- (c) increases span of observation
- (d) have low dispersion

81. To increase the angular magnification of a simple microscope, one should increase

NCERT Page-335 / N-241

- (a) the focal length of the lens
- (b) the power of the lens
- (c) the aperture of the lens
- (d) the object size

82. A student look at distant tree of height 15m with a telescope of magnifying powre 25 . To the student, the tree appears.

NCERT Page-339 / N-245

- (a) 20 times taller
- (b) 15 times taller
- (c) 15 times nearer
- (d) 25 times nearer

83. The focal length of the objective of a telescope is 60cm. To obtain a magnification of 20 , the focal length of the eye piece should be

NCERT Page-339 / N-245

- (a) 2cm
- (b) 3cm
- (c) 4cm
- (d) 5cm

84. If the focal length of objective lens is increased then magnifying power of :

NCERT Page-335, 339 / N-241, 242

- (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 increase.

85. A telescope has an objective lens of focal length 150cm and an eyepiece of focal length 5cm. If a 50m tall tower at a distance of 1km is observed through this telescope in normal setting, the angle formed by the image of the tower is θ , then θ is close to :

NCERT Page-339 / N-245

- (a) 6.1rad
- (b) 3.2rad
- (c) 1.5rad
- (d) 0.2rad

86. The focal length of the objective and the eyepiece of a telescope are 50cm and 5cm respectively. If the telescope is focussed for distinct vision on a scale distant 2m from its objective, then its magnifying power will be:

NCERT Page-339 / N-245

- (a) -4
- (b) -8
- (c) +8
- (d) -2

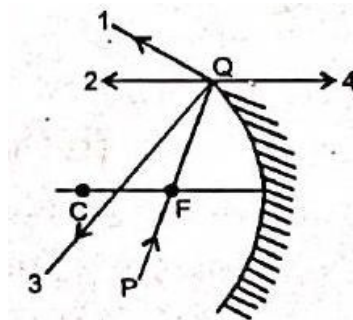
87. The focal lengths of objective and eye lens of an astronomical telescope are respectively 2 meter and 5cm. Final image is formed at (i) least distance of distinct vision (ii) infinity Magnifying power in two cases will be
(a) $-48, -40$ NCERT Page-339 / N-245
(b) $-40, -48$
(c) $-40, +48$
(d) $-48, +40$
88. In a compound microscope, the focal length of objective lens is 1.2cm and focal length of eye piece is 3.0cm. When object is kept at 1.25cm in front of objective, final image is formed at infinity. Magnifying power of the compound microscope should be:
(a) 200
(b) 100
(c) 400
(d) 150 NCERT Page- 339 / N-244
89. The magnifying power of a telescope is 9 . When it is adjusted for parallel rays, the distance between the objective and the eye piece is found to be 20cm. The focal length of lenses are NCERT Page-339 / N-245
(a) 18cm, 2cm
(b) 11cm, 9cm
(c) 10cm, 10cm
(d) 15cm, 5cm
90. The focal lengths of objective lens and eye lens of a Galilean telescope are respectively 30cm and 3.0cm. telescope produces virtual, erect image of an object situated far away from it at least distance of distinct vision from the eye lens. In this condition, the magnifying power of the Galilean telescope should be: NCERT Page-340 / N-245
(a) +11.2
(b) -11.2
(c) -8.8
(d) +8.8

Exercise 2 : NCERT Exemplar & NEET

NCERT Exemplar Questions

1. A ray of light incident at an angle θ on a refracting face of a prism emerges from the other face normally. If the angle of the prism is 5° and the prism is made of a material of refractive index 1.5 , the angle of incidence is NCERT Page-331 / N-240
(a) 7.5°
(b) 5°
(c) 15°
(d) 2.5°
2. A short pulse of white light is incident from air to a glass slab at normal incidence. After travelling through the slab, the first colour to emerge is NCERT Page-332 / N-240
(a) blue
(b) green

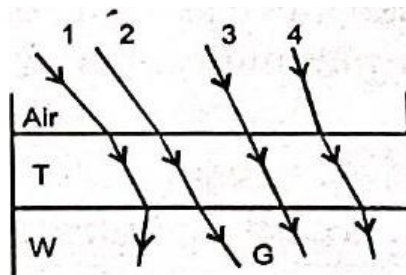
- (c) violet
(d) red
3. An object approaches a convergent lens from the left of the lens with a uniform speed 5m/s and stops at the focus. The image NCERT Page-332 / N-245
- (a) moves away from the lens with a uniform speed 5m/s
(b) moves away from the lens with a uniform acceleration
(c) moves away from the lens with a non-uniform acceleration
(d) moves towards the lens with a non-uniform acceleration
4. You are given four sources of light each one providing a light of a single colour - red, blue, green and yellow. Suppose the angle of refraction for a beam of yellow light corresponding to a particular angle of incidence at the interface of two media is 90° . Which of the following statements is correct if the source of yellow light is replaced with that of other lights without changing the angle of incidence? NCERT Page-320 / N-230
- (a) The beam of red light would undergo total internal reflection
(b) The beam of red light would bend towards normal while it gets refracted through the second medium
(c) The beam of blue light would undergo total internal reflection
(d) The beam of green light would bend away from the normal as it gets refracted through the second medium
5. The radius of curvature of the curved surface of a planoconvex lens is 20cm . If the refractive index of the material of the lens be 1.5 , it will NCERT Page-326 / N-234
- (a) act as a convex lens only for the objects that lie on its curved side
(b) act as a concave lens for the objects that lie on its curved side
(c) act as a convex lens irrespective of the side on which the object lies
(d) act as a concave lens irrespective of side on which the object lies
6. The phenomena involved in the reflection of radiowaves by ionosphere is similar to NCERT Page-320, 333, 334 / N-230
- (a) reflection of light by a plane mirror
(b) total internal reflection of light in air during a mirage
(c) dispersion of light by water molecules during the formation of a rainbow
(d) scattering of light by the particles of air
7. The direction of ray of light incident on a concave mirror is shown by PQ while directions in which the ray would travel after reflection is shown by four rays marked 1, 2, 3 and 4 (figure). Which of the four rays correctly shows the direction of reflected ray? NCERT Page-326 / N-222
- (a) 1
(b) 2
(c) 3
(d) 4



8. The optical density of turpentine is higher than that of water while its mass density is lower. Figure shows a layer of turpentine floating over water in a container. For which one of the four rays incident on turpentine in figure, the path shown is correct?

NCERT Page-317 / N-229

- (a) 1
(b) 2
(c) 3



- (d) 4

9. A car is moving with a constant speed of 60kmh^{-1} on a straight road. Looking at the rear view mirror, the driver finds that the car following him is at a distance of 100m and is approaching with a speed of 5kmh^{-1}

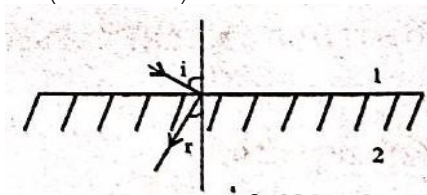
NCERT Page-326 / N-225, 226

In order to keep track of the car in the rear, the driver begins to glance alternatively at the rear and side mirror of his car after every 2s till the other car overtakes. If the two cars were maintaining their speeds, which of the following statement (s) is/are correct?

