PHYSICS

BOOKS - DC PANDEY PHYSICS (HINGLISH)

REFRACTION OF LIGHT

Example

1. Find the speed of light of wavelength $\lambda = 780nm$ (in air) in a medium of refractive index $\mu = 1.55$.

(b) What is the wavelength of this light in the given medium ?

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2. Refractive index of glass with respect to water is $(9/8)$.

Refractive index of glass with respect to air is $(3/2)$. find the refractive

index of water with respect to air .

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3. A ray of light passes through two slabs of same thickness. In the first slab n_1 waves are formed and in the second slab n_2. Find refractive index of second medium with respect to first.

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4. A light beam, passes from medium 1 to medium 2. Show that the emerging beam is parallel to the incident beam.

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5. A ray of light falls on a glass plate of refractive index $\mu = 1.5$.

What is the angle of incidence of the ray if the angle between the

reflected and

refracted rays is 90°?

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6. A pile 4m high driven into the bottom of a lake is 1m above the water . Determine the length of the shadow of the pile on the bottom of the lake if the sun rays make an angle of 45° with the water surface . The refractive index if water is $\frac{4}{3}$.`

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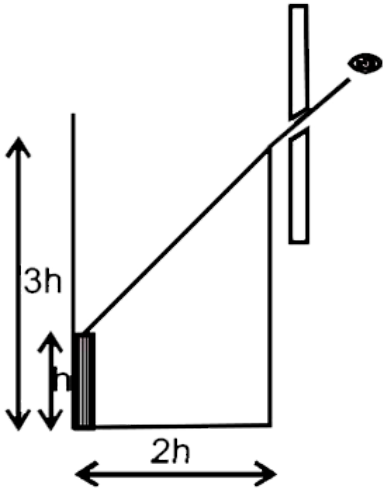
7. An observer can see through a pin-hole the top end of a thin rod of height h, placed as shown in the figure. The beaker height is 3h and its radius h. When the beaker is filled with a liquid up to a height 2h, he can

see the lower end of the rod. Then the refractive index of the liquid is



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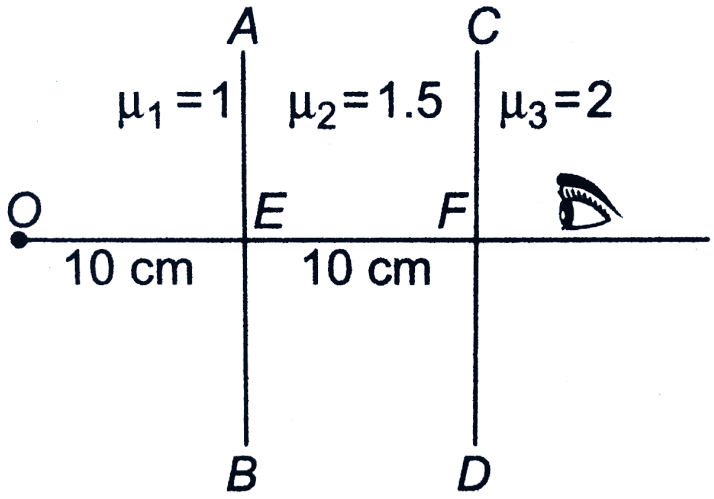
8. In Fig, find position of second image I_2 formed after two times refraction from two place surfaces AB and CD.



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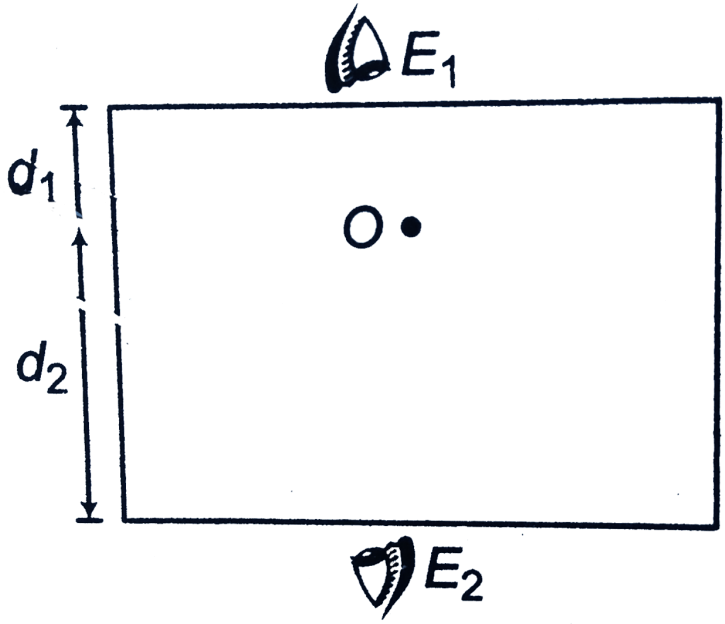
9. Refractive index of the glass slab is 1.5. There is a point object O inside the slab as shown. To eyeE_1 object appears at a distance of $6cm$ (From the top surface) and to eye E_2 it appears at a distance of $8cm$

(from the bottom surface). Find thickness of teh glass slab.



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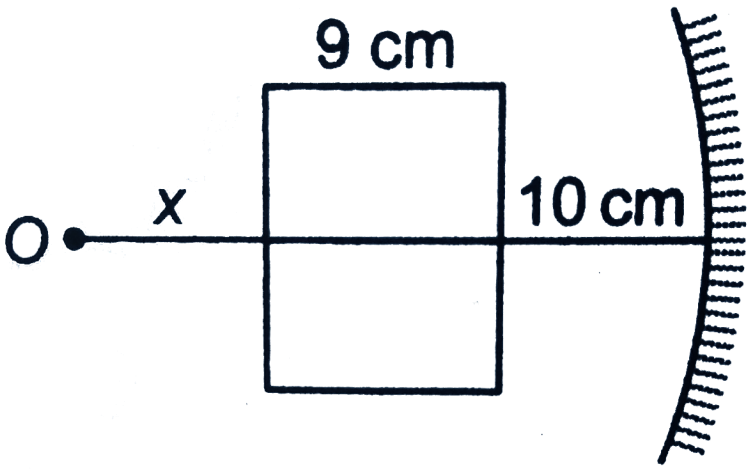
10. Refractive index of glass slab shown in figure is 1.5. Focal length of mirror is $20cm$. Find

(a) total number of reflections before final image is formed.

(b) reduced steps.

(c) value of x, so that final image coincides with the object.



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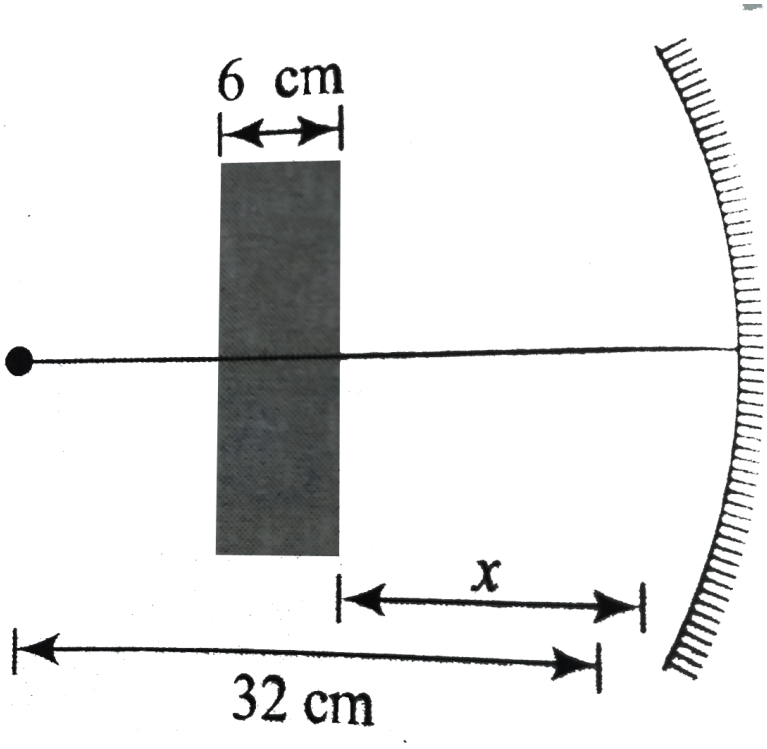
11. A point object O is placed in front of a concave mirror of focal length 10cm. A glass slab of refractive index $\mu = 3/2$ and thickness 6cm is inserted between the object and mirror.

Find the position of final image when the distance x shown in Fig... is, (a)

5cm and (b) 20 cm.



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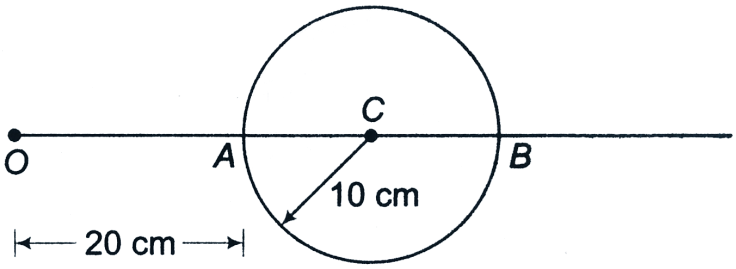
12. A glass sphere of radius $R = 10cm$ is kept inside water. A point object O is placed at $20cm$ from A as shown in figure. Find the position and nature of the image when seen from other side of the sphere. Also draw

the ray diagram. Given, $\mu_g = 3/2$ and $\mu_w = 4/3$



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13. A convex lens of power $2D$ and a concave lens of focal length $40cm$ are kept in contact, find

(a) Power of combination , (b) Equivalent focal length

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14. A converging lens of focal length $5.0cm$ is placed in contact with a diverging lens of focal length $10.0cm$. Find the combined focal

length of

the system.

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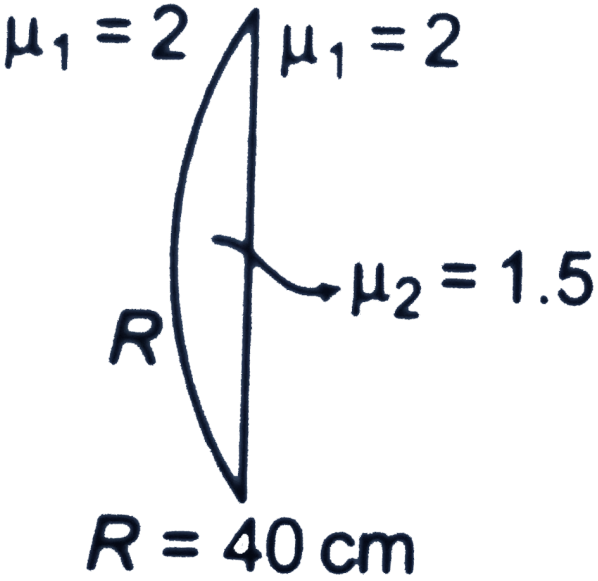

15.

Find focal length of the system shown in figure from left hand side.

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16. Focal length of a convex lense in air is $10cm$. Find its focal length in water. Given that $\mu_g = 3/2$ and $\mu_w = 4/3$.

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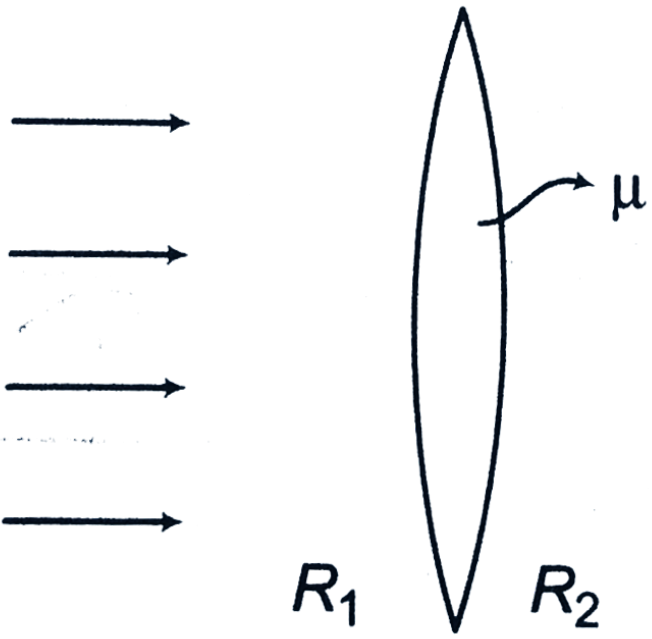
17. A biconvex lens $(\mu = 1.5)$ has radius of curvature $20cm$ (both). find its focal length.



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18. Find distanace of image from a convex lens of focal length $20cm$ if object is placed at a distance of $30cm$ from the lens. Also find its magnification.

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19. Find the distance of an object from a convex lens if image is two times magnified. Focal length of the lens is $10cm$

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20. Under what condition, a concave lens can make a real image.

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21. An image I is formed of point object O by a lens whose optic axis is AB as shown in figure.

(a) State whether it is a convex lens or concave?

(b) Draw a ray diagram to locate the lens and its focus.

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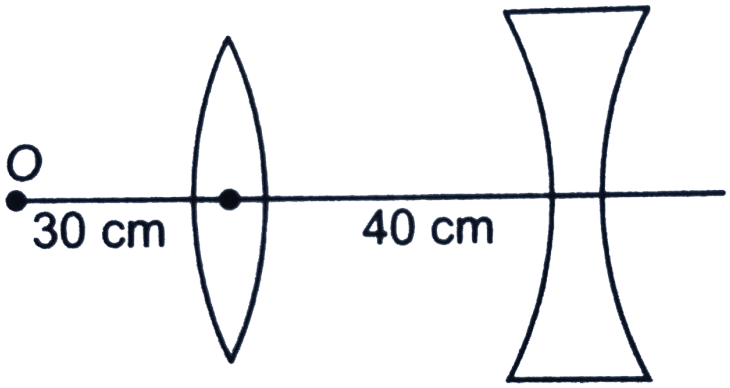
22. Focal length of a convex lens in air is $20cm.$ and of concave lens 40cm. Find the position of final image.



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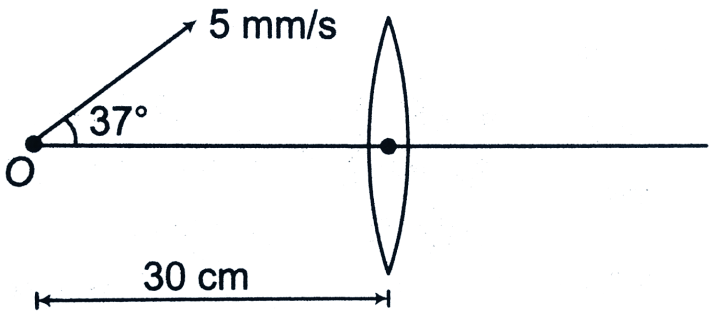
23. Focal length of the convex lens shown in figure is $20cm$. Find the image position and image velocity.



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24. Focal length of concave lens shown in figure is 60 cm. Find image position and its magnification.

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25. An isotropic point source is placed at a depth h below the water surface. A floating opaque disc is placed on the surface of water so that

the source is not visible from the surface. What is the minimum radius of the disc? Take refractive index of $\text{water} = \mu$.

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26. A point source of light is placed at a distance h below the surface of a large and deep lake. Show that the fraction f of light that escape directly from water surface is independent of h and is given by

$$f = \frac{\left[1 - \sqrt{1 - 1/\mu^2}\right]}{2}$$

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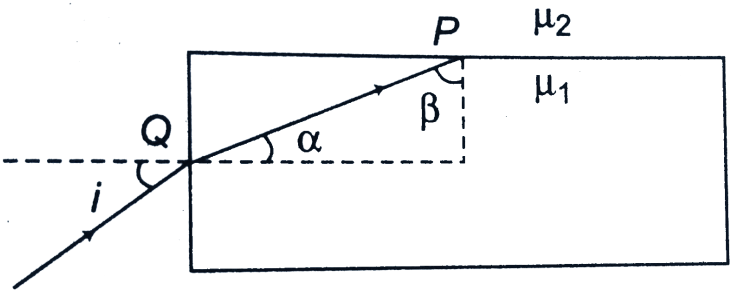
27. In the figure shown, $\mu_1 > \mu_2$. Find minimum value of i so that TIR never takes place at P.



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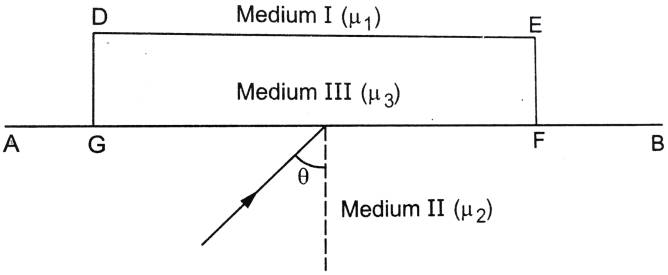
28. Monochramatic light is incident on the pLane interface AB between two media of refractive indices μ_1 and $\mu_2(\mu_2 > \mu_1)$ at an angle of incidence theta as shown in figure. The angle theta is infinitesimally greater thannte critical angle for the two media so thast total internal reflection takes place. Now, if a transparent slab DEFG of uniform thickness and of refractive inde μ_2 is introduced on theinterface (as shown in figure) , show that for any value of μ_2 all light will ultimately be

reflected back into medium II.



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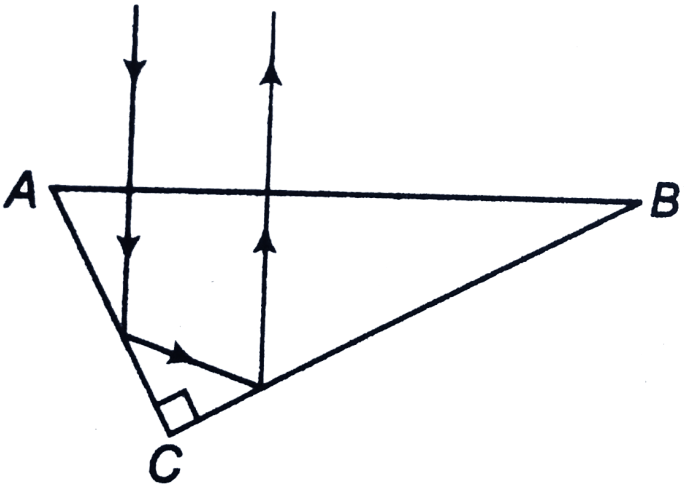
29. A right angled prism is to be made by selecting a proper material and the angles A and B `(BleA), as shown in figure. It is desired that a ray of light incident on the face AB emerges parallel to the incident direction after two internal reflections.



(a) What should be the minimum refractive index n for this to be possible?

(b) For $n = \frac{5}{3}$ is it possible to achieve this with the angle B equal to 30 degrees?

