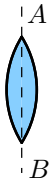
Practice Problems
(Geometrical Optics)

1. A convex glass lens (refractive index = 3/2) has a focal length of 8 cm when placed in air. What is the focal length of the lens when it is immersed in water (refractive index = 4/3)?

2. The equi-convex lens, as shown below, has a focal length f. What will be the focal length of each half, if it is cut along AB?



3. A planoconvex lens is made of glass of refractive index 3/2. The focal length f of the lens and radius of curvature R of its curved face are related as

(A) $f = R/2$ (B) $f = R$

(C) $f = 2R$ (D) $f = 3R/2$

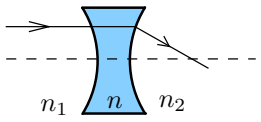
4. The least distance between a real object and its real image is 72 cm for a plano-convex lens. When the lens is placed at a distance 6 am from a real object, the plane surface being nearer to it, a virtual image is obtained at the center of curvature of the curved surface. The refractive index of the lens is equal to

(A) 2 (B) $\sqrt{3}$ (C) $\sqrt{2}$ (D) 1.5

5. A thin convergent glass lens (refractive index = 3/2) has a power of +5.0 D. When this lens is immersed in a liquid, it acts as a divergent lens of focal length 100 cm. Then the refractive index of the liquid is

(A) $\frac{4}{3}$ (B) $\frac{5}{3}$ (C) $\frac{5}{4}$ (D) $\frac{6}{5}$

6. What should be the relation between the refractive indices n, n_1, and n_2, if the light behaves as shown below?



(A) $n > n_2 > n_1$ (B) $n < n_2 < n_1$

(C) $n < n_2$; $n = n_1$ (D) $n_2 < n_1$

7. A convex lens is placed between an object and a screen which are fixed, some distance apart. For one position of the lens the magnification of the sharp image obtained on the screen is m_1. When the lens is moved a distance d (still remaining between the object and screen), the magnification of the image obtained on the screen is $m_2 (< m_1)$. Then the focal length of the lens is

(A) $\dfrac{d}{m_1 - m_2}$ (B) $\dfrac{d}{m_1 + m_2}$

(C) $d\dfrac{m_1}{m_2}$ (D) $d\dfrac{m_2}{m_1}$

8. A planoconvex lens acts like a concave mirror of 28 cm focal length when its plane surface is silvered and like a concave mirror of focal length 10 cm when its curved surface is silvered. What is the refractive index of the material of the lens?

9. The distance between an object and its real image formed by a convex lens is d. If the magnification be m (in magnitude), determine the focal length of the lens.

10. Two converging lenses of focal lengths f_1 and f_2 are separated coaxially by a distance d. The power of the combination will be zero, if d equals

(A) $(f_1 + f_2)/2$ (B) $|f_1 - f_2|/2$

(C) $f_1 + f_2$ (D) $\sqrt{f_1 f_2}$

11. A converging lens is used to form an image on a screen. When the upper half of the lens is covered by an opaque screen,

(A) half the image will disappear

(B) complete image will be formed

(C) intensity of the image will increase

(D) none of the above

12. A concave mirror is placed on a horizontal table, with its axis directed vertically upwards. Let O be the pole of the mirror and C its center of curvature. A point object is placed at C has a real image also located at C. If the mirror is now filled with water, the image will be

(A) real and remain at C

(B) real and located a point above C

(C) virtual and located between O and C

(D) real and located between O and C

13. The sun (diameter D) subtends an angle $\theta(\ll 1)$ at the pole of a concave mirror of focal length f. The diameter of the image of the sun formed by the mirror is

(A) $f\theta$ (B) $2f\theta$ (C) $\frac{f^2\theta}{D}$ (D) $D\theta$

14. Check out for the wrong one(s) for real objects

(A) A concave mirror can give a diminished virtual image

(B) A concave mirror can give a virtual image

(C) A convex mirror can give a diminished virtual image

(D) A convex mirror can give a real image

15. An object is placed in front of a convex mirror at a distance of 50 cm. A plane mirror is introduced covering the lower half of the convex mirror. If the distance between the object and the plane mirror is 30 cm, there is no parallax between the images formed by the two mirrors. The radius of curvature of the convex mirror in cm is

