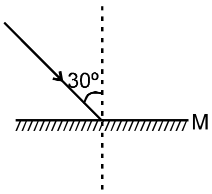
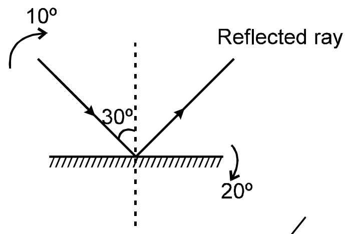
EXERCISE-1

SECTION (A) : PLANE MIRROR

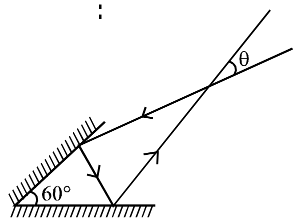
A 1. Find the angle of deviation (both clockwise and anticlockwise) suffered by a ray incident on a plane mirror, at an angle of incidence 30º.



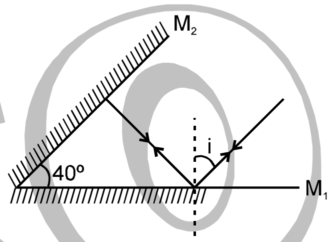
A 2. Figure shows a plane mirror onto which a light ray is incident. If the incident light ray is turned by 10º and the mirror by 20º, as shown, find the angle turned by the reflected ray.



A 3. A light ray is incident on a plane mirror, which after getting reflected strikes another plane mirror, as shown in figure. The angle between the two mirrors is 60º. Find the angle 'θ' shown in figure.



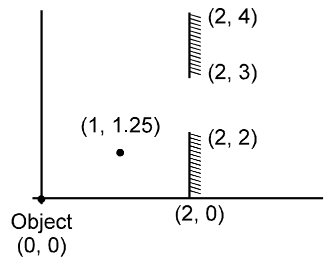
A 4. There are two plane mirror inclined at 40º, as shown. A ray of light is incident of mirror M_1. What should be the value of angle of incidence 'i' so that the light ray retraces its path after striking the mirror M_2.



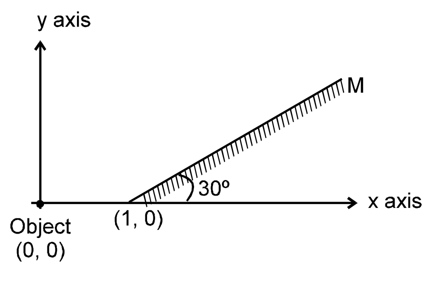
A 5. Sun rays are incident at an angle of 24° to the horizon. How can they be directed parallel to the horizon using a plane mirror?

A 6. A parallel beam propagates horizontally from a projector. How should a plane mirror be arranged so that the image of a slide is formed on the ceiling?

A 7. Two plane mirrors are placed as shown in the figure
(a) How many images will be formed.
(b) Find the position(s) of image(s).
(c) Will the ray passing through (1, 1.25) take part in image formation.



A 8. An object is placed at (0, 0) and a plane mirror is placed, inclined 30º with the x axis.
(a) Find the position of image.
(b) If the object starts moving with velocity 1 $\hat{i}$ m/s and the mirror is fixed find the velocity of image.



A 9. A point object is placed at (0, 0, 0) and a plane mirror is placed parallel to YZ plane at x = 2. Find the coordinate of image

SECTION (B) : SPHERICAL MIRROR

B 1. A rod of length 10 cm lies along the principal axis of a concave mirror of focal length 10 cm in such a way that the end farther from the pole is 20 cm away from it. Find the length of the image.

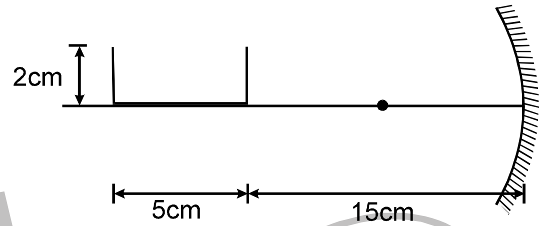
B 2. A point source is at a distance 35 cm on the optical axis from a spherical concave mirror having a focal length 25 cm. At what distance along the optical axis from the concave mirror should a plane mirror be placed (perpendicular to the principal axis) for the image it forms (due to rays falling on it after reflection from the concave mirror) to coincide with the point source?

B 3. A concave spherical mirror forms a threefold magnified real image of a real object. The distance from the object to the image is 2.6 m. What is the radius of curvature of the mirror?

B 4. Find the diameter of the image of the moon formed by a spherical concave mirror of focal length 11.4 m. The diameter of the moon in 3450 km and the distance between the earth and the moon is 3.8×10^5 km.

B 5. A candle flame 1 cm high is imaged in a ball bearing of diameter 0.4 cm. If the ball bearing is 20 cm away from the flame, find the location and the height of the image.

B 6. A U-shaped wire is placed before a concave mirror having radius of curvature 20 cm as shown in figure. Find the total length of the image.



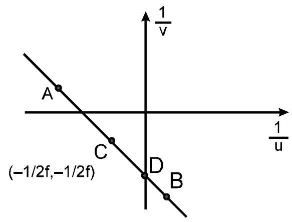
B 7. The radius of curvature of a convex spherical mirror is 1.2 m. How far away from the mirror is an object of height 12 cm if the distance between its virtual image & the mirror is 0.35 m? What is the height of the image?

B 8. A converging beam of solar rays is incident on a concave spherical mirror whose radius of curvature is 0.8 m. Determine the position of the point on the optical axis of the mirror where the reflected rays intersect, if the extensions of the incident rays intersect the optical axis 40 cm from the mirror's pole.

B 9. Draw the graph between $\frac{1}{v}$ and $\frac{1}{u}$ for a concave mirror.

B 10. In the above question, in which of the four quadrants no part of the graph lies.

B 11. In the above question the graph does not pass through a particular quadrant.It implies that a concave mirror does not form _________(Real/virtual) image of a ________ (Real/virtual) object.



B 12. What does point A indicate ? (f is magnitude of focal length, u and v are coordinates)

(i) Point A represents that the object is ___________(Real/Virtual) and the image is ___________(Real/Virtual).

(ii) Point A represents that |u| is ________ (larger,/smaller) than |v| and hence image size is _________ (larger/smaller) than the size of object.

B 13. Point B represents that the object is ___________(Real/Virtual) and the image is ___________(Real/Virtual).

B 14. Point B represents that |u| is ________ (larger,/smaller) than |v| and hence image size is _______(larger/smaller) than the size of object.

B 15. As we move from point C to D in the graph , the ______(real/virtual) object moves from _____to______.and the ________(real/virtual) image moves from ______to______.Show this movement in a diagram.

B 16. A point object is placed on the principal axis at 60 cm infront of a concave mirror of focal length 40 cm on the principal axis.If the object is moved with a velocity of 10 cm/s (a) along the principal axis,find the velocity of image (b) perpendicular to the principal axis, find the velocity of image at that moment.

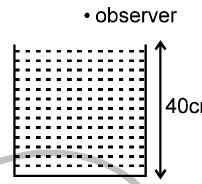
B 17. A man uses a concave mirror for shaving. He keeps his face at a distance of 20 cm from the mirror and gets an image which is 1.5 times enlarged. Find the focal length of the mirror.

SECTION (C) : REFRACTION IN GENERAL , REFRACTION AT PLANE SURFACE AND T.I.R.

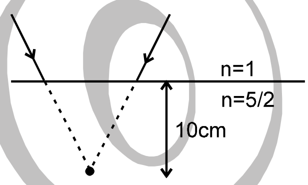
C 1. A light ray falling at an angle of 60° with the surface of a clean slab of ice of thickness 1.00 m is refracted into it at an angle of 15°. Calculate the time taken by the light rays to cross the slab. Speed of light in vacuum = 3×10^8 m/s.

C 2. A light ray is incident at 45° on a glass slab. The slab is 3 cm thick, and the refractive index of the glass is 1.5. What will the displacement of the ray be as a result of its passage through the slab? At what angle will the ray emerge from the slab?

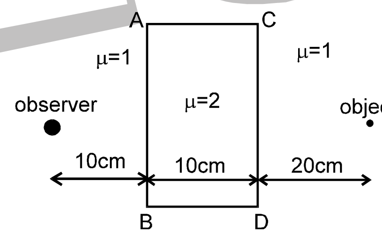
C 3. An observer in air (n = 1) sees the bottom of a beaker filled with water (n = 4/3) upto a height of 40 cm.What will be the depth felt by this observer.



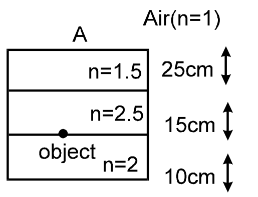
C 4. Rays incident on an interface would converge 10 cm below the interface if they continued to move in straight lines without bending. But due to refraction, the rays will bend and meet some where else. Find the distance of meeting point of refracted rays below the interface, assuming the rays to be making small angles with the normal to the interface.



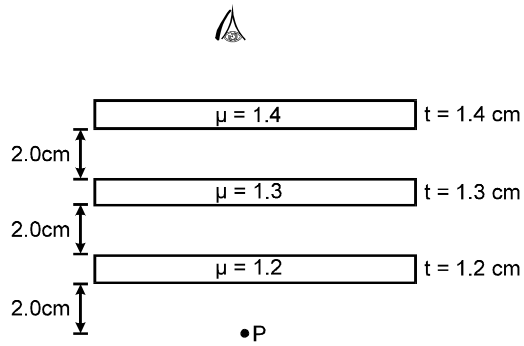
C 5. Find the apparent distance between the observer and the object shown in the figure and shift in the position of object.



C 6. Find the apparent depth of the object seen by obsever A ?

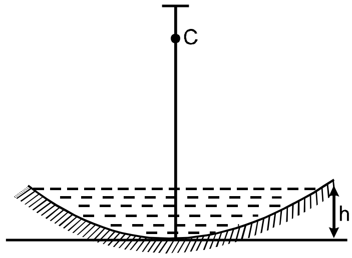


C 7. Locate the image of the point P as seen by the eye in the figure.



C 8. A small object is placed at the centre of the bottom of a cylindrical vessel of radius 3 cm and height 4 cm filled completely with water. Consider the ray leaving the vessel through a corner. Suppose this ray and the ray along the axis of the vessel are used to trace the image. Find the apparent depth of the image.Refractive index of water = 4/3.

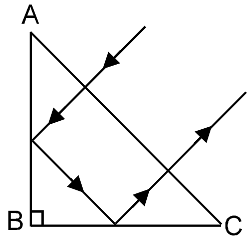
C 9. A concave mirror of radius R is kept on a horizontal table (figure). Water (refractive index = μ) is poured into it upto a height h. Where should an object be placed (its distance from the water surface) so that its final image is formed on itself. Consider two cases
(i) $h \to 0$ (ii) in terms of h



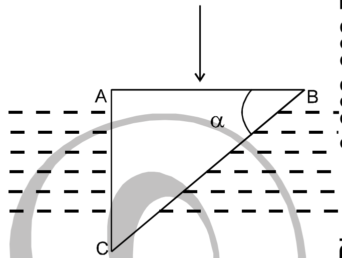
C 10. A point source is placed at a depth h below the surface of water (refractive index = μ).The medium above the surface of water is air (μ =1).Find the area on the surface of water through which light comes in air from water.

C 11. Light attempts to go from glass ($\mu = \frac{3}{2}$) to air. Find the angle of incidence for which the angle of deviation is

C 12. At what values of the refractive index of a rectangular prism can a ray travel as shown in figure. The section of the prism is an isosceles triangle & the ray is normally incident onto the face AC.



C 13. A rectangular glass wedge is lowered into water (μ = 4/3). The refractive index of glass is μ_g = 1.5. At what angle α will the beam of light normally incident on AB reach AC entirely?



SECTION (D) : REFRACTION BY PRISM

D 1. A prism (n = 2) of apex angle 90° is placed in air (n = 1). What should be the angle of incidence so that light ray strikes the second surface at an angle of 60º.

D 2. Ref. index of a prism (A = 60°) placed in air (n = 1) is n = 1.5. Light ray is incident on this prism at an angle of 60º. Find the angle of deviation. State whether this is a minimum deviation.