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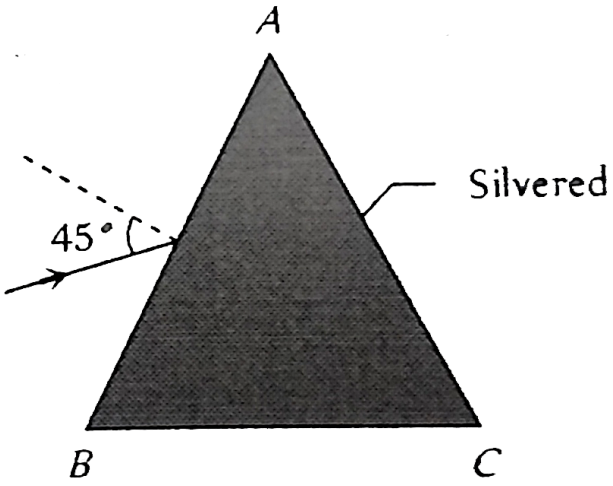
30. A prism ABC of angle 30° has its face AC silvered. A ray of light incident at an angle of 45° at the face AB retraces its path after refraction at face AB and reflection at face AC . The refractive index of the material of the prism is



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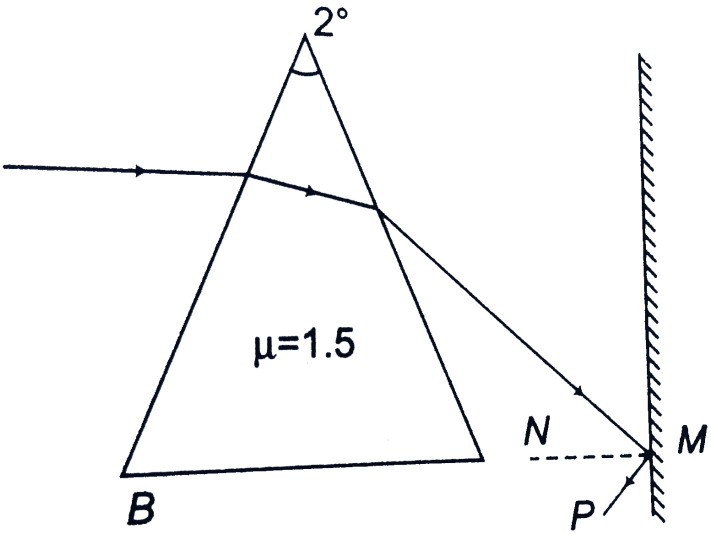
31. In the shown figure, mirror is rotated by an angle theta. Find theta if



ray of light retraces its path after reflection from M

ray of light MP turns in the direction of MN.

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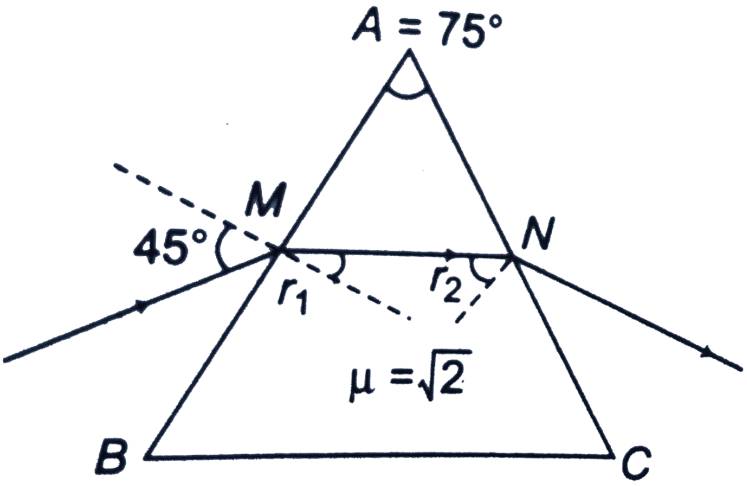
32. General method of finding deviation by prism.



In the ray diagram shown in figure, find total deviation by prism.

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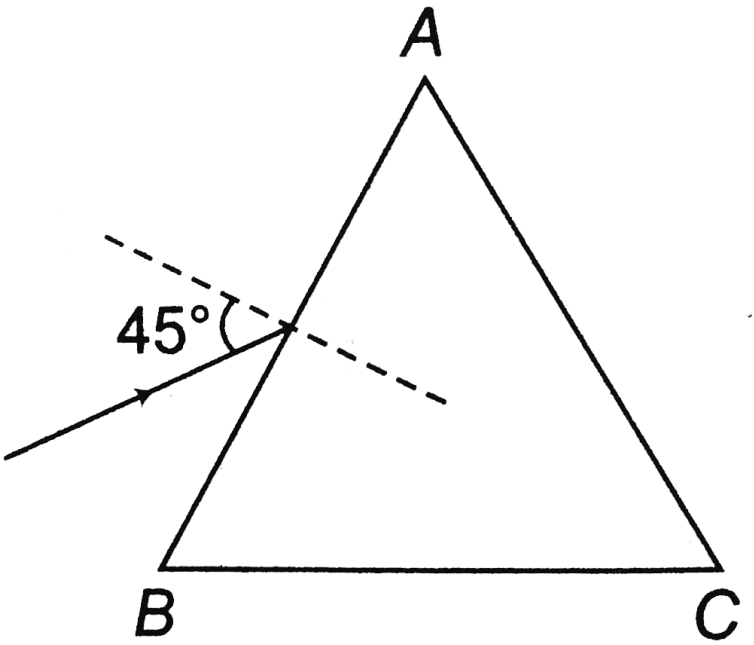
33. Based on the condition of no emergence from face AC

In the shown figure,

$A = 110^\circ, B = 20^\circ, C = 50^\circ, i_1 = 45^\circ$ and $\mu = \sqrt{2}$

Find the total deviation by prism.



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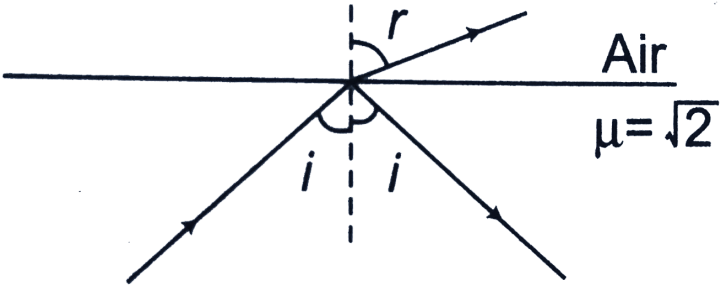
34. Theory



In the figure, i is increased from $0^\circ \text{to} 90^\circ$. But ray of light is travelling from denser to rarer medium. Therefore, TIR will take place when $i > \theta_C$, where $\theta_C = \sin^{-1}\left(\frac{1}{\mu}\right) = \sin^{-1}\left(\frac{1}{\sqrt{2}}\right) = 45^\circ$

From $0^\circ - 45^\circ$, refraction and reflection both will take place. After 45°, only reflection will take place.

Question Plot delta verses i graph between incident ray and refracted ray and, for $i \leq 45^\circ$ and with reflected ray for $i \geq 45^\circ$.

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35. An astronomical telescope has an angular magnification of magnitude 5 for distant object. The separation between the objective and eyepiece is

$36cm$ and the final image is formed at infinity. Determine the focal length of objective and eyepiece.

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36. A telescope has an objective of focal length $50cm$ and an eyepiece of focal length $5cm$. The least distance of distinct vision is $25cm$. The telescope is focused for distinct vision on a scale $2m$ away from the objective. Calculate (a) magnification produced and (b) separation between objective and eyepiece.

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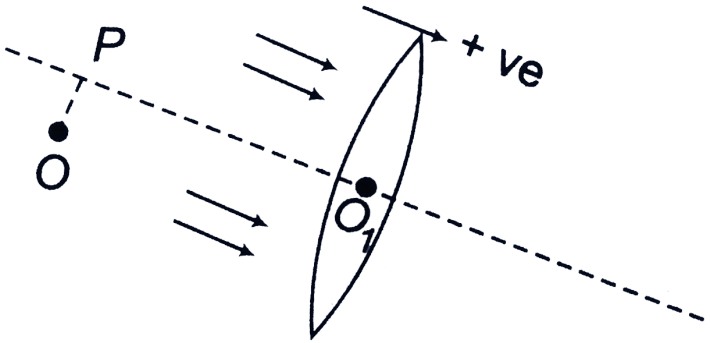
Example Type 10



1.

O_1P is the principal axis and O is the point object. Given,

$O_1P = 30cm$, $f = 20cm$ and $OP = 2mm$. Find the image distance and its position.

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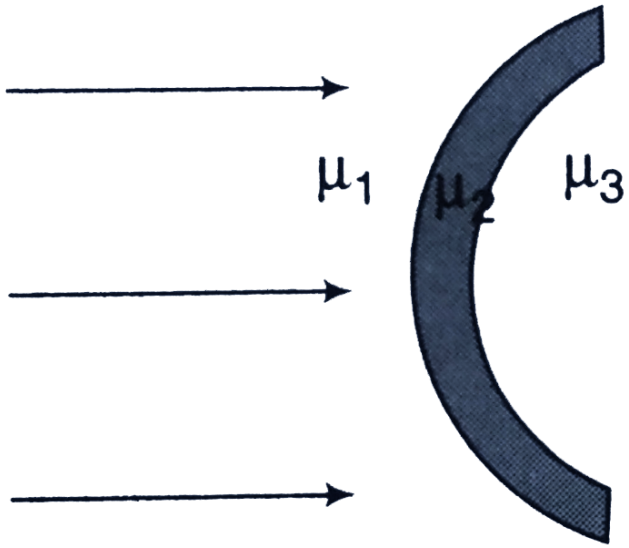
Example Type 11

1. In the figure, light is incident on a thin lens as shown. The radius of curvature for both the surfaces is R. Determine the focal length of this



system.

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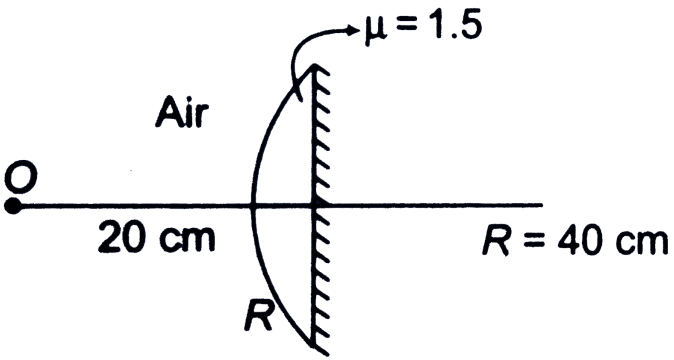

2.

Find focal length of the system as shown if figure.

Find image position.

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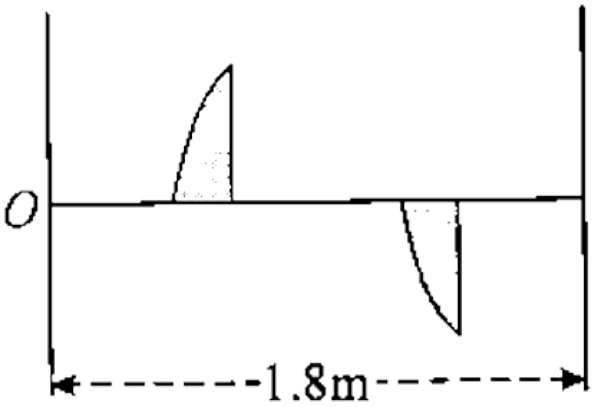
3. A thin plano-convex lens of focal length f is split into two halves. One of the halves is shifted along the optical axis as shown in figure. The separation between object and image planes is 1.8 m. The magnification of the image, formed by one of the ball lens is 2. Find the focal length of the lens and separation between the two halves. Draw the ray diagram for image formation.



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Solved Example

1. A spherical convex surface separates object and image space of refractive index 1.0 and $\frac{4}{3}$. If radius of curvature of the surface is $10cm$, find its power.

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2. A ray of light is incident at an angle of 60° on the face of a prism having refracting angle 30°. The ray emerging out of the prism makes an angle 30° with the incident ray. Show that the emergent ray is perpendicular to the face through which it emerges.

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3. The angle of minimum deviation for a glass prism with $\mu = \sqrt{3}$ equals the refracting angle of the prism. What is the angle of the prism?

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4. The distance between two point sources of light is $24cm$. Find out where would you place a converging lens of focal length $9cm$, so that the images of both the sources are formed at the same point.

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5. A source of light is located at double focal length from a convergent lens. The focal length of the lens is $f = 30cm$. At what distance from the lens should a flat mirror be placed, so that the rays reflected from the mirror are parallel after passing through the lens for the second time?

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6. Two equi-convex lenses of focal length $30cm$ and $70cm$, made of material of refractive index $= 1.5$, are held in contact coaxially by a rubber band round their edges.A liquidof refractive index 1.3 is introduced in the space between the lenses filling it completely. Find the

position of the image of a luminous point object placed on teh axis of the combination lens at a distance of $90cm$ from it.

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7. Two thin converging lenses are placed on a common axis, so that the centre of one of them coincides with the focus of the other. An object is placed at a distance twice the focal length from the left hand lens. Where will its image be? What is the lateral magnification? The focal of each lens is f.

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8. The refracting angle of a glass prism is 30°. A ray is incident onto one of the faces perpendicular to it. Find the angle δ between the incident ray and the ray that leaves the prism. The refractive index of glass is $\mu = 1.5$.

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9. A biconvex thin lens is prepared from glass of refractive index $3/2$. The two bounding surfaces have equal radii of $25cm$ each. One of the surfaces is silvered from outside to make it reflecting. Where should an object be placed before this lens so that the image coincides with the object.

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10. An object is $5.0m$ to the left of a flat screen. A converging lens for which the focal length is $f = 0.8m$ is placed between object and screen.

(a) Show that two lens positions exist that form images on the screen and deremine how far these positions are from the object?

(b) How do the two images differ from each other?

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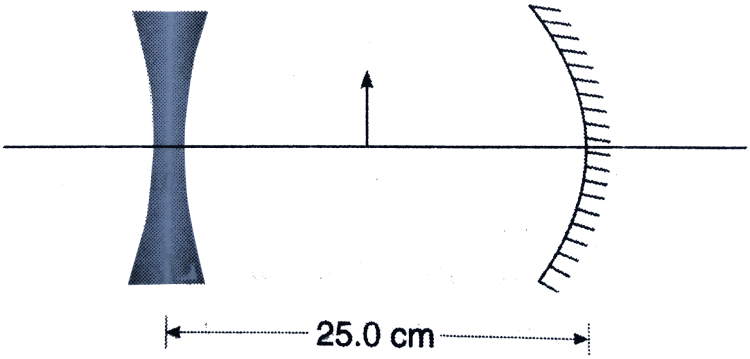
11. An object is midway between the lens and the mirror as shown. The mirror's radius of curvature is

$20.0cm$ and $the \leq nshasafocal \leq n > hof$-16.7 cm,` Considering only the rays that leaves the object and travels first towards the mirror, locate the final image formed by this system. Is this image real or virtual? Is it upright or inverted? What is the overall magnificaiton?



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12. An object is placed $12cm$ to the left of a diverging lens of focal length $-6.0cm$. A converging lens with a focal length of $12.0cm$ is placed at a distance d to the right of the diverging lens. Find the distance d that corresponds to a final image at infinity.

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13. A solid glass sphere with radius R and an index of refraction 1.5 is silvered over one hemisphere. A small object is located on the axis of the sphere at a distance 2R to the left of the vertex of the unsilvered hemisphere. Find the position of final image after all refractions and reflection have taken place.

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14. A converging lens forms a five fold magnified image of an object. The screen is moved towards the object by a distance $d = 0.5m,$ and the lens is shifted so that the image has the same size as the object. Find the power of lens and the initial distance between the object and the screen.

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15. Surfaces of a thin equi-convex glass lens have radius of curvature R. Paraxial rays are incident on it . If the final image is formed after n

internal reflections, calculate distance of this image from pole of the lens. Refractive index of glass is μ.

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Exercise 31 1

1. Given that $._1 \mu_2 = 4/3,._2 \mu_3 = 3/2$. Find $._1 \_ \mu_3$.

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2. What happens to the frequency, wavelength and speed of light that crosses from a medium with index of refraction μ_1 to one with index of refraction μ_2?

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3. A monochromatic light beam of frequency $6.0 \times 10^{14} Hz$ crosses from air into a transparent material where its wavelength is measured to be $300nm$. What is the index of refraction of the material?

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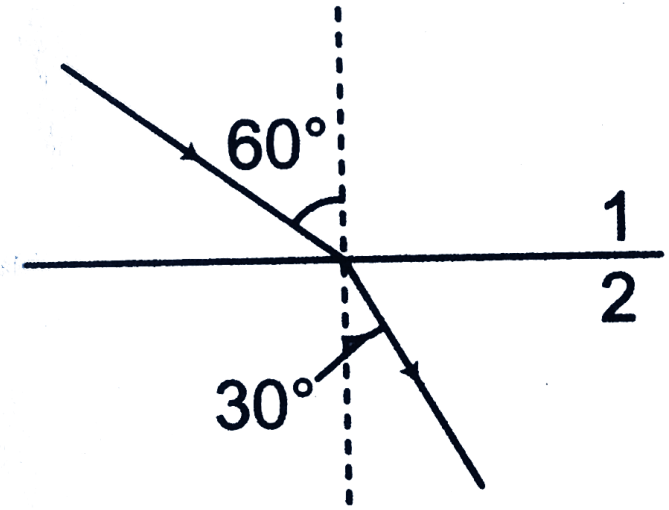
Exercise 31 2

1. In the figure shown, find $._1 \mu_2$.



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2. if ${}_1\mu_2$ is 1.5, then find the value of $\frac{\lambda_1}{\lambda_2}$.

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Introductory Exercise

1. In the figure shown, at what distance

(a) E_2 will appear to E_1

(b) E_1 will appear to E_2

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2. When a pin is moved along the principal axis of a small concave mirror, the image position coincides with the object at a point $0.5m$ from the mirror. If the mirror is placed at a depth of $0.2m$ in a transparent liquid,

the same phenomenon occurs when the pin is placed $0.4m$ from the mirror. find the refractive index of the liquid shown in fig.

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3. In figure, light refracts from material 1 to a thin layer of material 2, crosses that layer, and then is incident at the critical angle on the interface between materials 2 and 3.

(a) What is the angle θ?

(b) if θ is decreased, is there refraction of light into material 3?

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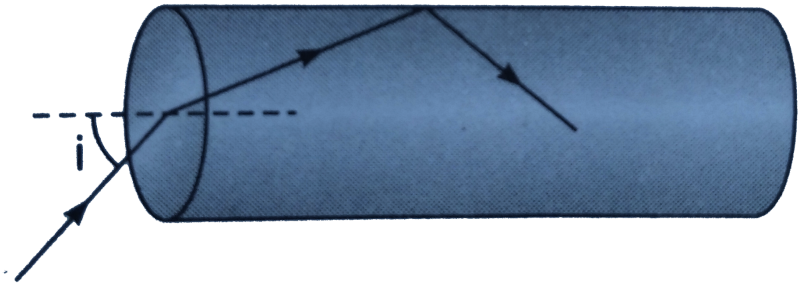
4. Light is incident at an angle i on one planer end of a transparent cylinderical rod of refractive index μ. Find the least value of μ so that the light entering the rod does not emerge from the curved surface of the

rod irrespective of the value of i.



