PHYSICS

BOOKS - AAKASH SERIES

RAY OPTICS

Example

1. The magnetic field an electromangetic wave in a substance is given by $B = \left(2 \times 10^{-6} T\right)$

cos $\left[\pi\left(0.04x + 10^7 t\right)\right]$. Find the electromagnetic wave speed.

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2. A point source of light S, placed at a distance L in front of the centre of a mirror of width d,

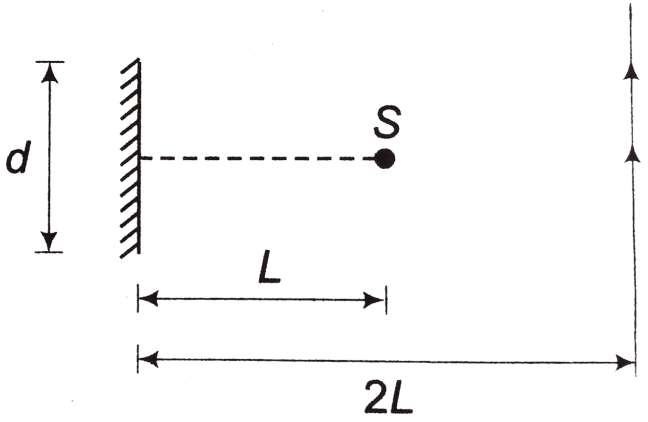
hangs vertically on a wall. A man walks in front of the

mirror along a line parallel to th mirror at a distane

2L form it as shown.The greatest distance over which

he can see the image of the light source in the mirror is

(a) $d/2$ (b) d (c) 2d (d) 3 d.



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3. A plane mirror is placed at origin parallel of y-axis, facing the positive x-axis. An object starts from (2m, 0, 0) with a velocity of $\left(2\hat{i}+2\hat{j}\right)m/s$. The relative velocity of image with respect to object is along

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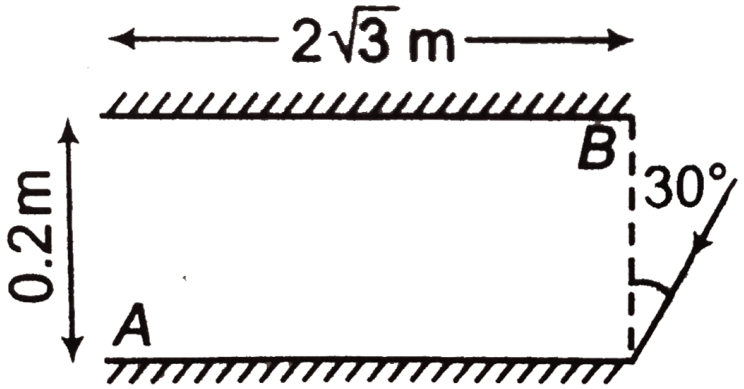
4. Two plane mirrors A and B are aligned parallel to each other as shown in the figure. A light ray is incident at an angle of 30° at a

point just inside one end of A. The number of times the ray undergoes reflections (including the first one) before it emerges out is



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5. A point light source lies on the principal axis of a concave spherical mirror with radius of

curvature 160 cm. Its image appears to be back of the mirror at a distance of 70 cm from the mirror. Determine the location of the light source.

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6. An object of length 10 cm is placed at right angles to the principal axis of a mirror of radius of curvature 60 cm such that its image is virtual, erect and has a length 6 cm. What

kind of mirror it is and also determine the position of the object ?

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7. An object is placed in front of a convex mirror at a distance of 50cm. A plane mirror is introduced covering the lower half of the convex mirror. If the distance between the object and the plane mirror is 30cm, it is found that there is no parallax between the

images formed by the two mirrors. What is the radius of curvature of the convex mirror?

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8. A concave mirror of focal length 10cm and a convex mirror of focal length 15cm are placed facing each other 40cm apart. A point object is placed between the mirrors, on their common axis and 15cm from the concave mirror. Find the position and nature of the image

produced by successive reflections, first at the concave mirror and then at the convex mirror.

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9. Fill in the blanks :

	Volume of cuboid	*Length*	*Breadth*	*Height*
(*i*)	90 cm^3	...	5 cm	3 cm
(*ii*)	840 cm^3	15 cm	...	7 cm
(*iii*)	62·5 m^3	10 m	5 m	...

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10. Light of wavelength 4500 Å in air is incident on a plane boundary between air and another medium at an angle 30º with the plane of boundary. As it enters from air into the other medium, it deviates by 15° towards the normal. Find refractive index of the medium and also the wavelength of given light in the medium.

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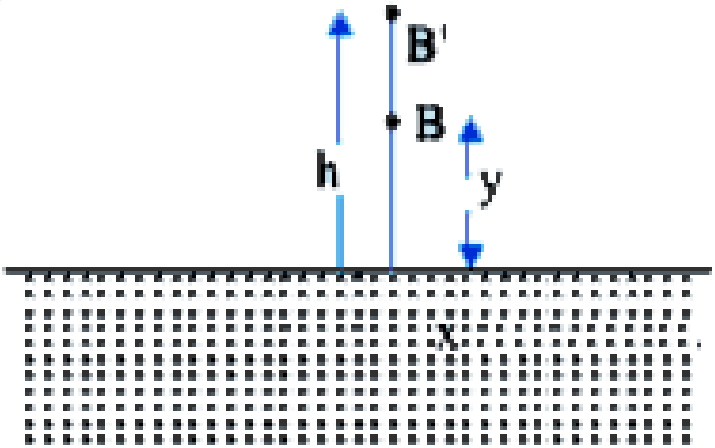
11. A fish rising vertically to the surface of water in a lake uniformly at the rate of3m/s observes a king fisher bird diving vertically towards water at the rate 9 m/s vertically above it. If the refractive index of water is $4/3$, find the actual velocity of the dive of the bird in $cm/\sec$.



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12. A $20cm$ thick glass slab of refractive index 1.5 is kept in front of a plane mirror. Find the position of the image (relative to mirror) as seen by an observer through the glass slab when a point object is kept in air at a distance of $40cm$ from the mirror.

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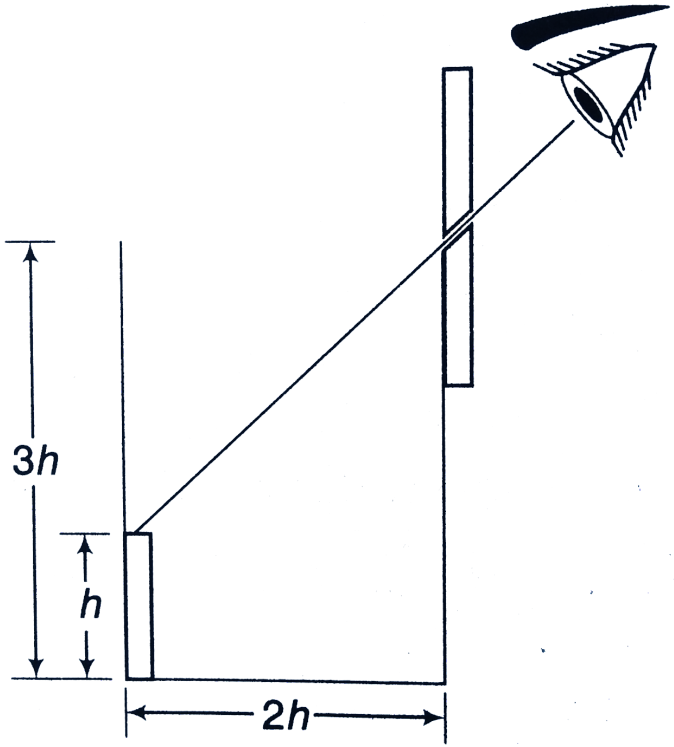
13. An observer can see through a pin-hole the top end of a thin rod of height h,placed as shown in the figure. The beaker height is 3h and its radius h. When the beaker is filled with a liquid up to a height 2h, he can see the lower end of the rod. Then, the refractive index of the liquid is