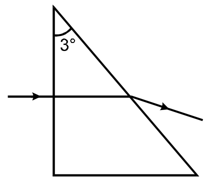
Given : $\sin^{-1}\frac{1}{\sqrt{3}} = 35º$, $\sin^{-1} 0.4 = 25º$, $\sin^{-1} 0.6 = 37º$.

D 3. The cross section of a glass prism has the form of an equilateral triangle. A ray is incident onto one of the faces perpendicular to it. Find the angle θ between the incident ray and the ray that leaves the prism. The refractive index of glass is μ = 1.5.

D 4. The angle of refraction of a prism is 60°. A light ray emerges from the prism at the same angle as it is incident on it. The refractive index of the prism is 1.5. Determine the angle by which the ray is deflected from its initial direction as a result of its passage through the prism.

D 5. Find the angle of deviation suffered by the light ray shown in figure. The refractive index for the prism material is μ = 3/2.

(i) When the prism is placed in air (μ = 1)
(ii) When the prism is placed in water (μ = 4/3)

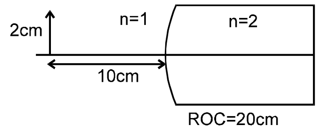


SECTION (E) : REFRACTION BY SPHERICAL SURFACE

E 1. A spherical surface of radius 30 cm separates two transparent media A and B with refractive indices 4/3 and 3/2 respectively. The medium A is on the convex side of the surface. Where should a point object be placed in medium A so that the paraxial rays become parallel after refraction at the surface?

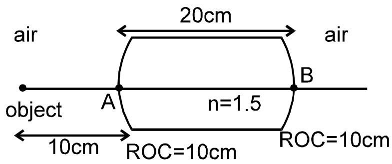
E 2. A narrow parallel beam of light is incident paraxially on a solid transparent sphere of radius r. What should be the refractive index if the beam is to be focused (a) At the surface of the sphere, (b) at the centre of the sphere.

E 3. An extended object of size 2 cm is placed at a distance of 10 cm in air (n = 1) from pole, on the principal axis of a spherical curved surface. The medium on the other side of refracting surface has refractive index n = 2. Find the position, nature and size of image formed after single refraction through the curved surface.

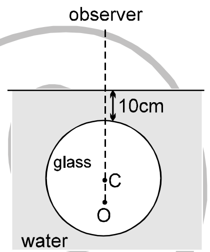


E 4. A point object lies inside a transparent solid sphere of radius 20 cm and of refractive index n = 2. When the object is viewed from air through the nearest surface it is seen at a distance 5 cm from the surface. Find the distance of object when it is seen through the farthest curved surface.

E 5. An object is placed 10 cm away from a glass piece (n = 1.5) of length 20 cm bound by spherical surfaces of radii of curvature 10 cm. Find the position of final image formed after twice refractions.



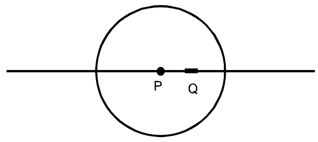
E 6. There is a small air bubble inside a glass sphere (μ = 1.5) of radius 5 cm. The bubble is 7.5 cm below the surface of the glass. The sphere is placed inside water ($\mu = \frac{4}{3}$) such that the top surface of glass is 10 cm below the surface of water. The bubble is viewed normally from air. Find the apparent depth of the bubble.



E 7. (i) A paper weight of n = 3/2 in the form of a hemisphere of radius 3.0 cm is used to hold down a printed page. An observer looks at the page vertically through the paperweight. At what height above the page will the printed letters near the centre appear to the observer?

(ii) Solve the previous problem if the paperweight is inverted at its place so that the spherical surface touches the paper.

E 8. A small object Q of length 1 mm lies along the principal axis of a spherical glass of radius R = 10 cm and refractive index is 3/2. The object is seen from air along the principal axis from left. The distance of object from the centre P is 5 cm. Find the size of the image. Is it real, inverted?

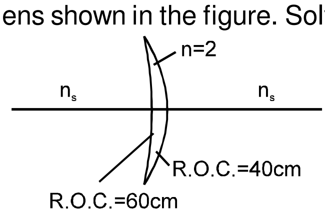


SECTION (F) : LENS

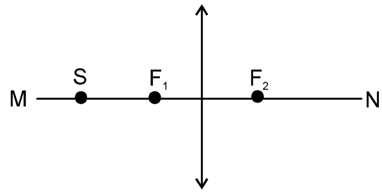
F 1. A double convex lens has focal length 50 cm. The radius of curvature of one of the surfaces is double of the other. Find the radii, if the refractive index of the material of the lens is 2.

F 2. Lenses are constructed by a material of refractive index 1.50. The magnitude of the radii of curvature are 20 cm and 30 cm. Find the focal lengths of the possible lenses with the above specifications.

F 3. Find the focal length of lens shown in the figure. Solve for three cases n_s = 1.5, n_s = 2.0, n_s = 2.5.

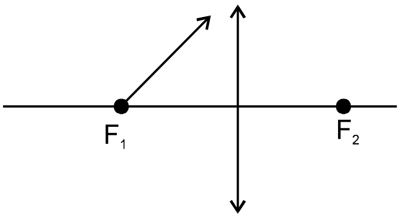


F 4. Given an optical axis MN, a converging lens, its foci & a point source S on the optical axis. Construct the image of the point source, using the ray diagram.

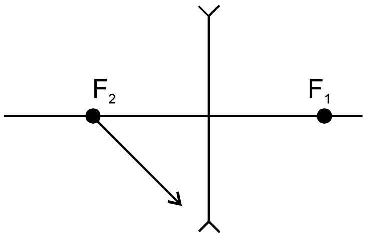


F 5. What will the paths of the rays be after refraction in the lenses.
[F_1 – First focus, F_2 – Second focus]

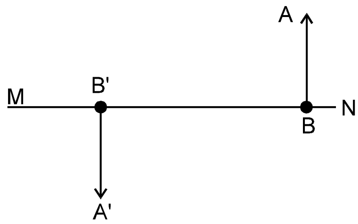
(a)



(b)



F 6. Given an optical axis MN & the positions of a real object A B and its image A' B', determine diagramatically the position of the lens (its optical centre O) and its foci. Is it a converging or diverging lens? Is the image real or virtual?



F 7 A thin lens made of a material of refractive index μ_2 has a medium of refractive index μ_1 on one side and a medium of refractive index μ_3 on the other side. The lens is biconvex and the two radii of curvature has equal magnitude R. A beam of light travelling parallel to the principal axis is incident on the lens. Where will the image be formed if the beam is incident from (a) the medium μ_1 and (b) from the medium μ_3?

F 8. An object of height 6 cm is set at right angles to the optical axis of a double convex lens of optical power 5 D & 25 cm away from the lens. Determine the focal length of the lens, the position of the image, the linear magnification of the lens, and the height of the image formed by it.

F 9. A lens placed between a candle and a screen forms a real triply magnified image of the candle on the screen. When the lens is moved away from the candle by 0.8 m without changing the position of the candle, a real image one-third the size of the candle is formed on the screen. Determine the focal length of the lens.

F 10. Two glasses with refractive indices of 1.5 & 1.7 are used to make two identical double-convex lenses.
(i) Find the ratio between their focal lengths.
(ii) How will each of these lenses act on a ray parallel to its optical axis if the lenses are submerged into a transparent liquid with a refractive index of 1.6?

F 11. A lens with a focal length of 16 cm produces a sharp image of a real object in two positions of lens which are 60 cm apart. Find the distance (fixed) from the object to the screen.

F 12. A convex lens produces a double size real image when an object is placed at a distance of 18 cm from it. Where should the object be placed to produce a triple size real image?

F 13. A pin of length 2.0 cm lies along the principal axis of a converging lens, the centre being at a distance of 11 cm from the lens. The focal length of the lens is 6 cm. Find the size of the image.

F 14. The diameter of the sun is 1.4×10^9 m and its distance from the earth is 1.5×10^{11} m. Find the diameter of the image of the sun formed by a lens of focal length 40 cm.

F 15. A 5.0 diopter lens forms a virtual image which is 4 times the object placed perpendicularly on the principal axis of the lens. Find the distance of the object from the lens.

F 16. A diverging lens of focal length 20 cm and a converging mirror of focal length 10 cm are placed coaxially at a separation of 5 cm. Where should an object be placed so that a real image is formed at the object itself?

F 17. A converging lens of focal length 12 cm and a diverging mirror of focal length 7.5 cm are placed 5.0 cm apart with their principal axes coinciding. Where should an object be placed so that its image falls on itself?

F 18. A converging lens and a diverging mirror are placed at a separation of 15 cm. The focal length of the lens is 25 cm and that of the mirror is 40 cm. Where should a point source be placed between the lens and the mirror so that the light, after getting reflected by the mirror and then getting transmitted by the lens, comes out parallel to the principal axis?

F 19. A converging lens of focal length 15 cm and a converging mirror of length 10 cm are placed 50 cm apart. If a object of length 2.0 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?

F 20. 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 (μ = 1.50) of thickness 1 cm is placed on the other side of the lens perpendicular to the axis. Locate the image of the point object.

F 21. A convex lens of focal length 20 cm and a concave lens of focal length 10 cm are placed 10 cm apart with their principal axes coinciding. A beam of light travelling parallel to the principal axis and having a beam diameter 5.0 mm, is incident on the combination. Show that the emergent beam is parallel to the incident one. Find the beam diameter of the emergent beam.

F 22. 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?

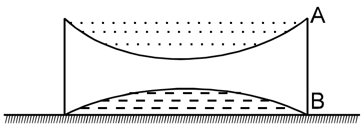
SECTION (G) : COMBINATION OF LENSES/LENS & MIRRORS.

G 1. 2 identical thin converging lenses brought in contact so that their axes coincide are placed 12.5 cm from an object. What is the optical power of the system & each lens, if the real image formed by the system of lenses is four times as large as the object?

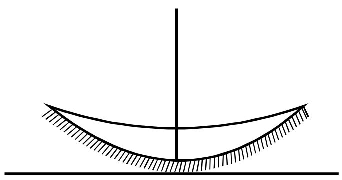
G 2. A point object is placed at a distance of 15 cm from a convex lens. The image is formed on the other side at a distance of 30 cm from the lens. When a concave lens is placed in contact with the convex lens, the image shifts away further by 30 cm. Calculate the focal lengths of the two lenses.

G 3. A convex & a concave lens are brought in close contact along their optical axes. The focal length of the convex lens is 10 cm. When the system is placed at 40 cm from an object, a sharp image of the object is formed on a screen on the other side of the system. Determine the optical power of the concave lens if the distance ℓ between the object & the screen is 1.6m.

G 4. A thin concavo-concave lens is surrounded by two different liquids A and B as shown in figure. The system is supported by a plane mirror at the bottom. Refractive index of A, lens and B are 9/5, 3/2 and 4/3 respectively. The radius of curvature of the surfaces of the lens are same and equal to 10 cm. Where should an object be placed infront of this system so that final image is formed on the object itself.



G 5. 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 as shown in figure. (a) Where should a pin be placed on the axis so that its image is formed at the same place? (b) If the concave part is filled with water (μ = 4.3), find the distance through which the pin should be moved so that the image of the pin again coincides with the pin.

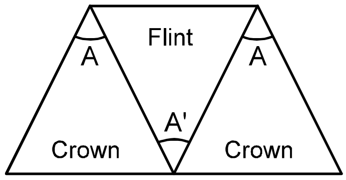


SECTION (H) : DISPERSION OF LIGHT

H 1. A certain material has refractive indices 1.56, 1.60 and 1.68 for red, yellow and violet light respectively. (a) Calculate the dispersive power. (b) Find the angular dispersion produced by a thin prism of angle 6° made of this material.

H 2. A flint glass prism and a crown glass prism are to be combined in such a way that the deviation of the mean ray is zero. The refractive index of flint and crown glasses for the mean ray are 1.620 and 1.518 respectively. If the refracting angle of the flint prism is 6.0°, what would be the refracting angle of crown prism?

H 3. Three thin prisms are combined as shown in figure. The refractive indices of the crown glass for red, yellow and violet rays are μ_r, μ_y and μ_v respectively and those for the flint glass are μ_r', μ_y' and μ_u' respectively. Find the ratio A′/A for which (a) there is no net angular dispersion, and (b) there is no net deviation in the yellow ray.