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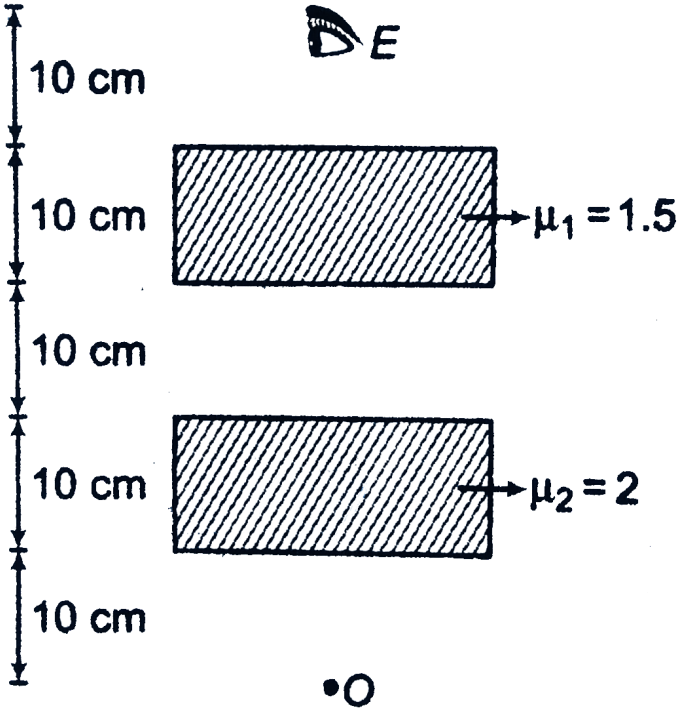
Exercise 31 4

1. At what distance eye E will observe the fourth image (after four refractions from plane surfaces) of object O from itself.



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Exercise 31 5

1. If an object is placed at the centre of a glass sphere and it is seen from outside, then prove that its virtual image is also formed at centre.

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2. A glass sphere of $(\mu = 1.5)$ with a radius of $15.0cm$ has a tiny air bubble $5cm$ above its centre. The sphere is viewed looking down along the extended radius containing the bubble. What is the apparent depth of the bubble below the surface of the sphere?

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3. One end of a long glass rod $(\mu = 1.5)$ is formed into a convex surface of radius $6.0cm$. An object is positioned in air along the axis of the rod. Find the image positions corresponding to object distances of (a) $20.0cm$, (b) $10.0cm$, (c) $3.0cm$ from the end of the rod.

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4. A dust particle is inside a sphere of refractive index $\frac{4}{3}$. If the dust particle is $10.0cm$ from the wall of the $15.0cm$ radius bowl, where does it appear to an observer outside the bowl.

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5. A parallel beam of light enters a clear plastic bead $2.50cm$ in diameter and index 1.44. At what point beyond the bead are these rays brought to a focus?

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Exercise 31 6

1. When an object is placed $60cm$ in front of a diverging lens, a virtual image is formed $20cm$ from the lens. The lens is made of a refractive index $\mu = 1.65$ and its two spherical surfaces have the same radius of curvature. What is the value of this radius?

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2. A converging lens has a focal length of $30cm$. Rays from a $2.0cm$ high filament that pass through the lens from a virtual image at a distance of $50cm$ from the lens. Where is the filament located? What is the height of the image?

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3. Show that the focal length of a thin lens is not changed when the lens is rotated so that the left and the right surfaces are interchanged.

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4. As an object is moved from the surface of a thin converging lens to a focal point, over what range does the image distance very?

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5. A diverging lens is made of material with refractive index 1.3 and has identical concaves surfaces of radius $20cm$. The lens is immersed in a transparent medium with refractive index 1.8.

(a) What is now the focal length of the lens?

(b) What is the minimum distance taht an immersed object must be from the lens so that a real image is formed?

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6. An object is located $20cm$ to the left of a converging lens with $f = 10cm$. A second identical lens is placed to the right of the first lens and then moved until the image it produces is identical in size and orientiation to the object. What is the separation between the lenses?

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7. Suppose an object has thickness du so that it extends from object distance u to $u + du$. Prove that the thickness dv of its image is given by

$\left(-\frac{v^2}{u^2}\right)du$, so the longitudinal magnification $\frac{dv}{du} = -m^2$, where m is the lateral magnification.

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8. Two thin similar convex glass are joined together front to front, with its rear portion silvered such that a sharp image is formed $0.2m$ for an object at infinity. When the air between the glass pieces is replaced by water $\left(\mu = \frac{4}{3}\right)$, find the position of image.

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9. When a lens is inserted between an object and a screen which are fixed distance apart the size of the image is either 6 cm or $\frac{2}{3}cm$. Find size of the object

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10. A lens of focal length $12cm$ forms an upright image three times the size of a real object. Find the distance in cm between the object and image.

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11. The distance between an object and its upright image is $20cm$. if the magnification is 0.5, what is the focal length of the lens that is being used to form the image?

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12. A thin lens of focal length $+10.0cm$ lies on a horizontal plane mirror. How far above the lens should an object be be held if its image is to coincide with the object?

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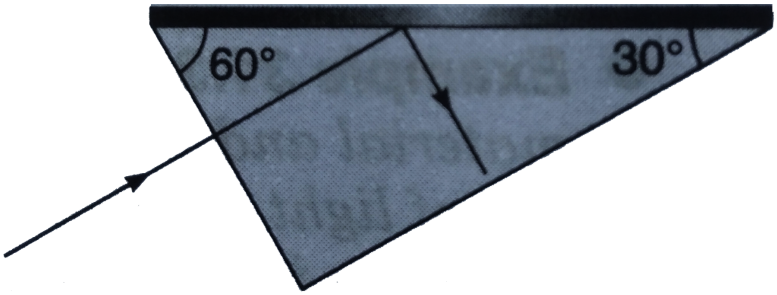
Exercise 31 7

1. Light is incident normally on the short face of a $30^\circ - 60^\circ - 90^\circ$ prism. A liquid is poured on the hypotenuse of the prism. If the refractive index of the prism is $\sqrt{3}$, find the maximum refractive index of the liquid so that light is totally reflected.



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2. If the speed of light in ice is $2.3 \times 10^8 m/s$, what is its index of refraction? What is the critical angle of incidence for light going from ice to air?

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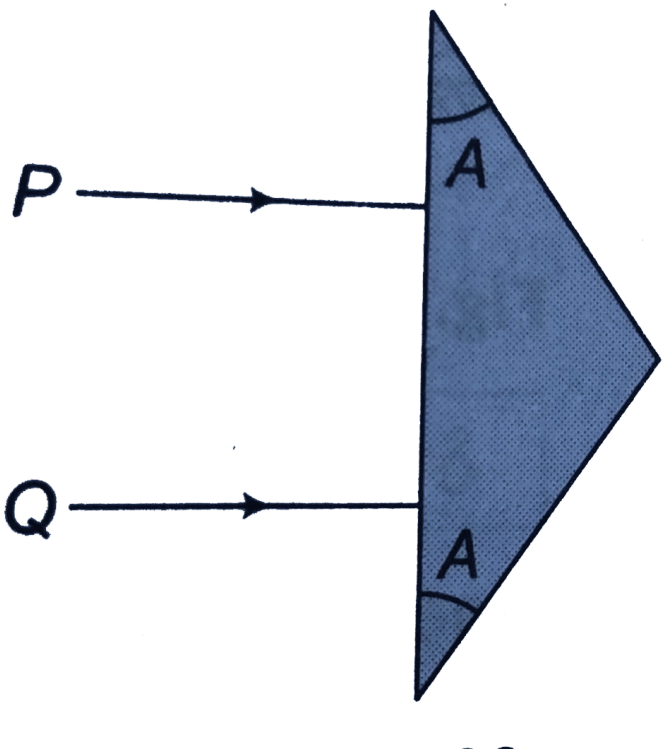
Exercise 31 8

1. The prism shown in figure has a refractive index of 1.60 and the angles A are 30°. Two light rays P and Q are parallel as they enter the prism. What is the angle between them after they emerge? $\left[\sin^{-1}(0.8) = 53^\circ\right]$



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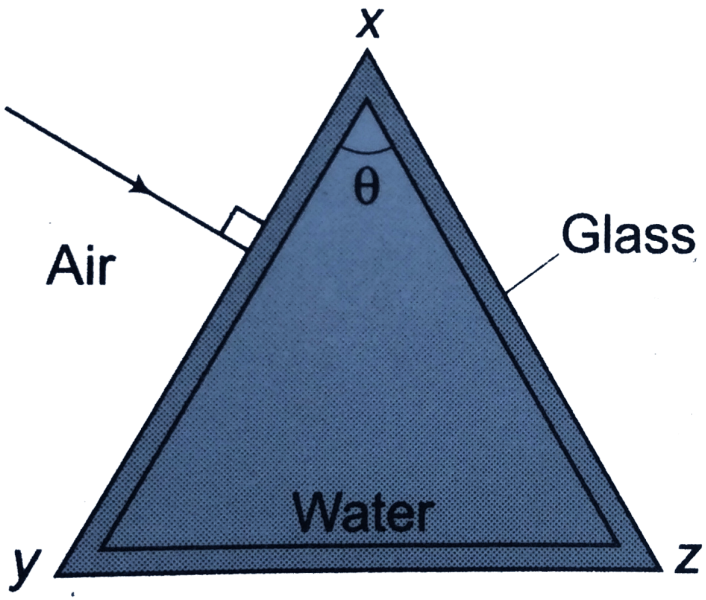
2. A glass vessel in the shape of a triangular prism is filled with water, and light is incident normally on the face xy. If the refractive indices for water and glass are $4/3$ and $3/2$ respectively, total internal reflection will occur a the glass-air surface xz only for $\sin\theta$ greater than

A $1/2$, B $2/3$

C $3/4$, D $8/9$

E $16/27$



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3. A light ray going through a prism with the angle of prism 60°, is founded to deviate at least by 30°. what Is the range of the refractive index of the prism?

Watch Video Solution

4. A ray of light falls on a normally on a refracting face of a prism. Find the angle of prism if the ray just fails to emerge from the prism $(\mu = 3/2)$.

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5. A ray of light is incident at an angle of 60° on the face of a prism having refracting angle 30°. The ray emerging out of the prism makes an angle 30° with the incident ray. Show that the emergent ray is perpendicular to the face through which it emerges and calculate the refractive index of the material of prism.

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6. A ray of light passing through a prism having refractive index $\sqrt{2}$ suffers minimum deviation. It is found that the angle of incidence is double the angle of refraction within the prism. What is the angle of prism?

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7. A ray of light undergoes deviation of 30° when incident on an equilateral prism of refractive index $\sqrt{2}$. what is the angle subtended by the ray inside the prism with the base of the prism?

Watch Video Solution

8. The refractive index of the material of a prism of refracting angle 45° is 1.6 for a certain monochromatic ray. What will be the minimum angle of

incidence of this ray on the prism so that no TIR takes place as the ray comes out of the prism.

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Level 1 Assertion And Reason

1. Assertion: Therefore is a glass slab between Ram and Anoop. Then, Ram appears nearer to Anoop as compared to the actual distance between them.

Reason: Ray of light starting from Ram will undergo two times refraction before reaching Anoop.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: B

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2. Assertion: Minimum distance between object and its real image by a convex lens is $4f$.

Reason: If object distance from a convex lens is $2f$, then its image distace is also $2f$.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: A::B

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3. Assertion: In case of single refraction by a plane surface image and object are on same side.

Reason: If object is real, image will be virtual and vice-versa.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: B

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4. Assertion: Ray of light passing through optical centre of a lens goes undeviated.

Reason: Ray falls normal at optical centre and in normal incidence, there is no deviation of light.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: C

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5. Assertion: In displacement method of finding focal length of a convex lens its magnification in one position of lens is $+2,$ then magnification in another position of lens should be $-\frac{1}{2}$.

Reason:This method can't be applied for a concave lens.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: B

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6. Assertion: If object is placed at infinity, then a virtual image will be formed at first focus of a concave lens.

Reason: First focal length of a concave lens is positive.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: D

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7. Assertion:Minimum deviation by an equilateral prism of refractive index sqrt2 is 30°.

Reason: It is from the relation, $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: A

Watch Video Solution

8. Assertion:A convex lens and a concave lens are kept in contact. They will behave as a diverging lens if focal length of convex lens is more.

Reason: Power of a concave lens is always less than the power of a convex

lens, as power of concave lens is negative whereas power of convex lens is positive.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: C

Watch Video Solution

9. Assertion: Image of an object is of same size by a convex lens. If a glass slab is placed between object and lens, image will become magnified.

Reason: By inserting the slab, image may be real or virtual.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: B

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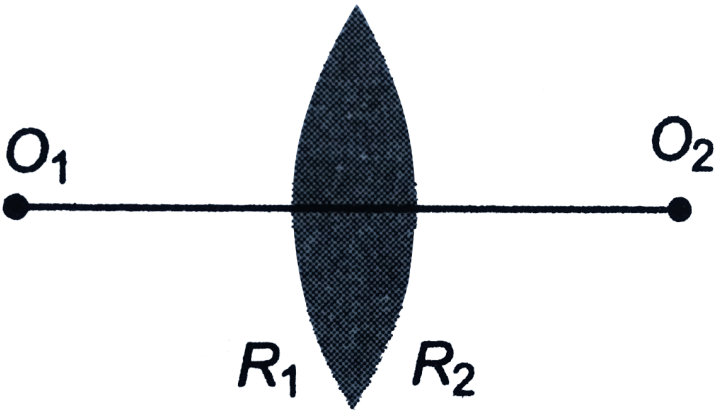
10. Assertion: In the figure shown $|R_1| > |R_2|$.Two point objects O_1 and O_2 are kept at same distance from the lens. Image distance of O_1 from the lens will be more compared to the image distance of O_2.



Reason: If medium on two sides of the lens is different, we cannot apply lens formulae directly.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: D

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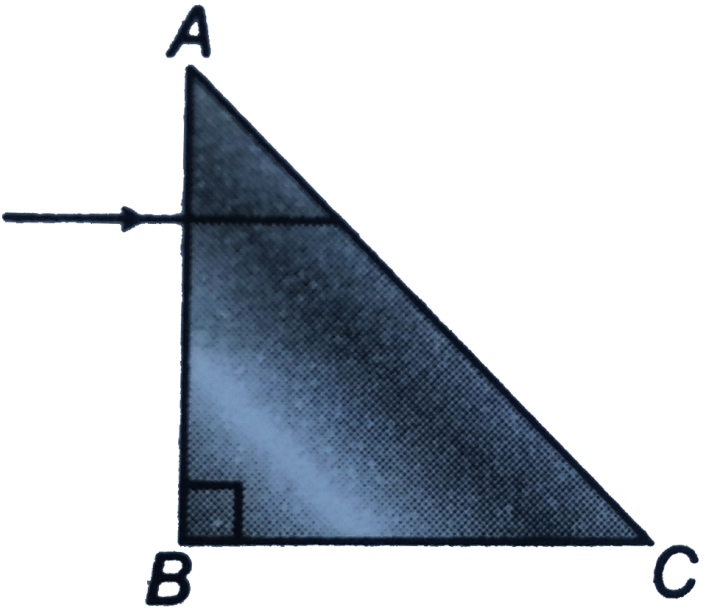
11. Assertion: White light is incident on face AB of an isosceles right angled prism as shown. Colors, for which refractive index of material of prism is more than 1.414, will be able to emerge from the face AC.



Reason: Total internal reflection cannot take place for the light travelling from a rarer medium to a denser medium.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: D

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12. Assertion:Image formed by concave lens is not always virtual.

Reason:Image formed by a lens is real if the image is formed in the direction of ray of light with respect to the lens.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: B

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13. Assertion:Although the surfaces of goggle lens are curved, It does not have any power.

Reason: In case of goggles, both the curved surfaces have equal radii of curvature and have centre of curvature on the same side.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

C. If both Assertion is true, but the Reason is false.

D. If both Assertion is false but the Reason is true.

Answer: A

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Level 1 Objective

1. An endoscope is employed by a physician to view the internal parts of body organ. It is based on the principle of

A. refraction

B. reflection

C. total internal reflection

D. dispersion

Answer: C

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2. Refractive index mu is given as $\mu = A + \frac{B}{\lambda^2}$, where A and B are constants and lambda is wavelength, then dimensions of B are same as that of

A. wavelength

B. volume

C. pressure

D. area

Answer: D

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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

Answer: C

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4. Critical angle of light passing from glass to air is least for

A. red

B. green

C. yellow

D. violet

Answer: D

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5. The power in dioptre of an equi-convex lens with radii of curvature of 10cm and refractive index 1.6 is

A. $+12$

B. $+18$

C. $+1.2$

D. $+1.8$

Answer: A

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6. The refractive index of water is $4/3$. The speed of light in water is

A. $1.50 \times 10^8 m/s$

B. $1.78 \times 10^8 m/s$

C. $2.25 \times 10^8 m/s$

D. $2.67 \times 10^8 m/s$

Answer: C

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7. White light is incident from under water on the the water-air interface. If the angle of incidence is slowly increased from zero, the emergent beam coming out into the air will turn from

A. white to violet

B. white to red

C. white to black

D. None of these

Answer: C

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8. When light enters from air to water, then its

A. frequency increases and speed decreases

B. frequency is same but the wavelength is smaller in water than in air

C. frequency is same but the wavelength in water is greater than in air

D. frequency decreases and wavelength is smaller in water than in air

Answer: B

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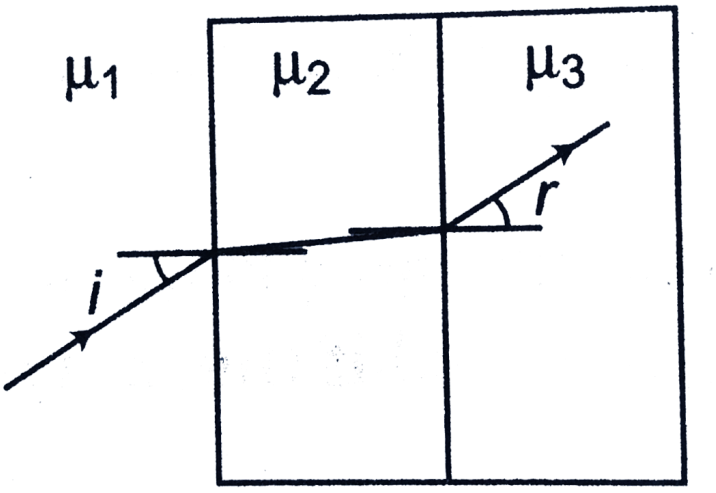
9. In the figure shown $\frac{\sin i}{\sin r}$ is equal to