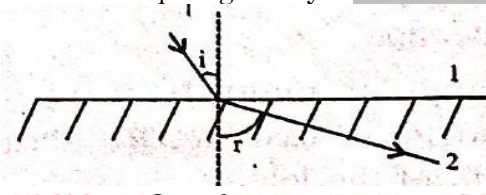
- (a) The speed of the car in the rear is 65kmh^{-1}
 (b) In the side mirror, the car in the rear would appear to approach with a speed of 5kmh^{-1} to the driver of the leading car
 (c) In the rear view mirror, the speed of the approaching car would appear to decrease as the distance between the cars decreases
 (d) In the side mirror, the speed of the approaching car would appear to increase as the distance between the cars decreases
10. There are certain materials developed in laboratories which have a negative refractive index figure. A ray incident from air (Medium 1) into such a medium (Medium 2) shall follow a path given by

NCERT Page-317 / N-228

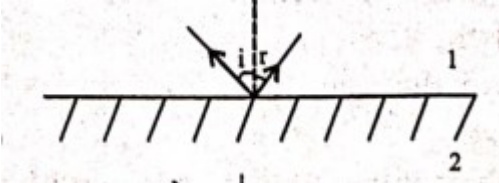
(a)



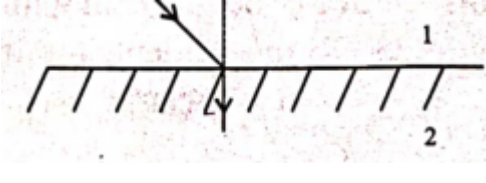
(b)



(c)



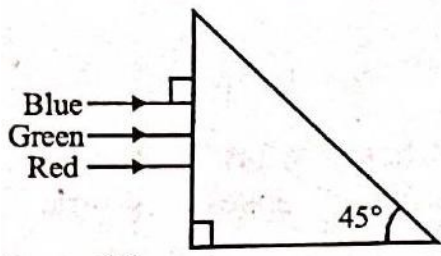
(d)



NEET

11. 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.

NCERT Page-322 / N-230



The prism will:

- (a) separate all the three colours from one another
 - (b) not separate the three colours at all
 - (c) separate the red colour part from the green and blue colours
 - (d) separate the blue colour part from the red and green colours
12. 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 : NCERT Page-331 / N-240
- (a) $45^\circ, \frac{1}{\sqrt{2}}$
 - (b) $30^\circ, \sqrt{2}$
 - (c) $45^\circ, \sqrt{2}$
 - (d) $30^\circ, \frac{1}{\sqrt{2}}$
13. A astronomical telescope has objective and eyepiece of focal lengths 40cm and 4cm respectively. To view an object 200cm away from the objective, the lenses must be separated by a distance: NCERT Page-339 / N-245
- (a) 37.3cm
 - (b) 46.0cm
 - (c) 50.0cm
 - (d) 54.0cm
14. 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 I . 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 NCERT Page-314
- (a) $\frac{y}{x}$
 - (b) $\frac{x}{2y}$
 - (c) $\frac{x}{y}$
 - (d) $\frac{y}{2x}$
15. An astronomical refracting telescope will have large angular magnification and high angular resolution, when it has an objective lens of NCERT Page-339 / N-245
- (a) small focal length and large diameter
 - (b) large focal length and small diameter
 - (c) small focal length and small diameter
 - (d) large focal length and large diameter
16. 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

NCERT Page-331 / N-240 |

- (a) 60°
- (b) 45°
- (c) Zero
- (d) 30°

17. An object is placed at a distance of 40cm from a concave mirror of focal length 15cm. If the object is displaced through a distance of 20cm towards the mirror, the displacement of the image will be

NCERT Page-315 / N-22

- (a) 30cm away from the mirror
- (b) 36cm away from the mirror
- (c) 36cm towards the mirror
- (d) 30cm towards the mirror

18. 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:

NCERT Page-329 / N-237, 238 |

- (a) 2 :
- (b) 1: 2
- (c) 2: 3
- (d) 3: 4

19. 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 :

NCERT Page-331 /

- (a) $\frac{2A}{\mu}$
- (b) μA
- (c) $\frac{\mu A}{2}$
- (d) $\frac{A}{2\mu}$

20. A convex lens 'A' of focal length 20cm and a concave lens 'B' of focal length 5cm are kept along the same axis with a distance 'd' between them. If a parallel beam of light falling on 'A' leaves 'B' as a parallel beam, then the distance 'd' in cm will be

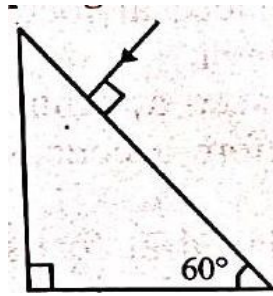
NCERT Page-326, 327 / N-234, 235 |

- (a) 30
- (b) 25
- (c) 15
- (d) 50

21. Find the value of the angle of emergence from the prism.

Refractive index of the glass is $\sqrt{3}$.

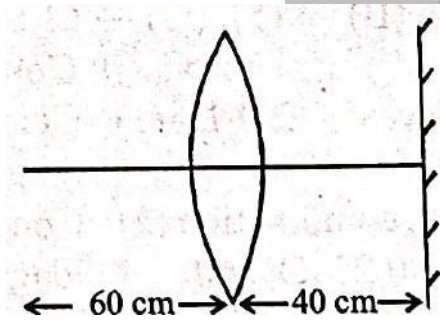
NCERT Page-331 / N-239, 240 |



- (a) 90°
- (b) 60°
- (c) 30°
- (d) 45°

22. A point object is placed at a distance of 60cm from a convex lens of focal length 30cm. If a plane mirror were put perpendicular to the principal axis of the lens and at a distance of 40cm from it, the final image would be formed at a distance of

NCERT/ Page-326 / N-235 /



- (a) 20cm from the plane mirror, it would be a virtual image
- (b) 20cm from the lens, it would be a real image
- (c) 30cm from the lens, it would be a real image
- (d) 30cm from the plane mirror, it would be a virtual image

23. A light ray falls on a glass surface of refractive index $\sqrt{3}$, at an angle 60° . The angle between the refracted and reflected rays would be:

NCERT Page-322 / N-228 |

- (a) 60°
- (b) 90°
- (c) 120°
- (d) 30°

24. Two transparent media *A* and *B* are separated by a plane boundary. The speed of light in those media are 1.5×10^8 m/s and 2.0×10^8 m/s, respectively. The critical angle for a ray of light for these two media is:

- (a) $\sin^{-1}(0.750)$
- (b) $\tan^{-1}(0.500)$
- (c) $\tan^{-1}(0.750)$
- (d) $\sin^{-1}(0.500)$

