

CHAPTER -9

RAY OPTICS AND OPTICAL INSTRUMENTS

One mark questions

1. Mention the wavelength range of electromagnetic waves which can be detected by human eye.(K)
2. Give the wavelength range of visible light. (K)
3. In which medium the speed of light has maximum value? (K)
4. Give the value of speed of light in air/vacuum up to three decimal places accuracy. (U)
5. Define pole of a mirror. (U)
6. Define principal axis of a mirror. (U)
7. Define principal focus of a mirror. (U)
8. Define focal length of spherical mirror. (U)
9. Draw the ray diagram for the formation of image by a concave mirror with object between P and F. (S)
10. Draw the ray diagram for the formation of image by a convex mirror with object between P and F.(S)
11. What is refraction of light? (K)
12. A ray of light travels from denser medium to rarer medium. If the angle of incidence is zero then what is the angle of refraction? (U)
13. What happens to speed of light when a ray of light travels from air to glass? (U)
14. Does the frequency of light change when it travels from one optical medium to another optical medium? (K)
15. The speed of light in a medium is $2 \times 10^8 \text{ ms}^{-1}$. What is the refractive index of that medium? (A)
16. State Snell's law of refraction. (K)
17. Write the formula for refractive index of the material for normal refraction. (U)
18. When is Snell's law of refraction not valid?
OR For what angle of incidence Snell's law is not valid? (U)
19. Refractive index of carbon disulphide and glass are 1.63 and 1.5 respectively. Which is optically denser? (U)
20. Two optical media of refractive indices n_1 and n_2 contain x and y waves of the same colour in the same thickness. What is the relative refractive Index n_{21} ? (U)
21. Is the optical density and material density the same? (U)
22. Is speed of light same in all optical media? (K)
23. What happens to a ray of light when it travels from optically rarer to denser medium? (K)
24. Define critical angle of a medium. (U)
25. What is the angle of refraction for a light ray if it incident at critical angle from denser medium? (U)
26. For which colour of light refractive index of a medium is minimum? (U)
27. For which colour of light refractive index of a medium is maximum? (U)
28. For which colour of light critical angle is minimum when light passes from glass to air? (U)
29. What is total internal reflection? (K)
30. Mention the relation between refractive index and critical angle of a medium. (K)

31. A water tank is viewed first normally and then obliquely. Are the apparent depths the same in both the cases? (U)
32. On what principle an optical fibre works? (K)
33. The focal length of an equiconvex lens is equal to its radius of curvature. What is the value of refractive index of the material of lens? (A)
34. Two converging lenses of equal focal lengths are placed in contact. What is the focal length of the combination? (A)
35. Define power of a lens. (U)
36. Write the relation between power and focal length of a lens. (K)
37. Two lenses one converging and other diverging lens each of focal length f are placed in contact. What is the power of the combination? (U)
38. Three lenses of powers $+1D$, $-1D$ & $+2D$ are kept in contact. What is the effective power of the combination? (A)
39. Write the expression for the power of number of thin lenses in contact. (K)
40. Define linear magnification of a lens. (U)
41. Write the expression for linear magnification of a lens in terms of object distance and image distance. (U)
42. An object is kept at a distance of 10cm from a lens whose magnification is 1.5 . At what distance from the lens image is formed? (A)
43. What is dispersion of light? (K)
44. State Rayleigh's law of scattering. (K)
45. Name the phenomenon involved in the formation of rainbow in the sky. (K)
46. How does the sky appear when viewed (What would be the colour of sky) in the absence of atmosphere? (U)
47. What is accommodation of eye? (U)
48. Define least distance of distinct vision? (U)
49. For normal vision what is the value of least distance of distinct vision? (K)
50. How to rectify myopia or near sightedness? (K)
51. How to correct hyper metropia or far sightedness? (K)
52. How to correct astigmatism defect in eye? (K)
53. Mention any one quality of a good refracting telescope. (K)
54. Define resolving power of an optical instrument. (U)
55. Where do we find the world's largest objective lens refracting type telescope? (K)
56. The largest telescope of India is situated in which place? (K)

Two mark questions

1. Write mirror equation and explain the terms. (K)
2. State the laws of reflection (K)
3. State the laws of refraction. (K)
4. Draw the ray diagram for Lateral shift of a ray refracted through a parallel-sided glass slab. (S)
5. If a glass rod is put in a beaker containing a colorless liquid, the rod immediately seems to disappear. What is the reason for this? Explain. (U)