(a) $\frac{5}{2}$, (b) $\sqrt{\frac{5}{2}}$, (c) $\sqrt{\frac{3}{2}}$, (d) $\frac{3}{2}$

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14. The x-z plane separates two media A and B of refractive indices $\mu_1 = 1.5$ and $\mu_2 = 2$. A ray of light travels from A to B. Its directions in the two media are given by unit vectors $u_1 = a\hat{i} + b\hat{j}$ and $u_2 = c\hat{i} + a\hat{j}$. Then

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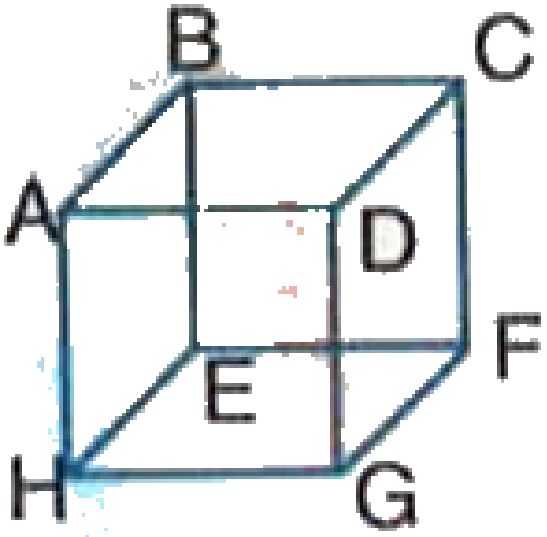
15. An air bubble is trapped inside a glass cube of edge 30 cm. Looking through the face ABEH, the bubble appears to be at normal distance

12 cm from this face and when seen from the opposite face CDGF, it appears to be at normal distance 8 cm from CDGF. Find refractive index of glass and also the actual position of the bubble.



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16. The XY plane is the boundary between two tranparednt media. Medium 1 with $z \geq 0$ has a refraxtive index of $\sqrt{2}$ and medium 2 with $z \leq 0$ has a refractive index of $\sqrt{3}$. A ray of light in medium 1 given by the vector $6\sqrt{3}\hat{i} + 8\sqrt{3}\hat{j} - 10\hat{k}$ is incident on teh plane of separation. Find the unit vector in the direction of teh refracted ray in medium 2.

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17. A ray of light travelling in a rarer medium strikes a plane boundary between the rarer medium and a denser medium at an angle of incidence 'i' such that the reflected and the refracted rays are mutually perpendicular. Another ray of light of same frequency is incident on the same boundary from the side of denser medium. Find the minimum angle of incidence at the denser-rarer boundary so that the second ray is totally reflected

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18. A small bulb is placed at a depth of $2\sqrt{7}$ m in water and floating opaque disc is placed over the bulb so that bulb is not visible from the surface. The minimum diameter of the disc is $(\mu_{\text{water}} = 4/3)$

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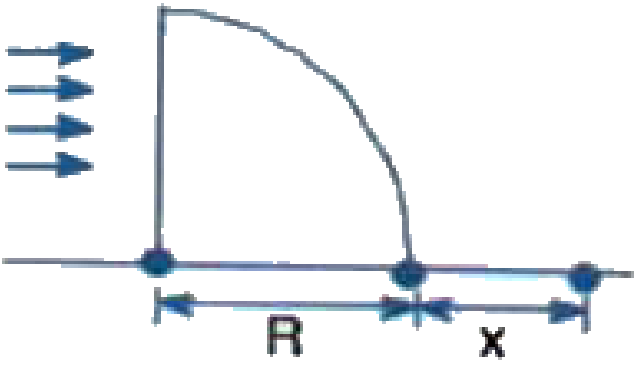
19. A uniform, horizontal beam of light is incident upon a quarter cyclinder of radius R=5cm, and has a refractive index$2/\sqrt{3}$. A

patch on the table at a distance 'x' from the cylinder is unilluminated. Find the value of 'x'?



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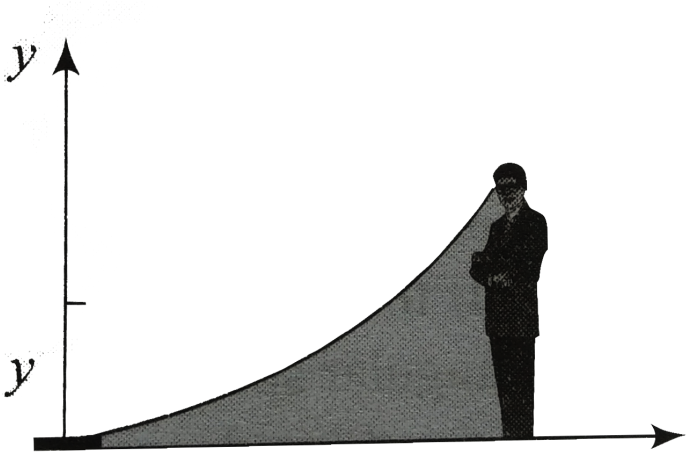
20. Due to a vertical temperature gradient in the atmosphere, the index of refraction varies. Suppose index of refraction varies as $n = n_0$

$\sqrt{1+ay}$, where n_0 is the index of refraction at the surface and $a = 2.0 \times 10^{-6} m^{-1}$. A person of height $h = 2.0m$ stands on a level surface. Beyond what distance will he not see the runway?



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21. A ray of light is incident on a glass slab at grazing incidence. The refractive index of the material of the slab is given by $\mu = \sqrt{(1+y)}$. If the thickness of the slab is $d = 2m$, determing the equation of the trajectory of the ray inside the slab and the coordinates of the point where the ray exits from the slab. Take the origin to be at the point of entry of the ray.

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22. A small object stuck on the surface of a glass sphere $(n = 1.5)$ is viewed from the diametrically opposite position. Find transverse magnification.

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23. One end of a cylindrical glass rod $(\mu = 1.5)$ is given the shape of a concave refracting surface of radius 10cm. An air bubble is situated in the glass rod at a point on its axis such that it appears to be at

distance 10 cm from the surface and inside glass when seen from the other medium. Find the actual location of air bubble.

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24. 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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25. What is the refractive index of material of a plano-convex lens, if the radius of curvature of the convex surface is $10cm$ and focal length of the lens is 30 cm ?

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26. A convex lens of focal length 10 cm. is used as a magnifying lens.

Where should the object be placed if the image is to be 30 cm from the lens?

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27. A convex lens of focal length 10 cm. is used as a magnifying lens.

What will be the magnification?

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28. 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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29. A converging beam of light forms a sharp image on a screen. A lens is placed in the path of the beam, at 10cm from the screen. It is found that the screen has to be moved 8 cm further away from the lens to obtain a sharp image. Find the focal length and nature of lens.