NCERT Page-320 / N-230 | N

25. A biconvex lens has radii of curvature, 20cm each, if the refractive index of the material of the lens is 1.5, the power of the lens is:

NCERT Page-326-328 / N-234 |

- (a) +20D
- (b) +5D

- (c) infinity
- (d) +2D

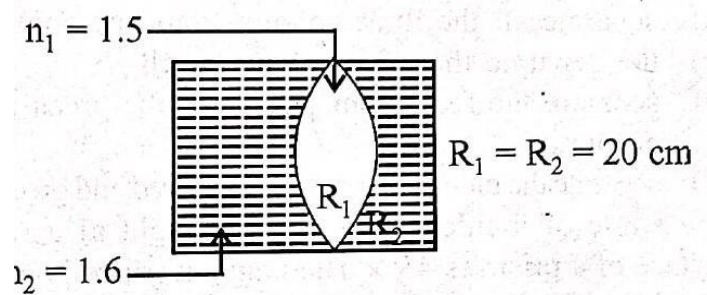
26. Light travels a distance x in time t_1 in air and $10x$ in time t_2 in another denser medium. What is the critical angle for this medium? NCERT | Page-320 / N-230 |

- (a) $\sin^{-1} \left(\frac{t_2}{t_1} \right)$
- (b) $\sin^{-1} \left(\frac{10t_2}{t_1} \right)$
- (c) $\sin^{-1} \left(\frac{t_1}{10t_2} \right)$
- (d) $\sin^{-1} \left(\frac{10t_1}{t_2} \right)$

27. Two thin lenses are of same focal lengths (f), but one is convex and the other one is concave. When they are placed in contact with each other, the equivalent focal length of the combination will be NCERT | Page-329 / N-238 |

- (a) Zero
- (b) $\frac{f}{4}$
- (c) $\frac{f}{2}$
- (d) Infinite

28. In the figure shown here, what is the equivalent focal length of the combination of lenses (Assume that all layers are thin)? NCERT | Page-329 / N-237, 238 |



- (a) 40cm
- (b) -40cm
- (c) -100cm
- (d) -50cm

Exercise 1: (NCERT Based Topic-wise MCQs)

1	(a)	10	(d)	19	(a)	28	(d)	37	(a)	46	(a)	55	(c)	64	(d)	73	(d)	82	(d)
2	(a)	11	(d)	20	(b)	29	(c)	38	(c)	47	(a)	56	(c)	65	(c)	74	(b)	83	(b)
3	(c)	12	(d)	21	(a)	30	(c)	39	(a)	48	(c)	57	(b)	66	(a)	75	(d)	84	(d)
4	(d)	13	(a)	22	(a)	31	(d)	40	(d)	49	(a)	58	(d)	67	(c)	76	(a)	85	(c)
5	(a)	14	(c)	23	(a)	32	(d)	41	(b)	50	(a)	59	(b)	68	(c)	77	(a)	86	(d)
6	(d)	15	(c)	24	(a)	33	(d)	42	(d)	51	(b)	60	(b)	69	(c)	78	(a)	87	(a)
7	(d)	16	(a)	25	(a)	34	(b)	43	(a)	52	(c)	61	(c)	70	(a)	79	(a)	88	(a)
8	(a)	17	(d)	26	(d)	35	(d)	44	(a)	53	(b)	62	(b)	71	(c)	80	(b)	89	(a)
9	(b)	18	(c)	27	(b)	36	(c)	45	(b)	54	(b)	63	(a)	72	(d)	81	(b)	90	(d)

Exercise 2 : (NCERT Exemplar & NEET)

1	(a)	4	(c)	7	(b)	10	(a)	13	(d)	16	(b)	19	(b)	22	(a)	25	(b)	28	(c)
2	(d)	5	(c)	8	(b)	11	(c)	14	(d)	17	(b)	20	(c)	23	(b)	26	(d)		
3	(c)	6	(b)	9	(d)	12	(b)	15	(d)	18	(b)	21	(b)	24	(a)	27	(d)		

HINTS & SOLUTIONS

EXERCISE-1

1. (a) Rectilinear propagation of light means light travels in straight line.
2. (a) Real, inverted and same in size because object is at the centre of curvature of the mirror.
3. (c) Because they form nearly point image of point source.
4. (d)
5. (a)
6. (d) Convex mirror always forms, virtual, erect and smaller image.
7. (d)

8. (a) From mirror formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ so, $\frac{dv}{dt} = -\frac{v^2}{u^2} \left(\frac{du}{dt}\right)$

$$\Rightarrow \frac{dv}{dt} = -\left(\frac{f}{u-f}\right)^2 \frac{du}{dt} \Rightarrow \frac{dv}{dt} = \frac{1}{15} \text{ m/s}$$

9. (b) For concave mirror

$$\frac{2}{R} = \frac{1}{v} + \frac{1}{u} \quad \text{or} \quad \frac{2}{-R} = \frac{1}{v} + \frac{1}{-u}$$

$$\therefore \frac{1}{v} = \frac{1}{U} - \frac{2}{R} = \frac{R-2U}{UR} \quad \text{or} \quad v = \left[\frac{RU}{R-2U} \right]$$

In spherical mirror, image velocity

$$v_i = -\left[\frac{v^2}{u^2}\right] v_0 = -\left[\frac{RU}{R-2U}\right]^2 \frac{v_0}{U^2} = -\left[\frac{R}{R-2U}\right]^2 v_0$$

10. (d)

11. (d) For P: $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

or $\frac{1}{v_P} + \frac{1}{-3} = \frac{1}{-1}$ or $v_P = -\frac{3}{2}m$

For Q: $\frac{1}{v_Q} + \frac{1}{-5} = \frac{1}{-1}$ or $v_Q = \frac{-5}{4}m$

So horizontal distance between image of P and Q is 0.25m

12. (d) The axial magnification $\delta v = -\frac{v^2}{u^2}(\delta u) = \left(\frac{f}{u-f}\right)^2 \ell$.

13. (a) $\vec{V}_{im} = \frac{v^2}{u^2} \vec{V}_{om}$

$0 - \frac{40}{13} = -\left(\frac{-10}{-10+x}\right)^2 \left(10 - \frac{40}{13}\right) \frac{-10}{-10+x} = \pm \frac{2}{3}$

$x = 25, -5cm$

Object is in front of mirror

Hence 25cm.

14. (c)

15. (c) For $M_1: V = -60, m_1 = -2$

For $M_1: u = +20, F = 10 \therefore \frac{1}{V} = \frac{1}{20} = \frac{1}{10} \Rightarrow V = 20$

$\therefore M_2 = -\frac{20}{20} = -1 \therefore M = m_1 \times m_2 = +2$

16. (a) Refractive index, $\frac{\mu_2}{\mu_{air}} = \frac{c}{v_2}$ or, $\therefore \frac{\sqrt{\mu_{r2} \epsilon_{r2}}}{(1)} = \frac{c}{v_2}$

17. (d)

$\therefore \sqrt{(1)(9)} = \frac{c}{v_2} \therefore v_2 = \frac{c}{3}$

18. (c) Let x = Apparent position of the silvered surface in cm. Since the image is formed due to reflection at the silvered face and by the property of mirror image distance of object from the mirror = Distance of image from the mirror or $x + 8 = 12 + 6 - x$ or $x = 5cm$.