6. A parallel sided slab is introduced in the path of converging beam of light. What will happen to the point of convergence and why? (U)
7. A properly cut diamond sparkles but a similarly cut glass does not sparkle. Give Reason. (U)
8. Explain the phenomenon of total internal reflection. (U)
9. Mention the conditions for total internal reflection to occur. (K)
10. With the help of a diagram show how to bend rays of light by 90° using total internal reflecting prisms. (S)
11. Represent with a diagram how to invert the image without changing its size using total internal reflecting prism. (S)
12. Draw a diagram to represent the bending of light rays by 180° using total internal reflecting prism. (S)
13. Why does the surface of an air bubble inside water or glass shine when light falls on it? (U)
14. A man is standing very near a swimming pool looks at a stone lying at the bottom. The depth of pool is 'd'. At what distance from the surface of water (R.I. = n) is the image of the stone formed? (U)
15. Mention any two uses of optical fibres.(K)
16. Why sunglasses have zero power even though their surfaces are curved? (U)
17. Name any two factors affecting focal length of a lens. (K)
18. Can convergent lens in one medium behave as a divergent lens in another medium? Explain. (U)
19. Write lens maker's formula and explain the terms. (K)
20. Define power of a lens. Mention the expression for it. (U)
21. What is the SI unit of power? Define the SI unit of power of a lens. (U)
22. Define linear magnification and give the expression for linear magnification produced by a thin lens in terms of object distance and image distance. (U)
23. Draw a neat labeled ray diagram representing the dispersion of white light by a prism. (S)
24. Draw a neat labeled ray diagram for the refraction of monochromatic light by a prism. (S)
25. Represent graphically the variation of angle of deviation with angle of incidence in case of a triangular prism. (S)
26. Draw a Schematic diagram of Newton's classic experiment on dispersion of white light through two prisms. (S)
27. A ray of composite light passes through a prism. Which colour is (a) most deviated and (b) least deviated? (U)
28. Write the expression for the refractive index of the material of the prism in terms of the angle of the prism and the angle of minimum deviation, and explain the terms. (U)
29. Which colour of light has maximum speed in (i) free space (ii) glass? (U)
30. According to Rayleigh scattering for which colour, intensity, is (a) highest and (b) least? (U)
31. Why does sun appear red at dawn and dusk? (U)
32. Why does sky appear blue? Explain. (U)
33. Why sea appears blue? Explain. (U)
34. What is hyper metropia? How can it be corrected? (K)
35. What is myopia? How can it be corrected? (K)
36. What is Astigmatism? How can it be corrected? (K)

37. Explain how rainbow is formed in nature. (U)
38. What are the conditions for the formation of a rainbow? (K)
39. Draw the ray diagram for the formation of primary rainbow. (S)
40. Draw the ray diagram for the formation of secondary rainbow. (S)
41. Give two differences between primary rainbow and secondary rainbow. (U)
42. Draw a neat labeled ray diagram for the image formation by a simple microscope. (S)
43. Mention the expression for the magnifying power of a simple microscope when the image is formed at near point, and explain the terms. (K)
44. Mention two optical instruments in which a system of combination of lenses is used? (K)
45. Give the expression for (a) tube length and (b) magnifying power of the refracting telescope. (K)
46. Draw a neat labeled ray diagram of an astronomical (reflecting) telescope. (S)
47. Give any two advantages of reflecting telescope over refracting telescope. (U)
48. Find the refractive index of a medium which has a critical angle of 45° . (A) [Ans.: $n=\sqrt{2}$]
49. If the focal length of a glass lens = 20 cm, find the power of the lens? (A) [Ans.: 5 D]
50. A concave mirror of focal length 1 cm produces a real image 10 times the size of the object. What is the distance of the object from the mirror? (A) [Ans.: 1.1cm]

Three mark questions

1. Explain the Cartesian sign conventions used for measuring the distances in case of spherical surfaces. (K)
2. Obtain the relation between focal length (f) and radius of curvature (R) of a mirror
OR show that $f = R/2$ for a mirror. (U)
3. Define critical angle and write the two conditions for total internal reflection to occur. (U)
4. Obtain the relation between refractive index and critical angle for a medium. (U)
5. Mention three illustrations of total internal reflection. (K)
6. Describe the demonstration of the phenomena of total internal reflection of light using a glass beaker. (U)
7. With the help of ray diagram write the significance of Newton's classic experiment on dispersion of white light. (S)
8. Explain why sky is blue in colour. (U)
9. Why sun appears red at rise and set? Explain. (U)
10. Briefly explain the formation of mirage with a schematic diagram. (S)
11. Explain the function of human eye when light incident on it. (U)
12. Which are the common defects of human eye, how to rectify them? (K)
13. Obtain the expression for linear magnification of a simple microscope. (U)
14. Derive the expression for the angular magnification of a simple microscope. (U)
15. Deduce the expression for magnification of a compound microscope. (U)
16. Write any three distinguishing properties between refracting and reflecting type telescopes. (U)
17. What is a thin prism? Write the expression for the deviation produced by a thin prism. Explain the symbols. (K)