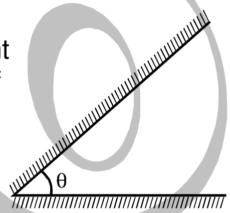
EXERCISE-2

Note : * Marked questions are MCQ.

SECTION (A) : PLANE MIRROR

A 1. Two plane mirrors are inclined to each other at an angle 60^0. If a ray of light incident on the first mirror is parallel to the second mirror, it is reflected from the second mirror
(A) Perpendicular to the first mirror (B) Parallel to the first mirror
(C) Parallel to the second mirror (D) Perpendicular to the second mirror

A 2. Two mirrors are inclined at an angle θ as shown in the figure. Light ray is incident parallel to one of the mirrors. The ray will start retracing its path after third reflection if :
(A) θ = 45° (B) θ = 30° (C) θ = 60° (D) all three



A 3.* Two plane mirrors are parallel to each other and spaced 20 cm apart. An object is kept in between them at 15 cm from A. Out of the following at which point(s) image(s) is/are not formed in mirror A (distance measured from mirror A):
(A) 15 cm (B) 25 cm (C) 45 cm (D) 55 cm

A 4. A point object is kept in front of a plane mirror. The plane mirror is doing SHM of amplitude 2 cm. The plane mirror moves along the x-axis and x- axis is normal to the mirror. The amplitude of the mirror is such that the object is always infront of the mirror. The amplitude of SHM of the image is
(A) zero (B) 2 cm (C) 4 cm (D) 1 cm

A 5. A person's eye level is 1.5 m. He stands in front of a 0.3m long plane mirror which is 0.8 m above the ground. The length of the image he sees of himself is:
(A) 1.5m (B) 1.0m (C) 0.8m (D) 0.6m

A 6. A person is standing in a room of width 200 cm. A plane mirror of vertical length 10 cm is fixed on a wall in front of the person. The person looks into the mirror from distance 50 cm. How much width (height) of the wall behind him will he be able to see:
(A) 30 cm (B) 40 cm (C) 50 cm (D) none of these

A 7. An unnumbered wall clock shows time 04: 25: 37, where 1st term represents hours, 2nd represents minutes & the last term represents seconds. What time will its image in a plane mirror show.
(A) 08: 35: 23 (B) 07: 35: 23 (C) 07: 34: 23 (D) none of these

A 8. A plane mirror is moving with velocity $4\hat{i} + 5\hat{j} + 8\hat{k}$. A point object in front of the mirror moves with a velocity $3\hat{i} + 4\hat{j} + 5\hat{k}$. Here $\hat{k}$ is along the normal to the plane mirror and facing towards the object. The velocity of the image is:
(A) $-3\hat{i} - 4\hat{j} + 5\hat{k}$ (B) $3\hat{i} + 4\hat{j} + 11\hat{k}$ (C) $-3\hat{i} - 4\hat{j} + 11\hat{k}$ (D) $7\hat{i} + 9\hat{j} + 11\hat{k}$

A 9. Images of an object placed between two plane mirrors whose reflecting surfaces make an angle of 90^0 with

one another lie on a :
(A) straight line (B) zig-zag curve (C) circle (D) ellipse

SECTION (B) : SPHERICAL MIRROR

B 1. A concave mirror of radius of curvature 20 cm forms image of the sun. The diameter of the sun subtends an angle 1º on the earth. Then the diameter of the image is (in cm):
(A) $2\pi/9$ (B) $\pi/9$ (C) 20 (D) $\pi/18$

B 2.* The image (of a real object) formed by a concave mirror is twice the size of the object. The focal length of the mirror is 20 cm. The distance of the object from the mirror is (are)
(A) 10 cm (B) 30 cm (C) 25 cm (D) 15 cm

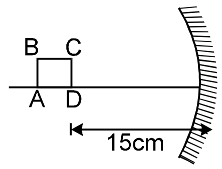
B 3. A candle is kept at a distance equal to double the focal length from the pole of a convex mirror. Its magnification will be:
(A) – 1/3 (B) 1/3 (C) 2/3 (D) – 2/3

B 4. An object is kept perpendicular to the principal axis of a convex mirror of radius of curvature 20 cm. If the distance of the object from the mirror is 20 cm then its magnification will be:
(A) + 1/3 (B) – 1/3 (C) – 1 (D) none of these

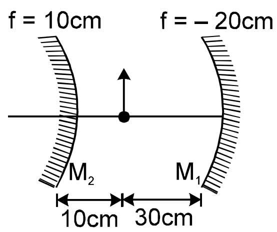
B 5. An object of height 1 cm is kept perpendicular to the principal axis of a convex mirror of radius of curvature 20 cm. If the distance of the object from the mirror is 20 cm then the distance between tips of the image and the object will be:
(A) $\sqrt{\frac{6404}{9}}$ (B) $\sqrt{\frac{6414}{9}}$ (C) $\frac{40}{3}$ (D) none of these

B 6. An object is kept between a plane mirror and a concave mirror facing each other. The distance between the mirrors is 22.5 cm. The radius of curvature of the concave mirror is 20 cm. What should be the distance of the object from the concave mirror so that after two successive reflections the final image is formed on the object itself: [Consider first reflection from concave mirror]
(A) 5 cm (B) 15 cm (C) 10 cm (D) 7.5 cm

B 7. A square ABCD of side 1mm is kept at distance 15 cm infront of the concave mirror as shown in the figure. The focal length of the mirror is 10 cm. The length of the perimeter of its image will be :
(A) 8 mm (B) 2 mm (C) 12 mm (D) 6 mm

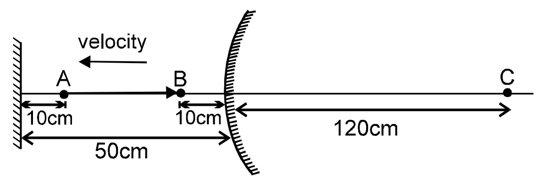


B 8. In the figure shown find the total magnification after two successive reflections first on M_1 & then on M_2
(A) + 1 (B) – 2 (C) + 2 (D) – 1



B 9. A luminous point object is moving along the principal axis of a concave mirror of focal length 12 cm towards it. When its distance from the mirror is 20 cm its velocity is 4 cm/s. The velocity of the image in cm/s at that instant is
(A) 6, towards the mirror (B) 6, away from the mirror
(C) 9, away from the mirror (D) 9, towards the mirror.

B 10.* In the figure shown consider the first reflection at the plane mirror and second at the convex mirror. AB is object.
(A) the second image is real, inverted of 1/5 th magnification
(B) the second image is virtual and erect with magnification 1/5
(C) the second image moves towards the convex mirror
(D) the second image moves away from the convex mirror.



B 11. A particle is moving towards a fixed spherical mirror. The image:

(A) must move away from the mirror
(B) must move towards the mirror
(C) may move towards the mirror
(D) will move towards the mirror, only if the mirror is convex.

B 12. A point object on the principal axis at a distance 15 cm in front of a concave mirror of radius of curvature 20 cm has velocity 2 mm/s perpendicular to the principal axis. The velocity of image at that instant will be:
(A) 2 mm/s (B) 4 mm/s (C) 8 mm/s (D) none of these

B 13. A point object at 15 cm from a concave mirror of radius of curvature 20 cm is made to oscillate along the principal axis with amplitude 2 mm. The amplitude of its image will be
(A) 2 mm (B) 4 mm (C) 8 mm (D) none of these

B 14. The distance of an object from the focus of a convex mirror of radius of curvature ' a ' is ' b '. Then the distance of the image from the focus is:
(A) $b^2 / 4a$ (B) a / b^2 (C) $a^2 / 4b$ (D) none of these

Sol. $|v-f|.\,|v-f| = f^2 \Rightarrow \quad |v-f| = \dfrac{a^2}{4b}$

B 15. A concave mirror cannot form:
(A) virtual image of virtual object (B) virtual image of a real object
(C) real image of a real object (D) real image of a virtual object

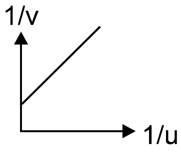
B 16. The largest distance of the image of a real object from a convex mirror of focal length 20 cm can be:
(A) 20 cm (B) infinite (C) 10 cm (D) depends on the position of the object

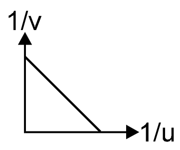
B 17.* Which one of the following statements are **incorrect** for spherical mirrors.
(A) a concave mirror forms only virtual images for any position of real object
(B) a convex mirror forms only virtual images for any position of a real object
(C) a concave mirror forms only a virtual diminished image of an object placed between its pole and the focus
(D) a convex mirror forms a virtual magnified image of an object placed between its pole and the focus.

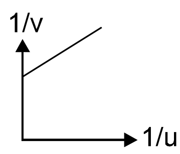
B 18. Which of the following can form erect, virtual, diminished image?
(A) plane mirror (B) concave mirror
(C) convex mirror (D) none of these

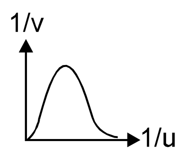
B 19. I is the image of a point object O formed by spherical mirror, then which of the following statement is incorrect :
(A) If O and I are on same side of the principal axis, then they have to be on opposite sides of the mirror.
(B) If O and I are on opposite sides of the principal axis, then they have to be on same side of the mirror.
(C) If O and I are on opposite side of the principal axis, then they can be on opposite side of the mirror as well.
(D) If O is on principal axis then I has to lie on principal axis only.

B 20. An object is placed at a distance *u* from a concave mirror and its real image is received on a screen placed at a distance of *v* from the mirror. If *f* is the focal length of the mirror, then the graph between 1/*v* versus 1/*u* is

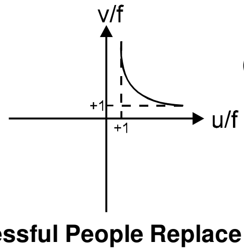
(A)


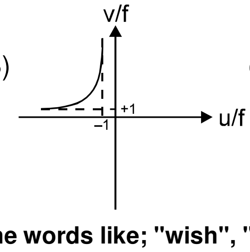
(B)


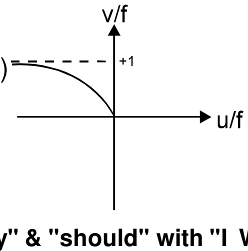
(C)


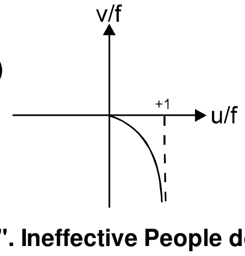
(D)


B 21. A real inverted image in a concave mirror is represented by (u, v, f are coordinates)

(A)


(B)


(C)


(D)


SECTION (C) : LAWS OF REFRACTION, REFRACTION AT PLANE SURFACE AND T.I.R.