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30. A convex lens of focal length 24 cm $(\mu = 1.5)$is totally immersed in water $(\mu = 1.33)$. Find its focal length in water.

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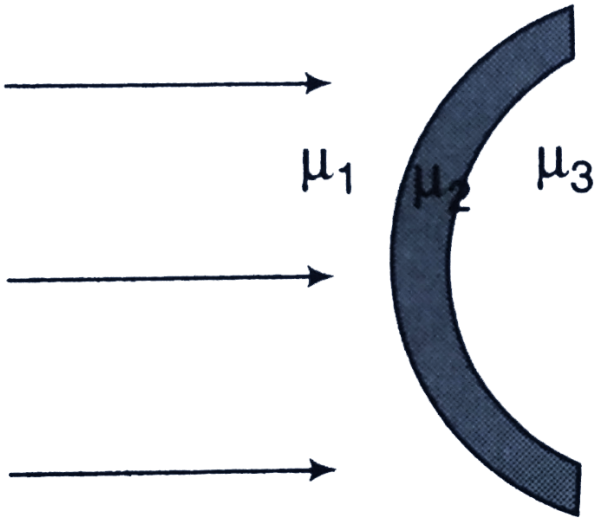
31. In the figure, light is incident on a thin lens as shown. The radius of curvature for both the surfaces is R. Determine the focal length of

this system.



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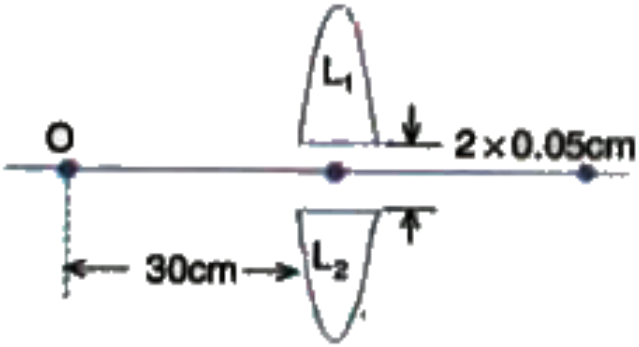
32. A point object O is placed at a distance of 30 cm from a convex lens of focal length 20 cm

cut into two halves each of which is displaced by 0.05 cm as shown in figure. Find the position of the image. If more than one image is formed, find their number and distance between them.



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33. 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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34. 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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35. 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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36. 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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37. 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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38. 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

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39. 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 upwords and is filled with oil of refractive index 1.6. The focal length of the combination will be

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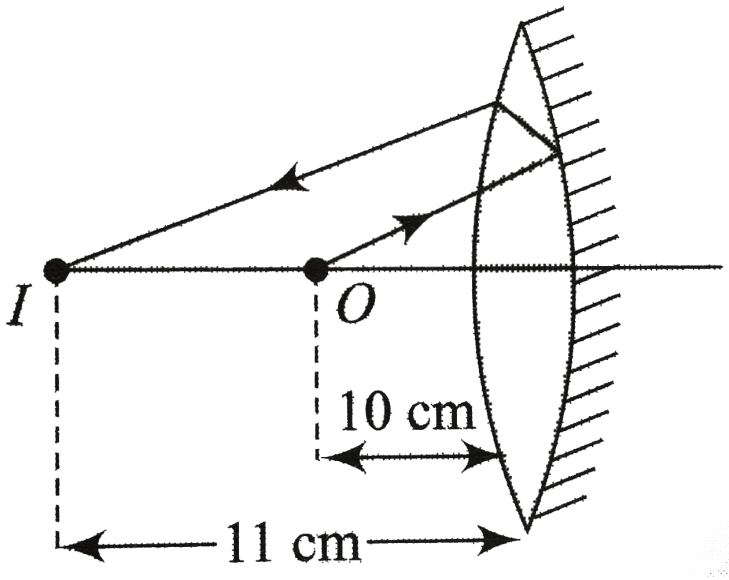
40. A pin is placed 10cm in front of a convex lens of focal length 20cm, made of a material having refractive index 1.5 . The surface of lens farther away from the pin is silvered and has a radius of curvature 22cm. Determine the position of the final image. Is the image real or virtual?



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41. 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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42. 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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43. A ray of light is incident at an angle of 60° on the face of a prism having refracting angle 30°. The roy emerging out of the prism makes an angle 30° with the incident ray. Show that

the emergert ray is perpendicular to the face through which, it emerges.

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44. One face of a prism with a-refractive angle of 30° is coated with silver.A ray incident on another face at an angle of 45° is refracted and reflected from the silver coated face and retraces its path. What is the refractive index of the prism?

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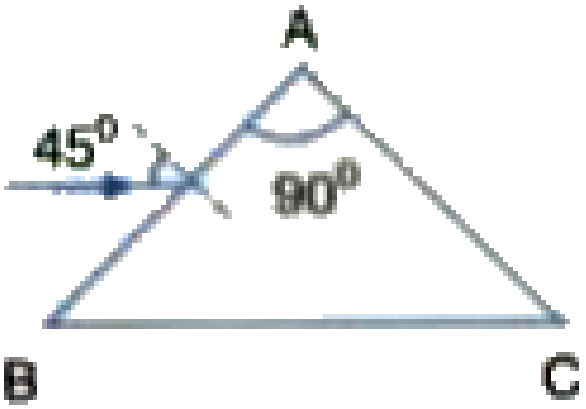
45. Monochromatic light falls on a right-angled prism at an angle of incidence 45°. The emergent light is found to slide along the face AC. Find the refractive index of material of prism



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46. A beam of light consisting of red, green and blue colurs is incident on a right angled prism as shown in figure. The refractive indices of the maaterial of the prism for above red, green and blue wavelengths are 1.39, 1.44 and 1.47, respectivley .

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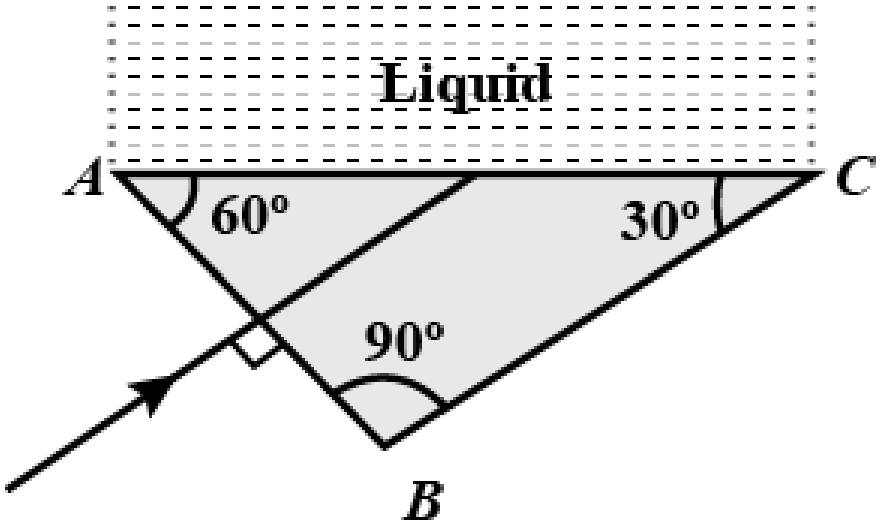
47. Light is incident normally on face AB of a prism as shown in Figure. A liquid of refractive index μ is placed on face AC of the prism. The prism is made of glass of refractive indes $3/2$. Find the limits of μ for which total internal reflection takes place on the face AC.