Therefore refractive index of glass

$= \frac{\text{Real depth}}{\text{Apparent depth}} = \frac{6}{5} = 1.2$.

19. (a) Given that $\mu_g = \frac{5}{4}$ and $\mu_w = \frac{4}{3}$

$\therefore a\mu_g = \mu_w \mu_g \therefore a\mu_w = \frac{5}{4} \times \frac{4}{3} = \frac{5}{3}$

20. (b) $\mu_g = 1.5$

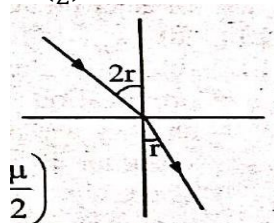
$\therefore 1.5 = \text{cosec } C$ or $C = 42^\circ$. Critical angle for glass = 42° . Hence a ray of light incident at 50° in glass medium undergoes total internal reflection. δ denotes the deviation of the ray.

$\therefore \delta = 180^\circ - (50^\circ + 50^\circ)$ or $\delta = 80^\circ$.

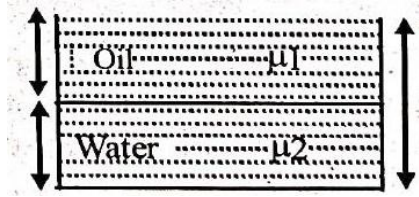
21. (a) $\mu = \frac{\sin i}{\sin r} \therefore i = 2r$

$\Rightarrow \mu = \frac{\sin 2r}{\sin r} = \frac{2 \sin r \cdot \cos r}{\sin r}$

$r = \cos^{-1} \left(\frac{\mu}{2}\right) \therefore 1 = 2 \cos^{-1} \left(\frac{\mu}{2}\right)$



22. (a)
23. (a)



As refractive index, $\mu = \frac{\text{Real depth}}{\text{Apparent depth}}$

\therefore Apparent depth of the vessel when viewed from above is

$$d_{\text{apparent}} = \frac{x}{2\mu_1} + \frac{x}{2\mu_2} = \frac{x}{2} \left(\frac{1}{\mu_1} + \frac{1}{\mu_2} \right)$$

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

24. (a) $n_d \sin i_c = n_r \sin 90^\circ$ (\because From Snell's law)

$$\sin i_c = \frac{n_r}{n_d} = \frac{v_d}{v_r} \quad (\because v = \frac{c}{n})$$

$$\sin i_c = \frac{1.5 \times 10^8}{2 \times 10^8} = \frac{1.5}{2}$$

$$\sin i_c = \frac{3}{4} \quad \tan i_c = \frac{3}{\sqrt{4^2 - 3^2}} \Rightarrow \frac{3}{\sqrt{7}}$$

The critical angle between them, $i_c = \tan^{-1} \left(\frac{3}{\sqrt{7}} \right)$

25. (a)
26. (d)

27. (b) We know that frequency of electromagnetic radiation remains the same when it changes the medium. Further

$$\mu = \frac{\text{wavelength of light in vacuum}}{\text{wavelength of light in medium}} = \frac{\lambda_v}{\lambda_m}$$

$$\lambda_m = \frac{\lambda_v}{\mu} = \frac{\lambda}{\mu}$$

Similarly, $\mu = \frac{\text{velocity of light in vacuum}}{\text{velocity of light in medium}}$

$$\lambda_m = \frac{v}{\mu}$$

28. (d) Let $2i$ be angle of incidence

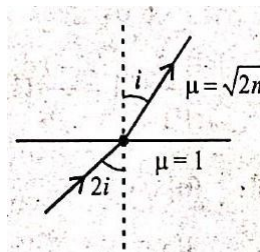
By Snell's law

$$\Rightarrow 1 \sin 2i = \sqrt{2n} \sin i$$

$$\Rightarrow 2 \sin i \cos i = \sqrt{2n} \sin i$$

$$\Rightarrow \cos i = \frac{\sqrt{n}}{2} \Rightarrow i = \cos^{-1} \left(\frac{\sqrt{n}}{2} \right)$$

$$\Rightarrow 2i = 2 \cos^{-1} \left(\frac{\sqrt{n}}{2} \right)$$



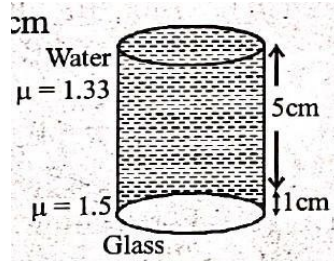
29. (c) Real depth = 5cm + 1cm = 6cm

$$\text{Apparent depth} = \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2} + \dots$$

$$= \frac{5}{1.33} + \frac{1}{1.5}$$

$$\approx 3.8 + 0.7 \approx 4.5\text{cm}$$

$$\therefore \text{Shift} = 6\text{cm} - 4.5\text{cm} \approx 1.5\text{cm}$$



30. (c) As $i > i_c$

At $i = i_c$ angle of refraction

$$'r' = 90^\circ$$

$$\therefore \frac{\sin i_c}{\sin 90^\circ} = \mu = 1$$

31. (d)

32. (d) We know that critical angle is given by

$$\sin C = \frac{\mu_r}{\mu_d} \text{ and } \mu \propto \frac{1}{v} \Rightarrow \frac{\mu_r}{\mu_d} = \frac{v_d}{v_r} = \frac{1.5 \times 10^{10}}{2 \times 10^{10}} = \frac{3}{4}$$

$$\text{So, } \sin C = \frac{3}{4} \Rightarrow C = \sin^{-1} \left(\frac{3}{4} \right)$$

Therefore, for TIR

$$\theta > C \Rightarrow \theta > \sin^{-1} \left(\frac{3}{4} \right)$$

33. (d)

34. (b) For critical angle θ_c , $\sin \theta_c = \frac{1}{\mu}$

For greater wavelength or lesser frequency μ is less. So, critical angle would be more. So, they will not suffer reflection and come out at angles less than 90° .