A. $\frac{\mu_2^2}{\mu_3\mu_1}$

B. $\frac{\mu_3}{\mu_1}$

C. $\frac{\mu_3\mu_1}{\mu_2^2}$

D. $\frac{\mu_1}{\mu_3}$

Answer: B

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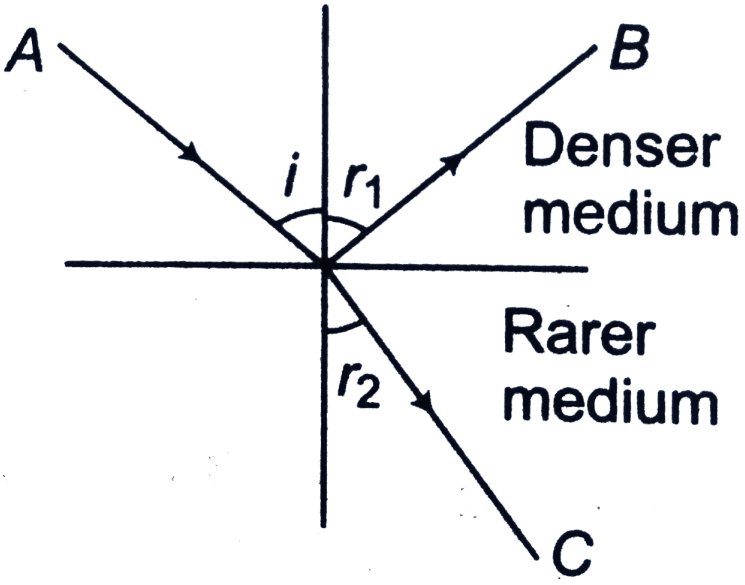
10. In figure, the reflected ray B makes an angle 90° with the ray C. If I, r_1 and r_2 are the angles of incidence, reflection and refraction,

respectively. Then, the critical angle of the medium is



A. $\sin^{-1}(\tan i)$

B. $\sin^{-1}(\cot i)$

C. r_1

D. r_2

Answer: A

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11. A prism of apex angle $A = 60^\circ$ has the refractive index $\mu = \sqrt{2}$. The angle of incidence for minimum deviation is

A. 30°

B. 45°

C. 60°

D. None of these

Answer: B

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12. A thin equi-convex lens is made of glass of refractive index 1.5 and its length is $0.2m$. If it acts as a concave lens of $0.5m$ focal length when dipped in a liquid, the refractive index of the liquid is

A. $\frac{17}{8}$

B. $\frac{15}{8}$

C. $\frac{13}{8}$

D. $\frac{9}{8}$

Answer: B

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13. A ray of light, travelling in a medium of refractive index mu, is incident at an angle i on a composite transparent plate consisting of three plates of refractive indices μ_1, μ_2 and μ_3. The ray emerges from the composite plate into a medium of refractive index μ_4, at angle x. Then,

A. $\sin x = \sin i$

B. $\sin x = \frac{\mu}{\mu_4} \sin i$

C. $\sin x = \frac{\mu_4}{\mu} \sin i$

D. $\sin x = \frac{\mu_1 \mu_3 \mu}{\mu_2 \mu_2 \mu_4} \sin i$

Answer: B

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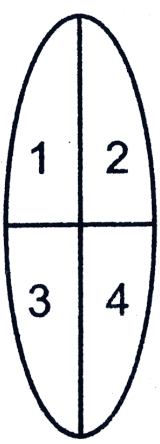
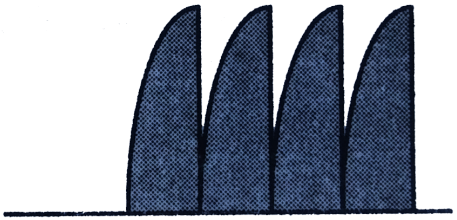
14. The given equi-convex lens is broken into four parts and rearranged as shown. If the initial focal length is f, then after rearrangement the equivalent focal length is





A. f

B. $f/2$

C. $f/4$

D. $4f$

Answer: B

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15. A thin convergent glass lens $(\mu_g = 1.5)$ has a power of $+5.0D$. When this lens is immersed in a liquid of refractive index μ_1, it acts as a divergent lens of focal length $100cm$. The value of μ_1 is

A. $4/3$

B. $5/3$

C. $5/4$

D. $6/5$

Answer: B

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16. Two convex lenses of focal length $10cm$ and $20cm$ respectively placed coaxially and are separated by some distance d. The whole system behaves like a concave lens. One of the possible value of d is

A. $15cm$

B. $20cm$

C. $25cm$

D. $40cm$

Answer: B

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17. A prism can have a maximum refracting angle of (θ_C = critical angle for the material of prism)

A. 60°

B. θ_C

C. $2\theta_C$

D. slightly less than 180°

Answer: C

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18. A ray is ihncident at an angle of incidence ii on one surface of a prism of small angle A and emerge normally from opposite surface. If the refractive index of the material of prism is μ. the angel of incidance I is nearly equal to

A. $\frac{A}{\mu}$

B. $\frac{A}{2\mu}$

C. μA

D. $\mu A/2$

Answer: C

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19. The refracting angle of a prism is A and refractive index of the material of prism is $\cot(A/2)$. The angle of minimum deviation will be

A. $180^\circ - 3A$

B. $180^\circ + 2A$

C. $90^\circ - A$

D. $180^\circ - 2A$

Answer: B

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20. A prism of refractive index sqrt2 has refractive angle 60°. In the order that a ray suffers minimum deviation it should be incident at an angle of

A. 45°

B. 90°

C. 30°

D. None

Answer: A

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21. The focal length of a combination of two lenses is doubled if the separation between them is doubled. If the separation is increased to 4 times, the magnitude of focal length is

A. doubled

B. quadrupled

C. halved

D. same

Answer: A

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22. A convexo-concave convergent lens is made of glass of refractive index 1.5 and focal length $24cm$. Radius of curvature for one surface is double than 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. $18, 36$

Answer: A

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23. An optical system consists of a thin convex lens of focal length $30cm$ and a plane mirror placed $15cm$ behind the lens. An object is placed $15cm$ in front of the lens. The distance of the final image from the object is

A. $60cm$

B. $30cm$

C. $75cm$

D. $45cm$

Answer: D

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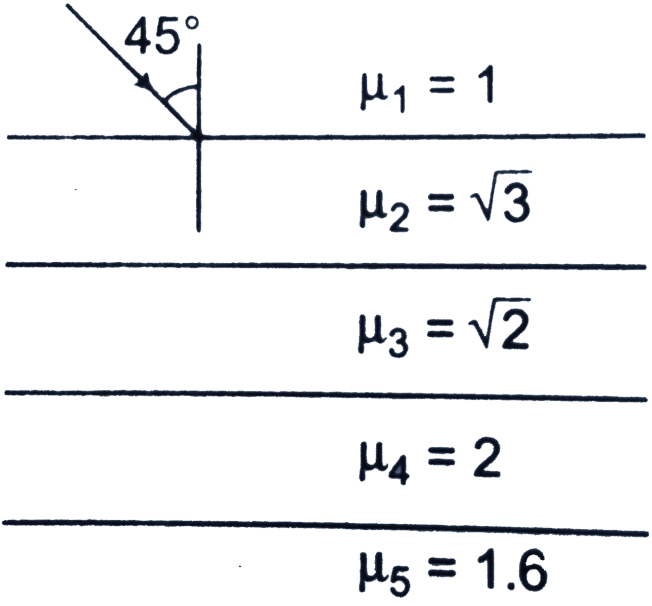
24. In the figure shown, the angle made by the light ray with the normal in the medium of refractive index $\sqrt{2}$ is



A. 30°

B. 60°

C. 90°

D. None of these

Answer: A

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25. For refraction through a small angled prism, the angle of minimum deviation

A. increases with increase in refractive index of a prism

B. will be 2δ for a ray of refractive index 2.4 if it is delta for a ray of refractive index 1.2

C. is directly proportional to the angle of the prism

D. will decrease with increase in refractive index of the prism

Answer: A

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26. A ray of light passes from vaccum 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. $2\sin^{-1}(n/2)$

Answer: C

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27. A thin convex lens of focal length $30cm$ is placed in front of a plane mirror. An object is placed at a distance x from the lens (not in between lens and mirror) so that its final image coincides with itself. Then, the value of x is

A. $15cm$

B. $30cm$

C. $60cm$

D. Insufficient data

Answer: B

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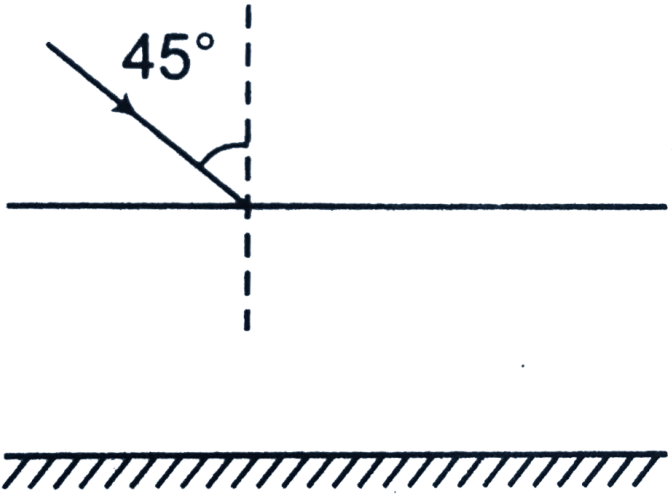
28. One side of a glass slab is silvered as shown in the figure. A ray of light is incident on the other side at angle of incidence 45°. Refractive index of glass is given as $\sqrt{2}$. The deflection suffered by the ray when it comes out of the slab is



A. 90°

B. 180°

C. 120°

D. 45°

Answer: A

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29. A prism has refractive index $\sqrt{\frac{3}{2}}$ and refractive angle 90°. Find the minimum deviation produced by prism

A. 60°

B. 45°

C. 30°

D. 15°

Answer: C

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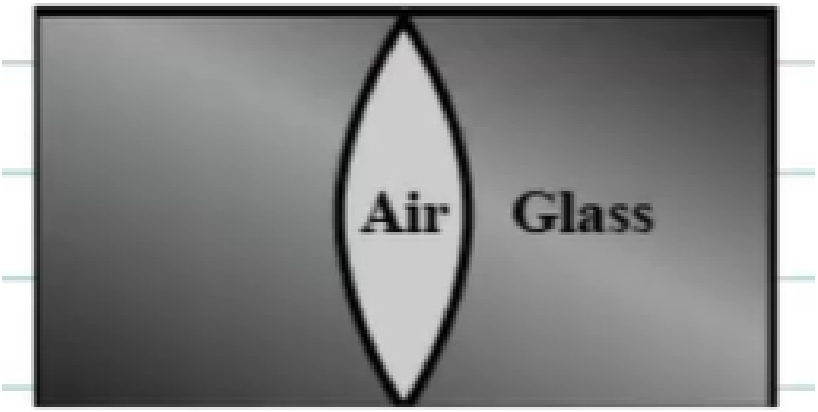
30. In figure, an air lens of radius of curvature of each surface equal to $10cm$ is cut into a cylinder of glass of refractive index 1.5. The focal length and the nature of lens are



A. $15cm$ diverging

B. $15cm$ converging

C. $10cm$ diverging

D. $10cm$ converging

Answer: A

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31. A point object is placed at a distance of $12cm$ from a convex lens of focal length $10cm$. On the other side of the lens, a convex mirror is placed at a distance of $10cm$ from the lens such that the image formed by the combination coincides with the object itself. The focal length of the convex mirror is

A. $20cm$

B. $25cm$

C. $15cm$

D. $30cm$

Answer: B

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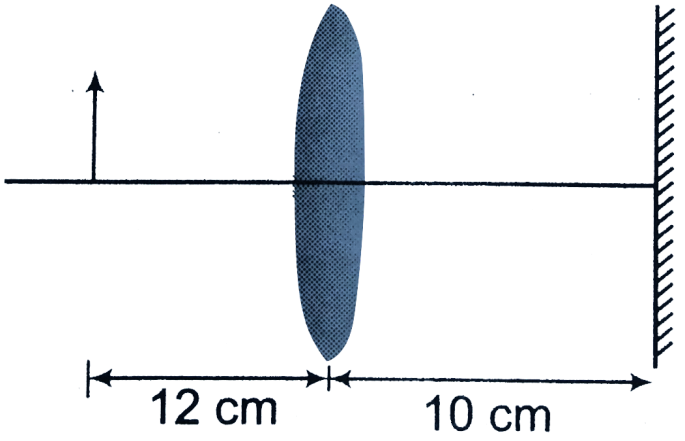
32. An object, a convex lens of focal length $20cm$ and a plane mirror are arranged as shown in the figure. How far behind the mirror is the second

image formed?



A. $30cm$

B. $20cm$

C. $40cm$

D. $50cm$

Answer: C

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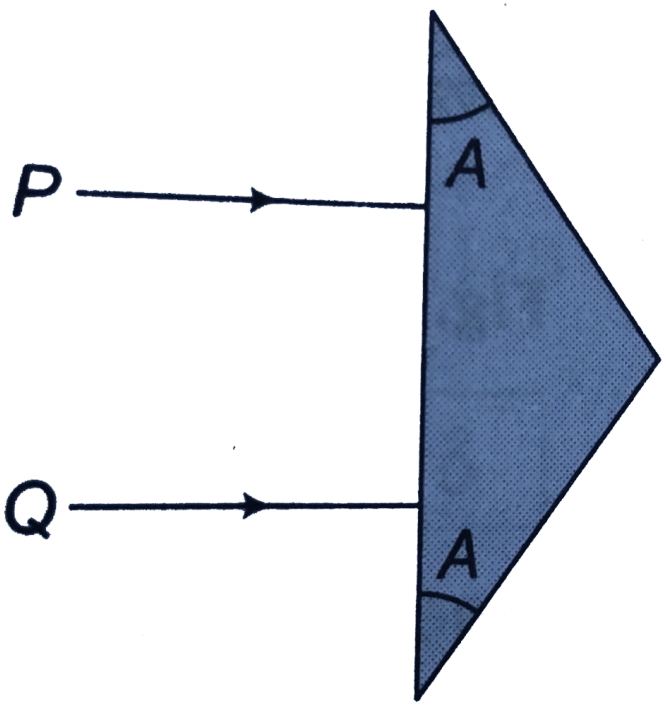
33. The prism shown in figure has a refractive index of 1.60 and the angles A are 30°. Two light rays P and Q are parallel as they enter the prism.

What is the angle between them after they emerge? $\left[\sin^{-1}(0.8) = 53^\circ\right]$



A. 15°

B. 30°

C. 45°

D. 60°

Answer: B

Watch Video Solution

34. A prism having refractive index $\sqrt{2}$ and refractive angle 30° has one of the refractive surfaces polished. A beam of light incident on the other surfaces will trace its path if the angle of incidence is

A. 0°

B. 30°

C. 45°

D. 60°

Answer: C

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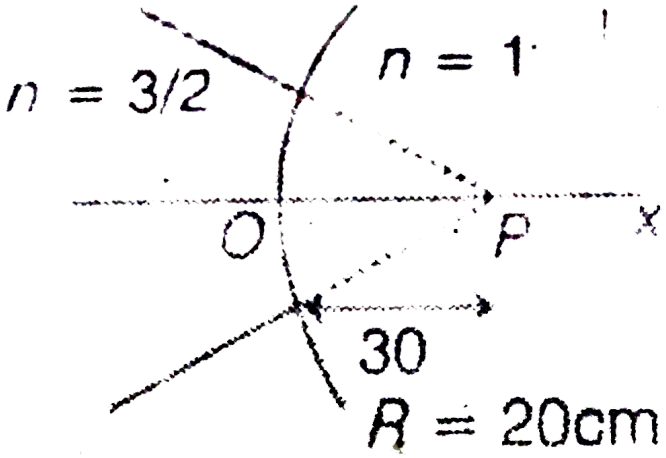
35. The image for the converging beam after refraction through the curved surface is formed at



A. $x = 40cm$

B. $x = 40/3$

C. $x = -40/3cm$

D. $x = 20cm$

Answer: A

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36. A concavo-convex lens is made of glass of refractive index 1.5. The radii of curvature of its two surfaces are $30cm$ and $50cm$. Its focal length when placed in a liquid of refractive index 1.4 is

A. $200cm$

B. $500cm$

C. $800cm$

D. $1050cm$

Answer: D

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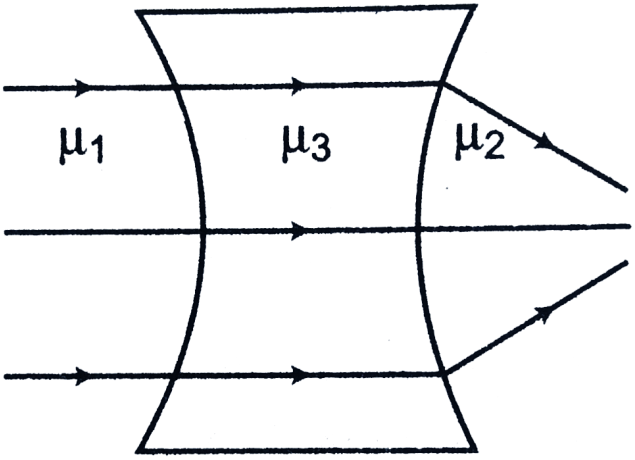
37. From the figure shown, establish a relation between $\mu_1, \mu_2,$ and μ_3



A. $\mu_1 < \mu_2 < \mu_3$

B. $\mu_3 < \mu_2, \mu_3 = \mu_1$

C. $\mu_3 > \mu_2, \mu_3 = \mu_1$

D. None of these

Answer: B

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38. When light of wavelength λ on an equilateral prism, kept on its minimum deviation position, it is found that the angle of deviation equals the angle the angle of the prism itself. The refractive index of the material of the prism for the wavelength λ is

A. $\sqrt{3}$

B. $\sqrt{3/2}$

C. 2

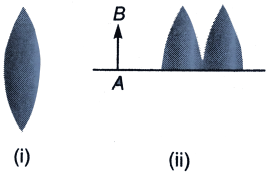
D. $\sqrt{2}$

Answer: A

Watch Video Solution

Objective Questions

1. In Fig.(i), a lens of focal length $10cm$ is shown. It is cut into two parts and placed as shown in Fig.(ii). An object AB of light $1cm$ is placed at a distance of $7.5cm$. The height of the image will be



A. $2cm$

B. $1cm$

C. $1.5cm$

D. $3cm$

Answer: A

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Level 1 Subjective

1. The laws of reflection or refraction are the same for sound as for light. The index of refraction of a medium (for sound) is defind as the ratio of the speed of sound in air $343m/s$ to the speed of sound in the medium. What is the index of refraction (for sound) of water $(v = 1498m/s)$? What is the critical angle θ, for total reflection of sound from water?

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2. Light from a sodium lamp $(\lambda_0 = 589nm)$ passes through a tank of glycerin (refractive index $= 1.47$) $20m$ long in a time t_1. If it takes a time t_2 to transverse the same tank when filled with carbon disulfide (index $= 1.63$), determine the difference $t_2 - t_1$.

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3. A light beam of wavelength $600nm$ in air passes through film $1(n_1 = 1.2)$ of thickness $1.0\mu m$,then through film 2(air) of thickness $1.5\mu m$, and finally through film $3(n_3 = 1.8)$ of $thick \neq ss$1.0mu m`.

(a) Which film does the light cross in the least time, and what is that least time?

(b) What are the total number of wavelength (at any instant) across all three films together?

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4. An object is at a distance of $d = 2.5cm$ from the surface of a glass sphere with a radius $R = 10cm$. Find the position of the final image produced by the sphere. The refractive index of glass is $\mu_{1.5}$.

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5. An air bubble is seen inside a solid sphere of glass $(n = 1.5)$ of $4.0cm$ diameter at a distance of $1.0cm$ from the surface of the sphere (on seeing along the diameter). Determine the real position of the bubble inside the sphere.