(A)$\mu > \frac{\sqrt{3}}{2}$ (B)$\frac{3\sqrt{3}}{4} > \mu$ (C)$\mu > \sqrt{3}$ (D)

$\mu < \frac{\sqrt{3}}{2}$



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48. A crown glass prism of refracting angle 6° is to be used for deviation without dispersion with a flint glass of angle of prisα . Given: for

crown glass $\mu_r = 1.513$ and $\mu_v = 1.523$, for flint glass $\mu_r = 1.645$ and $\mu_v = 1.665$. What should be the value of α ?

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49. A thin prism P_1 of angle 4° and refractive index $1.54^\circ C$ is combined with another thin prism P_2 of refractive index 1.72 to produce dispersion without deviation. The angle of P_2 is

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50. White light is passed through a prism of angle 5°. If the refractive indices for red and blue colours are $1.641 \text{and} 1.659$ respectively , calculate the angle of dispersion between them.

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51. Calculate (a) the refracting angle of a flint glass prism which should be combined with a crown glass prism of refracting angle 6^{o} so

that the combination may have no deviation for D line and (b) the angular separation between the C and F lines, given that the refractive indices of the materials are as follows:

	C	D	F
Flint	1.790	1.795	1.805
Crown	1.527	1.530	1.535

Solution :

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Exercise Long Answer Questions

1. Construct the reflected wavefront when a plane wavefront is incident on a plane reflecting surface. Hence, explain the laws of reflection. Why does an expanding spherical wave continue to expand outward from the source?

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2. Prove the law of reflection of light on the basis of Huygens wave theory of light

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3. Define critical angle and explain it with a neat ray diagram? Deduce the relation between critical angle and refractive index.

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4. What is total internal reflection? State the conditions to be fulfilled for total internal refection. Describe the construction and working of an optical fibre. State its uses.

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5. Obtain an expression for refraction at a single convex spherical surface separating the two media having refractive indices μ_1(rarer medium) and μ_2(denser medium) i.e., a relation between u, v, μ_1, μ_2 and R.

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6. On what factors does the angle of minimum deviation depend?

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7. In a regular prism, what is the relation between angle of incidence and angle of emergence when it is in the minimum deviation position ?

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8. Discuss the phenomenon of refraction through a prism. Prove that $\delta = A(\mu - 1)$ for a small angled prism, where the symbols have their usual meanings.

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9. Describe different types of pollination.

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Exercise Short Answer Questions

1. Hugen's wave theory of light could not explain

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2. Define: wavefront and wave normal, State the nature of the wavefronts in the following (i) The source is point source of light. (ii) A narrow slit is illuminated by a source of light.

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3. Explain the dual nature of light.

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4. What is the cause of refraction of light?

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5. State optical path and optical path difference.

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6. State the laws of refraction of light. State at least three examples of refraction of light.

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7. Find the apparent shift due to refraction at a plane surface when the object in denser and observer in rarer medium.

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8. What is lateral shift and normal shift

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9. Explain the mirage.

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10. Explain how a fish deep inside a pond full of water can see everything above the water near the pond. Show that the field of vision of

the fish is concentrated within a cone of apex angle 98°.

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11. What is magnification ? Obtain lateral magnification due to refraction at curved surface

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12. The equation of refraction at a spherical surface is $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$. Taking R= infinity , show that this equation leads to the equation $\frac{\text{real depth}}{\text{Apparent depth}} = \frac{\mu_1}{\mu_2}$ for refraction at a plane surface .

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13. Define first and second principal focus in lens.

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14. Show that the distance between a real object and its real image formed by a thin converging lens is always greater than or equal to four times the focal length of the lens.

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15. If the plane surface of a plano-convex lens of radius of curvature R and refractive index μ

is silvered, then its focal length would be

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16. Consider a ray of light passing through a prism (angle A) in the position of minimum deviation δ. Show that the angles of incidence and refraction are given by: $i = \frac{A + \delta}{2}$ and $r = \left(\frac{A}{2}\right)$.

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17. Show that deviation produced by a thin prism of prism angle A and refractive index μ is given by $\delta = (\mu - 1)A$.

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18. Obtain the minimum value of refractive index of a prism of angle A so that an incident ray cannot emerge out of it, whatever be the angle of incidence?

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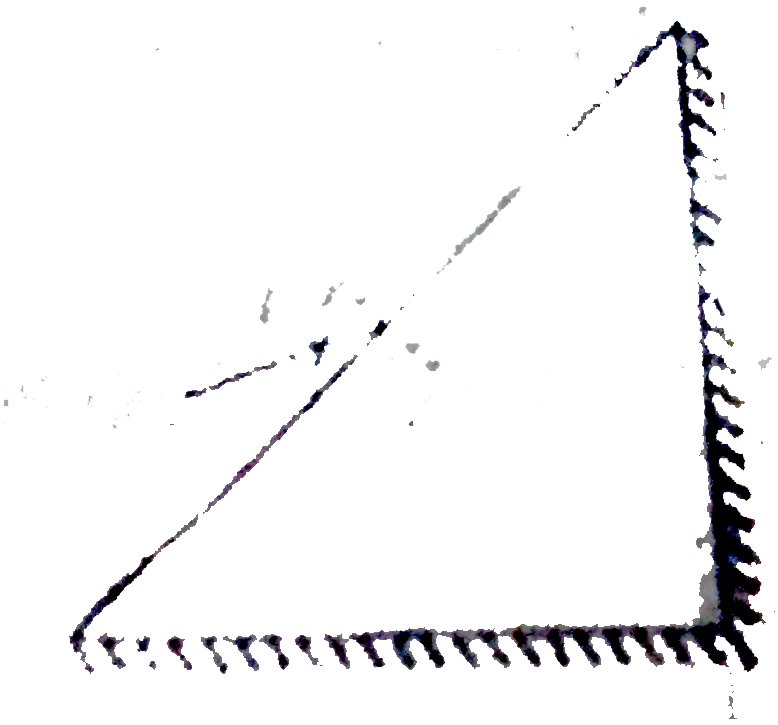
19. The sides of an isosceles right prism are coated with a reflecting coating. A ray of light falls on the hypotenuse at an arbitrary angle i. For what value of i the ray leaving the prism is parallel to the incident ray ?



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20. Find the angle of minimum deviation for an equilateral prism made of a material of refractive index 1.732. What is the angle of incidence for this deviation ?

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21. Show that the limiting value of the angle of prism is twice its critical angle.

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22. What are pure and impure spectra? State the conditions to produce a pure spectrum.

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23. What are Fraunhoffer lines? Explain their origin.

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24. State the significance of emission and absorption spectra.

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Exercise Very Short Answer Questions

1. When a plane wavefront of light is incident on the separating surface between two media, the reflected wavefront is of same width like the incident wavefront whereas the refracted wavefront is of different width. Explain?

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2. What is the shape of the wavefront in each of the following cases

Light overging from the point source

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3. What will happen to the image formed by a mirror if half of it is covered with a black paper?

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4. For a plane mirror what is the focal length? The magnification?

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5. Can two plane mirrors inclined to each other ever form even number of images? Explain?

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6. A ray of light is incident on a horizontal plane mirror at an angle of incidence 30°. By what angle should the mirror be rotated so that the reflected ray becomes horizontal?

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7. For sperical mirros graph plotted between $-\frac{1}{V}$ and $-\frac{1}{u}is$.

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8. Can a convex mirror form a real image! Explain.