35. (d) $\sin C = \frac{1}{\mu} = \frac{1}{\sqrt{2}} \therefore C = \sin^{-1} \left(\frac{1}{\sqrt{2}} \right) = 45^\circ$

$$\text{Now } \frac{\sin C}{\sin r} = \frac{1}{\mu} \text{ or } \frac{\sin 45^\circ}{\sin r} = \frac{1}{\sqrt{2}}$$

$$\sin r = 1 \text{ or } r = 90^\circ$$

36. (c) For total internal reflection

$$\sin i > \sin C$$

where,

i = angle of incidence, C = critical angle

$$\text{But, } \sin C = \frac{1}{\mu} \therefore \sin i > \frac{1}{\mu} \text{ or } \mu > \frac{1}{\sin i}$$

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

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

37. (a) If a lens is cut into two half along principal axis, its focal length remain unchanged only the intensity of image get reduced.

$$\text{So, power of } L_1 \text{ will remain unaffected as } P = \frac{1}{f}$$

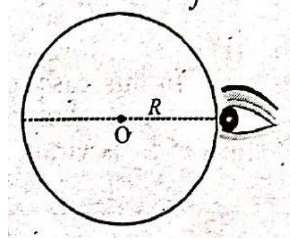
38. (c)

$$(c) \frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$\text{or } \frac{1}{v} - \frac{1.5}{-R} = \frac{1-1.5}{-R}$$

$$\therefore v = -R = -6\text{cm}$$

$$39. (a) \frac{1}{f} = (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$



$$\frac{1}{16} = (1.5 - 1) \left(\frac{1}{R} - \frac{1}{\infty} \right) \Rightarrow \frac{1}{16} = 0.5 \times \frac{1}{R} \Rightarrow R = 8\text{cm}$$

$$40. (d) P_2 = P - P_1 = \frac{100}{80} - \frac{100}{20} = -3.75\text{D}$$

$$41. (b) R_1 = 60\text{cm}, R_2 = \infty, \mu = 1.6$$

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

$$\frac{1}{f} = (1.6 - 1) \left(\frac{1}{60} \right) \Rightarrow f = 100\text{cm}.$$

$$42. (d) P = \frac{1}{f} = (\mu_1 - \mu_2) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

(μ_1 is refractive index of lens and μ_2 is of surrounding medium)

$$\Rightarrow 1.25 = (1.5 - \mu_2) \left(\frac{1}{0.2} + \frac{1}{0.4} \right)$$

$$\Rightarrow \frac{1.25 \times 0.08}{0.6} = (1.5 - \mu_2) \Rightarrow \mu_2 = \frac{4}{3}$$

$$43. (a)$$

$$44. (a) \frac{|P_1|}{|P_2|} = \frac{2}{3} \Rightarrow \frac{f_2}{f_1} = \frac{2}{3}$$

Focal length of their combination

$$\frac{1}{f} = \frac{1}{f_1} - \frac{1}{f_2} \Rightarrow \frac{1}{30} = \frac{1}{f_1} - \frac{1 \times 3}{2f_1}$$

$$\Rightarrow \frac{1}{30} = \frac{1}{f_1} \left[1 - \frac{3}{2} \right] = \frac{1}{f_1} \times \left(-\frac{1}{2} \right) \therefore f_1 = -15\text{cm}$$

$$\therefore f_2 = \frac{2}{3} \times f_1 = \frac{2}{3} \times 15 = 10\text{cm}$$

$$45. (b)$$

$$46. (a) \text{ Let the distance between the lenses be } d.$$

Then, equivalent power is

$$P = P_1 + P_2 - dP_1P_2$$

$$\text{Given } P_1 = P_2 = +5\text{D} \therefore P = (10 - 25d)\text{D}$$

$$\text{For } P \text{ to be -ve, } 10 - 25d < 0 \Rightarrow d > \frac{2}{5}\text{m}$$

$$\text{or, } d > 0.4\text{m} \text{ or } d > 40\text{cm}$$

$$47. (a) \text{ Let refractive index of glass be } \mu.$$

Let after first refraction, image distance be v then

$$\frac{\mu}{v} - \frac{1}{\infty} = \frac{\mu - 1}{R} \Rightarrow v = \frac{\mu R}{\mu - 1}$$

Now second refraction will take place.

So distance of first image from O is

$u_1 = \frac{\mu R}{\mu - 1} - R = \frac{R}{\mu - 1}$ and image is formed at R

$$\therefore \frac{1}{R} - \frac{\mu(\mu - 1)}{R} = \frac{2(1 - \mu)}{R}$$

$$\Rightarrow \mu^2 - 3\mu + 1 = 0 \text{ So, } \mu = \frac{3 + \sqrt{5}}{2}$$

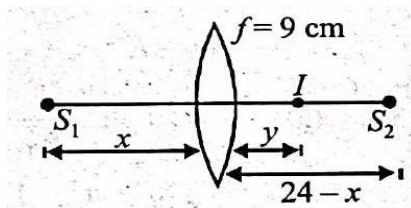
48. (c)

49. (a) In this case, one of the image will be real and the other virtual. Let us assume that image of S_1 is real and that of S_2 is virtual.

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

For S_1 : $\frac{1}{y} + \frac{1}{x} = \frac{1}{9}$

For S_2 : $\frac{1}{y} + \frac{1}{24-x} = \frac{1}{9}$



Solving eqs. (i) and (ii), we get $x = 6\text{cm}$

50. (a)

51. (b) Cutting a lens in transverse direction doubles their focal length i.e., $2f$.

Using the formula of equivalent focal length.

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + \frac{1}{f_4}$$

We get equivalent focal length as $\frac{f}{2}$.

52. (c) Since $l_R > l_V$, $m_R < m_V$

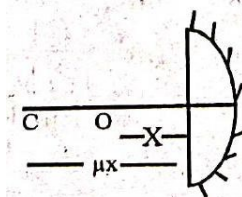
$$\left(\because \mu \propto \frac{1}{\lambda} \right) \Rightarrow f_V < f_R \left(\because \frac{1}{f} \propto (\mu - 1) \right)$$

53. (b) Due to difference in refractive indices images obtained will be two. Two mediums will form images at two different points due to difference in focal lengths.

54. (b)

55. (c) For the image to be real and of same size as object, final image should be formed at the position of object itself.

Let x be the distance of object from plane surface. Apparent distance from



surface = μx

This should be centre of curve

$$\therefore \mu x = 30 \Rightarrow 1.5x = 30 \Rightarrow x = 20$$

56. (c) If f_e be the focal length of the lens, then

$$\frac{1}{f_e} = \frac{2}{15} + \frac{1}{\infty} \text{ or } f_e = 7.5\text{cm}$$

Now using mirror formula, we have

$$\frac{1}{v} + \frac{1}{-20} = \frac{1}{-7.5} \therefore v = -12\text{cm}$$

57. (b) Here, $P_1 = 5\text{D}$

$$P_2 = P - P_1 = 2 - 5 = -3D$$

$$\frac{\omega_1}{\omega_2} = -\frac{f_1}{f_2} = \frac{-P_2}{P_1} = \frac{3}{5}$$

58. (d) If f_e is the effective focal length of the system, then $\frac{1}{f_e} = \frac{2}{f_e} + \frac{1}{f_m} = \frac{2}{12} + \frac{1}{\infty} \therefore f_e = 6\text{cm}$

