Ray Optics and Optical Instruments

Assertion & Reason Type Questions

Directions: In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

b. Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

c. Assertion (A) is true but Reason (R) is false.

d. Both Assertion (A) and Reason (R) are false.

Q1. Assertion (A): The centre of curvature is not a part of the mirror. It lies outside its reflecting surface.

Reason (R): The reflecting surface of a spherical mirror forms a part of a sphere. This sphere has a centre.

Answer : (a) Both A and R are true and R is the correct explanation of A.

Q2. Assertion (A): The air bubble shines in water.

Reason (R): Air bubble in water shines due to refraction of light.

Answer : (c) Shining of air bubble in water is on account of total internal reflection.

Q3. Assertion (A): The images formed by total internal reflections are much brighter than those formed by mirrors or lenses.

Reason (R): There is no loss of intensity in total internal reflection.

Answer : (a) In total internal reflection, 100% of incident light is reflected back into the same medium and there is no loss of intensity, while in reflection from mirrors and refraction from lenses, there is always some loss of intensity. Therefore, images formed by total internal reflection are much brighter than those formed by mirrors or lenses.

Q4. Assertion (A): Propagation of light through an optical fibre is due to total internal reflection taking place at the core-cladding interface.

Reason (R): Refractive index of the material of the cladding of the optical fibre is greater than that of the core. **(CBSE SQP 2023-24)**

Answer : (c) Assertion (A) is true but Reason (R) is false.

Q5. Assertion (A): A convex lens of glass (μ_g = 1.5) behave as a diverging lens when immersed in carbon disulphide of higher refractive index (μ_e = 1.65).

Reason (R): A diverging lens is thinner in the middle and thicker at the edges.

Answer :

(b) Refractive index, $\mu = \frac{\mu_g}{\mu_c} = \frac{1.5}{1.65} < 1$

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

$\therefore$ f becomes negative and the lens behaves as a diverging lens.

Q6. Assertion (A): Combination of lenses helps to obtain diverging or converging lenses of desired magnification.

Reason (R): It enhances sharpness of the image.

Answer : (b) Combination of lenses helps to obtain desired magnification. It also enhances the sharpness of the image. Since the image formed by the first lens becomes the object for the second, the total magnification of the combination is a product of magnification of individual lenses.

Q7. Assertion (A): The focal length of an equiconvex lens placed in air is equal to radius of curvature of either face.

Reason (R): For an equiconvex lens radius of curvature of both the faces is same.

Answer :

(b) For an equiconvex lens, $R_1 = R_2 = R$

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

for lens, $\mu = 1.5$ placed in air,

$$\frac{1}{f} = (1.5 - 1)\frac{2}{R} \Rightarrow f = R.$$

Q8. Assertion (A): The minimum distance between an object and its real image formed by a convex lens is $2f$.

Reason (R): The distance between an object and its real image is minimum when its magnification is two.

Answer : (d) The distance between the object and its real image is minimum when its magnification is 1. We know that the magnification of convex lens is given by (m) = v/u for m = 1, v = u.

Now from lens formula, v = u = 2f

hence, minimum distance v + u = 4f

Q9. Assertion (A): A double convex lens (∞ = 1.5) has focal length 10 cm. When the lens is immersed in water (∞ = 4/3) its focal length becomes 40 cm.

Reason (R): $\frac{1}{f}=\frac{\mu_1-\mu_m}{\mu_m}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

Answer : (a) Focal length of lens immersed in water is four times the focal length of lens in air. It means $f_w = 4f_a = 4 \times 10 = 40$ cm.

Q10. Assertion (A): Angle of deviation depends on the angle of prism.

Reason (R): For thin prism, $\delta = (\mu - 1)A$.

Answer :

(a) For a thin prism, the relation between angle of deviation δ, angle of prism A and refractive index μ is $\delta = (\mu - 1)A$.

Q11. Assertion (A): Microscope magnifies the image.

Reason (R): Angular magnification for image is more than object in microscope.

Answer : (a) Microscope is an optical instrument which forms a magnified image of a small nearby object and thus, increases the visual angle subtended by the image at the eye so that the object is seen to be bigger and distinct. Therefore, angular magnification for image is more than object.

Q12. Assertion: Plane mirror may form real image.

Reason: Plane mirror forms virtual image, if object is real.

Q13. Assertion: The focal length of the convex mirror will increase, if the mirror is placed in water.

Reason: The focal length of a convex mirror of radius R is equal to , f = R/2.

Q14. Assertion: The image formed by a concave mirror is certainly real if the object is virtual.

Reason: The image formed by a concave mirror is certainly virtual if the object is real.

Q15. Assertion: The image of an extended object placed perpendicular to the principal axis of a mirror, will be erect if the object is real but the image is virtual.

Reason: The image of an extended object, placed perpendicular to the principal axis of a mirror, will be erect if the object is virtual but the image is real.

Q16. Assertion: An object is placed at a distance off from a convex mirror of focal length f its image will form at infinity.

Reason: The distance of image in convex mirror can never be infinity

Q17. Assertion: The image of a point object situated at the centre of hemispherical lens is also at the centre.

Reason: For hemisphere Snell's law is not valid.

Q18. Assertion: The focal length of an equiconvex lens of radius of curvature R made of material of refractive index $\mu = 1.5$, is R.

Reason: The focal length of the lens will be R/2.

Q19. Assertion: If the rays are diverging after emerging from a lens; the lens must be concave.

Reason: The convex lens can give diverging rays.

Q20. Assertion: The resolving power of a telescope is more if the diameter of the objective lens is more.

Reason: Objective lens of large diameter collects more light.

Q21. Assertion: The optical instruments are used to increase the size of the image of the object.

Reason: The optical instruments are used to increase the visual angle.

ANSWER KEY 12 to 21

Q12 : (b)

Q13 : (d) Focal length of the spherical mirror does not depend on the medium in which it placed.

Q14 : (c) The image of real object may be real in case of concave mirror.

Q15 : (b) **Q16 :** (d)

Q17 : (c) The rays from centre of hemisphere cut at the centre after refraction – Snell's law is valid in each case of refraction.

Q18 : (c)

Q19 : (d) If the rays cross focal point of convex lens, they become diverging.

Q20 : (a) RP α diameter of objective.

Q21 : (d)