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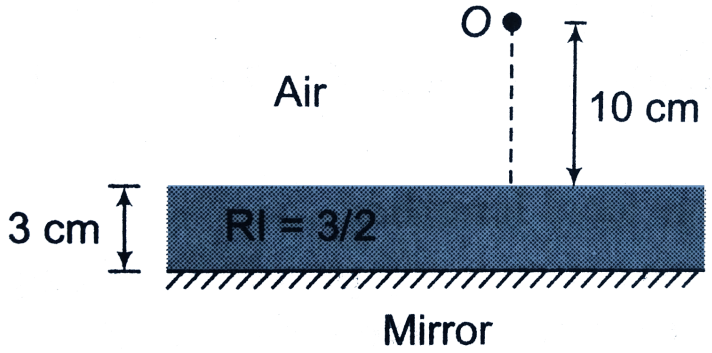
6. Find the position of final image of an object O as shown in figure.



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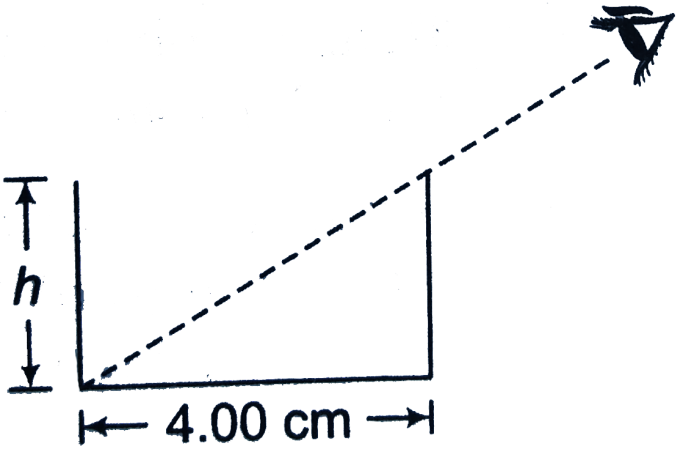
7. One face of a rectangular glass plate $6cm$ thick is silvered. An object held $8cm$ in front of the unsilvered face forms an image $10cm$ behind the silvered face.Find the refractive index of glass. Consider all the three steps.

Watch Video Solution

8. A shallow glass dish is $4.00cm$ wide at the bottom as shown in figure. When an observer's eye is positioned as shown, the observer sees the edge of the bottom of the empty dish. When this dish is $4.00cm$ wide at the bottom as shown in figure. When an observer's eye is positioned as shown, the observer sees the edge of the empty dish. When this dish is filled with water, the observer sees the centre of the bottom of the dish.

Find the height of dish $\mu_w = 4/3$.



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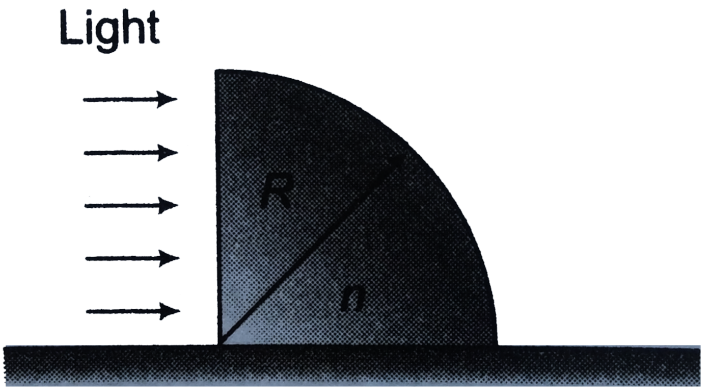
9. A glass prism in the shape of a quarter cylinder lies on a horizontal table. A uniform, horizontal light beam falls on its vertical plane surface as shown in the figure. If the radius of the cylinder is $R = 5cm$ and the refractive index of the glass is $n = 1.5,$ where on the table beyond the

cylinder, will a path of light be found?



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10. A glass sphere with $10cm$ radius has a $5cm$ radius spherical hole at its centre. A narraow beam of parallel light is directed into the sphere. Where, if anywhere, will the sphere produce an image? The index of refraction of the glass is 1.50.

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11. A glass sphere has radius of $5.0cm$ and a refractive index of 1.6. A paperweight is constructed by slicing through the sphere on a plate that is $2.0cm$ from the centre of the sphere and perpendicular to radius of the sphere that passes through the centre of the circle formed by the intersection of the plane and the sphere. The paperweight is placed on a table and viewed from directly above an observer who is $8.0cm$ from the table top, as shown in figure. When viewed through the paperweight, how far away does the table top appear to the observer?

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12. A fish is rising up veritcally inside a pond with velocity $4m/s$, and notices a bird, which is dividing downward and its velocity appear to be $16m/s$ (to fish). What is the real velocity of the diving bird, if refractive index of water is $4/3$?

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13. A lens with a focal length of $16cm$ produces a sharp image of an object in two positions, which are $60cm$ apart. Find the distance from the object to the screen.

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14. Two glasses with refractive indices of $1.5 \text{ and } 1.7$ are used to make two indentical double convex lenses.

Find the ratio between their focal lengths.

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?

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15. A converging beam of rays in incident on a diverging lens. Having passed through the lens the rays intersect at a point $15cm$ from the lens.

If the lens is removed, the point where the rays meet, move $5cm$ closer to the mounting that holds the lens. Find the focal length of the lens.

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16. A parallel beam of rays is incident on a convergent lens with a focal length of $40cm$. Where a divergent lens with a focal length of $15cm$ be placed for the beam of rays to remain parallel after passing through the two lenses.

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17. An optical system consists of two convergent lenses with focal length $f_1 = 20cm$ and $f_2 = 10cm$. The distance between the lenses is $d = 30cm$. An object is placed at a distance of $30cm$ from the first lens. At what distance from the second lens will the images be obtained ?

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18. Determine the position of the image produced by an optical system consisting of a concave mirror with a focal length of $10cm$ and a convergent lens with a focal length of $20cm$. The distance from the mirror to the lens is $30cm$ and from the lens to the object is $40cm$. Consider only two steps. Plot the image.

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19. A parallel beam of rays is incident on a consisting pf three thin lenses with a common optical axis. The focal length of the lenses are equal to $f_1 = +10cm$ and $f_2 = -20cm$, and $f_3 = +9cm$ respectively. The distance between the first and the second lens is $15cm$ and between the second and the third is $5cm$. Find the position of the point at which the beam converges when it leaves the system of lenses.

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20. A ray of light travelling in glass $(\mu_g = 3/2)$ is incident on a horizontal glass-air surface at the critical angle θ_C. If a thin layer of water $(\mu_w = 4/3)$ is now poured on the glass-air surface. At what angle will the ray of light emerges into water at glass-water surface?

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21. A ray of light is incident on the left vertical face of glass cube of refractive index n_2, as shown in figure. The plane of incidence is the plane of the page, and the cube is surrounded by liquid (refractive index $= n_1$). What is the largest angle of incidence θ_1 for which total internal reflection occurs at the top surfaces? 

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22. Light is incident from glass $\left(\mu_g = \frac{3}{2}\right)$ to water $\left(\mu_w = \frac{4}{3}\right)$. Find the range of the angle of deviat on for refracted light.

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23. The angle of minimum deviation for a glass prism with $\mu = \sqrt{3}$ equals the refracting angle of the prism. What is the angle of the prism?

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24. A ray incident on the face of a prism is refracted and escape through an adjacent face. What is the maximum permissible angle of the prism, if it is made of glass with a refractive index of $\mu = 1.5$?

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25. In an equilateral prism of $\mu = 1.5$, the condition for minimum deviation is fulfilled. If face AC is polished

Find the net deviation.

If the system is placed in water what will be the net deviation for same angle of incidence? Refractive index of water $= \frac{4}{3}$. 

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26. In a certain spectrum produced by a glass prism of dispersive power $0.0305,$ it is found that the refractive index for the red ray is $1.645.$ and that for the violet ray is $1.665.$ What is the refractive index for the yellow ray?

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27. An achromatic lens-doublet is formed by placing in contact a convex lens of focal length $20cm$ and a concave lens of focal length $30cm.$ The dispersive power of the material of the convex lens is $0.8.$ Determine the dispersive power of the material of the concave lens. Calculate the focal length of the lens-doublet.

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28. An achromatic convergent lens of focal length $150cm$ is made by combining flint and crown glass lenses. Calculate the focal length of both the lenses and point out which one is divergent if the ratio of the dispersive power of flint and crown glasses is $3:2$.

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29. The index of refraction of heavy flint glass is 1.68 at $434nm$ and 1.65 at $671nm$. Calculate the difference in the angle of deviation of blue $(434nm)$ and red $(671nm)$ light incident at 65° on one side of a heavy flint glass prism with apex angle 60°.

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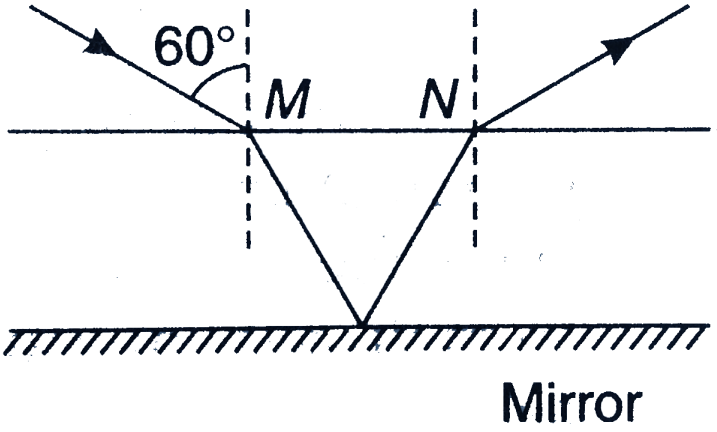
Subjective Questions

1. A plate with plane parallel faces having refractiv $\in dex1.8$ $restsonapla \neq mirr$ or . $Alightrayis \in cidentontheupperfaceoftheplate$

60^@.

$How far om the entry p \int will the ray emer \geq after ref \leq ction by the mirr$ or 6cm` thick?



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2. A point source of light S is placed at the bottom of a vessel containg a liquid of refractive index $5/3$. A person is viewing the source from above the surface. There is an opaque disc of radius $1cm$ floating on the surface. The centre of the disc lies vertically above the source S. The liquid from the vessel is gradually drained out through a tap. What is the maximum height of the liquid for which the source cannot at all be seen from above?

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3. A convexo-convex has a focal length of $f_1 = 10cm$. One of the lens surfaces having a radius of curvature of $R = 10cm$ is coated with silver. Construct the image of the object produced by the given optical system and determine the position of the image if the object is at a distance of $a = 15cm$ from the lens. Refractive index of lens $= 1.5$.

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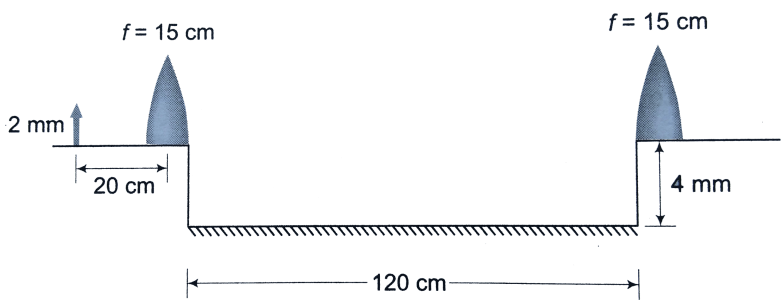
4. A convex lens of focal length $15cm$ is split into two halves and the two halves are placed at a separation of $120cm$. Between, the two halves of convex lens a plane mirror is placed horizontal and at a distance of $4mm$ below the principal axis of the lens halves. An object of length $2mm$ is placed at a distance of $20cm$ from one half lens as shown in figure.



Find the position and size of the final image.

Trace the path of rays forming the image.

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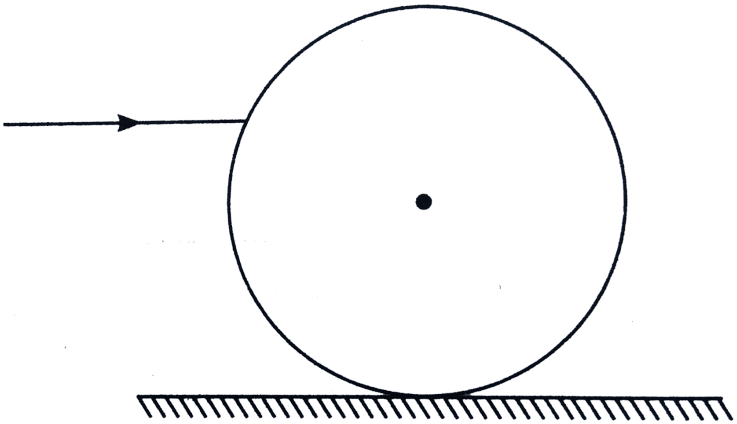
5. A cylinderical glass rod of radius $0.1m$ and refractive index $\sqrt{3}$ lies on a horizontal plane mirror. A horizontal ray of light moving perpendicular to the axis of the rod is incident on it. At what height from the mirror should the ray be incident so that it leaves the rod at a height of $0.1m$ above the plane mirror? At what centre to centre distance a second similar rod, parallel to the first, be placed on the mirror, such that the emergent ray from the second rod is in line with the incident ray on the

first rod?



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6. A ray of light is refracted through a sphere whose material has a refractive index μ in such a way that it passes through the extremities of two radii which make an angle β with each other. Prove that if α is the deviation of the ray caused by its passage through the sphere, then

$$\cos\left(\frac{\beta-\alpha}{2}\right)=\mu\cos\left(\frac{\beta}{\alpha}\right)$$

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7. A man of height $2.0m$ is standing on a level road because of temprature variation the refractive index of air is varying as $\mu = \sqrt{1+ay}$, where y is height from road. If $a = 2.0 \times 10^{-6} m^{-1}$. Then, find distant point that he can see on the road.

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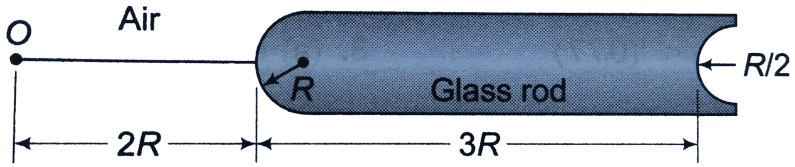
8. A glass rod has ends as shown in figure. The refractive index of glass is μ. The object O is at a distance $2R$ from the surface of larger radius of curvature. The distance between apexes of ends is $3R$. Find the distance of image formed of the point object from right hand vertex. What is the condition to be satisfied if the image is to be real?



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Level 2 Single Correct

1. A bird is flying over a swimming pool at a height of $2m$ from the water surface. If the bottom is perfectly plane reflecting surface and depth of swimming pool is $1m,$ then the distance of final image of bird from the bird itself is $\mu_w = 4/3$

A. $\frac{11}{3}m$

B. $\frac{23}{3}m$

C. $\frac{11}{4}m$

D. $\frac{11}{2}m$

Answer: D

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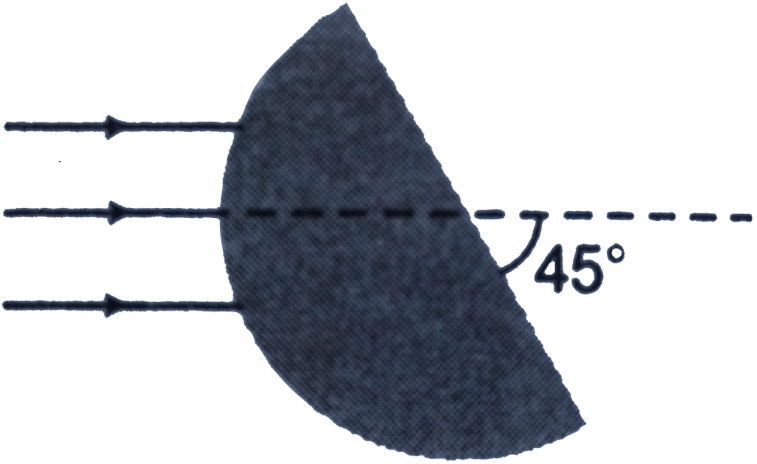
2. A parallel narrow beam of light is incident on the surface of a transparent hemisphere of radius R and refractive index $\mu = 1.5$ as

shown. The position of the image formed by refraction at the image formed by refraction at the spherical surface only as



A. $\frac{R}{2}$

B. $3R$

C. $\frac{R}{3}$

D. $2R$

Answer: B

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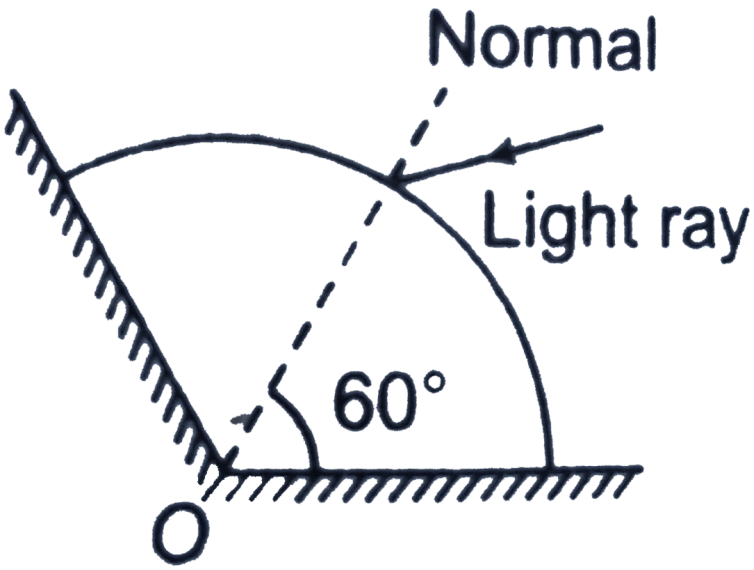
3. Consider the situation as shown in figure. The point O is the centre. The light ray forms an angle of 60° with the horizontal and each mirror makes an angle 60° with the normal. The value of refractive index of that spherical portion so that light ray retraces its path is



A. $\sqrt{2}$

B. $\frac{2}{\sqrt{3}}$

C. $\frac{3}{2}$

D. $\sqrt{3}$

Answer: D

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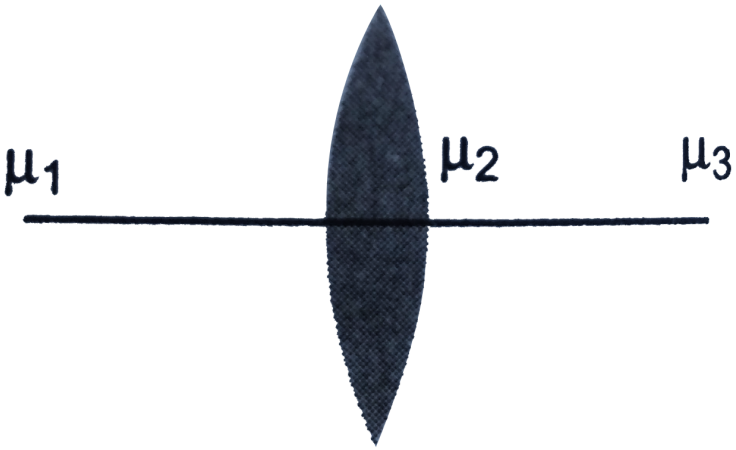
4. The figure shows an equi-convex lens. What should be the condition of the refractive indices so that the lens becomes diverging?