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9. A convex mirror of focal length f produced an image $(1/n)^{th}$ of the size of the object. The distance of the object from the mirror is

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10. What kind of mirror is used in a car to observe the traffic at the back?

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11. If an object far away from a convex mirror moves towards the mirror, the image also moves. Does it move faster, slower or at the same speed as compared to the object ?

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12. Figure shows two rays P and Q being reflected by a mirror and going as 'P' and 'Q'. State which type of mirror is this?

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13. What do you mean by refraction? Give an example.

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14. State the Snell's laws of refraction of light.

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15. What is dispersion ?

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16. Define refractive index and relative refractive index

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17. Give the ratio of velocities of two light waves traveling in vacuum and having wavelengths $5000A^{\circ}$ and $6000A^{\circ}$.

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18. For the same angle of incidence, the angles of refraction in three different media A, B and Care $30^{\circ}, 60^{\circ}$ and 45° respectively. In which medium will the velocity or light be maximum?

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19. Can absolute refractive index of a medium be less than unity ?

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20. Can absolute refractive index of a medium be less than unity ?

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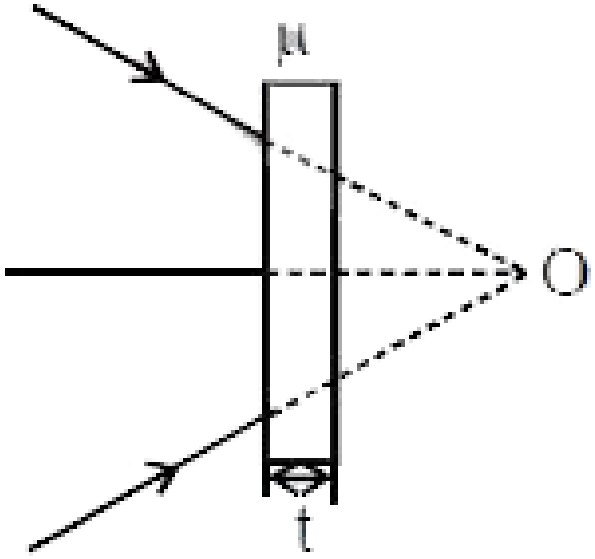
21. A beam of light is converging towards a point. A plane parallel plate of glass of thickness t, refractive index μ is introduced in the path of the beam. The convergent point is shifted by (assume near normal incidence) :



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22. Explain why: (a) A flying bird appears higher in the sky than it really is. (b) Stars appear to twinkle but the sun does not. [Sun is close to the earth so one or the other ray from it always reaches the eye, so it does not appear to twinkle but shines continuously.]

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23. 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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24. Suppose you are inside the water in a swimming pool near an edge. A friend is standing on the edge. Do you find your friend taller or shorter than his usual height ?

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25. Light enters from air to glass having refractive index 1.50. What is the speed of light in the glass? The speed of light in vacuum is $3 \times 10^8 ms^{-1}$.

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26. Define bond energy. On what factors does it depend?

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27. State the consequences of total internal reflection?

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28. What is an optical fibre? State its principle.

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29. Why do diamonds sparkle?

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30. A ray of light while traveling from a denser to rarer medium grazes the separating surface. Express the critical angle in terms of the speed of light in the two media.

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31. If θ_c in the critical angle, write the deviation value when the ray travels from denser to

rarer for $i > \theta_c$.

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32. Consider a ray of light passing from one medium to another. If the angle of refraction is less than the angle of incidence, will the speed of light in the second medium be less or more than that in the first medium?

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33. Mention any three uses of optical fibres.

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34. It is possible for a lens to act as convergent in one medium and divergent in the other medium?

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35. Can a single lens ever form a real and erect image?

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36. If the two radii of a thin lens are not equal, will the focal length change with change in surface facing the light?

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37. What is the focal length if plane surface is silvered in previous illustration.

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38. What will be the equivalent focal length of a system consisting of a thin convex lens and a thin concave lens of same focal length f (a) when they are put in contact (b) when they are separated by a distance d=f (c) when they are separated by a distance, d = 3f ?

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39. An air bubble is formed inside water. Does it act as a converging lens or a diverging lens ?

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40. 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?

Watch Video Solution

41. Define refracting angle and principal section of a prism

Watch Video Solution

42. The graph between angle of deviation (δ) and angle of incidence (i) for a triangular prism is represented by:

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43. Name the shape of wavefront after refraction of (1) Plane wavefront through convex lens (ü) Plane wavefront through prism.

Watch Video Solution

44. What is angular dispersion? On what factors does it depend?

Watch Video Solution

45. Can we have dispersion without deviation with a pair of prisms of the same material but of different angles?

Watch Video Solution

46. Can a beam of white light when passed through a hollow prism give spectrum? Explain.

Watch Video Solution

47. If three identical prisms are combined is it possible to pass a beam that emerges undeviated? Undispersed?

Watch Video Solution

48. Distinguish between a pure spectrum and an impure spectrum.

Watch Video Solution

49. What is a line spectrum? What does its study give?

Watch Video Solution

50. What is a band spectrum? What does its study give?

Watch Video Solution

51. What are Fraunhoffer lines? Explain their origin.

Watch Video Solution

52. What is a total solar eclipse?

Watch Video Solution

53. White light is passed through sodium vapours contained in a thin walled glass flask

and the transmitted light is examined with the help of a spectrometer. The spectrum so obtained is :

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Problems Level I

1. The magnetic field in a plane electromagnetic wave is given by $B_y = 2 \times 10^7 T \sin\left(0.5 \times 10^3 x + 1.5 \times 10^{11} t\right) T$

(a) What is the wavelength and frequency of

the wave?

(b) Write an expression for the eletric field.

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2. If the magnetic field in a plane electromagnetic wave is given by $\vec{B} = 2 \times 10^{-7}$ $\sin\left(0.5 \times 10^{3} x + 15 \times 10^{10} t\right) \hat{k} T$, then what will be the expression for electric field ?

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3. A sinusoidal electromagnetic plane wave travels through empty space in the x-direction. The electric wave is polarized (plane of vibration in single plane) in the y-direction. Frequency of wave is 1.5 GHz. At a certain point P in space, the oscillating electric field E_y attains a maximum magnitude $E_0 = 63$ V/m. What is the wavelength of the wave?

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4. A sinusoidal electromagnetic plane wave travels through empty space in the x-direction. The electric wave is polarized (plane of vibration in single plane) in the y-direction. Frequency of wave is 1.5 GHz. At a certain point P in space, the oscillating electric field E_y attains a maximum magnitude $E_0 = 63$ V/m. What is the maximum magnitude B_0 of the magnetic field at the same point? What is the direction of B?

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5. If two plane mirrors are inclined at an angle of 120° to each other, how many images of an object are

formed?

Watch Video Solution

6. If two plane mirrors are inclined at an angle of 120° to each other, how many images of an object are

seen?

Watch Video Solution

7. Two plane mirrors are placed parallel to each other and 40 cm apart. An object is placed 10 cm from one mirror .What is the distance from the object to the image for each of the five images that are closest to the object?

Watch Video Solution

8. A ray of light is incident on a horizontal plane mirror at an angle of incidence 30°. By what angle should the mirror be rotated so that the reflected ray becomes horizontal?