(A) 60 (B) 50 (C) 30 (D) 25

16. An object is placed at a distance $2f$ from the pole of a curved mirror of focal length f.

(A) The linear magnification is 1 for both types of curved mirror

(B) The linear magnification is 1 for a concave mirror

(C) The linear magnification is 1/3 for a convex mirror

(D) Data insufficient

17. Which of the following form(s) the virtual and erect image for all positions of real object?

(A) concave mirror (B) convex lens

(C) convex mirror (D) concave lens

18. A real image I is formed by a converging lens L on its optic axis. On introduction of a rectangular glass slab of thickness d and refractive index μ between the image and lens the image displaces it by

(A) $d(\mu-1)$ away from L

(C) $d(\mu-1)$ towards L

(B) $d\left(1-\frac{1}{\mu}\right)$ away from L

(D) $d\left(1-\frac{1}{\mu}\right)$ towards L

19. If f_B and f_R are the focal lengths of convex lens for blue and red lights respectively and F_B and F_R are the respective values for concave lens, then

(A) $F_B > F_R$ and $f_B > f_R$

(C) $F_B < F_R$ and $f_B > f_R$

(B) $F_B > F_R$ and $f_B < f_R$

(D) $F_B < F_R$ and $f_B < f_R$

20. The plane faces of two identical plano-convex lenses, each with focal length f are pressed against each other using optical glue to form a usual convex lens. The distance from the optical center at which an object must be placed to obtain the image same as the size of the object is

(A) $\frac{f}{4}$ (B) $\frac{f}{2}$ (C) f (D) $2f$

21. A parallel beam of light incident on a concave lens of focal length 10 cm emerges as a parallel beam from a convex lens placed coaxially, the separation between the lenses being 10 cm. The focal length of the convex lens (in cm) is

(A) 10 (B) 20 (C) 15 (D) 30

22. A short linear object of length b lies along the axis of a concave mirror of focal length f, at a distance u from the mirror. The size of image approximately is

(A) $b\sqrt{\frac{u-f}{f}}$ (B) $b\left(\frac{f}{u-f}\right)$

(C) $b\left(\frac{u-f}{f}\right)$ (D) $b\left(\frac{f}{u-f}\right)^2$

23. A transparent sphere of radius R made of material of refractive index 3/2 is kept in air. The distance from the center of the sphere must a point object be placed so as to form a real image at the same distance from the sphere is

(A) R (B) $2R$ (C) $3R$ (D) $4R$

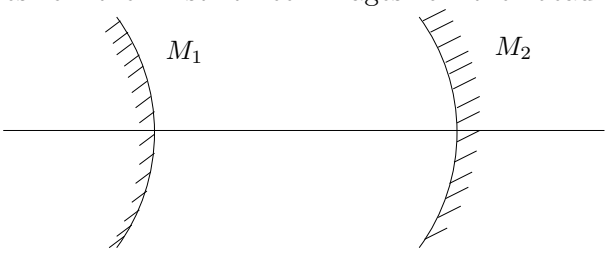
24. An object is placed at a distance of 12 cm from a convex lens on its principal axis and a virtual image of certain size is formed. On moving the object 8 cm away from the lens, a real image of the same size as that of virtual image is formed. The focal length of the lens in cm is

(A) 15 (B) 16 (C) 17 (D) 18

25. A boy of height $1m$ stands in front of a convex mirror at the focus of the mirror. The image of boy will have a height of

(A) 2/3 m (B) 1/3 m (C) 1/4 m (D) 1/2 m

26. Two spherical mirrors M_1 and M_2, one convex and other concave having same radius of curvature R are arranged co-axially at a distance $2R$ (consider their pole separation to be $2R$). A bead of radius a is placed at the pole of the convex mirror as shown. The ratio of the sizes of the first three images of the bead is