A. $2\mu_3 > \mu_1 - \mu_2$

B. $2\mu_2 < \mu_1 + \mu_3$

C. $2\mu_2 > 2\mu_1 - \mu_3$

D. None of these

Answer: B

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5. An object is kept at a distance of $16cm$ from a thin lens and the image formed is real. If the object is kept at a distance of $6cm$ from the lens, the image formed is virtual. If the sizes of the images formed are equal, the focal length of the lens will be

A. $19cm$

B. $17cm$

C. $21cm$

D. $11cm$

Answer: D

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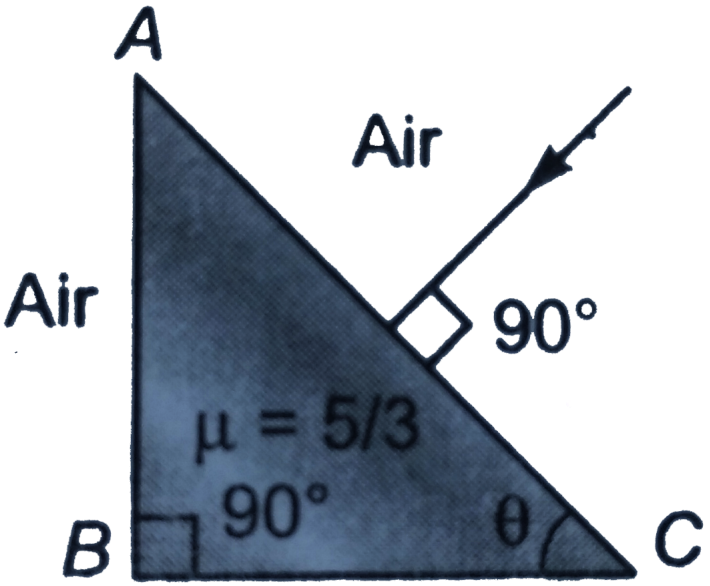
6. A ray of light makes normal incidence on the diagonal face of a right angled prism as shown in figure. If $\theta = 37^\circ$, then the angle of deviation after second step (from AB) is $(\sin 37^\circ = 3/5)$



A. 53°

B. 74°

C. 106°

D. 90°

Answer: B

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7. A bird in air looks at a fish directly below it inside in a transparent liquid in a tank. If the distance of the fish as estimated by the bird is h_1 and that of the bird as estimated by the fish is h_2, then the refractive index of the liquid is

A. $\frac{h_2}{h_1}$

B. $\frac{h_1}{h_2}$

C. $\frac{h_1 + h_2}{h_1 - h_2}$

D. $\frac{h_1 - h_2}{h_1 + h_2}$

Answer: A

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8. Diameter of the flat surface of a circular plano-convex lens is $6cm$ and thickness at the centre is $3mm$. The radius of curvature of the curved part is

A. $15cm$

B. $20cm$

C. $30cm$

D. $10cm$

Answer: A

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9. When the object is at distance μ_1 and μ_2 from the optical centre of a convex lens, a real and a virtual image of the same magnification are obtained. The focal length of the lens is

A. $\frac{u_1 - u_2}{2}$

B. $u_1 + u_2$

C. $\sqrt{u_1 u_2}$

D. $\frac{u_1 + u_2}{2}$

Answer: D

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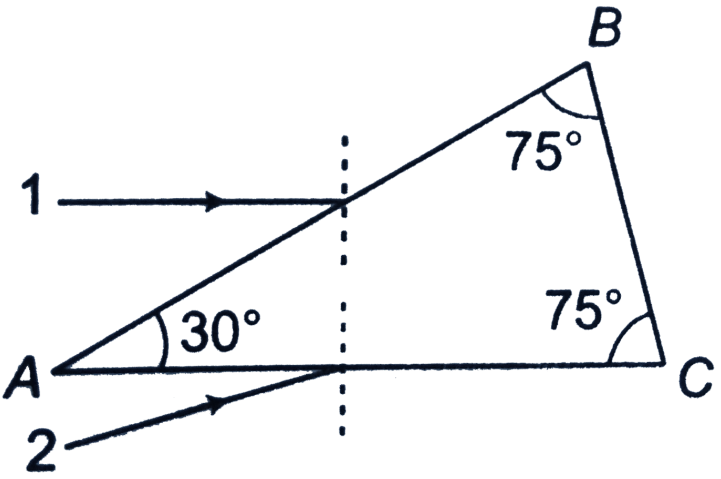
10. Two convex lenses placed in contact form the image of a distant object at P. If the lens B is moved to the right, the image will



A. move to the left

B. move to the right

C. remain at P

D. move either to the left or right, depending upon focal length of the lenses

Answer: B

Watch Video Solution

11. Refractive index of a prism is $\sqrt{7/3}$ and the angle of prism is 60°. The minimum angle of incidence of a ray that will be tramitted through the prixm is

A. 30°

B. 45°

C. 15°

D. None of these

Answer: A

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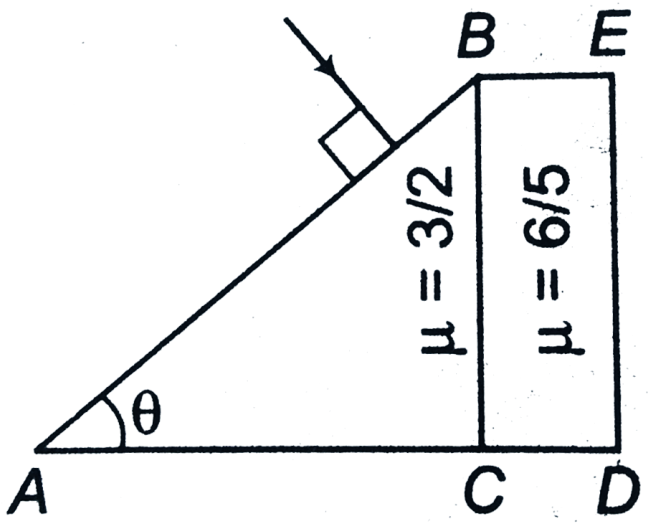
12. A plano-convex thin lens of focal length $10cm$ is silvered at its plane surface. The distance d at which an object must be kept in order to get its image on itself is



A. $5cm$

B. $20cm$

C. $10cm$

D. $2.5cm$

Answer: C

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13. 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 the C for all values of mu

B. At C for all values of mu.

C. At C for $\mu = 1.5,$ but away from C for mu not equal to 1.5

D. At C for $2 < \mu < 1.5$

Answer: B

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14. In the figure ABC is the cross-section of a right angled prism and BCDE is the cross-section of a glass slab. The value of theta so that light incident normally on the face AB does not cross the face BC is $(Given \sin^{-1} 3/5 = 37^\circ)$

A. $\theta < 37^\circ$

B. $\theta < 53^\circ$

C. $\theta \geq 37^\circ$

D. $\theta \geq 53^\circ$

Answer: A

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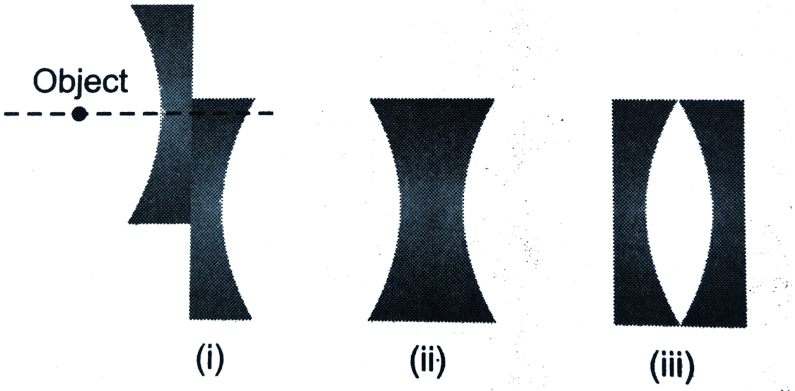
15. If a symmetrical bi-concave thin lens is cut into two identical halves, and they are placed in different ways as shown, then



A. three images will be formed in case (ii)

B. three images will be formed in case (i)

C. the ratio of focal lengths in (ii) and (iii) is 1

D. the ratio of focal lengths in (ii) and (iii) is 2

Answer: C

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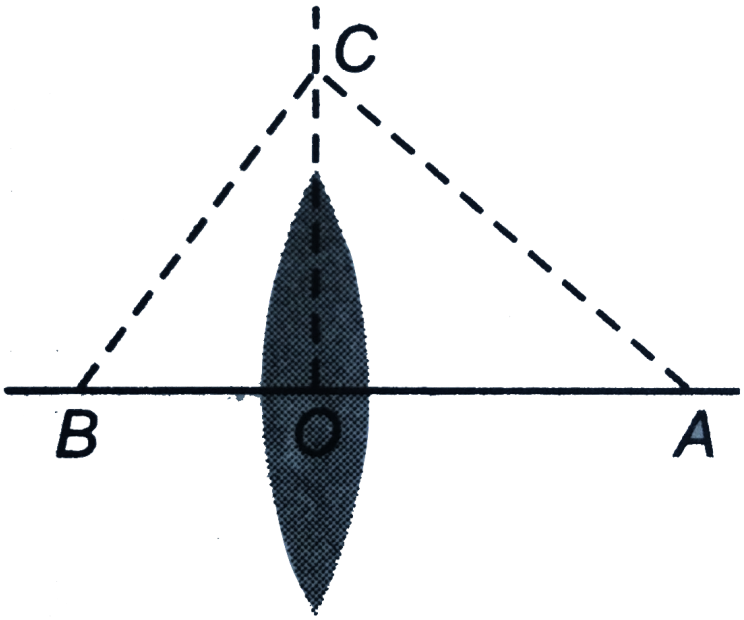
16. If an object is placed at $A(OA > f)$, where f is the focal length of the lens, the image is formed at B. A perpendicular is erected at O and C is chosen on it such that the angle $(\angle BCA)$ is a right angle. Then, the

value of f will be



A. $\frac{AB}{OC^2}$

B. $\frac{(AC)(BC)}{OC}$

C. $\frac{OC^2}{AB}$

D. $\frac{(OC)(AB)}{AC+BC}$

Answer: C

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

A. $12cm$

B. $4cm$

C. $6cm$

D. $8cm$

Answer: B

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18. How much water should be filled in a container of height $21cm,$ so that it appears half filled to the observer when viewed from the top of the container $(\mu = 4/3)$.

A. $8cm$

B. $10.5cm$

C. $12cm$

D. $14cm$

Answer: D

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

A. $x = 20cm$

B. $x = -30cm$

C. $x = -10cm$

D. origin

Answer: C

Watch Video Solution

20. A thin plano-convex lens acts like a concave mirror of radius of curvature $20cm$ when its plane surface is silvered. The radius of curvature of the curved surface if index of refraction of its matarial is 1.5 will be

A. $40cm$

B. $30cm$

C. $10cm$

D. $20cm$

Answer: C

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21. A thin lens, made of glass of refractive index $3/2,$ produces a real and magnified image of an object in air. If the whole system, maintaining the

same distance between the object and the lens, is immersed in water $(RI = 4/3)$, then the image formed will be

A. real, magnified

B. real,diminished

C. virtual, magnified

D. virtual,diminished

Answer: C

Watch Video Solution

22. The maximum value of refractive index of a prism which permits the transmission of light through it when the refracting angle of the prism is 90°, is given by

A. 1.500

B. 1.414

C. 2.000

D. 1.732

Answer: B

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23. A glass slab of thickness $4cm$ contains the same number of waves as $5cm$ of water, when both are traversed by the same monochromatic light. If the refractive index of water is $4/3,$ then refractive index of glass is

A. $5/3$

B. $5/4$

C. $16/15$

D. 1.5

Answer: A

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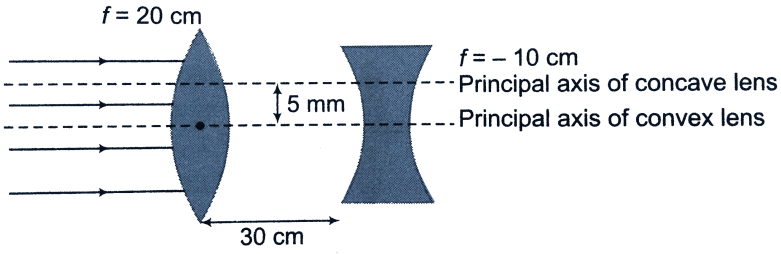
24. If the optic axis of convex and concave lenses are separated by a distance $5mm$ as shown in the figure. Find the coordinate of the final image formed by the combination if parallel beam of light is incident on lens. Origin is at the optical centre of convex lens



A. $(25cm, 0.5cm)$

B. $(25cm, 0.25cm)$

C. $(25cm, -0.5cm)$

D. $(25cm, -2.5cm)$

Answer: B

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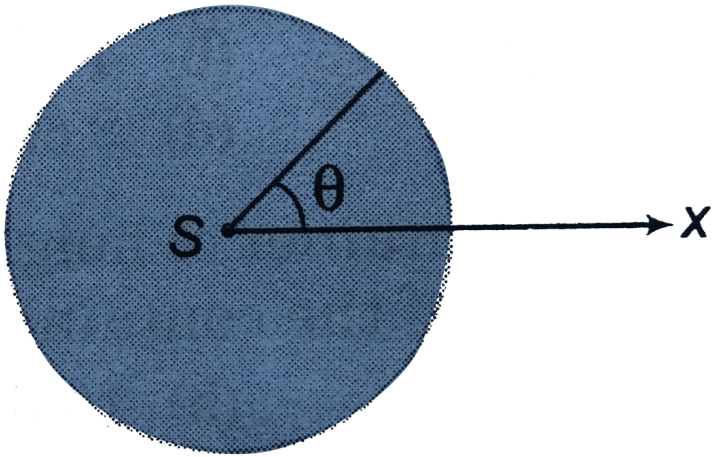
25. A light source S is placed at the centre of a glass sphere of radius R and refractive index μ. The maximum angle θ with the x-axis (as shown in the figure) an incident light ray can make without suffering total internal reflection is



A. $\cos^{-1}\left(\frac{1}{\mu}\right)$

B. $\sin^{-1}\left(\frac{1}{\mu}\right)$

C. $\tan^{-1}\left(\frac{1}{\mu}\right)$

D. there will never be total internal reflection

Answer: D

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26. A sphere $\left(\mu = \frac{4}{3}\right)$ of radius $1m$ has a small cavity of diameter $1cm$ at its centre. An observer who is looking at it from tight, sees the magnification of diameter of the cavity as

A. $\frac{4}{3}$

B. $\frac{3}{4}$

C. 1

D. 0.5

Answer: A

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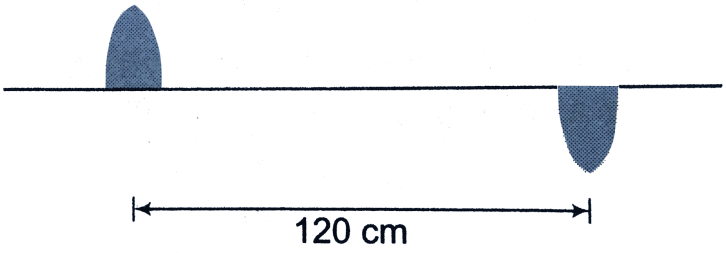
27. An equi-convex lens of $\mu = 1.5$ and $R = 20cm$ is cut into two equal parts along its axis. Two parts are then separated by a distance of $120cm$ (as shown in figure). An object of height $3mm$ is placed at a distance of

$30cm$ to the left of first half lens. The final image will form at



A. $120cm$ to the right of first half lens, $3mm$ in size and inverted

B. $150cm$ to the right of first half lens, $3mm$ in size and erect

C. $120cm$ to the right of first half lens, $4mm$ in size and inverted

D. $150cm$ to the right of first half lens, $4mm$ in size and erect

Answer: B

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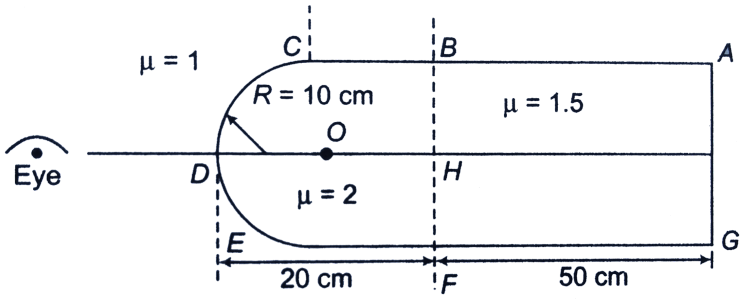
28. As shown in the figure, region BCDEF and ABFG are of refractive index $2.0 \text{ and } 1.5$ respectively. A particle O is kept at the mid of DH. Image of

the object as seen by the eye is at a distance



A. $10cm$ from point D

B. $22.5cm$ from point D

C. $30cm$ from point D

D. $20cm$ from point D

Answer: A

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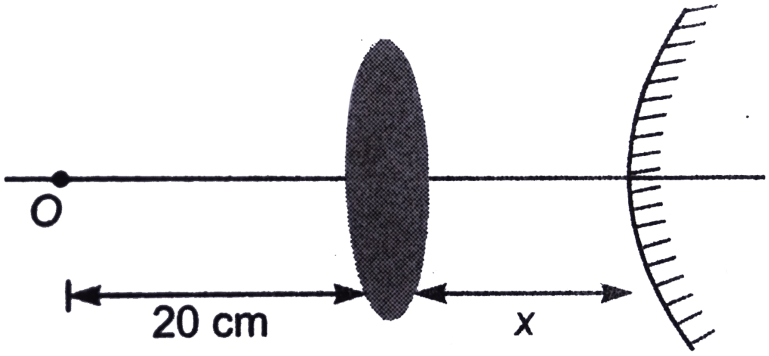
29. A point object O is placed at a distance of $20cm$ from a convex lens of focal length $10cm$ as shown in the figure. At what distance x from the lens should a convex mirror of focal length $60cm,$ be placed so that final

image coincide with the object?