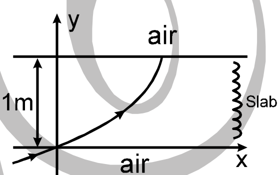
C 1. When a wave is refracted:
(A) its path must change
(B) its amplitude must change
(C) its velocity must change
(D) its frequency must change

C 2. The wavelength of light in vacuum is 6000 ^{0}A and in a medium it is 4000 ^{0}A. The refractive index of the medium is:
(A) 2.4 (B) 1.5 (C) 1.2 (D) 0.67

C 3. A ray of light passes from vacuum into a medium of refractive index n. If the angle of incidence is twice the angle of refraction, then the angle of incidence is:
(A) $\cos^{-1}(n/2)$ (B) $\sin^{-1}(n/2)$ (C) $2\cos^{-1}(n/2)$ (D) $2\sin^{-1}(n/2)$

C 4. A ray of light is incident on a parallel slab of thickness *t* and refractive index *n*. If the angle of incidence θ is small, than the displacement in the incident and emergent ray will be:
(A) $\frac{t\theta\,(n-1)}{n}$ (B) $\frac{t\theta}{n}$ (C) $\frac{t\theta\, n}{n-1}$ (D) none

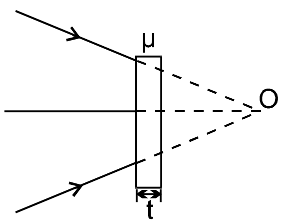
C 5. A ray of light travelling in air is incident at grazing angle on a slab with variable refractive index, $n(y) = [k\,y^{3/2} + 1]^{1/2}$ where $k = 1\ m^{-3/2}$ and follows path as shown. What is the total deviation produced by slab when the ray comes out.
(A) 60º (B) 53º
(C) $\sin^{-1}(4/9)$ (D) no deviation at all



C 6. A ray incident at a point at an angle of incidence of 60^0 enters a glass sphere of $\mu = \sqrt{3}$ and it is reflected and refracted at the farther surface of the sphere. The angle between reflected and refracted rays at this surface is
(A) 50^0 (B) 90^0 (C) 60^0 (D) 40^0

C 7. How much water should be filled in a container of 21 cm in height, so that it appears half filled (of total height of the container) when viewed from the top of the container ?
(Assume near normal incidence and μ_w=4/3)
(A) 8.0 cm (B) 10.5 cm (C) 12.0 cm (D) 14.0 cm

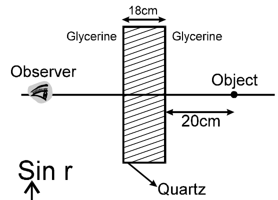
C 8. A beam of light is converging towards a point. A plane parallel plate of glass of thickness t, refractive index μ is introduced in the path of the beam. The convergent point is shifted by (assume near normal incidence):
(A) $t\left(1-\frac{1}{\mu}\right)$ away
(B) $t\left(1+\frac{1}{\mu}\right)$ away
(C) $t\left(1-\frac{1}{\mu}\right)$ nearer
(D) $t\left(1+\frac{1}{\mu}\right)$ nearer



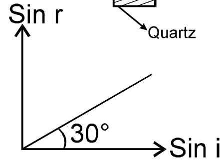
C 9. Given that, velocity of light in quartz = 1.5×10^8 m/s and velocity of light in glycerine = $(9/4) \times 10^8$ m/s. Now a slab made of quartz is placed in glycerine as shown. The shift of the object produced by slab is
(A) 6 cm (B) 3.55 cm (C) 9 cm (D) 2 cm

C 10. An object is seen through a glass slab of thickness 36 cm and refractive index 3/2. The observer, object and the slab are dipped in water (n = 4/3). The shift produced in the position of the object is:

(A) 12 cm (B) 4 cm
(C) cannot be calculated (D) 9/2 cm



C 11.* A ray of monochromatic light is incident on the plane surface of separation between two media *x & y* with angle of incidence '*i*' in the medium x and angle of refraction '*r*' *in* the medium *y*. The graph shows the relation between sin r and sin i.



(A) the speed of light in the medium y is $(3)^{1/2}$ times then in medium x.
(B) the speed of light in the medium y is $(1/3)^{1/2}$ times then in medium x.
(C) the total internal reflection can take place when the incidence is in x.
(D) the total internal reflection can take place when the incidence is in y.

C 12. The critical angle of light going from medium A to medium B is θ. The speed of light in medium A is v. The speed of light in medium B is:
(A) $\frac{v}{\sin\theta}$ (B) v $\sin\theta$ (C) v $\cot\theta$ (D) v $\tan\theta$

SECTION (D) : REFRACTION BY PRISM

D 1. A ray of monochromatic light is incident on one refracting face of a prism of angle 75^0. It passes through the prism and is incident on the other face at the critical angle. If the refractive index of the material of the prism is $\sqrt{2}$, the angle of incidence on the first face of the prism is
(A) 30^0 (B) 45^0 (C) 60^0 (D) 0^0

D 2. A prism having refractive index $\sqrt{2}$ and refracting angle 30º, has one of the refracting surfaces polished. A beam of light incident on the other refracting surface will retrace its path if the angle of incidence is:
(A) 0º (B) 30º (C) 45º (D) 60º

D 3. A ray of light is incident at angle *i* on a surface of a prism of small angle A & emerges normally from the opposite surface. If the refractive index of the material of the prism is μ, the angle of incidence *i* is nearly equal to:
(A) A/μ (B) $A/(2\mu)$ (C) μA (D) $\mu A/2$

D 4.* For the refraction of light through a prism
(A) For every angle of deviation there are two angles of incidence.
(B) The light travelling inside an isosceles prism is necessarily parallel to the base when prism is set for minimum deviation.
(C) There are two angles of incidence for maximum deviation.
(D) Angle of minimum deviation will increase if refractive index of prism is increased keeping the outside medium unchanged.

D 5.* An equilateral prism deviates a ray through 40º for two angles of incidence differing by 20º. The possible angles of incidences are:
(A) 40^0 (B) 50^0 (C) 20^0 (D) 60^0

D 6. A beam of monochromatic light is incident at i = 50^0 on one face of an equilateral prism, the angle of emergence is 40^0, then the angle of minimum deviation is:
(A) 30^0 (B) $< 30^0$ (C) $\leq 30^0$ (D) $\geq 30^0$

D 7.* For refraction through a small angled prism, the angle of minimum deviation ($n_s < n_p$)
(A) increases with the increase in R.I. of the prism
(B) will be 2D for a ray of R.I. 2.4 if it is D for a ray of R.I. 1.2
(C) is directly proportional to the angle of the prism
(D) will decrease with the increase in R.I. of a prism.

D 8. A prism of refractive index $\sqrt{2}$ has refracting angle 60º. In order that a ray suffers minimum deviation it should be incident at an angle :
(A) 45^0 (B) 90^0 (C) 30^0 (D) none

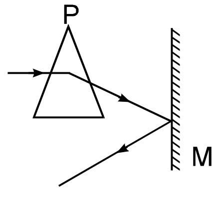
D 9. For a glass prism ($\mu = \sqrt{2}$) the angle of minimum deviation is equal to the refracting angle of the prism. The angle of the prism is:
(A) 80^0 (B) 45^0 (C) 60^0 (D) 90^0

D 10. The maximum refractive index of a material of a prism of apex angle 90^0 for which light will be transmitted is:

(A) $\sqrt{3}$ (B) 1.5 (C) $\sqrt{2}$ (D) None of these

D 11. A prism having an apex angle of 4^0 and refractive index of 1.50 is located in front of a vertical plane mirror as shown. A horizontal ray of light is incident on the prism. The total angle through which the ray is deviated is

(A) 4^0 clockwise (B) 178^0 clockwise
(C) 2^0 clockwise (D) 8^0 clockwise



SECTION (E) : REFRACTION BY SPHERICAL SURFACE

E 1. There is a small black dot at the centre C of a solid glass sphere of refractive index μ. When seen from outside, the dot will appear to be located:

(A) away from C for all values of μ (B) at C for all values of μ

(C) at C for μ = 1.5, but away from C for $\mu \neq 1.5$ (D) at C only for $\sqrt{2} \leq \mu \leq 1.5$.

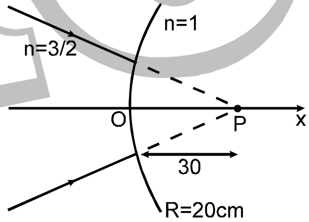
E 2. A fish is near the centre of a spherical water filled fish bowl . A child stands in air at a distance 2 R (R is radius of curvature of the sphere) from the centre of the bowl . At what distance from the centre would the child's nose appear to the fish situated at the centre (R.I. of water = 4/3)

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

E 3. The image for the converging beam after refraction through the curved surface is formed at:

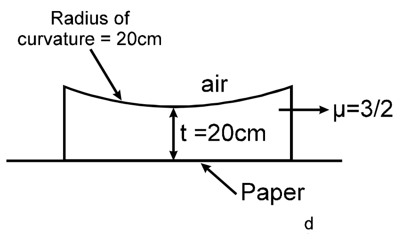
(A) x = 40 cm (B) x = $\frac{40}{3}$ cm

(C) x = $-\frac{40}{3}$ cm (D) x = $\frac{180}{7}$ cm



E 4. A planoconcave lens is placed on a paper on which a flower is drawn. How far above its actual position does the flower appear to be?

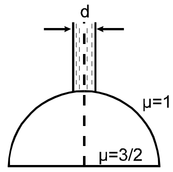
(A) 10 cm (B) 15 cm
(C) 50 cm (D) none of these



E 5. A beam of diameter ‘ d ‘ is incident on a glass hemisphere as shown. If the radius of curvature of the hemisphere is very large in comparison to d, then the diameter of the beam at the base of the hemisphere will be:

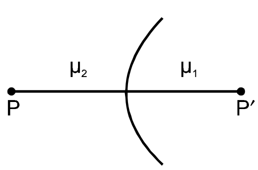
(A) $\frac{3}{4}$ d (B) d (C) $\frac{d}{3}$

(D) $\frac{2}{3}$ d



E 6*. Two refracting media are separated by a spherical interface as shown in the figure. P P′ is the principal axis, μ_1 and μ_2 are the refractive indices of medium of incidence and medium of refraction respectively. Then:

(A) if $\mu_2 > \mu_1$, then there cannot be a real image of real object
(B) if $\mu_2 > \mu_1$, then there cannot be a real image of virtual object
(C) if $\mu_1 > \mu_2$, then there cannot be a virtual image of virtual object
(D) if $\mu_1 > \mu_2$, then there cannot be a real image of real object



SECTION (F) : LENS

F 1. The power (in diopters) of an equi convex lens with radii of curvature of 10 cm & refractive index 1.6 is:

(A) + 12 (B) – 12 (C) + 1.2 (D) – 1.2

F 2. A convexo - concave diverging lens is made of glass of refractive index 1.5 and focal length 24 cm. Radius of curvature for one surface is double that of the other. Then radii of curvature for the two surfaces are (in cm):
(A) 6, 12 (B) 12, 24 (C) 3, 6 (D) 18, 36

F 3. Two symmetric double convex lenses A and B have same focal length, but the radii of curvature differ so that $R_A = 0.9\ R_B$. If $n_A = 1.63$, find n_B.
(A) 1.7 (B) 1.6 (C) 1.5 (D) 4/3

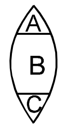
F 4. When a lens of power P (in air) made of material of refractive index μ is immersed in liquid of refractive index μ_0. Then the power of lens is:
(A) $\dfrac{\mu - 1}{\mu - \mu_0}$ P (B) $\dfrac{\mu - \mu_0}{\mu - 1}$ P (C) $\dfrac{\mu - \mu_0}{\mu - 1} \cdot \dfrac{P}{\mu_0}$ (D) none of these

F 5. A lens behaves as a converging lens in air and a diverging lens in water. The refractive index of the material is (refractive index of water = 1.33)
(A) equal to unity (B) equal to 1.33
(C) between unity and 1.33 (D) greater than 1.33

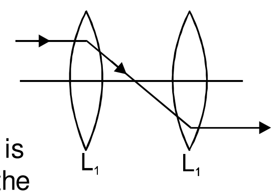
F 6. The diameter of the sun subtends an angle of 0.5^0 at the surface of the earth. A converging lens of focal length 100 cm is used to provide an image of the sun on to a screen. The diameter in mm of the image formed is about
(A) 1 (B) 3 (C) 5 (D) 9

F 7. A thin lens of focal length f and its aperture diameter d, forms a real image of intensity I. Now the central part of the aperture upto diameter (d/2) is blocked by an opaque paper. The focal length and image intensity would change to
(A) f/2, I/2 (B) f, I/4 (C) 3f/4, I/2 (D) f, 3I/4

F 8. A thin symmetrical double convex lens of power P is cut into three parts, as shown in the figure. Power of A is:
(A) 2 P (B) $\dfrac{P}{2}$ (C) $\dfrac{P}{3}$ (D) P

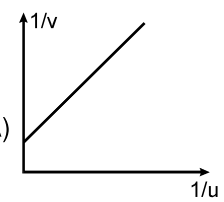


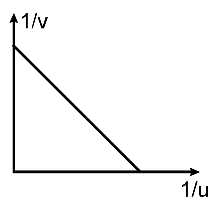
F 9. In the figure given below, there are two convex lens L_1 and L_2 having focal length of f_1 and f_2 respectively. The distance between L_1 and L_2 will be
(A) f_1 (B) f_2 (C) $f_1 + f_2$ (D) $f_1 - f_2$

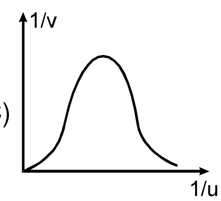


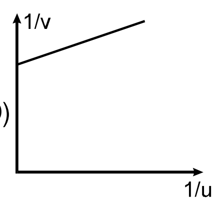
F 10.* Which of the following cannot form real image of a real object ?
(A) concave mirror (B) convex mirror
(C) plane mirror (D) diverging lens

F 11. An object is placed at a distance *u* from a **converging lens** and its real image is received on a screen placed at a distance of *v* from the lens. If *f* is the focal length of the lens, then the graph between 1/*v* versus 1/*u* is:

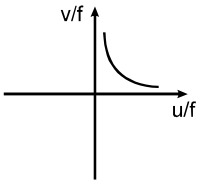
(A) 

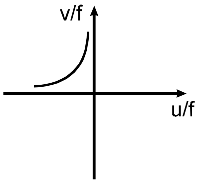
(B) 

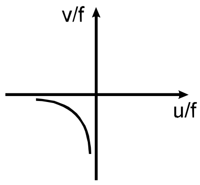
(C) 

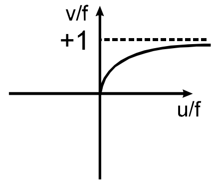
(D) 

F 12. A virtual erect image by a **diverging lens** is represented by (u, v, f are coordinates)

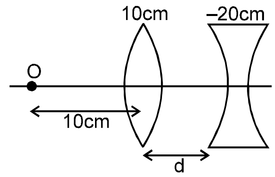
(A) 

(B) 

(C) 

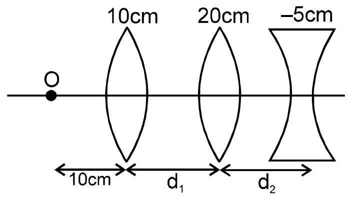
(D) 

F 13. What should be the value of distance d so that final image is formed on the object itself. (focal lengths of the lenses are written on the lenses).