(A) 1:2:3 (B) $1 : \frac{1}{2} : \frac{1}{3}$

(C) $\frac{1}{3} : \frac{1}{11} : \frac{1}{41}$ (D) 3:11:41

27. A point object is placed at a distance of 0.3 m from a convex lens of focal length 0.2 m cut into two halves, each of which is displaced by 0.0005 m, as shown in figure. If C_1 and C_2 be their optical centers then,

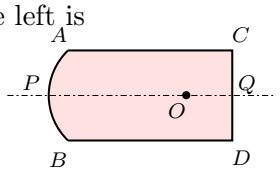
(A) an image is formed at a distance of 0.6 m from C_1 or C_2 along principal axis

(B) two images are formed, one at a distance of 0.6 m and other 1.2 m from C_1 or C_2 along principal axis

(C) an image is formed at a distance of 0.12 m from C_1 or C_2 along principal axis

(D) two images are formed at a distance of 0.6 m from C_1 or C_2 along principal axis

28. The slab of a material of refractive index 2 shown in figure has a curved surface APB of radius of curvature 10 cm and a plane surface CD. On the left APB is air and on the right of CD is water with refractive indices as given in figure. An object O is placed at a distance of 15 cm from pole as shown. The distance (in cm) of the final image of O from P, as viewed from the left is



(A) 20 (B) 30 (C) 40 (D) 50

29. A thin rod of length $1/3f$ is placed along the optic axis of a concave mirror of focal length f such that its image which is real and elongated just touches the rod. The magnification is

(A) 4/3 (B) 5/3 (C) 3/2 (D) NOT

30. A concave mirror is placed on horizontal table, with its axis directed vertically upwards. Let O be the pole of the mirror and C its center of curvature. A pint object is placed at C. It has a real image, also located at C. If the mirror is now filled with water, the image will be

(A) real an will remain at C

(B) real and located between C and ∞

(C) virtual and located at a point between C and O

(D) real and located at a point between C and O

31. A spherical surface of radius of curvature R separates air from glass (RI=1.5). The center of curvature is in the glass. A point object P placed in air is found to have a real image Q in the glass. The line PQ cuts the surface at the point O and PO=OQ. The distance PO is equal to

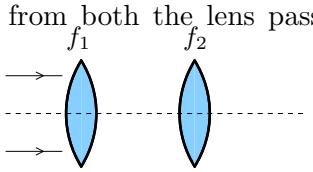
(A) $5R$ (B) $3R$ (C) $2R$ (D) $1.5R$

32. A plano convex fits exactly into a plano concave lens. Their plane surfaces are parallel to each other. If the lenses are made of different materials of refractive indices μ_1 and μ_2 and R is the radius of curvature of the curved surface of the lenses, the focal length of the combination is

(A) $\frac{R}{\mu_1-\mu_2}$ (B) $\frac{R}{2(\mu_1-\mu_2)}$

(C) $\frac{2R}{\mu_1-\mu_2}$ (D) $\frac{R}{2-(\mu_1+\mu_2)}$

33. Parallel beam of light is incident on the system of two convex lenses of focal length $f_1 = 20$ cm and $f_2 = 10$ cm. What should be the distance (in cm) between the two lenses so that the rays after refraction from both the lens pass undeviated?



(A) 60 (B) 30 (C) 90 (D) 40

34. Optic axis of a thin equiconvex lens is the $x-$axis. The co-ordinates of a point object and its image are (-40cm, 1cm) and (50cm, -2cm) respectively. Lens is located at

(A) $x = +20$ cm (B) $x = -10$ cm

(C) $x = -30$ cm (D) origin

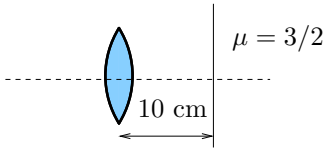
35. The magnification of an object placed in front of a convex lens of focal length 20 cm is +2. To obtain a magnification of -2, the object will has to be moved a distance(in cm) equal to