A. $10cm$

B. $40cm$

C. $20cm$

D. Final image can never coincide with the object in the given conditions

Answer: C

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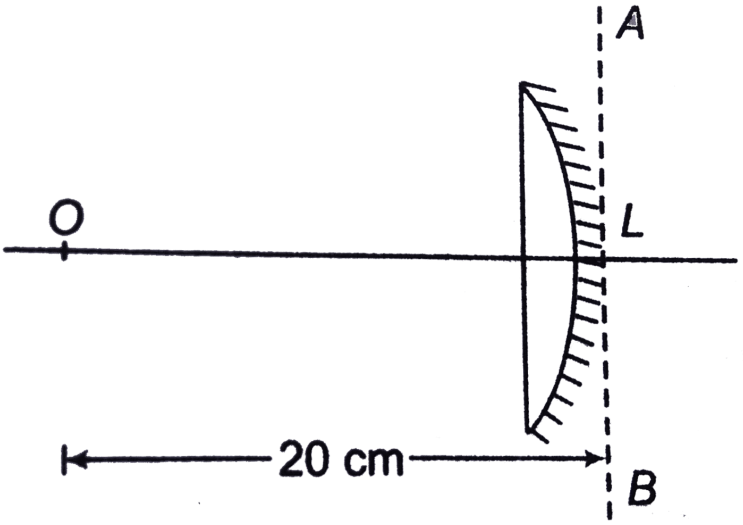
30. A point object is placed at a distance of $20cm$ from a thin plano-convex lens of focal length $15cm(\mu = 1.5)$. The curved surface is silvered. The image will form at



A. $60cm$ left of AB

B. $30cm$ left of AB

C. $\frac{20}{7}cm$ left of AB

D. $60cm$ right of AB

Answer: C

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31. A flat glass slab of thickness $6cm$ and index 1.5 is placed in front of a plane mirror. An observer is standing behind the glass slab and looking at the mirror. The actual distance of the observer from the mirror is $50cm$. The distance of his image from himself, as seen by the observer is

A. $94cm$

B. $96cm$

C. $98cm$

D. $100cm$

Answer: B

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32. Distance of an object from the first focus of an equi-convex lens is $10cm$ and the distance of its real image from second focus is $40cm$. The focal length of the lens is

A. $25cm$

B. $10cm$

C. $20cm$

D. $40cm$

Answer: C

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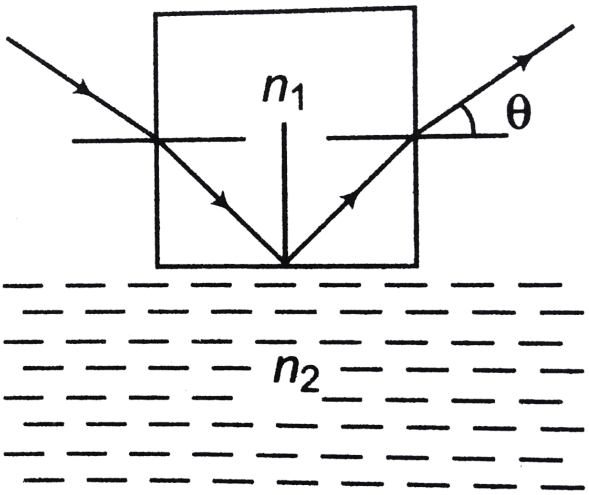
33. A cubical block of glass of refractive index n_1 is in contact with the surface of water of refractive index n_2. A beam of light is incident on vertical face of the block. After refraction a total internal reflection at the base and refraction at the opposite face take place. The ray emerges at

angle θ as shown. The value of θ is given by



A. $\sin\theta < \sqrt{n_1^2 - n_2^2}$

B. $\cos\theta < \sqrt{n_1^2 - n_2^2}$

C. $\sin\theta < \dfrac{1}{\sqrt{n_1^2 - n_2^2}}$

D. $\cos\theta < \dfrac{1}{\sqrt{n_1^2 - n_2^2}}$

Answer: A

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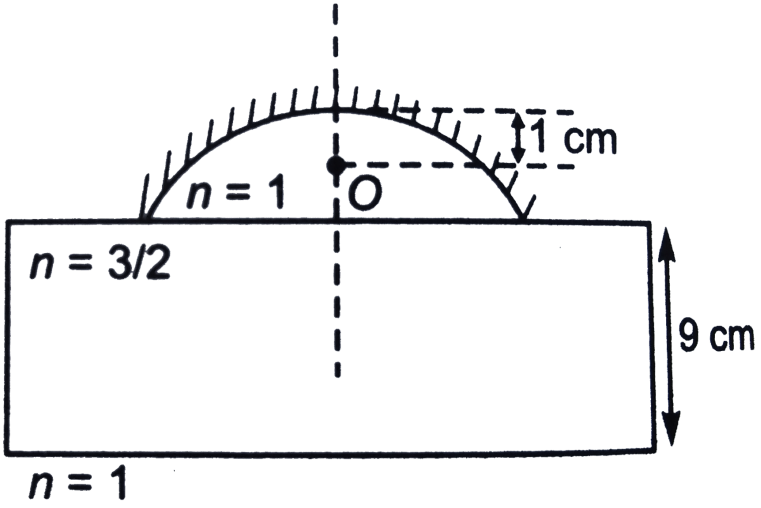
34. A concave mirror of focal length $2cm$ is placed on a glass slab as shown in the figure. The image of point object O formed due to reflection at mirror and then refraction by the slab



A. is virtual and at $2cm$ from pole of the concave mirror

B. is virtual and on the pole of mirror

C. is real and on the object itself

D. None of these

Answer: D

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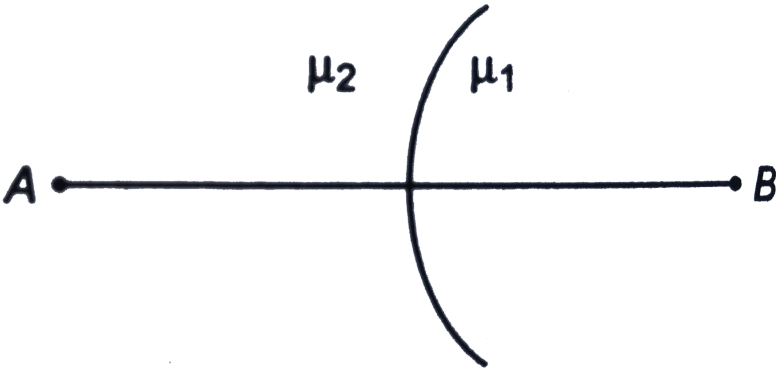
35. Two refracting media are separated by a spherical interfaces as shown in the figure. AB is the principal axis, μ_1 and μ_2 are the refractive indices of medium of incidence and medium of refraction respectively. Then,



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 real image of virtual object

D. If $\mu_1 > \mu_2$, then there cannot be a virtual image of virtual object

Answer: D

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36. A concavo-convex lens has refractive index 1.5 and the radii of curvature of its surfaces are $10cm$ and $20cm$. The concave surface is upwards and is filled with oil of refractive index 1.6. The focal length of the combination will be

A. $18.18cm$

B. $15cm$

C. $22cm$

D. $28.57cm$

Answer: D

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37. A convex spherical refracting surfaces separates two media glass and air $(\mu_g = 1.5)$. If the image is to be real, at what minimum distance u should the object be placed in air if R is the radius of curvature

A. $u > 3R$

B. $u > 2R$

C. $\underline{t}4R$

D. $\underline{t}R$

Answer: B

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38. An object is moving towards a converging lens on its axis. The image is also found to be moving towards the lens. Then, the object distance u must satisfy

A. $2f < u < 4f$

B. $f < u < 2f$

C. $u > 4f$

D. $u < f$

Answer: D

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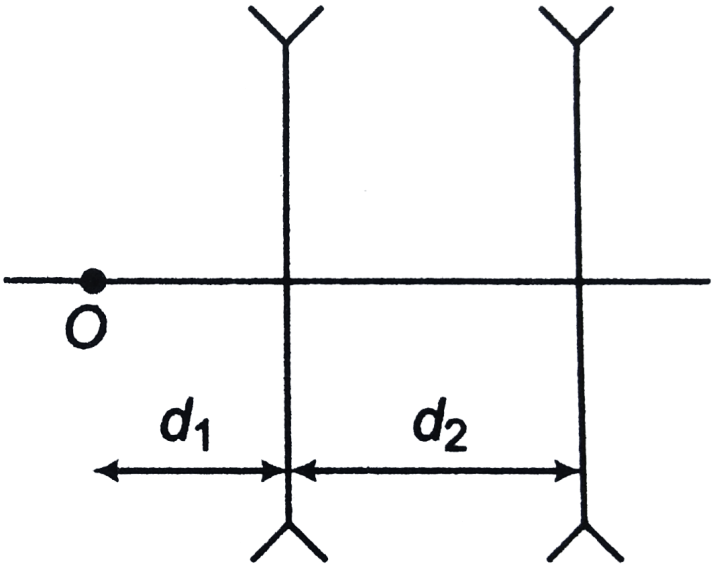
39. Two diverging lenses are kept as shown in figure. The final image formed will be



A. virtual for any value of d_1 and d_2

B. real for any value of d_1 and d_2

C. virtual or real depends on d_1 and d_2 only

D. virtual or real depends on d_1 and d_2 and also on the focal lengths of the lens

Answer: A

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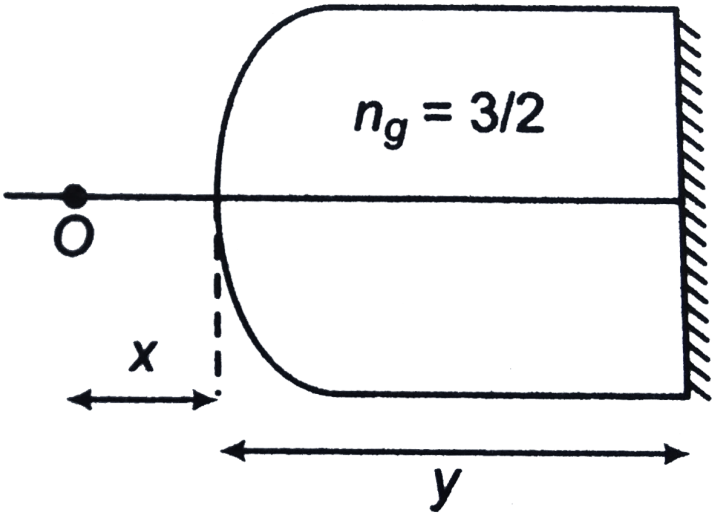
40. In the figure shown , a point object O is placed in air on the principal axis. The radius of curvature of the spherical surfaces is $60cm$. I is the final image formed after all reflections and refractions.



A. If $x = 120cm$, then I is formed on O for any value of y

B. If $x = 240cm$, then I is formed on O for any value of $y = 360cm$

C. If $x = 240cm$, then I is formed on O for any value of y

D. None of these

Answer: A

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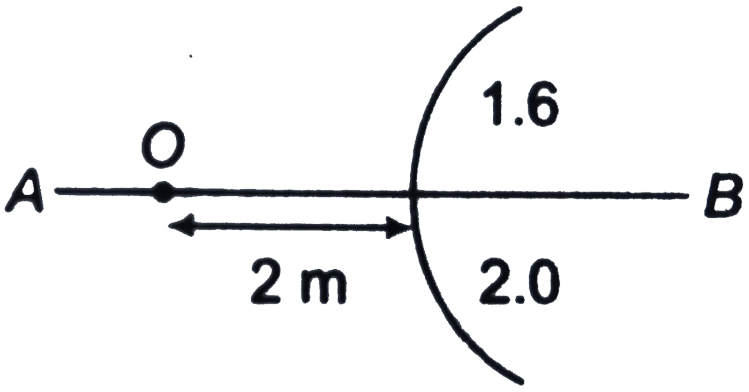
41. In the figure, a point object O is placed in air. A spherical boundry separates two media of radius of curvature $1.0m$. AB is principal axis. The separation between the images formed due to refraction at spherical surface is



A. $12m$

B. $20m$

C. $14m$

D. $10m$

Answer: A

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Single Correct Option

1. The apparent depth of water in water in cylindrical water tank of diameter $2Rcm$ is reducing at the rate of $xcm/\min$ when is being drained out a constant rate. The amount of water drained in $cm/\min$ is ($n_1 =$ refractive index of air, $n_2 =$ refractive index of water)

A. $\frac{x\pi R^2 n_1}{n_2}$

B. $\frac{x\pi R^2 n_1}{n_1}$

C. $\frac{2\pi Rn_1}{n_2}$

D. $\pi R^2 x$

Answer: B

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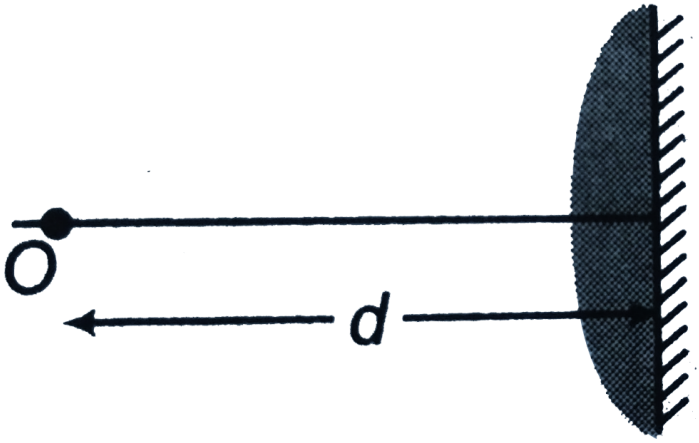
2. Two light rays 1 and 2 are incident on two faces AB and AC on an isosceles prism as shown in the figure. The rays emerge from the side BC.



Then, `

A. minimum deviation of ray $1 >$ minimum deviation of $ray 2$`

B. minimum deviation of ray 1 < minimum deviation of ray 2

C. minimum deviation of ray 1 = minimum deviation of ray 2

D. cannot be determined

Answer: C

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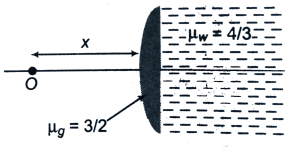
3. An object O is kept in air in front of a thin plano-convex lens of radius of curvature $10cm$. Its refractive index at $3/2$ and the medium towards right of the plane surface is water of refractive index $4/3$. What should be distance x of the object so that the rays becomes parallel finally?



A. $5cm$

B. $10cm$

C. $20cm$

D. $15cm$

Answer: C

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More Than One Correct Option

1. n number of identical equilateral prisms are kept in contact as shown in figure. If deviation through a single prism is δ. Then, (n,m are integers)

A. if $n = 2m,$ deviation through n prisms is zero

B. if $n = 2m + 1,$ deviation through system of n prisms is δ

C. if $n = 2m,$ deviation through system n prisms is δ

D. if $n = 2m + 1,$ deviation through system of n prisms is zero

Answer: A::B

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Level 2 More Than One Correct

1. A ray of monochromatic light is incident on the plane surface of separation between two media x and 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 i and sin r.

A. The speed of light in the medium y is $\sqrt{3}$ times than in mediun x

B. The speed of light in the medium y is $\frac{1}{\sqrt{3}}$ times than 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

Answer: B::D

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2. Which of the following statement (s) is/are true?

A. In vaccum the speed of red colour is more than that of violet colour

B. An object in front of a mirror is moved towards the pole of a spherical mirror from infinity, it is found that image also moves towards the pole. The mirror must be convex

C. There exist two angles of incidence in a prism for which angles of deviation are same except minimum deviation

D. A ray travels from a rarer medium to denser medium. There exist three angles of incidence for which the deviation is same

Answer: B::C

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3. A lense of focal length f is placed in between an object and screen at a distance D. The lens forms two real images of object on the screen for two of its different positions, a distance x apart. The two real images have magnification m_1 and m_2 respectively $(m_1 > m_2)$. Choose the correct statement(s).

A. $m_1 m_2 = -1$

B. $m_1 m_2 = 1$

C. $f = \dfrac{D^2 - x^2}{4D}$

D. $D \geq 4f$

Answer: B::C::D

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4. A small angled prism of apex angle $A = 4^\circ$ and refractive index $\mu = 1.5$ is placed in front of a vertical plane mirror as shown in figure. If the mirror is rotated through an angle θ, then the light ray becomes

horizontal either after the mirror or after second time passing from the prism in opposite direction. The value θ is

A. 1°

B. 2°

C. 4°

D. Not possible

Answer: A::B

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Level 2 Comprehension Based

1. A plano-convex lens P and a concavo-convex lens Q are in contact as shown in figure. The refractive index o fthe material of the lens P and Q is $1.8 \text{ and } 1.2$ respectively. The radius of curvature of the concave surface of the lens Q is double the radius of curvature of the convex surface. The

convex surface of Q is silvered.

An object is placed on the placed on the principal axis at a distance $10cm$ form the plane surface. The image is formed at a distance $40cm$ from the plane surfaces on the same side. The focal length of the system is

A. $-8cm$

B. $8cm$

C. $-\frac{40}{3}cm$

D. $\frac{40}{3}cm$

Answer: A

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2. A plano-convex lens P and a concavo-convex lens Q are in contact as shown in figure. The refractive index o fthe material of the lens P and Q is $1.8 \text{ and } 1.2$ respectively. The radius of curvature of the concave surface of the lens Q is double the radius of curvature of the convex surface. The

convex surface of Q is silvered.

The radius of curvature of common surface is

A. $48cm$

B. $24cm$

C. $12cm$

D. $8cm$

Answer: A

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3. A plano-convex lens P and a concavo-convex lens Q are in contact as shown in figure. The refractive index o fthe material of the lens P and Q is $1.8 \text{ and } 1.2$ respectively. The radius of curvature of the concave surface of the lens Q is double the radius of curvature of the convex surface. The convex surface of Q is silvered.

The radius of curvature of common surface is

A. convex mirror of focal length $24cm$

B. concave mirror of focal length $8cm$

C. concave mirror of focal length $24cm$

D. convex mirror of focal length $8cm$

Answer: C

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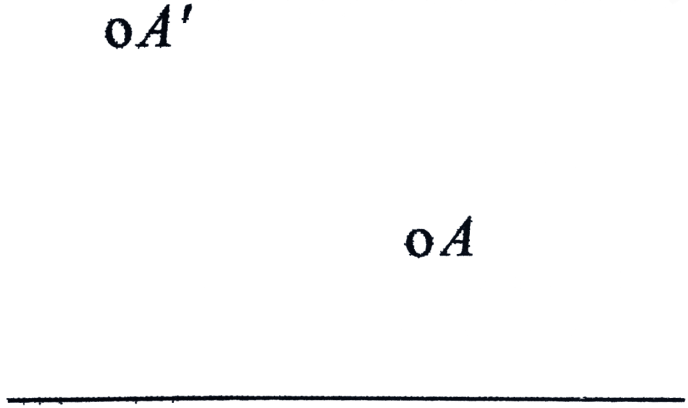
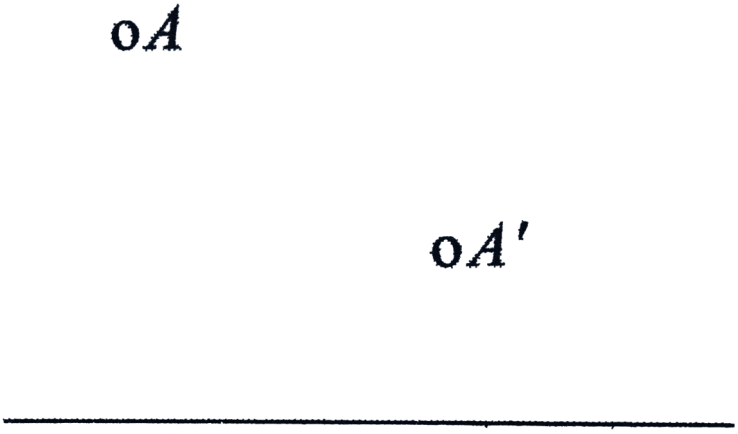
Level 2 Subjective

1. a. Figure (a) shows the optical axis of a lens, the point source of light A, and its virtual image A' . Trace the rays to find the position of the lens and of its focuses. What type of lens is it?



b. Solve the problem similar to the previous one using Figure.