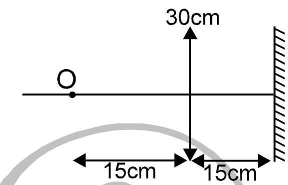
(A) 10 cm (B) 20 cm
(C) 5 cm (D) none of these

F 14.* The values of d_1 & d_2 for final rays to be parallel to the principle axis are: (focal lengths of the lenses are written above the respective lenses)



(A) d_1 = 10 cm, d_2 = 15 cm
(B) d_1 = 20 cm, d_2 = 15 cm
(C) d_1 = 30 cm, d_2 = 15 cm
(D) None of these

F 15.* An object O is kept infront of a converging lens of focal length 30 cm behind which there is a
plane mirror at 15 cm from the lens.



(A) the final image is formed at 60 cm from the lens towards right of it
(B) the final image is at 60 cm from lens towards left of it
(C) the final image is real
(D) the final image is virtual.

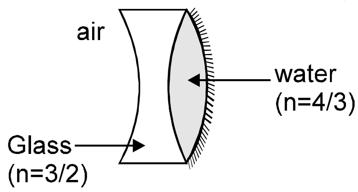
F 16. A thin linear object of size 1 mm is kept along the principal axis of a convex lens of focal length 10 cm. The object is at 15 cm from the lens. The length of the image is:
(A) 1 mm (B) 4 mm (C) 2 mm (D) 8 mm

F 17. A biconvex lens is used to project a slide on screen. The slide is 2 cm high and 10 cm from the lens. The image is 18 cm high. What is the focal length of the lens?
(A) 9 cm (B) 18 cm (C) 4.5 cm (D) 20 cm

F 18. The minimum distance between a real object and its real image formed by a thin convex lens of focal length f is
(A) 4f (B) 2f (C) f (D) f/2

SECTION (G) : COMBINATION OF THIN LENS/LENS AND MIRRORS.

G 1.* The radius of curvature of the left & right surface of the concave lens are 10 cm & 15 cm respectively. The radius of curvature of the mirror is 15 cm.



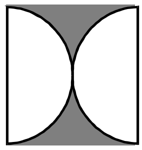
(A) equivalent focal length of the combination is -18 cm
(B) equivalent focal length of the combination is +36 cm
(C) the system behaves like a concave mirror
(D) the system behaves like a convex mirror.

G 2. A plano-convex lens, when silvered at its plane surface is equivalent to a concave mirror of focal length 28 cm. When its curved surface is silvered and the plane surface not silvered, it is equivalent to a concave mirror of focal length 10 cm, then the refractive index of the material of the lens is:
(A) 9/14 (B) 14/9 (C) 17/9 (D) none

G 3. In the above question the radius of curvature of the curved surface of plano-convex lens is :

(A) $\frac{280}{9}$ cm (B) $\frac{180}{7}$ cm (C) $\frac{39}{3}$ cm (D) $\frac{280}{11}$ cm

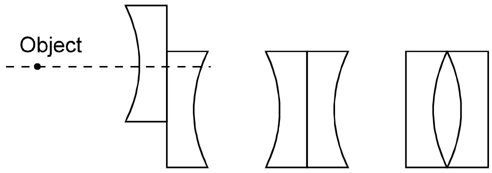
G 4. Two plano-convex lenses each of focal length 10 cm & refractive index $\frac{3}{2}$ are placed as shown. In the space left, water $\left(\text{R.I.}=\frac{4}{3}\right)$ is filled. The whole arrangement is in air. The optical power of the system is (in diopters):



(A) 6.67 (B) - 6.67 (C) 33.3 (D) 20

G 5. The focal length of a plano-concave lens is – 10 cm, then its focal length when its plane surface is polished is:
(A) 20 cm (B) – 5 cm (C) 5 cm (D) none of these

G 6.* If a symmetrical biconcave thin lens is cut into two identical halves. They are placed in different ways as shown:



Fig(i) Fig(ii) Fig(iii)

(A) three images will be formed in case (i)
(B) two images will be formed in the case (i)
(C) the ratio of focal lengths in (ii) & (iii) is 1
(D) the ratio of focal lengths in (ii) & (iii) is 2

G 7. A convex lens of focal length 25 cm and a concave lens of focal length 20 cm are mounted coaxially separated by a distance d cm. If the power of the combination is zero, *d* is equal to
(A) 45 (B) 30 (C) 15 (D) 5

SECTION (H) : DISPERSION OF LIGHT

H 1. The dispersion of light in a medium implies that :
(A) lights of different wavelengths travel with different speeds in the medium
(B) lights of different frequencies travel with different speeds in the medium
(C) the refractive index of medium is different for different wavelengths
(D) all of the above.

H 2. Critical angle of light passing from glass to air is minimum for
(A) red (B) green (C) yellow (D) violet

H 3. A plane glass slab is placed over various coloured letters. The letter which appears to be raised the least is:
(A) violet (B) yellow (C) red (D) green

H 4. A medium has $n_v = 1.56$, $n_r = 1.44$. Then its dispersive power is:
(A) 3/50 (B) 6/25 (C) 0.03 (D) none of these

H 5. All the listed things below are made of flint glass. Which one of these have greatest dispersive power (ω).
(A) prism (B) glass slab (C) biconvex lens (D) all have same ω

H 6. A thin prism P_1 with angle 4^0 made of glass of refractive index 1.54 is combined with another thin prism P_2 made of glass of refractive index 1.72 to produce dispersion without deviation. The angle of the prism P_2 is :
(A) 3^0 (B) 2.6^0 (C) 4^0 (D) 5.33^0

H 7. Light of wavelength 4000 Å is incident at small angle on a prism of apex angle 4º. The prism has $n_v = 1.5$ & $n_r = 1.48$. The angle of dispersion produced by the prism in this light is:
(A) 0.2º (B) 0.08º (C) 0.192º (D) none of these

H 8.* A norrow beam of white light goes through a slab having parallel faces
(A) The light never splits in different colours
(B) The emergent beam is white
(C) The light inside the slab is split into different colours
(D) The light inside the slab is white

H 9.* By properly combining two prisms made of different materials, it is possibel to
(A) have dispersion without average deviation
(B) have deviation without dispersion
(C) have both dispersion and average deviation
(D) have neither dispersion nor average deviation

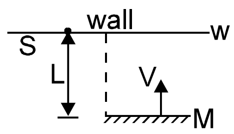
H 10.* Which of the following quantities increases when wavelength is increased? Consider only the magnitudes
(A) The power of a converging lens (B) The focal length of a converging lens
(C) The power of a diverging lens (D) The focal length of a diverging lens

EXERCISE-3

Note : * marked questions are MCQ.

SELECT THE CORRECT ALTERNATIVE(S)

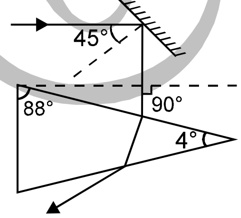
1.* A flat mirror M is arranged parallel to a wall W at a distance *l* from it. The light produced by a point source S kept on the wall is reflected by the mirror and produces a light patch on the wall. The mirror moves with velocity v towards the wall.



(A) The patch of light will move with the speed v on the wall.
(B) The patch of light will not move on the wall.
(C) As the mirror comes closer the patch of light will become larger and shift away from the wall with speed larger then v.
(D) The size of the light patch on the wall remains the same.

2. An object is placed 30 cm (from the reflecting surface) in front of a block of glass 10 cm thick having its farther side silvered. The image is found to be at 23.2 cm behind the silvered face, by an observer infront of the block. The refractive index of glass is :
(A) 1.41 (B) 1.46 (C) 200/ 132 (D) 1.61

3. A ray of light strikes a plane mirror at an angle of incidence 45º as shown in the figure. After reflection, the ray passes through a prism of refractive index 1.50, whose apex angle is 4º. The angle through which the mirror should be rotated if the total deviation of the ray is to be 90º is :

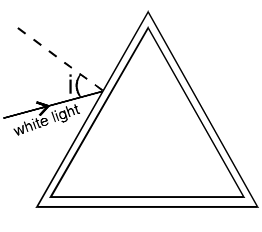


(A) 1^0 clockwise (B) 1^0 anticlockwise
(C) 2^0 clockwise (D) 2^0 anticlockwise

4. When the object is at distances u_1 & u_2 the images formed by the same lens are real and virtual respectively and of the same size. Then focal length of the lens is:
(A) $\frac{1}{2}\sqrt{u_1u_2}$ (B) $\frac{u_1+u_2}{2}$ (C) $\sqrt{u_1u_2}$ (D) $2\,(u_1 + u_2)$

5.* A man wishing to get a picture of a Zebra photographed as white donkey after fitting a glass with black streaks onto the lens of his camera.
(A) The image will look like a white donkey on the photograph.
(B) The image will look like a Zebra on the photograph
(C) The image will be more intense compared to the case in which no such glass is used.
(D) The image will be less intense compared to the case in which no such glass is used.

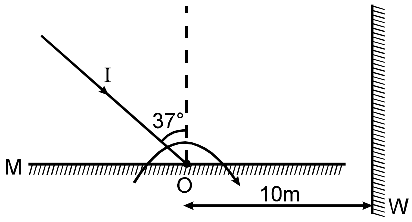
6. A beam of white light is incident on hollow prism of glass. Then :



(A) the light emerging from prism gives no dispersion
(B) the light emerging from prism gives spectrum but the bending of all colours is away from base.
(C) the light emerging from prism gives spectrum, all the colours bend towards base, the violet the most and red the least.
(D) the light emerging from prism gives spectrum, all the colours bend towards base, the violet the least and red the most.

7. A light ray I is incident on a plane mirror M. The mirror is rotated in the direction as shown in the figure by an arrow at frequency $9/\pi$ rps. The light reflected by the mirror is received on the wall W at a distance 10 m from the axis of rotation. When the angle of incidence becomes 37º the speed of the spot (a point) on the wall is:

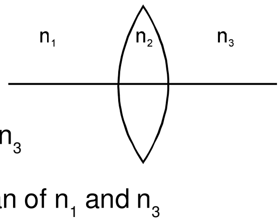
(A) 10 m/s (B) 1000 m/s
(C) 500 m/s (D) none of these



8.* Two plane mirrors are inclined to each other with their reflecting faces making acute angle. A light ray is incident on one plane mirror. The total deviation after two successive reflections is:

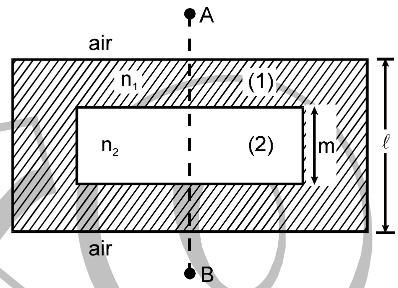
(A) independent of the initial angle of incidence
(B) independent of the angle between the mirrors
(C) dependent on the initial angle of incidence
(D) dependent on the angle between the mirrors.