(A) 10 (B) 20 (C) 30 (D) 40

36. A plano convex glass lens ($\mu = 3/2$) of radius of curvature $R = 10$ cm is placed at a distance of b from a concave lens of focal length 20 cm. What should be the distance a(in cm) of a point object O from the plano convex lens so that the position of the final image is independent of b

(A) 40 (B) 60 (C) 30 (D) 20

37. Focal length of a thin convex lens is 30 cm. At a distance of 10 cm from the lens there is a plane refracting surface of refractive index 3/2. Where will the parallel rays incident on lens converge?



(A) At a distance of 27.5 cm from the lens

(B) At a distance of 25 cm from the lens

(C) At a distance of 45 cm from the lens

(D) At a distance of 40 cm from the lens

38. Distance of an object from the first focus of an equiconvex lens is 10 cm and the distance of its real image from second focus is 40 cm. The focal length (in cm) of the lens is

(A) 25 (B) 10 (C) 20 (D) 40

39. A point object is placed at a distance of 25 cm from a convex lens of focal length 20 cm. If a glass slab of thickness t and $\mu = 1.5$ is inserted between the lens and the object the image is formed at infinity. The thickness t (in cm) is

(A) 10 (B) 5 (C) 20 (D) 15

40. A convex lens of focal length 10 cm is painted black at the middle portion as shown in figure. An object is placed at a distance of 20 cm from the lens. Then

(A) only one image will be formed by the lens

(B) the distance between the two images formed by such a lens is 6 mm

(C) the distance between the images is 4 mm

(D) the distance between the images is 2 mm

41. A point object is placed on the optic axis of a convex lens of focal length f at a distance of $2f$ to the left of it. The diameter of the lens is d. An eye is placed at a distance of $3f$ to the right of the lens and a distance h below the optic axis. The maximum value of h to see the image is

(A) d (B) $d/2$ (C) $d/3$ (D) $d/4$

42. A point object O is placed at a distance of 20 cm from a convex lens of focal length 10 cm as shown in figure. At what distance x from the lens should a concave mirror of focal length 60 cm, be placed so that final image coincides with the object

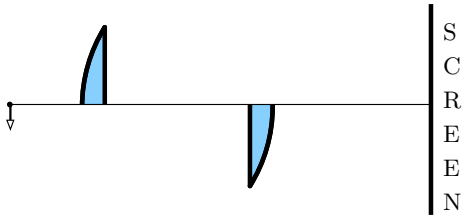
(A) 10 cm

(B) 40 cm

(C) 20 cm

(D) final image can never coincide with the object in the given conditions

43. A thin planoconvex lens of focal length f is split into two equal halves. One of the halves is shifted along the optical axis as shown.



The separation between the object and the screen is 1.8 m and the magnification of the image formed by one of the half lens is 2. Determine f and the separation d between the two halves.

44. A planoconvex lens has thickness 4 cm. When placed on a horizontal table with the curved face in contact with it, the apparent depth of the bottom-most point of the lens is found to be 3 cm. If the lens is inverted such that the plane face is in contact with the table, the apparent depth of the center of the plane face of the lens is found to be 25/8 cm. Determine the focal length of the lens.

45. The convex surface of a thin concavo- convex lens of glass of refractive index 1.5 has a radius of curvature 20 cm. The concave surface has a radius of curvature 60 cm. The convex side is silvered and placed on a horizontal surface.

(i) Where should a pin be placed on the axis such that its image is formed at the same place?

(ii) If the concave part is filled with water ($\mu_w = 4/3$, find the distance through which the pin should be moved so that the image of the pin again coincides with the pin.

46. A thin equi convex lens (radius of curvature of either face is 33 cm) is placed on a horizontal plane mirror and a pin held 20 cm vertically above the lens coincides in position with its own image. The space between the lower surface of the lens and the mirror is filled with a liquid and then, to coincide with the image as before, the pin has to be raised a distance of 25 cm from the lens. Find the refractive index of the liquid.

