Chapter- 9

Ray Optics and Optical Instrument

Very Short Answer Type Questions each carrying 1 mark :

01. A concave mirror is placed in water. Will there be any change in the focal length? Give reason.

02. When a ray of light travels from rarer to a denser medium the speed decreases. Does this decrease in speed imply a decrease in the energy carried by the light wave? Justify your answer.

03. If a ray of light propagates from rarer to a denser medium, how does its frequency change?

04. What is the critical angle for a material of refractive index $\sqrt{2}$?

05. The refractive index of diamond is much greater than that of glass. How does a diamond cutter make use of this fact?

06. What is the focal length of a plane mirror?

07. Which spherical mirror is called a divergent mirror?

08. Why are convex mirrors used as side-view mirrors in cars?

09. Write the mathematical value of the index of refraction?

10. What is the cause of refraction of lights?

11. Does the critical angle depend on the colour of light?

12. How does the speed of light in glass change on increasing the wavelength of light?

13. Under what condition does a biconvex lens of glass having a certain refractive index acts as a plane glass sheet when immersed in a liquid.

14. A convex lens of the glass of refractive index μ_L is immersed in a medium of refractive index μ_M . How will the lens behave when $\mu_L < \mu_M$?

15. A Convex lens is placed in a medium in which it behaves as an ordinary plate. What is the refractive index of the medium relative to the lens?

16. A lens of glass is immersed in water. What will be its effect on the power of the lens?

17. How does the focal length of a convex lens change if the monochromatic red light is used instead of monochromatic blue light?

18. How does the power of a lens vary, if the incident red light is replaced by violet light?

19. Refractive index of glass for a light of yellow, green and red colours are μ_y, μ_g, μ_r respectively. Rearrange these symbols in decreasing order of values.

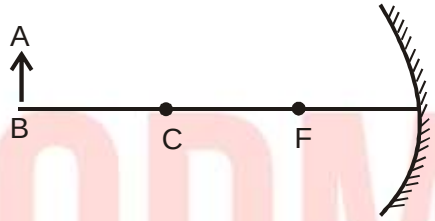
20. Why should the objective of a telescope have a larger focal length?

21. For the same value of angle of incidence, the angles of refraction in three media A, B and C are 15^0, 25^0 and 35^0 respectively. In which medium would the velocity of light be minimum?

Short Answer Type (2 Marks) Questions:

22. A concave mirror of small aperture forms a sharper image, why?

23. An object AB is kept in front of a concave mirror as shown in figure
(i) Complete the ray diagram showing the image formation of the object.
(ii) How will the position and intensity of the image be affected if the lower half of the mirror's reflecting surface is painted black?



24. What is total internal reflection? Under what condition does it take place?

25. (i) What is the relation between critical angle and refractive index of a material?
(ii) Does the critical angle depend on the colour of light? Explain.

26. What are optical fibres? Give their one use.

27. A biconvex lens has a focal length 2/3 times the radius of curvature of either surface. Calculate the refractive index of the lens material.

28. A magician during a show makes a glass lens $\mu = 1.5$ disappear in a trough of liquid. What is the refractive index of liquid? Is liquid water?

29. The image obtained with a convex lens is erect and its length is four times the length of the object. If the focal length of the lens is 20 cm. Calculate the object and image distances.

30. How does the angle of deviation vary with the angle of incidence in the case of a prism? What is the angle of minimum deviation?

31. What is a rainbow? What is the essential condition for observing it?

32. What is the effect of increasing the diameter of the objective of a telescope on it's (i) magnifying power, (ii) resolving power?

33. A ray of light, incident on an equilateral glass prism $\left(\mu g = \sqrt{3}\right)$ moves parallel to the baseline of the prism inside it. Find the angle of incidence for this ray.

34. A ray of light passing through an equilateral triangular prism from air undergoes minimum deviation when the angle of incidence is $3/4^{th}$ of the angle of prism. Calculate the speed of light in a prism.

