

CLASS 12

PHYSICS

EXTRA QUESTIONS

## Class 12 Physics Chapter 9 Ray Optics and Optical Instruments – Extra Questions with Answers

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These extra practice questions for Class 12 Physics Chapter 9 – Ray Optics and Optical Instruments go beyond the NCERT textbook exercises to reinforce mirror/lens sign conventions, refraction, total internal reflection, and optical-instrument formulas. Useful for board exam revision and quick concept checks.

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### Very Short Answer Type Questions (1 Mark)

**Q1. Why does a convex mirror always form a virtual, erect, and diminished image, no matter where the object is placed?**

Ans: For a convex mirror, the image always forms behind the mirror because the reflected rays diverge and only appear to meet at a virtual point behind it. Since the focal length is on the far side of the mirror, the image distance calculated from the mirror formula always comes out positive (behind the mirror) and smaller in magnitude than the object distance, so the image is always virtual, erect, and smaller than the object, for every possible object position.

**Q2. What is the power of a lens, and what is its SI unit?**

Ans: Power of a lens is a measure of how strongly it converges or diverges light, defined as the reciprocal of its focal length in metres ( $P = 1/f$ ). Its SI unit is the dioptre (D), where  $1\text{ D} = 1\text{ m}^{-1}$ . A converging (convex) lens has positive power, while a diverging (concave) lens has negative power.

**Q3. State the condition for total internal reflection to occur.**

Ans: Total internal reflection occurs when light travels from an optically denser medium to a rarer medium and the angle of incidence in the denser medium exceeds the critical angle for that pair of media — at that point, no light is refracted out and all of it is reflected back into the denser medium.

**Q4. Why do stars twinkle but planets do not?**

Ans: Stars are point sources that are extremely far away, so their light undergoes continuous refraction through Earth's turbulent, density-varying atmosphere, causing rapid, random fluctuations in apparent brightness — this is twinkling. Planets are much closer and appear as a collection of many point sources (a small disc), so the individual fluctuations from different points average out, and the net brightness stays nearly constant.

**Q5. What is meant by the “resolving power” of an optical instrument?**

Ans: Resolving power is the ability of an optical instrument to distinguish between two closely spaced objects (or two close points on an object) as separate, rather than as a single blurred point. For microscopes it depends on the wavelength of light and the numerical aperture of the objective; for telescopes it depends on the wavelength and the diameter of the objective aperture — a larger aperture gives better (higher) resolving power.

### Short Answer Type Questions (2–3 Marks)

**Q6. Derive the relation between critical angle and refractive index for a medium with respect to air.**

Ans: At the critical angle  $C$ , the angle of refraction is  $90^\circ$ . Applying Snell's law at the denser-to-rarer interface:  $n \sin C = 1 \times \sin 90^\circ = 1$ , so  $\sin C = 1/n$ , giving  $C = \sin^{-1}(1/n)$ , where  $n$  is the refractive index of the denser medium with respect to air. A higher refractive index gives a smaller critical angle, meaning total internal reflection occurs more easily.

**Q7. A compound microscope has an objective of focal length 1cm and an eyepiece of focal length 5cm, separated by 20cm. If the final image forms at the near point (25cm), explain qualitatively how the tube length and eyepiece focal length affect the magnifying power.**

Ans: The magnifying power of a compound microscope is  $M = m_o \times m_e$ , where  $m_o$  (objective magnification)

increases roughly with the tube length (the separation between the lenses, since a longer tube length lets the objective produce a larger real image before the eyepiece), and  $m_e = 1 + D/f_e$  (eyepiece magnification, for image at near point) increases as the eyepiece focal length  $f_e$  decreases. So a longer tube length and a shorter-focal-length eyepiece both increase overall magnifying power, though practical aberration limits restrict how far this can be pushed.

**Q8. Why is the objective lens of an astronomical telescope made with as large a diameter (aperture) as possible?**

Ans: A larger aperture collects more light from a distant, faint astronomical object, producing a brighter image — important since stars and galaxies are extremely dim point sources. A larger aperture also improves the telescope's resolving power (its ability to distinguish two close objects, such as a binary star system, as separate), since resolving power is directly proportional to aperture diameter.

### Higher Order Thinking Skills (HOTS)

**Q9. A biconvex lens made of glass (refractive index 1.5) has both faces of radius of curvature 20cm. If this lens is now placed in a liquid of refractive index 1.33, will its focal length increase, decrease, or become negative? Explain using the lens-maker's formula, without calculating the exact value.**

Ans: The lens-maker's formula is  $1/f = (n_{\text{lens}}/n_{\text{medium}} - 1)(1/R_1 - 1/R_2)$ . In air,  $n_{\text{lens}}/n_{\text{medium}} = 1.5/1 = 1.5$ , giving a relatively large  $(n-1)$  factor and hence a short focal length. In the liquid,  $n_{\text{lens}}/n_{\text{medium}} = 1.5/1.33 \approx 1.128$ , a much smaller  $(n-1)$  factor of about 0.128 compared to 0.5 in air. Since  $1/f$  is directly proportional to this factor,  $f$  becomes larger — the lens still converges light (remains a converging lens, since  $n_{\text{lens}} > n_{\text{liquid}}$ ), but its focal length increases substantially (the lens becomes “weaker”) when immersed in the liquid, compared to when it is in air.

**Q10. Two thin lenses of focal lengths  $f_1$  and  $f_2$  are placed in contact. Show that the power of the combination is the sum of the individual powers, and explain why this makes power a more convenient quantity than focal length when combining lenses.**

Ans: For two thin lenses in contact, the combined focal length  $F$  satisfies  $1/F = 1/f_1 + 1/f_2$  (derived by applying the lens formula twice in succession, treating the image of the first lens as the object for the second, with both lenses sharing the same optical centre since they are in contact). Since power  $P = 1/f$  (with  $f$  in metres), this relation directly becomes  $P = P_1 + P_2$ . This makes power more convenient than focal length for lens combinations because powers simply add algebraically (accounting for sign, converging positive and diverging negative), whereas focal lengths must be combined through a reciprocal relation — power also scales linearly with correcting lens strength, which is why optometrists prescribe corrective lenses in dioptres rather than focal length.

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