



Attempt all questions before checking the answer key. Use the Cartesian sign convention. Take least distance of distinct vision $D = 25$ cm.

A. Very short answers - 1 mark each

1. Define refractive index and relate it to speed of light.
2. State the two conditions for total internal reflection.
3. What is the power of a converging lens of focal length 25 cm?
4. Why is a convex mirror useful as a rear-view mirror?
5. What is meant by normal adjustment of an astronomical telescope?

B. Short answers / practice - 2 marks each

6. A concave mirror of focal length 15 cm has an object 30 cm in front of it. Find image position and magnification.
7. Find the critical angle for glass of refractive index $\sqrt{2}$ relative to air.
8. An object is 30 cm in front of a convex lens of focal length 20 cm. Find image position and magnification.
9. Lenses of powers +5 D and -2 D are in contact. Find equivalent power, focal length and nature.
10. Explain the working principle of an optical fibre with a labelled ray sketch.
11. Can a convex lens form a virtual image?
12. Find refractive index if light speed is 2×10^8 m/s in a medium.
13. Find power of a concave lens of focal length 50 cm.
14. What happens to focal length when a lens is cut into two parts along its principal axis?
15. Explain the difference between real and virtual images.
16. A telescope has $f_o = 80$ cm and $f_e = 4$ cm. Find normal magnifying power.
17. Can total internal reflection occur from air to glass?
18. A plane mirror is moved 2 cm towards a fixed object. How far does its image move?
19. Find critical angle when refractive index relative to air is 2.
20. Draw a simple microscope ray diagram with the final image at the near point.

C. Short answers - 3 marks each

21. A glass slab of thickness 12 cm and refractive index 1.5 is viewed normally from air. Find apparent thickness and upward shift of its bottom surface.

22. An equiconvex lens has radii of curvature 20 cm and refractive index 1.5 in air. Find focal length. Predict what happens when immersed in a liquid of the same refractive index.

23. A convex lens of focal length 15 cm and a concave lens of focal length 30 cm are in contact. Find the final image for an object 30 cm from the combination.

24. A prism has angle 60° and minimum deviation 40° . Write its refractive index as a trigonometric expression and describe the symmetric ray path.

25. A telescope has objective focal length 100 cm and eyepiece focal length 5 cm. Find its normal-adjustment magnifying power and length; explain the inverted image.

D. Long answers - 5 marks each

26. Derive the relation $\mu = \sin[(A + \delta_m)/2] / \sin(A/2)$ for a prism at minimum deviation. Draw the ray diagram and the deviation-versus-incidence graph.

27. Explain a compound microscope using a labelled ray diagram. Obtain magnifying power for the final image at infinity and at the near point, stating the usual approximations.

28. Explain a refracting astronomical telescope in normal adjustment and derive its magnifying power and length. Describe two advantages of a reflecting telescope.

29. Derive the refraction formula for a spherical surface and use it to obtain the lens-maker's formula for a thin lens in air, with sign conventions stated.

30. Derive the thin-lens formula and explain linear magnification. A 2 cm object is 20 cm before a convex lens of focal length 12 cm; find image position, size and nature.

ANSWER KEY - Numerical / short answers

3) +4 D. 6) $v = -30$ cm; $m = -1$. 7) 45° . 8) $v = +60$ cm; $m = -2$. 9) +3 D; $+1/3$ m; converging. 11) Yes, when the object lies between lens and focus. 12) 1.5. 13) -2 D. 14) Each part has the same focal length as the original thin lens. 16) -20; magnitude 20. 17) No. 18) 4 cm towards the object. 19) 30° . 21) 8 cm; upward shift 4 cm. 22) 20 cm; matched liquid: zero power, infinite focal length. 23) Equivalent $f = +30$ cm; final image at infinity. 24) $\sin 50^\circ / \sin 30^\circ \approx 1.532$; $i = e = 50^\circ$, $r_1 = r_2 = 30^\circ$. 25) $m = -20$; length 105 cm. 30) $v = +30$ cm; image height = -3 cm; real, inverted, enlarged.