35. Show by drawing ray diagrams, how a reflecting glass prism can be used to deviate a ray of light through (i) 90^0 (ii) 180^0

Long Answer Type I (3 Marks) Questions:

36. With the help of a suitable ray diagram, derive the mirror formula for a concave mirror.

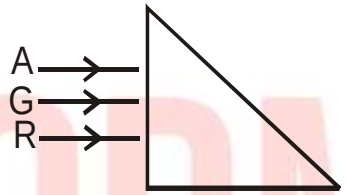
37. Use the mirror equation to show that

a) an object placed between f and 2f of a concave mirror produces a real image beyond 2f.

b) a convex mirror always produces a virtual image independent of the location of the object.

c) an object placed between the pole and focus of a concave mirror produces a virtual and enlarged image.

38. Three rays of light - red (R), green (G) and blue (B) - are incident on the face AB of a right-angled prism ABC. The refractive indices of the material of the prism for red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. Trace the path of the rays through the prism. How will the situation change, if these rays were incident normally on one of the paces of an equilateral prism?



39. Derive the expression for the angle of deviation for a ray of light passing through an equilateral prism of refracting angle 'λ'.

40. Explain why:

i) Does the bluish colour predominate in a clear sky?

ii) Sun appear reddish at sun-set or sun-rise?

iii) Blue light deviates more than red light by a prism?

41. Draw a graph to show the variation of angle of deviation 'D' with that of the angle of incidence 'i' for a monochromatic ray of light passing through a glass prism of refracting angle 'A'. Hence deduce relation $\mu = \dfrac{\sin\left(\dfrac{Dm + A}{2}\right)}{\sin A/2}$.

42. A converging lens has a focal length of 20 cm in air. It is made of material of refractive index 1.6. If it is immersed in a liquid of refractive index 1.3, what will be its new focal length?

43. A figure divided into squares each of size 1 mm^2 is being viewed at a distance of 9 cm through a magnifying glass of focal length 10 cm, held close to the eye.

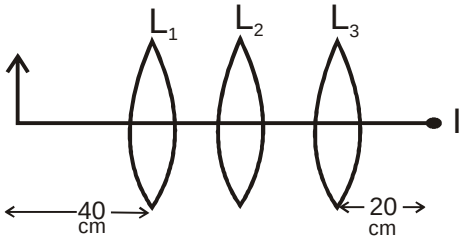
i) find the magnification produced by the lens. How much is the area of each square in the virtual image?

ii) What is the angular magnification (magnifying power) of the lens?

44. A concave lens made of a material of refractive index n_1 is kept in a medium of refractive index n_1 is kept in a medium of refractive index n_2. A parallel beam of light is incident on the lens. Complete the path of the rays of light emerging from the concave lens if

(i) $n_1 > n_2$ (ii) $n_1 = n_2$ (iii) $n_1 < n_2$

45. You are given three lens L_1, L_2, and L_3 each of focal length 20 cm. An object is kept at 40 cm in front of L_1 as shown. The final real image is formed at the focus 'I' of L_3. Find the separation between L_1, L_2 and L_3.



46. Draw a labelled ray diagram for a refracting type astronomical telescope. How will its magnifying power be affected on increasing for its eye place (i) the focal length and (ii) the aperture? Justify your answer.

47. Explain with reason, how the resolving power of an astronomical telescope will change when:
(i) frequency of the incident light on the objective lens is increased.
(ii) the focal length of the objective lens is increased and
(iii) the aperture of the objective lens is halved.

Long Answer Type II (5 marks) questions:

48. With the help of a ray diagram, show the formation of an image of a point object by the refraction of light at a spherical surface separating two media of refractive indices n_1 & n_2 ($n_2 > n_1$) respectively. Using this diagram, derive the relation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$.
Write the sign conventions used. What happens to the focal length of the convex lens when it is immersed in water?

50. Derive the lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, for a concave lens, using the necessary ray diagram.
Two lenses of powers 10D and -5D are placed in contact.
i) Calculate the power of the new lens.
ii) Where should an object be held from the lens, to obtain a virtual image of magnification 2?