9.* An equiconvex lens of refractive index n_2 is placed such that the refractive index of the surrounding media is as shown. Then the lens:



(A) must be diverging if n_2 is less than the arithmetic mean of n_1 and n_3
(B) must be converging if n_2 is greater than the arithmetic mean of n_1 and n_3
(C) may be diverging if n_2 is less than the arithmetic mean of n_1 and n_3
(D) will neither be diverging nor converging if n_2 is equal to arithmetic mean of n_1 and n_3

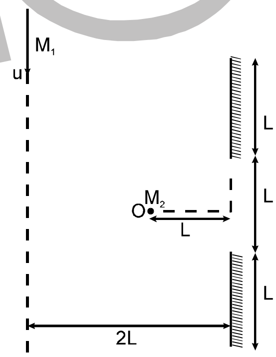
10. In a thick glass slab of thickness ℓ and refractive index n_1 a cuboidal cavity of thickness 'm' is carved as shown in the figure & is filled with liquid of R. I. n_2 ($n_1 > n_2$). The ratio of ℓ/m, so that shift produced by this slab is zero when an observer A observes an object B with paraxial rays is:



(A) $\dfrac{n_1 - n_2}{n_2 - 1}$ (B) $\dfrac{n_1 - n_2}{n_2(n_1 - 1)}$

(C) $\dfrac{n_1 - n_2}{n_1 - 1}$ (D) $\dfrac{n_1 - n_2}{n_1(n_2 - 1)}$

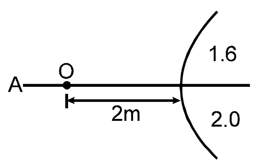
11. Two plane mirrors of length L are separated by distance L and a man M_2 is standing at distance L from the connecting line of mirrors as shown in figure. A man M_1 is walking in a straight line at distance 2 L parallel to mirrors at speed u, then man M_2 at O will be able to see image of M_1 for time:



(A) $\dfrac{4L}{u}$ (B) $\dfrac{3L}{u}$ (C) $\dfrac{6L}{u}$ (D) $\dfrac{9L}{u}$

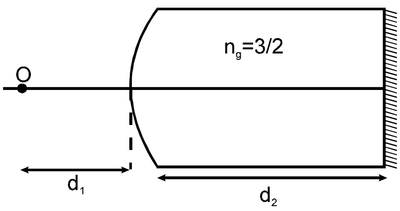
12. In the figure shown a point object O is placed in air. A spherical boundary of radius of curvature 1.0 m separates two media. AB is principal axis. The refractive index above AB is 1.6 and below AB is 2.0. The separation between the images formed due to refraction at spherical surface is:

(A) 12 m (B) 20 m (C) 14 m (D) 10 m

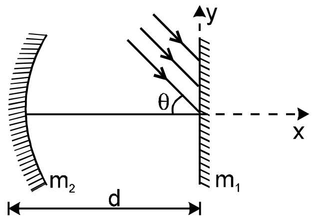


13.* In the figure shown a point object O is placed in air on the principal axis. The radius of curvature of the spherical surface is 60 cm. I_f is the final image formed after all the refractions and reflections.

(A) If d_1 = 120 cm, then the 'I_f' is formed on 'O' for any value of d_2.
(B) If d_1 = 240 cm, then the 'I_f' is formed on 'O' only if d_2 = 360 cm.
(C) If d_1 = 240 cm, then the 'I_f' is formed on 'O' for all values of d_2.
(D) If d_1 = 240 cm, then the 'I_f' cannot be formed on 'O'.



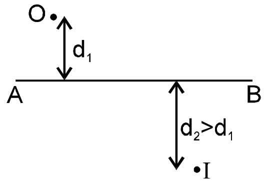
14. In the figure shown a thin parallel beam of light is incident on a plane mirror m_1 at small angle 'θ'. m_2 is a concave mirror of focal length 'f'. After three successive reflections of this beam the x and y coordinates of the image is :



(A) x = f – d, y = fθ (B) x = d + f , y = fθ
(C) x = f – d, y = – fθ (D) x = d – f , y = – fθ

15. The distance between an object and its doubly magnified image by a concave mirror is: [Assume f = focal length]
(A) 3 f/2 (B) 2 f/3 (C) 3 f
(D) depends on whether the image is real or virtual.

16. In the figure shown, the image of a real object is formed at point I. AB is the principal axis of the mirror. The mirror must be:

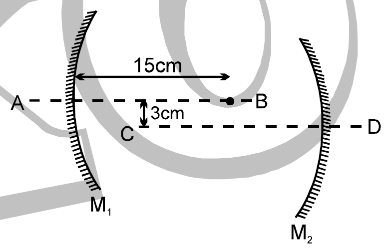


(A) concave & placed towards right of I
(B) concave & placed towards left of I
(C) convex & placed towards right of I
(D) convex & placed towards left of I.

17. An object is kept on the principal axis of a convex mirror of focal length 10 cm at a distance of 10 cm from the pole. The object starts moving at a velocity 20 mm/sec towards the mirror at angle 30º with the principal axis. What will be the speed of its image & direction with the principal axis at that instant.

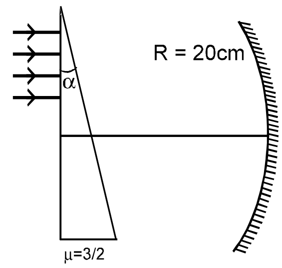
(A) speed = $5\frac{\sqrt{7}}{4}$ mm/sec (B) speed = $5\sqrt{7}$ mm/sec
(C) $\tan^{-1}\frac{2}{\sqrt{3}}$ with the principal axis (D) none of these

18. M_1 & M_2 are two concave mirrors of the same focal length 10 cm. AB & CD are their principal axes respectively. A point object O is kept on the line AB at distance 15 cm from M_1. The distance between the mirrors 20 cm. Considering two successive reflections first on M_1 and then on M_2. The distance of final image from the line AB is:



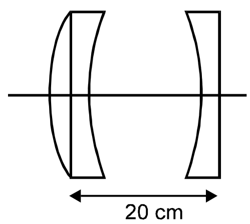
(A) 3 cm (B) 1.5 cm
(C) 4.5 cm (D) 1 cm

19. A parallel beam of light is incident on the upper part of a prism of angle 1.8º & R.I. 3/2. The light coming out of the prism falls on a concave mirror of radius of curvature 20 cm. The distance of the point (where the rays are focused after reflection from the mirror) from the principal axis is:



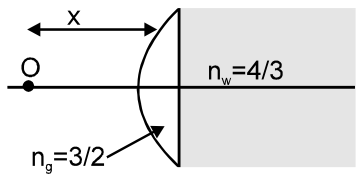
(A) 9 cm (B) 1.5 7 mm
(C) 3.14 mm (D) none of these

20. A symmetrical converging convex lens of focal length 10 cm & diverging concave symmetrical lens of focal length – 20 cm are cut from the middle & perpendicularly and symmetrically to their principal axis. The parts thus obtained are arranged as shown in the figure. The focal length of this arrangement will be:



(A) ∞ (B) 20 cm
(C) 40 cm (D) 80 cm

21. An object ' O ' is kept in air in front of a thin plano convex lens of radius of curvature 10 cm. It's refractive index is 3/2 and the medium towards right of plane surface is water of refractive index 4/3. What should be the distance ' x ' of the object so that the rays become parallel finally.



(A) 5 cm (B) 10 cm
(C) 20 cm (D) none of these

22. For a prism of apex angle 45^0, it is found that the angle of emergence is 45^0 for grazing incidence. Calculate the refractive index of the prism.
(A) $(2)^{1/2}$ (B) $(3)^{1/2}$ (C) 2 (D) $(5)^{1/2}$

23*. The angle of minimum deviation from a prism is 30º. If the prism angle is 90º, if the refractive index of the material of the prism is μ and the angle of incidence required for minimum deviation is i, then
(A) $\mu = \sqrt{\frac{3}{2}}$ (B) i = 60° (C) μ = 1.5 (D) i = 90º

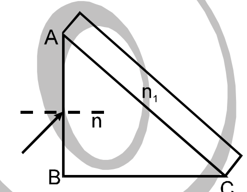
24. The angular dispersion produced by a small angle prism placed in air :
(A) increases if the average refractive index of the prism increases
(B) increases if the average refractive index decreases
(C) remains constant whether the average refractive index increases or decreases
(D) has no relation with average refractive index

25.* Which of the following quantities related to a lens depend on the wavelength of the incident light?
(A) power (B) focal length
(C) chromatic aberration (D) radii of curvature

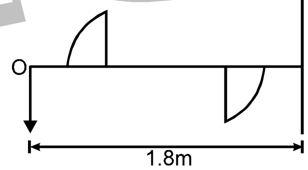
EXERCISE-4

1. A right angle prism (45°– 90°– 45°) of refractive index n has a plate of refractive index n_1 (n_1 < n) cemented to its diagonal face. The assembly is in air. a ray is incident on AB (see the figure).

(i) Calculate the angle of incidence at AB for which the ray strikes the diagonal face at the critical angle.
(ii) Assuming n = 1.352. Calculate the angle of incidence at AB for which the refracted ray passes through the diagonal face undeviated.
[JEE '96, 3/100]



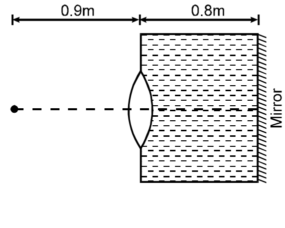
2. A thin plano–convex. Lens of focal length F is split into two halves, one of the halves is shifted along the optical axis. The separation between object and image planes is 1.8 m. The magnification of the image formed by one of the half lenses is 2. Find the focal length of the lens and separation between the two halves. Draw the ray diagram for image formation.
[JEE '96, 5/100]



3. Which of the following form(s) a virtual and erect image for all positions of the object?
(A) Convex lens (B) Concave lens (C) Convex mirror (D) Concave mirror
[JEE '96, 2/100]

4. A small fish, 0.4 m below the surface of a lake, is viewed through a simple converging lens of focal length 3 m. The lens is kept at 0.2 m above the water surface such that the fish lies on the optical axis of the lens. Find the image of the fish seen by the observer. The refractive index of the water is 4/3.
[REE '96, 5]

5. A thin equiconvex lens of glass of refractive index μ = 3/2 & of focal length 0.3 m in air is sealed into an opening at one end of a tank filled with water (μ = 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 is placed outside the tank in front of the lens at a distance of 0.9 m from the lens along its axis. Find the position (relative to the lens) of the image of the object formed by the system.
[JEE ' 97, 5]



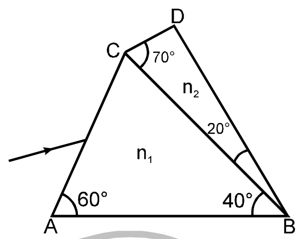
6. **[JEE '98 3/200 Each]**

(i) 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 centre of curvature. A point 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, & will remain at C
(B) real, & located at a point between C and ∞
(C) virtual, & located at a point between C and O
(D) real, & located at a point between C and O

(ii) A ray of light travelling in a transparent medium falls on a surface separating the medium from air at an angle of incidence of 45º. The ray undergoes total internal reflection. If n is the refractive index of the medium with respect to air, select the possible value(s) of n from the following:
(A) 1.3 (B) 1.4 (C) 1.5 (D) 1.6

(iii) A spherical surface of radius of curvature R separates air (refractive index 1.0) from glass (refractive index 1.5). The centre 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 a point O and PO = OQ. The distance PO is equal to:
(A) 5 R (B) 3 R (C) 2 R (D) 1.5 R

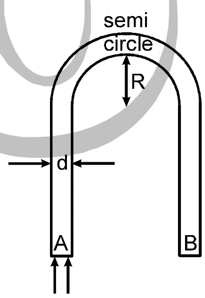
7. A prism of refractive index n_1 and another prism of refractive index n_2 are stuck together without a gap as shown in the figure. The angles of the prisms are as shown. n_1 and n_2 depend on λ, the wavelength of light according to $n_1 = 1.20 + \dfrac{10.8\times10^4}{\lambda^2}$ and $n_2 = 1.45 + \dfrac{1.80\times10^4}{\lambda^2}$ where λ is in nm.