Now using mirror formula, $f = -6\text{cm}$

$$\frac{1}{v} + \frac{1}{-20} = \frac{1}{-6} \therefore v = -8.6\text{cm}$$

$$59. (b) \frac{P_a}{P_1} = \frac{\left(\frac{\mu_g}{\mu_a} - 1\right)}{\left(\frac{\mu_g}{\mu_1} - 1\right)} = \frac{+5}{-100/100} = -5$$

$$-5 \left(\frac{\mu_g}{\mu_1} - 1\right) = \frac{\mu_g}{\mu_a} - 1$$

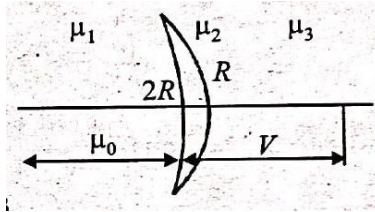
$$\frac{1.5}{\mu_1} - 1 = \frac{-1}{5} (1.5 - 1) = -0.1; \mu_1 = \frac{1.5}{0.9} = \frac{5}{3}$$

60.

$$(b) \frac{\mu_2}{v} - \frac{\mu_1}{-u_0} = \frac{\mu_2 - \mu_1}{-2R}$$

$$\frac{\mu_3}{V_f} - \frac{\mu_2}{V} = \frac{\mu_3 - \mu_2}{-R}$$

$$\frac{\mu_3}{V_f} + \frac{\mu_1}{u_0} = \frac{\mu_1 - \mu_2}{2R} + \frac{\mu_2 - \mu_3}{R}$$



$$\therefore \frac{\mu_1 - \mu_2}{2} < \mu_3 - \mu_2 \Rightarrow \mu_1 - \mu_2 < 2\mu_3 - 2\mu_2$$

$$\Rightarrow \mu_1 + \mu_2 < 2\mu_3$$

61. (c) For reading purposes :

$$u = -25\text{cm}, v = -50\text{cm}, f = ?$$

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = -\frac{1}{50} + \frac{1}{25} = \frac{1}{50}; P = \frac{100}{f} = +2D$$

For distant vision, $f =$ distance of far point $= -3\text{m}$

$$P = \frac{1}{f'} = -\frac{1}{3} D = -0.33D$$

62. (b) If $R_1 = R, R_2 = -2R$

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

$$\frac{1}{6} = (1.5 - 1) \left(\frac{1}{R} + \frac{1}{2R} \right) = \frac{0.5 \times 3}{2R}$$

$$R = 4.5\text{cm}$$

63. (a) Considering refraction at the curved surface,

$$u = -20, \mu_2 = 1$$

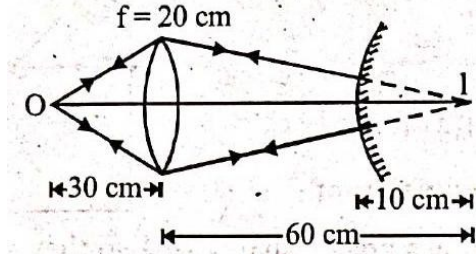
$$\mu_1 = 3/2, R = +20$$

$$\text{Applying } \frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$\Rightarrow \frac{1}{v} - \frac{3/2}{-20} = \frac{1 - 3/2}{20} \Rightarrow v = -10$$

i.e., 10cm below the curved surface or 10cm above the actual position of flower.

64. (d)
65. (c)



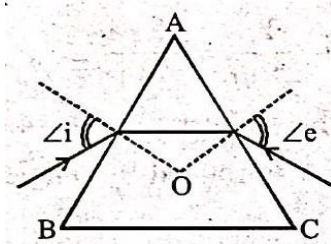
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}; \frac{1}{v} - \frac{1}{-30} = \frac{1}{20} \Rightarrow v = 60\text{cm}$$

Coincidence is possible when the image is formed at the centre of curvature of the mirror. Only then the rays refracting through the lens will fall normally on the convex mirror and retrace their path to form the image at O. So the distance between lens and mirror = $60 - 10 = 50\text{cm}$.

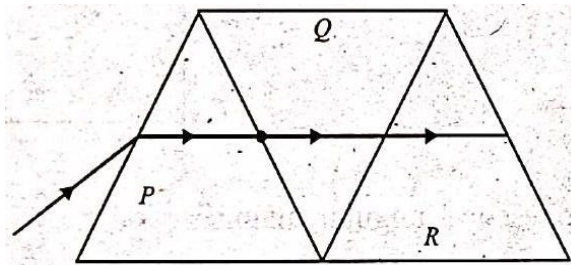
66. (a) In the position of minimum deviation, $i_1 = i_2$.
67. (c) In the position of minimum deviation

$$i = e = \frac{A + \delta_m}{2} = \frac{60 + 30}{2} = 45^\circ$$

68. (c) At the minimum deviation, $f = D_m$ angle of incidence $\angle i =$ angle of emergence $\angle e$ and inside the prism refracted ray parallel to the base of the prism



69. (c)



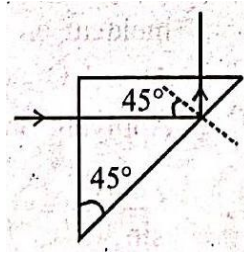
There will be no refraction from P to Q and then from Q to R (all being identical). Hence the ray will now have the same deviation.

70. (a)
71. (c) For the prism as the angle of incidence (i) increases, the angle of deviation (δ) first decreases goes to minimum value and then increases.
72. (d) For T.I.R. $45^\circ > C$

$$\therefore \sin 45^\circ > \sin C$$

$$\therefore \frac{1}{\sqrt{2}} > \frac{4}{3n}$$

$$\therefore n > \frac{4\sqrt{2}}{3}$$



73. (d) As we know $\mu = \frac{1}{\sin C}$

$$\mu = \frac{1}{\sin 60^\circ} = \frac{2}{\sqrt{3}}$$

For total internal reflection to take place

$$\sin C = \frac{1}{\mu} = \frac{2}{3}, \therefore C = \sin^{-1} \frac{2}{3} \cong 42^\circ$$

$$\theta < 45^\circ$$

Angle of incidence > critical angle, hence TIR takes place

74. (b) $i = \frac{A + \delta_m}{2} = \frac{60 + 30}{2} = 45^\circ$.

75. (d) $i_1 = i_2 = \frac{3}{4}A$

As $A + \delta = i_1 + i_2$

$$\therefore \delta = i_1 + i_2 - A = \frac{3}{4}A + \frac{3}{4}A - A = \frac{A}{2} = \frac{60^\circ}{2} = 30^\circ$$

76. (a) For a thin prism, $D = (\mu - 1)A$

Since $\lambda_b < \lambda_r \Rightarrow \mu_r < \mu_b \Rightarrow D_1 < D_2$

77. (a) In a prism: $r + r' = A \Rightarrow r = A - r'$

$$\therefore r = 60^\circ - (10 + t^2) = 50 - t^2$$

78. (a) $\mu = \frac{\sin(\frac{A + \delta_m}{2})}{\sin(A/2)} = \frac{\sin 45^\circ}{\sin 26.5^\circ} = 1.58$

79. (a) $\therefore f_o + f_e = 30$

And magnification, $m = \frac{f_o}{f_e}$

$$2 = \frac{f_o}{f_e} \Rightarrow f_o = 2f_e \Rightarrow f_o + \frac{f_o}{2} = 30 \therefore f_o = 20\text{cm}$$

80. (b) The aperture of objective lens of Astronomical telescope is large to get better resolution. Since resolution of telescope power is $R = \frac{D}{1.22\lambda}$, where D is the diameter of the objective lens of Telescope.