Five mark questions

1. Derive the mirror equation in the case of real and inverted image formed by a concave mirror. (U)
2. Derive the relation between object distance (u) and image distance (v) in terms of refractive index of the medium (n) and the radius of curvature(R) of the spherical surface.
OR Obtain the relation between u , v , R and n for spherical surface. (U)
3. Briefly explain the principle, construction and working of optical fibres. (U)
4. Derive Lens maker's formula for a double convex lens. (U)
5. Obtain the expression for the refractive index of the material of the prism in terms of the angle of the prism and the angle of minimum deviation. (U)
6. Define focal length of a lens. Derive the expression for equivalent focal length of combination of two thin convex lenses in contact. (U)
7. Which phenomenon is responsible for the formation of rainbow? Explain in detail the formation of rainbow. (U)
8. With neat labeled ray diagram of a simple microscope for the image formation, briefly explain its working and write the expression for its magnification when the image is at near point. (S)(U)
9. With neat labeled ray diagram of a compound microscope explain briefly its working and mention the expression for its magnification when the final image is formed at (i) near point and (ii) at infinity. (S)(U)

NUMERICAL PROBLEMS

1. A candle is held 6 cm away from a concave mirror of radius of curvature 24cm. Where does the image formed? What is the nature of the image?(A) [**$v=12\text{cm}$ virtual and magnified erect image**]
2. An object is placed at a distance of 40cm. from a concave mirror of focal length 15 cm. If the object is displaced through a distance of 20 cm towards the mirror, by how much distance is the image displaced? (A) [**$v' = -60\text{cm}$**]
3. A car has a convex mirror as its side mirror of focal length 30 cm. A second car is 5m behind the first car. Find the position of the second car as seen in the mirror of first car. (A) [**0.28m**]
4. A ball is approaching a convex mirror of focal length 30 cm with speed 20 m/s. Calculate the speed of its image when the ball was at 5 m from the mirror? (A) [**0.064 m s^{-1}**]
5. A convex lens has a focal length of 0.3 m in air. Calculate its focal length when it is immersed in water. Given that refractive index of water = $4/3$ and refractive index of glass = $3/2$. (A) [**1.2m**]
6. A small bulb is placed at the bottom of a tank containing water to a depth of 60 cm.
What is the area of the surface of water through which light from the bulb can emerge out?
Refractive index of water is 1.33. (Consider the bulb to be a point source.) (A) [**1.47m^2**]
7. A transparent cube of side 15 cm contains an air bubble in it. When viewed normally through one face, the bubble appears to be at 6 cm from the surface. When viewed normally through the opposite face the distance appears to be 4 cm. Find the actual distance of the bubble from the second face and the refractive index of the material of the cube. (A) [**6 cm , $n = 1.5$**]
8. Find the refractive index of the material of a prism of angle $59^\circ 42'$, if the angle of minimum deviation produced for a particular colour of light is $39^\circ 28'$. Also find angle of incidence. (A)
[**$n=1.53$ and $i = 49^\circ 35'$**]

9. Find the angle of minimum deviation produced by an equilateral prism of refractive index 1.55. Also find the angle of minimum deviation when the prism is completely immersed in water ($n=1.33$). (A)
 [$D_m=41^\circ 36'$ and $D_m'=11^\circ 16'$]
10. A ray light is incident on one face of an equilateral prism of glass of refractive index 1.55 at an angle of 40° . Calculate the angle of deviation produced by the prism. For what other angle of incidence, the deviation will be the same? (A)
 [$44^\circ 16'$]
11. A convex lens of focal length 0.24 m and of refractive index 1.5 is completely immersed in water of refractive index 1.33. Find the change in focal length of the lens (A)
 [0.70 m]
12. A convex lens of focal length 0.25 m is kept in contact with a concave lens of focal length 0.15m. Calculate the focal length and power of the combination.(A)
 [-0.375m and -2.667 diopter]
13. An image of height 2cm is formed by a convex lens when an object of height 8cm is placed at a distance of 80cm from it. Find the focal length and power of the lens. (A)
 [$f = 16\text{ cm}=0.16\text{m}$ and $P = 6.25\text{D}$]
14. A compound microscope has objective lens and eye-piece of focal lengths 5cm and 8 cm respectively. If an object is placed at a distance of 8 cm from the objective, then find the magnification produced by the microscope when the final image at near point. (A)
 [-6.88]