Watch Video Solution

9. Find the position and nature of the image of an object of height 3 cm when placed 60 cm from a mirror of focal length 15cm, when the

mirror is

concave,

View Text Solution

10. Find the position and nature of the image of an object of height 3 cm when placed 60 cm from a mirror of focal length 15cm, when the mirror is

convex.

View Text Solution

11. An object is placed at a distance of 30 cm from a concave mirror and its real image is formed at a distance of 30 cm from the mirror. The focal length of the mirror is

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12. An object 2 cm high is placed at right angles to the principal axis of a mirror of focal length 25 cm such that an erect image 6 cm high is formed. What kind of mirror is it and what is the position of the object?

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13. The sun subtends an angle half a degree at the pole of a concave mirror which has a radius of curvature of 15 m. Then the size (diameter) of the image of sun formed by the concave mirror is

Watch Video Solution

14. An object 2 cm high is placed at right angles to the principal axis of a mirror of focal length 25 cm such that an erect image 0.5 cm high is formed. What kind of mirror its is and what is the position of the object?

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15. A person looks at himself in a silvered ball of diameter 64 cm from a distance of 2.7m. Find the position and nature of the image.

Watch Video Solution

16. A convex mirror of radius of curvature 4 m is used as rear -view mirror in an automobile. If a vehicle of size 4 m is at a distance of 5 m from the mirror, what is the position of the image and size of the image?

Watch Video Solution

17. If the refractive index of diamond is 2.4 find the velocity of light in diamond.

$(c = 3 \times 10^8 m/s)$

Watch Video Solution

18. The wavelength of blue light in air is 4500 Å . What is its frequency? If the refractive index for blue light is 1.55 in glass what will be the wavelength of blue light in glass? $(c = 3 \times 10^8 m/s)$

Watch Video Solution

19. A beam of light is incident on a glass slab of refractive index 1.5 at an angle of incidence of 45o. Find the ratio of the width of refracted beam to the incident beam.

Watch Video Solution

20. Find the time taken by light to travel a distance of 3 cm in glass. $\left(c = 3 \times 10^8 m/s\right.$ and refractive index of water = 4/3)

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21. 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

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22. The refractive index of denser medium with respect to rarer medium is 1.125. The difference between the velocities of light in the two

media is $0.25 \times 10^8 m/s$. Find the velocities of light in the two media. $\left(c = 3 \times 10^8 m/s\right)$.

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23. A source of yellow light placed in air is observed by a person swimming under water. If the wavelength of yellow light in air is 6000Å , then determine its velocity, wavelength and colour as observed by the person. Take velocity of light in air $\left(c = 3 \times 10^8 m/s^{-1}\right)$

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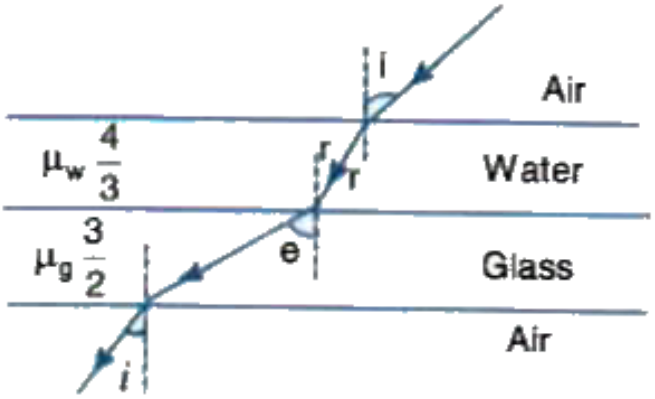
24. In the arrangement shown in the figure a light ray is incident at an angle of 37° on the layer of water. Find the angle of emergence (e) through the layer of glass.



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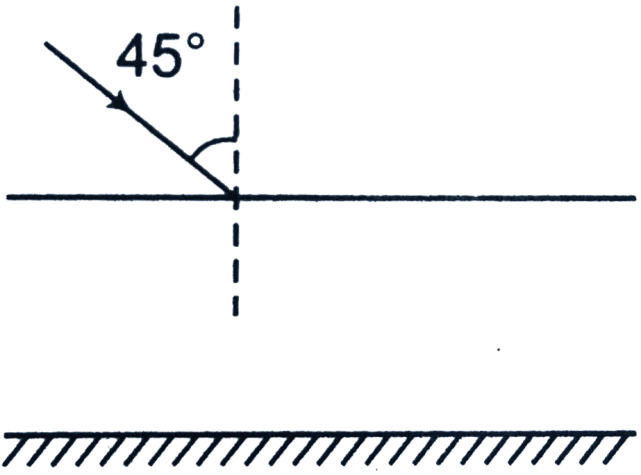
25. One side of a glass slab is silvered as shown in the figure. A ray of light is incident on the other side at angle of incidence 45°. Refractive index of glass is given as $\sqrt{2}$. The deflection suffered by the ray when it comes out of the slab is



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26. Calculate the refractive index of material with respect to air if its critical angle is 60°.

Watch Video Solution

27. The velocities of light in two different media are $2*10^8$m/s and $2.5 * 10^8$m/s respectively.The critical angle for these media is

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28. An optical fibre (RI = 1.72) is surrounded by a glass coating (RI= 1.50). Find the critical angle for total internal reflection at the fibre-glass interface.

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29. A ray of light travelling in glass $\left(\mu_g = 3/2\right)$ is incident on a horizontal glass-air surface at the critical angle θ_C. If a thin layer of water $\left(\mu_w = 4/3\right)$ 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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30. A liquid of refractive index 1.5 is poured into a cyclindrical jar of radius 20 cm upto a height of 20 cm. A small bulb at the centre of bottom glowing. Find area of the liquid surface through which the light of the bulb passes into air.

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31. The radii of curvature of a lens are + 20 cm and + 30 cm. The material of the lens has a refracting index 1-6. Find the focal length of the lens (a) if it is placed in air, and (b) if it is placed in water (mu = 1.33).

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32. The radii of curvature of a lens are + 20 cm and + 30 cm. The material of the lens has a

refracting index 1-6. Find the focal length of the lens (a) if it is placed in air, and (b) if it is placed in water (mu = 1.33).

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33. An object of size 3.0 cm is placed 14 cm in front of a concave lens of focal length 21cm. Descibe the image produced by the lens. What happens if the object is moved further away from the lens?

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34. A concave - convex lens has faces of radii 4 cm and 3 cm respectively and is made of glass of refractive index 1.6. Determine its focal length

Watch Video Solution

35. A concave - convex lens has faces of radii 4 cm and 3 cm respectively and is made of glass of refractive index 1.6. Determine

position of image when object is placed at 28 cm in front of the lens

Watch Video Solution

36. A concave - convex lens has faces of radii 4 cm and 3 cm respectively and is made of glass of refractive index 1.6. Determine its focal length

Watch Video Solution

37. If the angle of prism is 60° and the angle of minimum deviation is also 60°, find the refractive index of the material of the prism.

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38. 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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39. A ray of light passes through an equilateral glass prism, such that the angle of incidence is equal to the angle of emergence. If the angle of emergence is 3/4 times the angle of prism, calculate the refractive index of the glass prism.

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

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41. A ray of light is incident normally on one of the refracting surfaces of a prism of refracting

angle 60°. The emergent ray grazes the other refracting surface. Find the refractive index of the material of the prism.

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42. For an equilateral prism, it is observed that when a ray strikes grazingly at one face it emerges grazingly at the other. Its refractive index will be

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

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44. 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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45. A 5.0 diopter lens forms a virtual image which is 4 times the object placed

perpendicularly on the principal axis of the lens. Find the distance of the object from the lens.