81. (b) One should increase the power of lens i.e., decrease the focal length of a lens.

82. (d)

83. (b) In normal adjustment,

$$M = \frac{f_o}{f_e} = 20, f_e = \frac{f_o}{20} = \frac{60}{20} = 3\text{cm}$$

84.. (d)

(d)

85. (c) Magnifying power of telescope,

$$MP = \frac{\beta \text{ (angle subtended by image at eye piece)}}{\alpha \text{ (angle subtended by object on objective)}}$$

$$\text{Also, } MP = \frac{f_o}{f_e} = \frac{150}{5} = 30, \therefore \alpha = \frac{50}{1000} = \frac{1}{20} \text{ rad}$$

$$\therefore \beta = \theta = MP \times \alpha = 30 \times \frac{1}{20} = \frac{3}{2} = 1.5 \text{ rad}$$

86. (d)

87. (a)

$$(i) M = -\frac{f_0}{f_e} \left(1 + \frac{f_e}{d}\right) = -\frac{200}{5} \left(1 + \frac{5}{25}\right) = -48$$

(since least distance $d = 25 \text{ cm}$)

$$(ii) M = -\frac{f_0}{f_e} = -\frac{200}{5} = -40$$

88. (a) Given : $f_0 = 1.2 \text{ cm}$; $f_e = 3.0 \text{ cm}$

$$u_0 = 1.25 \text{ cm}; M_\infty = ?$$

$$\text{From } \frac{1}{f_0} = \frac{1}{v_0} - \frac{1}{u_0} \Rightarrow \frac{1}{1.2} = \frac{1}{v_0} - \frac{1}{(-1.25)}$$

$$\Rightarrow \frac{1}{v_0} = \frac{1}{1.2} - \frac{1}{1.25} \Rightarrow v_0 = 30 \text{ cm}$$

Magnification at infinity,

$$M_\infty = -\frac{v_0}{u_0} \times \frac{D}{f_e} = \frac{30}{1.25} \times \frac{25}{3}$$

($\because D = 25 \text{ cm}$ least distance of distinct vision) = 200 Hence the magnifying power of the compound microscope is 200

89. (a) $\frac{f_0}{f_e} = 9, \therefore f_0 = 9f_e$

Also $f_0 + f_e = 20$ (\because final image is at infinity)

$$9f_e + f_e = 20, f_e = 2 \text{ cm}, \therefore f_0 = 18 \text{ cm}$$

90. (d) Given, Focal length of objective, $f_0 = 30 \text{ cm}$

focal length of eye lens, $f_e = 3.0 \text{ cm}$

Magnifying power, = ?

Magnifying power of the Galileian telescope,

$$M_D = \frac{f_0}{f_e} \left(1 - \frac{f_e}{D}\right) = \frac{30}{3} \left(1 - \frac{3}{25}\right) [\because D = 25 \text{ cm}]$$

$$= 10 \times \frac{22}{25} = 8.8 \text{ cm}$$

EXERCISE-2

1. (a) As we know that the deviation

$$\delta = (\mu - 1)A$$

By geometry, the angle of refraction by first surface is 5° and given $\mu = 1.5$

$$\text{So, } \delta = (1.5 - 1) \times 5^\circ = 2.5^\circ$$

also, $\delta = \theta - r$,

By putting the value of δ and r in equation (ii)

$$2.5^\circ = \theta - 5^\circ$$

$$\text{So, } \theta = 5 + 2.5 = 7.5^\circ$$

2. (d) As we know that when light ray goes from one medium to other medium, the frequency of light remains unchanged.

And, $c = \nu \lambda$

So, $c \propto \lambda$ the light of red colour is of highest wavelength and therefore of highest speed. Thus, after travelling through the slab, the red colour emerge first.

3. (c) According to the question, when object is at different position, and if an object approaches towards a convergent lens from the left of the lens with a uniform speed of 5 m/s , the image move away from the lens to infinity with a nonuniform acceleration

4. (c)

5. (c)

6. (b) The reflection of radiowaves by ionosphere is similar to total internal reflection of light in air during a mirage because angle of incidence is greater than critical angle so that internal reflection of radio wave, take place.
7. (b) The incident PQ ray of light passes through focus F on the concave mirror, after reflection should become parallel to the principal axis, i.e., ray-2.
8. (b) As we know, when the ray goes from rarer medium air to optically denser turpentine, then it bends towards the normal i.e., $i > r$ whereas when it goes from optically denser medium turpentine to rarer medium water, then it bends away from normal i.e., $i < r$.
So, the path of ray 2 is correct.
9. (d) As we know that, the image formed by convex mirror does not depend on the relative position of object w.r.t. mirror.
So, when the car approaches in the rear side, initially it appear at rest as images is formed at focus. Hence the speed of the image of the car would appear to increase as the distance between the cars decreases.

10. (a)

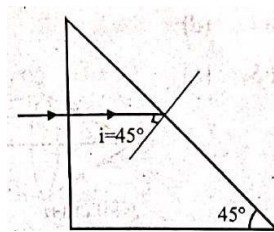
11. (c) For total internal reflection, incident angle (i) $>$ critical angle (i_c)

So, $\sin i > \sin i_c$

$$\sin 45^\circ > \frac{1}{\mu}$$

$$\Rightarrow \mu > \sqrt{2} \Rightarrow 1.414$$

Since refractive index μ of



green and violet are greater than 1.414 so they will total internal reflected. But red colour will be refracted.

12. (b) $i = 45^\circ$; $A = 60^\circ$;

Angle of minimum deviation, $\delta_m = 2i - A = 30^\circ$

Refractive index of material of prism.

$$\mu = \frac{\sin \left(\frac{A + \delta_m}{2} \right)}{\sin \frac{A}{2}} = \frac{\sin 45^\circ}{\sin 30^\circ} = \frac{1}{\sqrt{2}} \cdot \frac{2}{1} = \sqrt{2}$$

13. (d) Given: Focal length of objective, $f_0 = 40\text{cm}$

Focal length of eye - piece $f_e = 4\text{cm}$

image distance, $v_0 = 200\text{cm}$

Using lens formula for objective lens

$$\frac{1}{v_0} - \frac{1}{u_0} = \frac{1}{f_0} \Rightarrow \frac{1}{v_0} = \frac{1}{f_0} + \frac{1}{u_0}$$

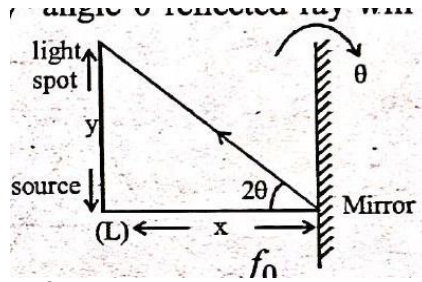
$$\Rightarrow \frac{1}{v_0} = \frac{1}{40} + \frac{1}{-200} = \frac{+5 - 1}{200} \Rightarrow v_0 = 50\text{cm}$$

Tube length $\ell = |v_0| + f_e = 50 + 4 = 54\text{cm}$.