(i) Calculate the wavelength λ_0 for which rays incident at any angle on the interface BC pass through without bending at that interface.

(ii) For light of wavelength λ_0, find the angle of incidence i on the face AC such that the deviation produced by the combination of prisms is minimum. **[JEE '98, (2 + 6)/200]**

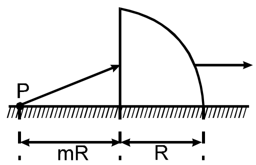
8. A rod made of glass (μ = 1.5) and of square cross-section is bent into the shape shown in figure. A parallel beam of light falls perpendicularly on the plane flat surface A. Referring to the diagram, d is the width of a side and R is the radius of inner semicircle. Find the maximum value of ratio d/R so that all light entering the glass through surface A emerge from the glass through surface B. **[REE '98, 5]**



9. A concave lens of glass, refractive index 1.5, has both surfaces of same radius of curvature R. On immersion in a medium of refractive index 1.75, it will behave as a
(A) convergent lens of focal length 3.5R (B) convergent lens of focal length 3.0 R.
(C) divergent lens of focal length 3.5 R (D) divergent lens of focal length 3.0 R
[JEE '99, 2/100]

10. The x-y plane is the boundary between two transparent media. Medium-1 with z > 0 has refractive index $\sqrt{2}$ and medium -2 with z < 0 has a refractive index $\sqrt{3}$. A ray of light in medium-1 given by the vector $\vec{A} = 6\sqrt{3}\,\hat{i} + 8\sqrt{3}\,\hat{j} - 10\,\hat{k}$ is incident on the plane of separation. Find the unit vector in the direction of refracted ray in medium – 2. **[JEE '99, 10/100]**

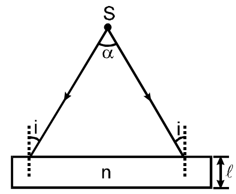
11. A quarter cylinder of radius R and refractive index 1.5 is placed on a table. A point object P is kept at a distance of mR from it. Find the value of m for which a ray from P will emerge parallel to the table as shown in the figure. **[JEE '99, 5/100]**



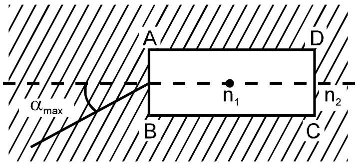
12. Two symmetric double-convex lenses L_1 & L_2 with their radii of curvature 0.2 m each are made from glasses with refractive index 1.2 & 1.6 respectively. The lenses with a separation of 0.345 m are submerged in a transparent liquid medium with a refractive index of 1.4. Find the focal lengths of lens L_1 & L_2. An object is placed at a distance of 1.3 m from L_1, find the location of its image while the whole system remains inside the liquid. **[REE '99, 5]**

13. **[JEE '2000 (Screening) 3/105 Each]**

(a) A diverging beam of light from a point source S having divergence angle α, falls symmetrically on a glass slab as shown. The angles of incidence of the two extreme rays are equal. If the thickness of the glass slab is t and the refractive index n, then the divergence angle of the emergent beam is
(A) zero (B) α (C) $\sin^{-1}(1/n)$ (D) $2\sin^{-1}(1/n)$



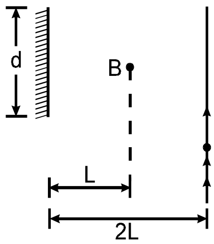
(b) A rectangular glass slab ABCD, of refractive index n_1, is immersed in water of refractive index $n_2 (n_1 > n_2)$. A ray of light is incident at the surface AB of the slab as shown. The maximum value of the angle of incidence α_{max}, such that the ray comes out only from the other surface CD is given by



(A) $\sin^{-1}\left[\frac{n_1}{n_2}\cos\left(\sin^{-1}\frac{n_2}{n_1}\right)\right]$ (B) $\sin^{-1}\left[n_1\cos\left(\sin^{-1}\frac{1}{n_2}\right)\right]$

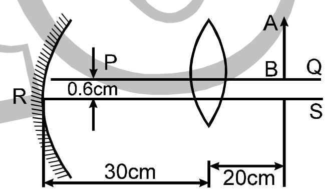
(C) $\sin^{-1}\left(\frac{n_1}{n_2}\right)$ (D) $\sin^{-1}\left(\frac{n_2}{n_1}\right)$

(c) A point source of light B is placed at a distance L in front of the centre of a mirror of width d hung vertically on a wall. A man walks in front of the mirror along a line parallel to the mirror at a distance 2L from it as shown. The greatest distance over which he can see the image of the light source in the mirror is
(A) d/2 (B) d (C) 2d (D) 3d



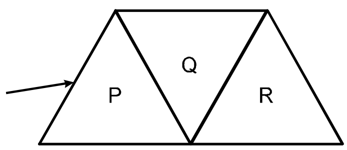
(d) A hollow double concave lens is made of very thin transparent material. It can be filled with air or either of two liquids L_1 or L_2 having refractive indices n_1 and n_2 respectively ($n_2 > n_1 > 1$). The lens will diverge a parallel beam of light if it is filled with
(A) air and placed in air. (B) air and immersed in L_1.
(C) L_1 and immersed in L_2. (D) L_2 and immersed in L_1.

14. A convex lens of focal length 15 cm and a concave mirror of focal length 30 cm are kept with their optic axes PQ and RS parallel but separated in vertical direction by 0.6 cm as shown. The distance between the lens and mirror is 30 cm. An upright object AB of height 1.2 cm is placed on the optic axis PQ of the lens at a distance of 20 cm from the lens. If A′B′ is the image after refraction from the lens and reflection from the mirror, find the distance A′B′ from the pole of the mirror and obtain its magnification. Also locate positions of A′ and B′ with respect to the optic axis RS. **[JEE 2000 Mains 6/100]**

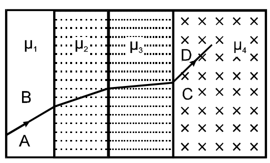


15. **[JEE 2001 (Screening 3/105 Each]**

(i) A given ray of light suffers minimum deviation in an equilateral prism P Additional prisms Q and R of identical shape and of the same material as P are now added as shown in the figure. The ray will now suffer.
(A) greater deviation (B) no deviation
(C) same deviation as before (D) total internal reflection



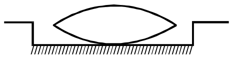
(ii) A ray of light passes through four transparent media with refractive indices μ_1, μ_2, μ_3 & μ_4 as shown in the figure. The surfaces of all media are parallel. If the emergent ray CD is parallel to the incident ray AB, we must have:
(A) $\mu_1 = \mu_2$ (B) $\mu_2 = \mu_3$ (C) $\mu_3 = \mu_4$ (D) $\mu_4 = \mu_1$



16. **[JEE 2001 (Mains) 5/100 Each]**

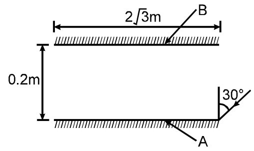
(i) The refractive indices of the crown glass for blue and red lights are 1.51 & 1.49 respectively and those of the flint glass are 1.77 & 1.73 respectively. An isosceles prism of angle 6º is made of crown glass. A beam of white light is incident at a small angle on this prism. The other flint glass isosceles prism is combined with the crown glass prism such that there is no deviation of the incident light. Determine the angle of the flint glass prism. Calculate the net dispersion of the combined system.

(ii) A thin biconvex lens of refractive index 3/2 is placed on a horizontal plane mirror as shown in the figure. The space between the lens and the mirror is then filled with water of refractive index 4/3. It is found that when a point object is placed 15 cm above the lens on its principal axis, the object coincides with its own image. On repeating with another liquid, the object and the image again coincide at a distance 25 cm from the lens. Calculate the refractive index of the liquid.



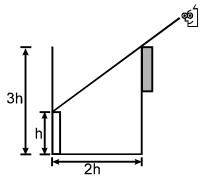
17. **[JEE Screening 2002, 3/105 Each]**

(i) Two plane mirrors A & B are aligned parallel to each other, as shown in the figure. A light ray is incident to an angle of 30º at a point just inside one end of A. The plane of incidence coincides with the plane of the figure. The maximum number of times the ray undergoes reflections (including the first one) before it emerges out is:



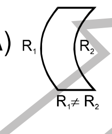
(A) 28 (B) 30 (C) 32 (D) 34

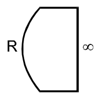
(ii) An observer can see through a pinhole the top end of a thin rod of height h, placed as shown in the figure. The beaker height is 3h and its radius h. When the beaker is filled with a liquid up to a height 2h, he can see the lower end of the rod. Then the refractive index of the liquid is:

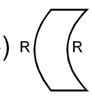


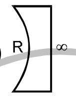
(A) $\frac{5}{2}$ (B) $\sqrt{\frac{5}{2}}$ (C) $\sqrt{\frac{3}{2}}$ (D) $\frac{3}{2}$

(iii) Which one of the following spherical lenses does not exhibit dispersion? The radii of curvature of the surface of the lenses are as given in the diagrams.

(A) 

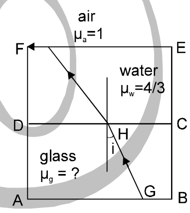
(B) 

(C) 

(D) 

18. **[JEE 2003 (Screening) 3/90 Each]**

(i) In ray of light (CH) is incident on the glass-water interface DC at an angle 'i'. It emerges in air along the water-air interface EF (see figure). If the refractive index of water μ_w is 4/3, the refractive index of glass μ_g is :

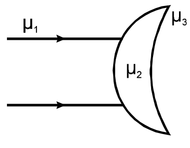


(A) $\frac{3}{4\sin i}$ (B) $\frac{1}{\sin i}$ (C) $\frac{4\sin i}{3}$ (D) $\frac{4}{3\sin i}$

(ii) A thin convex lens of focal length 30 cm forms an image 2 cm high, of an object at infinity. A thin concave lens of focal length 20 cm is placed 26 cm from the convex lens on the side of the image. The height of the image now is :

(A) 1.0 cm (B) 1.25 cm (C) 2 cm (D) 2.5 cm

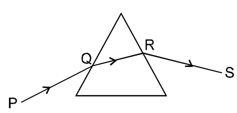
19. A meniscus lens is made of a material of refractive index μ_2. Both its surfaces have radii of curvature R. It has two diffrent media of refractive indices μ_1 and μ_3 respectively, on its two sides (shown in the figure). Calculate its focal length for $\mu_1 < \mu_2 < \mu_3$, when light is incident on it as shown **[JEE 2003 (Mains) 2/60]**



20. A point object is situated at the centre of a solid glass sphere of radius 6cm and refractive index 1.5 . The distance of its virtual image from the surface of the sphere is. **[JEE 2004 (Scr.) 3/84]**

(A) 4 cm (B) 6 cm (C) 9 cm (D) 12 cm

21. An equilaterial prism is kept on a horizontal surface. A typical ray of light PQRS is shown in the figure. For minimum deviation **[JEE 2004 (Scr.), 3/84]**



(A) the ray PQ must be horizontal (B) the ray RS must be horizontal

(C) the ray QR must be horizontal (D) any one of them can be horizontal

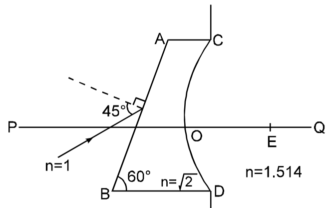
22. A ray of white light is incident on an interface between glass and air from glass towards air. The angle of incidence is such that the green light just suffers total internal reflection. The ray of light emerging from glass to air contains: **[JEE 2004 (Scr.), 3/84]**

(A) red, orange and yellow colours (B) violet, indigo and blue colour

(C) all colours (D) all colours except green

23. A ray of light in air is incident on face AB of an irregular block made of material with refractive index $\sqrt{2}$, as shown in figure. The face CD opposite to AB is a spherical surface of radius of curvature 0.4 m. From this face the refracted ray enters a medium of refractive index 1.514 and meets the axis PQ at point E. Determine the distance OE correct to two decimal places.