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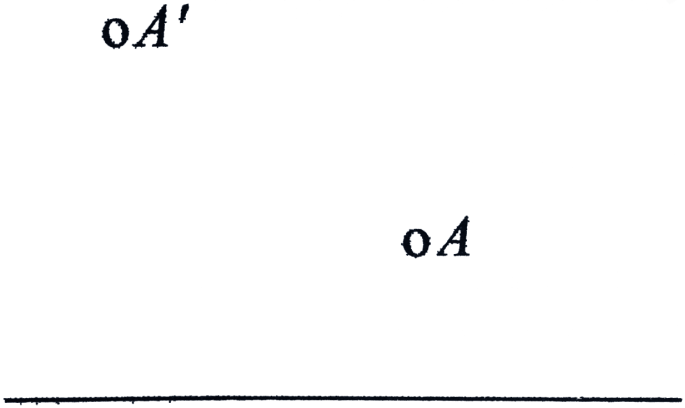
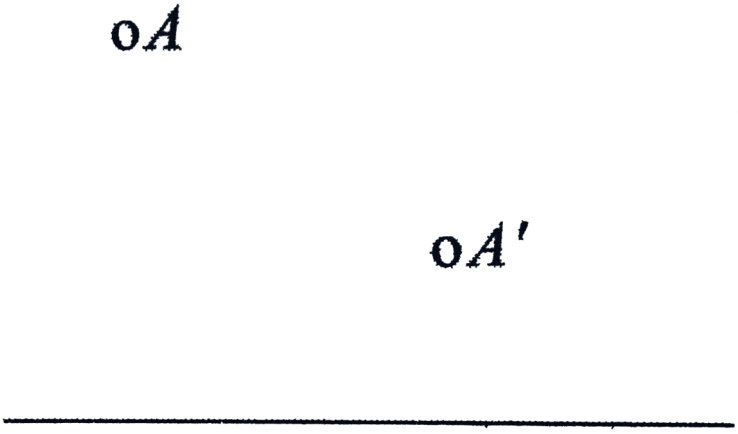
2. a. Figure (a) shows the optical axis of a lens, the point source of light A, and its virtual image A' . Trace the rays to find the position of the lens and of its focuses. What type of lens is it?



b. Solve the problem similar to the previous one using Figure.



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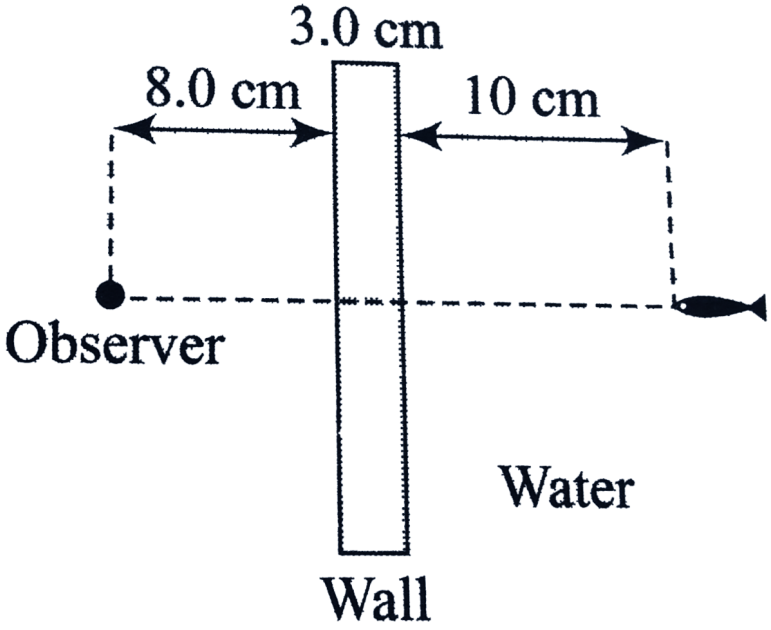
3. In Figure, a fish watcher watches a fish through a 3.0 cm thick glass wall of a fish tank. The watcher is in level with the fish, the index of refraction of the glass is $8/5$ and that of the water $4/3$.

a. To the fish, how far away does the watcher appear to be ?

b. To the watcher, how far away does the fish appear to be ?



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4. A concave spherical mirror with a radius of curvature of $0.2m$ is filled with water. What is the focal length of this system? Refractive index of water is $4/3$.

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5. A lens with a focal length of $f = 30cm$ produces on a screen a sharp image of an object that is at a distance of $a = 40cm$ from the lens. A plane parallel plate with thickness of $d = 9cm$ is placed between the lens and the object perpendicular to the optical axis of the lens. Through what distance should the screen be shifted for the image of the object to remain distinct? The refractive index of the glass of the plate is $\mu = 1.8$.

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6. One side of radius of curvature $R_2 = 120cm$ of a convexo-convex lens of material of refractive index $\mu = 1.5$ and focal length $f_1 = 40cm$ is slivered. It is placed on a horizontal surface with silvered surface in contact with it. Another convex lens of focal length $f_2 = 20cm$ is fixed coaxially $d = 10cm$ above the first lens. A luminous point object O on the axis gives rise to an image coincide with it. Find its height above the upper lens.

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7. A small object is placed on the principal axis of concave spherical mirror of radius $20cm$ at a distance of $30cm$. By how much will the position of the image alter only after mirror, when a parallel-sided slab of glass of thickness $6cm$ and refractive index 1.5 is introduced between the centre of curvature and the object? The parallel sides are perpendicular to the principal axis.

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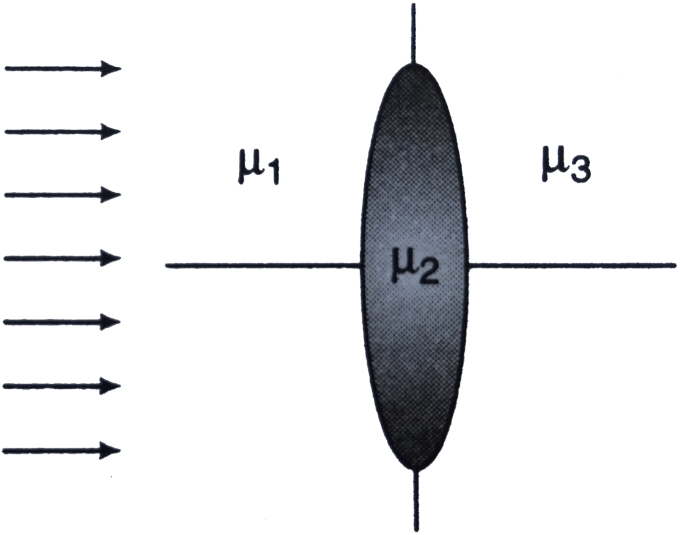
8. A thin glass lens of refractive index $\mu_2 = 1.5$ behaves as an interface between two media of refractive indices $\mu_1 = 1.4$ and $\mu_3 = 1.6$ respectively. Determine the focal length of the lens for the shown

arrangement of radius of curvature of both surfaces $20cm$.



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9. A glass hemisphere of radius $10cm$ and $\mu = 1.5$ is silvered over its curved surface. There is an air bubble in the glass $5cms$ from the plane surface along the axis. Find the position of the images of this bubble seen by observer looking along the axis into the flat surface of the atmosphere.

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10. A equilateral prism of flint glass $(\mu_g = 3/2)$ is placed water $(\mu_w = 4/3)$.

At what angle should a ray of light fall on the face of the prism so that inside the prism the ray is perpendicular to the bisector of the angle of the prism.

Through what angle will the ray turn after passing through both faces of the prism?

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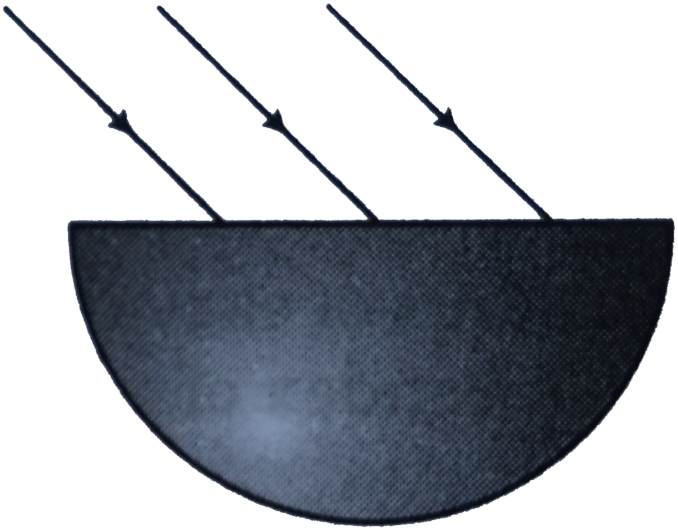
11. Rays of light fall on the plane surface of a half cylinder at an angle 45° in the plane perpendicular to the axis (see figure). Refractive index of glass is $\sqrt{2}$. Discuss the condition that the rays do not suffer total

internal reflection.



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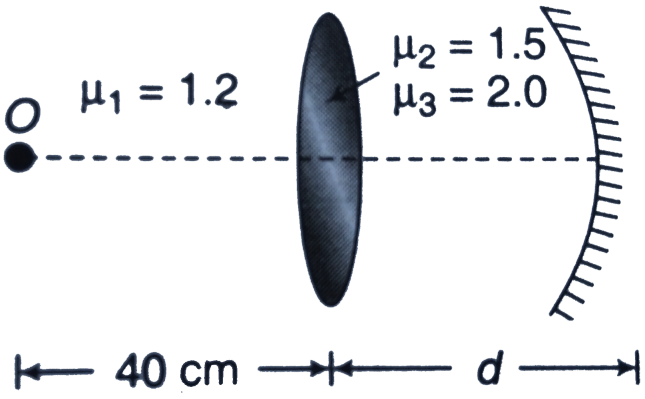
12. The figure shows an arrangement of an equi-convex lens and a concave mirror. A point object O is placed on the principal axis at a distance $40cm$ from the lens such that the final image is also formed at the position of the object. If the radius of curvature of the concave mirror is $80cm,$ find the distance d. Also draw the ray diagram. The focal length

of the lens in air is $20cm$.



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13. A convex lens is held $45cm$ above the bottom of an empty tank. The image of a point at the bottom of a tank is formed $36cm$ above the lens. Now, a liquid is poured into the tank to a depth of $40cm$. It is found that the distance of the image of the same point on the bottom of the tank is $48cm$ above the lens. Find the refractive index of the liquid.

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14. A parallel beam of light falls normally on the first face of a prism of small angle .At the second face it is partly reflected,the reflected beam striking at the first face again, and emerging from it in a direction making an angle 6° 30' with the reversed direction of the incident beam. The refracted beam is found to have undergone a deviation of $1^\circ 15'$ from the original direction.Find the refractive index of the glass and the angle of the prism.

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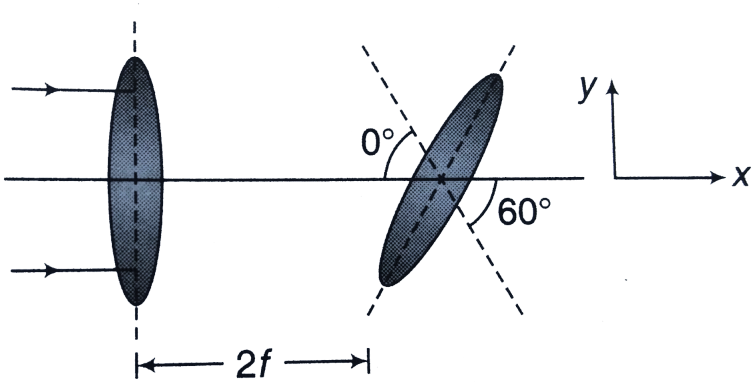
15. Two converging lenses of the same focal length f are separated by a distance 2f. The axis of the second lens is inclined at angle $\theta = 60^\circ$ with respect to the axis of the first lens. A parallel paraxial beam of light is incident from left side of the lens. Find the coordinates of the final image

with respect to the origin of the first lens.



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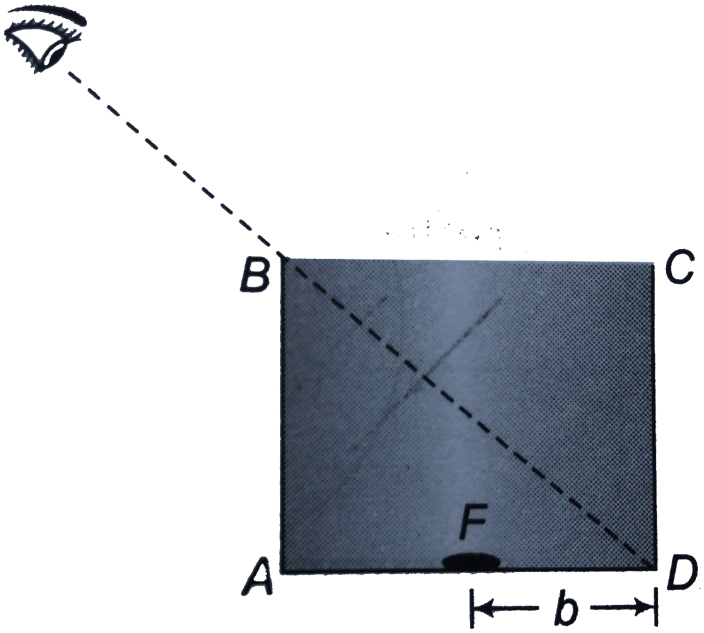
16. A cubical vessel with non-transparent walls is so located that the eye of an observer does not see its bottom but sees all of the wall CD.

To what height should water be poured into the vessel for the observer to see an object F arranged at a distance of $b = 10cm$ from corner D?

The face of the vessel is $a = 40cm$. Refractive index of water is $\frac{4}{3}$.



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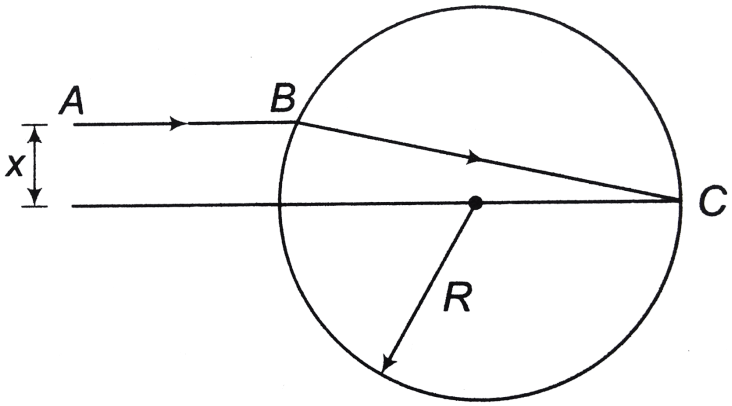
17. A spherical ball of transparent material has index of refractionμ. A narrow beam of light AB is aimed as shown. What must the index of refraction be in order that the light is focused at the point C on the opposite end of the diameter from where the light entered? Given that

$x > > R.$



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18. A ray incident on the droplet of water at an angle of incidence i undergoes two reflections (not total) and emerges. If the deviation suffered by the ray within the drop is minimum and the refractive index of the droplet be μ, then show that $\cos i = \frac{\sqrt{(u^2 - 1)}}{8}$.

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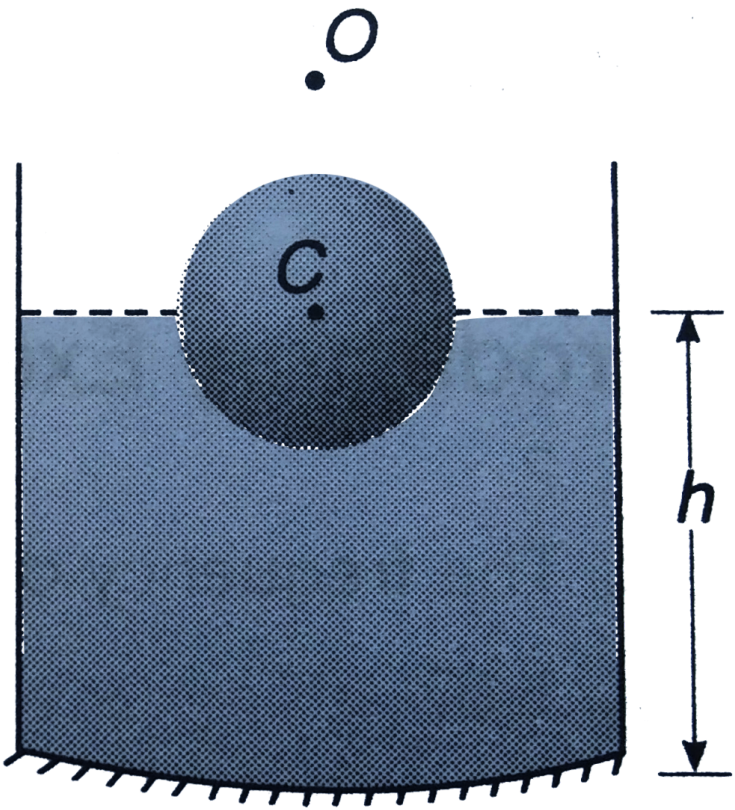
19. A transparent solid sphere of radius $2cm$ and density ρ floats in a transparent liquid of density 2ρ kept in a beaker. The bottom of the beaker is spherical in shape with radius of curvature $8cm$ and is silvered to make it concave mirror as shown in the figure. When an object is placed at a distance of $10cm$ directly above the centre of the sphere C, its final image coincides with it. Find h (as shown in the figure), the height of the liquid surface in the beaker from the apex of the bottom. Consider the paraxial rays only. The refractive index of the sphere is $3/2$ and that

of the liquid is $4/3$.



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20. A hollow sphere of glass of inner and outer radii R and 2R respectively has a small mark on its inner surface. This mark is observed from a point outside the sphere such that the centre of the sphere lies in between.

Prove that the mark will appear nearer than it really it, by a distance $(\mu - 1)(R)/(3\mu - 1)$

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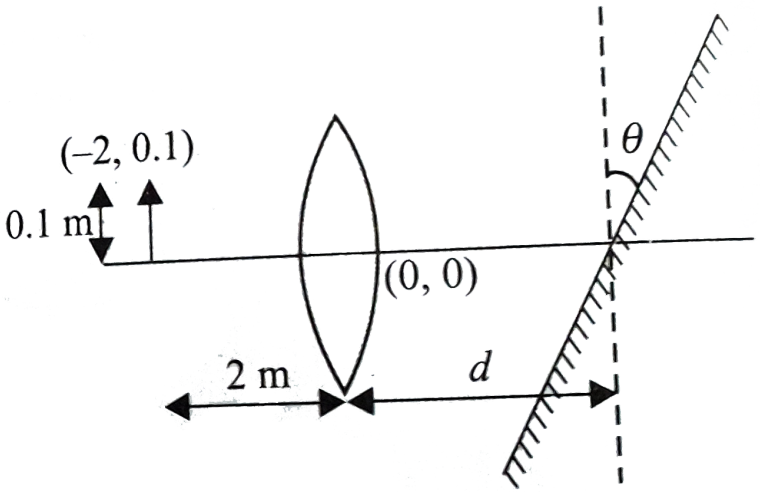
21. A convex lens of focal length 1.5m is placed in a system of coordinate axis such that its optical centre is at origin and principa, axis coinciding with the x-axis. An object and a plane mirror are arrange on theh principal axis as shown in figure. Find value of d (in m) so that y-coordinate of image (after refraction and reflection) is 0.3m. (Take $\tan\theta = 0.3$)



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