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

$$y = 2\theta$$

$$\Rightarrow \theta = \frac{y}{2x}$$



15. (d) For telescope, angular magnification = $\frac{f_0}{f_E}$

So, focal length of objective lens should be large.

Angular resolution = $\frac{D}{1.22\lambda}$ So, D should be large.

So, objective lens of refracting telescope should have large focal length (f_0) and large diameter D for larger angular magnification.

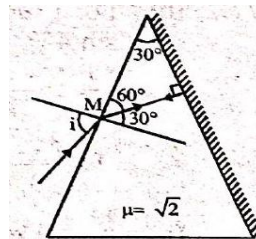
16. (b) For retracing the path, light ray should be normally incident on silvered face.

$$A = r + 0 \Rightarrow r = 30^\circ$$

Applying Snell's law at point M ,

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

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



17. (b)

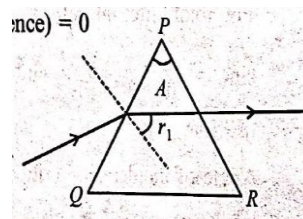
18. (b)

19. (b) Light ray emerges normally from another surface, hence, e (angle of emergence) = 0

$$\therefore r_2 = 0$$

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

$$\mu_1 \cdot \sin i = \mu_2 \cdot \sin r$$

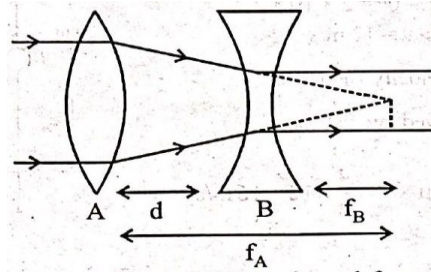


Applying Snell's law on first surface PQ

$$\Rightarrow 1 \cdot \sin i = \mu \cdot \sin r_1 \Rightarrow \sin i = \mu \sin A$$

For small angles ($\sin \theta \approx \theta$) $\therefore i = \mu A$

20. (c)



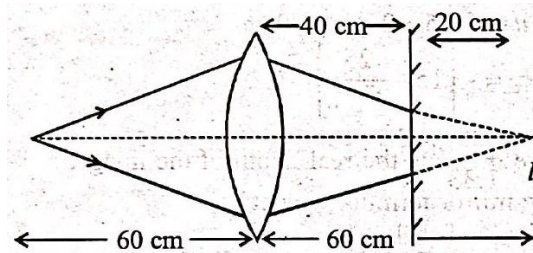
From the ray diagram light refracted from convex lens virtually meet at focus of concave lens

$$\therefore d = f_A - f_B = 20 - 5 = 15\text{cm}$$

21. (b)

22. (a) For first refraction from convex lens $v_1 = ?$, $u = -60\text{cm}$, $f = 30\text{cm}$ From lens formula,

$$\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v_1} + \frac{1}{60} = \frac{1}{30} \Rightarrow v_1 = 60\text{cm}$$



$v_1 =$ first image by lens

Image produced by plane mirror at distance 20cm left of it.

Therefore for second refraction from convex lens,

$u = -20\text{cm}$, $v = ?$, $f = 30\text{cm}$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} + \frac{1}{20} = \frac{1}{30}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{30} - \frac{1}{20} \Rightarrow v = -60\text{cm}$$

Hence the final image which is virtual formed at a distance, $60 - 40 = 20\text{cm}$ from plane mirror.

23. (b)

24. (a) $\sin C = \frac{\mu_r}{\mu_d}$ and, $\mu \alpha \frac{1}{v}$

$$\text{therefore, } \frac{\mu_r}{\mu_d} = \frac{v_d}{v_r} = \sin c = \frac{v_d}{v_r} = \frac{1.5 \times 10^8}{2 \times 10^8} = \frac{3}{4}$$

$$\text{so, } \theta = \sin^{-1} \left(\frac{3}{4} \right) = \sin^{-1} (0.750)$$

25. (b) We have power $P = \frac{1}{f} = (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$

$$= (1.5 - 1) \left(\frac{1}{20} - \frac{1}{-20} \right) \times \frac{1}{10^{-2}} = 0.5 \times \frac{2}{20} \times 100 = +5\text{D}$$

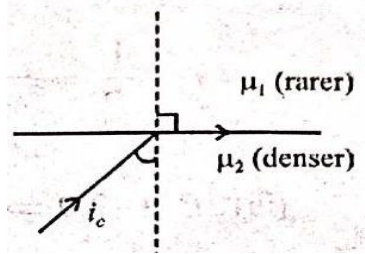
26. (d) $\mu_2 \sin i_c = \mu_1 \Rightarrow \sin i_c = \frac{\mu_1}{\mu_2}$

$$\mu = \frac{c}{V}$$

$$\therefore \sin i_c = \frac{\mu_1}{\mu_2} = \frac{V_2}{V_1}$$

$$\sin i_c = \frac{10xt_1}{t_2x}$$

$$\therefore i_c = \sin^{-1} \left(\frac{10t_1}{t_2} \right)$$



27. (d) We know that

For convex lens $f_1 > 0$,

concave lens $f_2 < 0$

$$\frac{1}{f_{\text{net}}} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{f} - \frac{1}{f} = 0 \Rightarrow f_{\text{net}} = \infty$$

28. (c) Effective focal length (f_{eff}) is

$$\frac{1}{f_{\text{eff}}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$$

From the lens maker's formula

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

$$\frac{1}{f_1} = (1.6 - 1) \left(\frac{1}{\infty} - \frac{1}{20} \right) = \frac{-0.6}{20} = \frac{-3}{100}$$

$$\frac{1}{f_2} = (1.5 - 1) \left(\frac{1}{20} - \frac{1}{-20} \right) = \frac{0.5}{10} = \frac{1}{20}$$

$$\frac{1}{f_3} = (1.6 - 1) \left(\frac{1}{-20} - \frac{1}{\infty} \right) = \frac{-0.6}{10} = \frac{-3}{100}$$

$$\Rightarrow \frac{1}{f_{\text{eff}}} = \frac{-3}{100} + \frac{1}{20} - \frac{3}{100} \Rightarrow \frac{1}{f_{\text{eff}}} = \frac{-1}{100}$$

$$\Rightarrow f_{\text{eff}} = -100 \text{ cm}$$