47. An object is placed 40 cm in front of the curved surface off a thin plano convex lens whose plane surface is silvered. Due to refraction at the curved surface and reflection at the silvered surface, the real image of the object is 60 cm from the lens on the same side as the object. Find the focal length of the lens.

48. A pin is placed 10 cm in front of a convex lens of focal length 20 cm and made of a material of refractive index 1.5. The surface of the lens farther away from the pin is silvered and has a radius of curvature of 22 cm. Determine the nature and position of the final image.

49. The radius of curvature of convex face of a plano convex lens is 12 cm and its $\mu = 1.5$

(i) Find the focal length of the lens

The plane side is now silvered

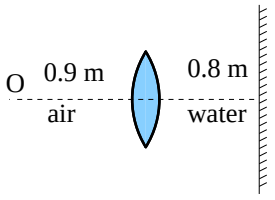
(ii) At what distance from the lens will parallel rays incident on the convex surface converge?

(iii) Sketch the ray diagram to locate the image, when a point object is placed on the axis 20 cm from the lens.

(iv) calculate the image distance when the object is placed as in (iii).

50. A parallel beam of light travelling in water (refractive index=4/3) is refracted by a spherical air bubble of radius 2 mm situated in water. Assuming the light rays to be paraxial, (a) find the position of the image due to refraction at the first surface and the position of the final image and (b) draw a ray diagram showing the position of both the images.

51. A thin equi convex lens made of glass of refractive index $\mu = 3/2$ and of focal length 0.3 m in air is sealed into an opening at one end of a tank filled with water ($\mu = 4/3$). On the opposite side of the lens a mirror is placed inside the tank on the tank wall perpendicular to the lens axis as shown in figure. The separation between the lens and the mirror is 0.8 m. A small object O is placed outside the tank in front of the lens at a distance of 0.9 m from the lens on its axis. Find the position of the image (relative to the lens) of the image of the object formed by the system.



52. A convex lens of focal length 15 cm and a concave mirror of focal length 30 cm are kept with their optical axes PQ and RS parallel but separated in vertical direction by 0.6 cm as shown in figure. The distance between the lens and the mirror is 30 cm. An upright object AB of height 1.2 cm is placed on the optic axis PQ of the lens and reflection from the mirror, find the distance of A'B' from the pole of the mirror and obtain its magnification its magnification. Also locate position of A' and B' with respect to the optic axis RS.

53. A converging lens of focal length 15 cm and a converging mirror of focal length 10 cm are placed 50 cm apart. If a pin of length 2 cm is placed 30 cm from the lens farther away from the mirror, where will the final image form and what will be the size of the final image.

54. A point object is placed on the principal axis of a convex lens ($f = 15$ cm) at a distance of 30 cm from it. A glass plate ($\mu = 1.5$) of thickness 1 cm is placed on the other side of the lens perpendicular to the axis. Locate the image of the point object.

55. A convex lens of focal length 20 cm and a concave lens of focal length 10 cm are placed 10 am apart with heir principal axes coinciding. A beam of light travelling parallel to the principal axis having a beam diameter 5 mm, is incident on the combination. Show that the emergent beam is parallel to the incident incident one. Find the beam diameter of the emergent beam.

56. A diverging lens of focal length 20 cm and a converging lens of focal length 30 cm are placed 15 cm apart with their principal axes coinciding. Where should an object be placed on the principal axis so that its image is formed at infinity?

57. A 5 mm high pin is placed at a distance of 15 cm from a convex lens of focal length 5 cm is placed 40 am from the first lens and 55 cm from the pin. Find (a) the position of the final image (b) its nature and (c) its size.

58. A beam of light is incident on a thin equi convex lens, which is made up of two transparent materials. The upper part has refractive index μ and the lower part has refractive index 2μ. If $\mu = 1.5$ then what is the distance between the two images formed on the optical axis?