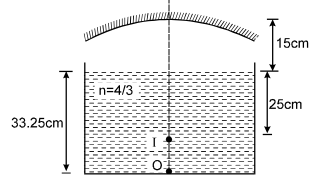
[JEE 2004 (Mains) 2/60]



24. An object is placed at a distance of 0.4 m from a lens having focal length 0.3 m. The object is moving towards the lens at a speed of 0.01 m/s. Find the rates of change of position of image and lateral magnification of image. **[JEE 2004 (Mains) 4/60]**

25. Figure shows object O. Final image I is formed after two refractions and one reflection is also shown in figure. Find the focal length of mirror. (in cm) :

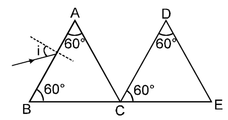
[JEE 2005 (Scr) 3/60]



(A) 10 (B) 15 (C) 20 (D) 25

26. In the figure two triangular prisms are shown each of refractive index $\sqrt{3}$.

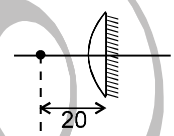
[JEE 2005 (Mains) 4/60]



(a) Find the angle of incidence on the face AB for minimum deviation from the prism ABC?

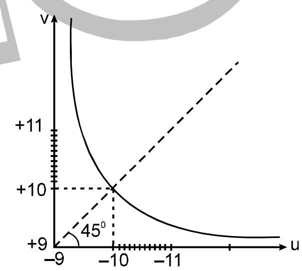
(b) Find the angle through which the prism DCE should be rotated about the edge passing through point C so that there should be minimum deviation from the system?

27. A point object is placed at distance of 20 cm from a thin planoconvex lens of focal length 15 cm. The plane surface of the lens is now silvered. The image created by the system is at : **[JEE 2006]**



(A) 60 cm to the left of the system. (B) 60 cm to the right of the system.
(C) 12 cm to the left of the system. (D) 12 cm to the right of the system.

28. The graph between object distance u and image distance v for a lens is given below. The focal length of the lens is: **[JEE 2006]**



(A) 5 ± 0.1 (B) 5 ± 0.05

(C) 0.5 ± 0.1 (D) 0.5 ± 0.05

29. A biconvex lens of focal lengthf forms a circular image of radius r of sun in focal plane. Then which option is correct: **[JEE 2006]**

(A) $\pi r^2 \propto f$
(B) $\pi r^2 \propto f^2$
(C) If lower half part is convered by black sheet, then area of the image is equal to $\pi r^2/2$
(D) if f is doubled, intensity will increase

ANSWER

EXERCISE - 1

SECTION (A) :

A 1. 120º anticlockwise and 240º clockwise.

A 2. 30º clockwise.

A 3. 60º **A 4.** 40º

A 5. Mirror should be placed on the path of the rays at an ∠ of 78º or 12° to the horizontal

A 6. Mirror should be placed at an ∠ of 45° to the horizontal with mirror surface facing upwards

A 7. (a) 1 ; (b) (4, 0) ; (c) No

A 8. Position of image = (1 cos 60º, – 1 sin 60º)

Velocity of image = 1 cos 60º $\hat{i}$, + 1 sin 60º $\hat{j}$ m/s.

A 9. (4, 0, 0)

SECTION (B) :

B 1. infinitely large. **B 2.** 61.25 cm

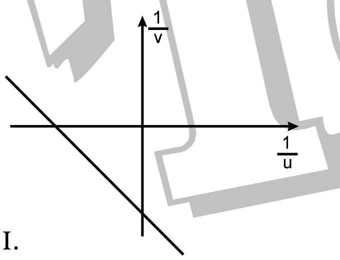
B 3. 1.95 m **B 4.** 10.35 cm

B 5. approx 0.1cm inside the ball bearing 5×10^{-3}cm.

B 6. 16 cm **B 7.** 84 cm, 0.05 m

B 8. 0.2 m from the mirror

B 9.



B 10. I.

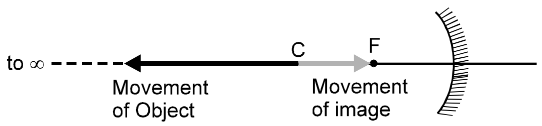
B 11. virtual, virtual

B 12. **(i)** Real object, Virtual image,
(ii) smaller, larger

B 13. Virtual object, Real image

B 14. larger, smaller

B 15.



real, 2f, infinity : real,2f , f

B 16. (a) 40 cm/s opposite to the velocity object.,

(b) 20 cm/s opposite along the velocity of object.

B 17. 60 cm

SECTION (C) :

C 1. $2/3 \times 10^{-8}$ sec **C 2.** 9.9 mm

C 3. 30 cm **C 4.** 25 cm.

C 5. 35 cm , Shift = 5 cm.

C 6. $\frac{68}{3}$ cm **C 7.** 0.9 cm above P

C 8. 2.25 cm, 1.78 **C 9.** (i) $\frac{R}{\mu}$ (ii) $\frac{(R-h)}{\mu}$

C 10. $\frac{\pi h^2}{\mu^2 - 1}$ **C 11.** 45°

C 12. $\mu > \sqrt{2}$ **C 13.** $\alpha > \sin^{-1}\frac{8}{9}$

SECTION (D) :

D 1. 90º

D 2. 37º, This deviation is not minimum.

D 3. $\theta = 60°$

D 4. $38° = \delta_m = 2\sin^{-1}(3/4) - 60º$

D 5. (i) 1.5°, (ii) $\frac{3°}{8}$

SECTION (E) :

E 1. 240 cm away from the separating surface

E 2. (a) 2, (b) not possible, it will focus close to the centre if the refractive index is large

E 3. 40 cm from pole in the medium of refrative index 1, virtual, erect and 4 cm in size.

E 4. 80 cm **E 5.** 50 cm

E 6. 13.5 cm below the surface of water

E 7. (i) No shift is observed (ii) 1 cm

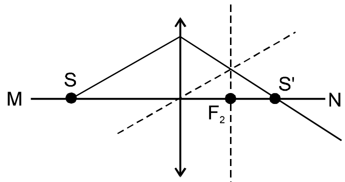
E 8. 8/3 mm, virtual at v = - 20, no invertion

SECTION (F) :

F 1. 75 cm, 150 cm **F 2.** ± 24 cm, ± 120 cm

F 3. 360 cm; ∞ ; – 600 cm

F 4.



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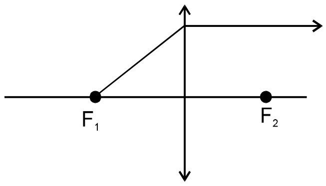
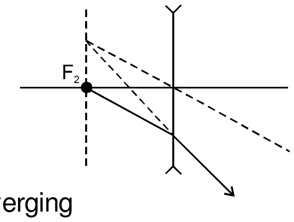
F 5. **(a)**



(b)



F 6. Converging

F 7 (a) $\dfrac{\mu_3 R}{2\mu_2 - \mu_1 - \mu_3}$ (b) $\dfrac{\mu_1 R}{2\mu_2 - \mu_1 - \mu_3}$

F 8. 20 cm, 1 m, –4, 24 cm **F 9.** 0.3 m

F 10. **(i)** $F_1/F_2 = 1.4$
(ii) In this liquid the 1st lens will be diverging & the 2nd a converging one

F 11. 1 m **F 12.** 16 cm

F 13. 3 cm **F 14.** 28/75 = 0.37 cm

F 15. 15 cm

F 16. 60 cm from the lens further away from the mirror

F 17. 30 cm from the lens further away from the mirror

F 18. 1.67 cm from the lens

F 19. At the object itself, of the same size

F 20. 30.33 cm from the lens

F 21. 1.0 cm if the light is incident from the side of concave lens and 2.5 mm if it is incident from the side of the convex lens.

F 22. 60 cm from the diverging lens or 210 cm from the converging lens.

SECTION (G) :

G 1. 10 D , Optical power of each lens = 5 D.

G 2. 10 cm for convex lens and 60 cm for concave lens

G 3. – 6.7 D

G 4. 75 cm

G 5. (a) 15 cm from the lens on the axis
(b) 1.14 cm towards the lens

SECTION (H) :

H 1. (a) 0.2° (b) 0.72°

H 2. 7.2°

H 3. (a) $\dfrac{2(\mu_v - \mu_r)}{\mu_v' - \mu_r'}$, (b) $\dfrac{2(\mu_y - 1)}{\mu_y' - 1}$

EXERCISE - 2

SECTION (A) :

A 1. B	**A 2.** B	**A 3.*** C
A 4. C	**A 5.** D	**A 6.** C
A 7. C	**A 8.** B	**A 9.** C

SECTION (B) :

B 1. D	**B 2.*** A B	**B 3.** B
B 4. A	**B 5.** A	**B 6.** D
B 7. C	**B 8.** C	**B 9.** C
B 10.* BC	**B 11.** C	**B 12.** B
B 13. C	**B 14.** C	**B 15.** A
B 16. A	**B 17.*** A C D	**B 18.** C
B 19. C	**B 20.** B	**B 21.** A

SECTION (C) :

C 1. C	**C 2.** B	**C 3.** C
C 4. A	**C 5.** D	**C 6.** B
C 7. D	**C 8.** A	**C 9.** A
C 10. B	**C 11.*** B D	***C 12.*** *A*

SECTION D :

D 1. B	**D 2.** C	**D 3.** C
D 4.* C D	**D 5.*** A D	**D 6.** B
D 7.* A C	**D 8.** A	**D 9.** D
D 10. C	**D 11.** B	

SECTION (E) :

E 1. B	**E 2.** C	**E 3.** A
E 4. A	**E 5.** D	**E 6*.** A C

SECTION (F) :

F 1. A	**F 2.** A	**F 3.** A
F 4. C	**F 5.** C	**F 6.** D
F 7. D	**F 8.** D	**F 9.** C
F 10.* B C D	**F 11.** B	**F 12.** D
F 13. A	**F 14.*** A B C	**F 15.*** B C
F 16. B	**F 17.** A	**F 18.** A

SECTION (G) :

G 1.* A C	**G 2.** B	**G 3.** A
G 4. A	**G 5.** C	**G 6.*** A C
G 7. D		

SECTION (H) :

H 1. D	**H 2.** D	**H 3.** C
H 4. B	**H 5.** D	**H 6.** A
H 7. D	**H 8.*** B C	**H 9.*** A B C
H 10.* B D		

EXERCISE - 3

Q.No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans	BD	C	B	B	BD	A	B	AD	ABD	B
Q.No.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans	C	A	AB	D	A	B	C	B	B	D
Q.No.	**21**	**22**	**23**	**24**	**25**					
Ans	C	D	A B	ABC	ABC					

EXERCISE - 4

1. **(i)** $\sin^{-1}\left[\frac{1}{\sqrt{2}}\left(\sqrt{n^2 - n_1^{\,2}} - n_1\right)\right]$

(ii) $r_1 = \sin^{-1}(n \sin 45º) = 72.94º$

2. f = 0.4 m, separation = 0.6 m

3. B, C

4. On the object itself

5. 90 cm from the lens towards right

6. **(i)** D **(ii)** C, D **(iii)** A

7. **(i)** $\lambda_0 = 600$ nm, n = 1.5
(ii) $i = \sin^{-1}(0.75) = 48.59º$

8. $(r/R)_{max} = 1/2$

9. A

10. $\vec{r} = \frac{3}{5\sqrt{2}}\,\hat{i} + \frac{2\sqrt{2}}{5}\,\hat{j} - \frac{1}{\sqrt{2}}\,\hat{k}$
(angle of incidence = 60º, r = 45º)

11. m = 4/3

12. $f_1 = -70$ cm, $f_2 = 70$ cm,
V = 560 cm to the right of L_2

13. **(a)** B **(b)** A **(c)** D **(d)** D

14. A′B′ at 15 cm to the right of mirror. B′ is 0.3 cm above RS & A′ is 1.5 cm below RS. Magnification is 1.5

15. (i) C (ii) D

16. **(i)** A = 4º, θ = 0.04 **(ii)** n = 8/5 = 1.6

17. **(i)** B **(ii)** B **(iii)** C **18.** **(i)** B **(ii)** D

19. $f = \frac{\mu_3 R}{(\mu_3 - \mu_1)}$

20. B **21.** C **22.** A

23. OE = 6.06 m

24. $\frac{dv}{dt} = 0.09$ m/s; $\frac{dm}{dt} = -0.3\ \text{sec}^{-1}$

25. C **26.** (a) i = 60° (b) 60°

27. C **28.** B **29.** B