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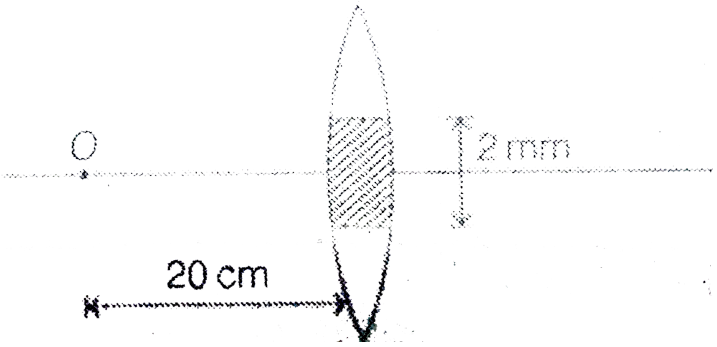
46. A convex lens of focal length 10 cm is painted black at the middle portion as shown in figure. An object placed at a distance of 20

cm from the lens. Then



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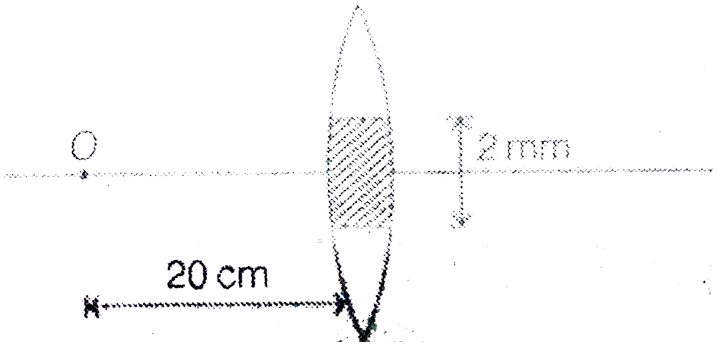
47. A convex lens of focal length 10 cm is painted black at the middle portion as shown in figure. An object placed at a distance of 20

cm from the lens. Then



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48. A 35 mm film is to be projected on a 20 m wide screen situated at a distance of 40 m from the filmprojector. Calculate the distance of the film from the projection lens and focal length of projection lens.

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49. A small object area 6 cm $\times$ 3 cm is placed (plane normal to principal axis) at 10 cm in front of convex mirror of focal length 5 cm. Find the area of the image formed by the mirror.

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50. What is the focal length of a convex lens of focal length 30 cm in contact with a concave lens of focal length 20 cm? Is the system a converging or a diverging lens? Ignore thickness of the lenses.

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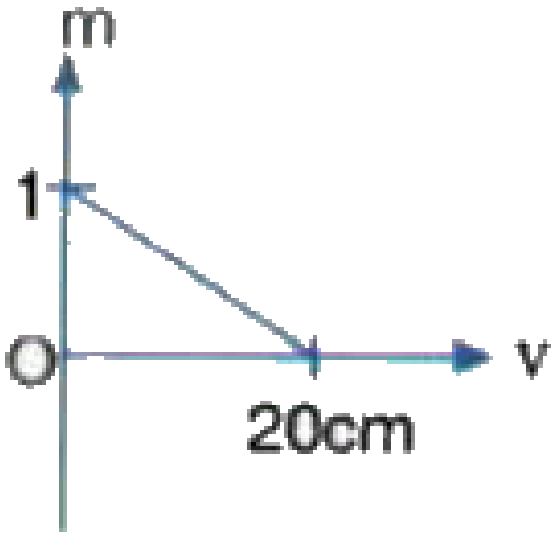
51. To a real object, magnification and image distance graph is as shown in the figure. Find (a) the nature of the mirror and image. (b) the

power of the mirror.



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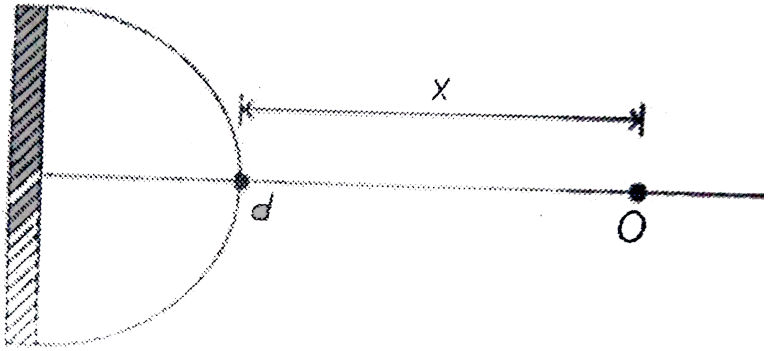
52. A hemishperical surface of radius R and refractive index $\mu = 1.5$ is polished as shown. At what distance x from point P a point object

O be placed so that its image coincides with the object itself?



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53. A ray of light falls on the surface of a spherical glass paper weight making an angle α with the normal and is refracted in the medium at an angle β. The angle of deviation

of the emergent ray from the direction of the incident ray is

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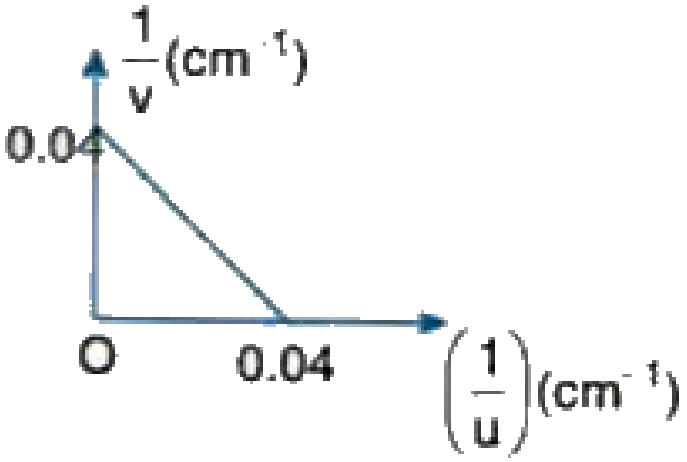
54. The object distance 'u' and the image distance v from a convex lens vary as shown in figure. Find



(a) The nature and focal length of the lens.

(b) The minimum distance between an object and its real image.

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55. A particle executes a simple harmonic motion of amplitude 1.0 cm along the principal axis of a convex lens of focal length 12 cm. The mean position of oscillation is at 20 cm from the lens. Find the amplitude of oscillation of the image of the particle.

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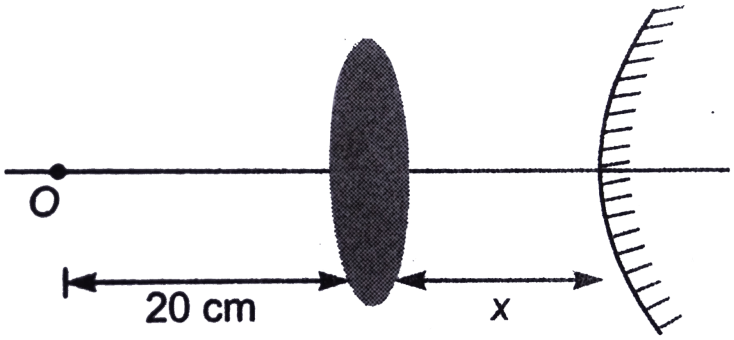
56. A point object O is placed at a distance of $20cm$ from a convex lens of focal length $10cm$ as shown in the figure. At what distance x from the lens should a convex mirror of focal length $60cm$, be placed so that final image coincide with the object?



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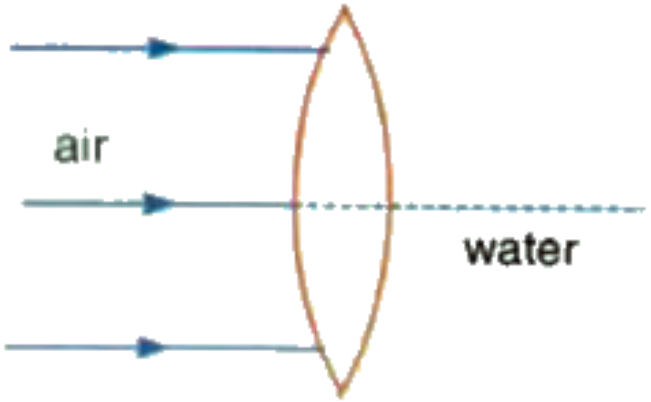
57. A thin equiconvex lens made of glass (n = 3/2) is placed in such a way the that one surface is in contact with water (n = 4/3) and another surface is in contact with air. Find focal length of setup if the rays are incident as shown. Radius of curvature (R = 30 cm)



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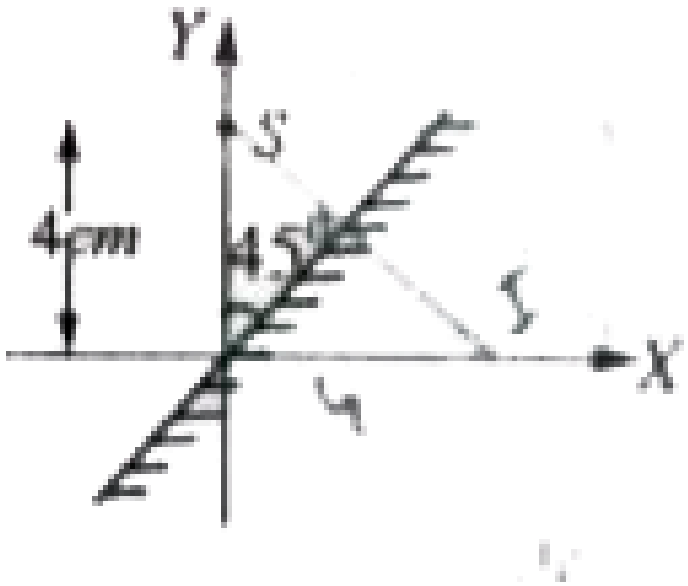
Problems Level Ii

1. What are the co-ordinates of the imasge of S formed by a plane mirror as shown in figure?



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2. A ray of light in incident along a vector $\hat{i} + \hat{j} - \hat{k}$ on a plane mirror lying in y-z plane. The unit vector along the reflected ray can be

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3. Write a relationship between angle of incidence and angle of refraction for a given pair of media.

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4. A bird looking down vertically into a pond from 12cm above the surface sees a fish apparently 18 cm below the surface. What is the actual depth of the fish? What is the apparent height of bird as seen by the fish? [Refractive index of water = 4/3]

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5. There is a dust particle in a glass slab of thickness t and refractive index $\mu = 1.5$. When seen from one side of the slab, the dust particle appears at a distance 6 cm. From opposite side it appears at 4 cm. Find the thickness t of the glass slab.

Watch Video Solution

6. A parallel beam of light is incident on a rectangle transparent plate of thickness 8 cm.

The angle of incidence and refraction of the beam is 60° and 30° respectively. Find the lateral shift.

Watch Video Solution

7. 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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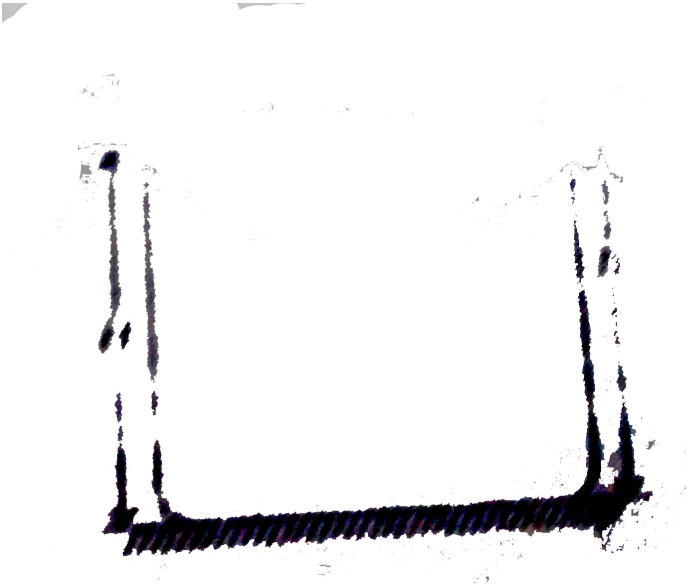
8. A point object is placed at a distance of 20 cm from a glass slab, H=18cm, half immersed in water as shown in figure. The distance between two images when seen from the other side of the slab is

$\left(\mu_g = \frac{3}{2} \text{ and } \mu_w = \frac{4}{3}\right)$



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9. A ray of light travelling in a rarer medium strikes a plane boundary between the rarer medium and a denser medium at an angle of

incidence 'i' such that the reflected and the refracted rays are mutually perpendicular. Another ray of light of same frequency is incident on the same boundary from the side of denser medium. Find the minimum angle of incidence at the denser-rarer boundary so that the second ray is totally reflected

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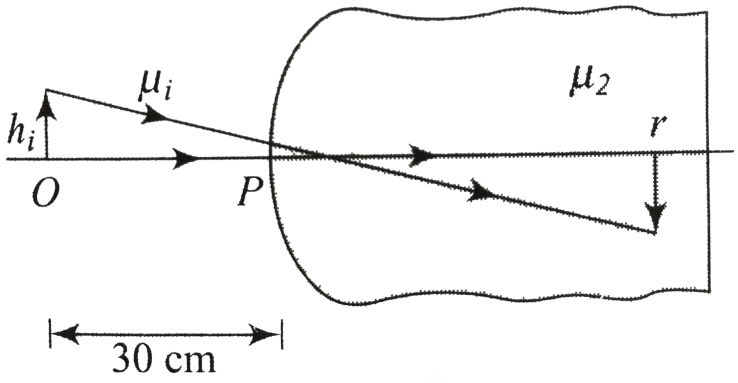
10. A small object of height 0.5 cm is placed in front of a convex surface of glass $(\mu - 1.5)$ of

radius of curvature 10cm. Find the height of the image formed in glass.



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11. A paperweight in the form of a hemisphere of radius 3.0 cm is used to hold down a printed page. An observer looks at the page vertically through the paperweight. At what

height above the page will the printed letters near the centre appear to the observer ?

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12. A convex glass lens $(\mu = 1.5)$ produces a real image of an object. The size of the image equals the size of the object. When the air surrounding the lens is replaced by a liquid, the size of the image is found to be twice that of the object. Find the refractive index of the liquid.

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13. Two plano-convex lens of glass of refractive index 1.5 have radii of curvature 20cm and 30cm. They are placed in contact with curved surface towards each other and the space between them is filled with a liquid of refractive index $\frac{4}{3}$. Find the focal length of the system.

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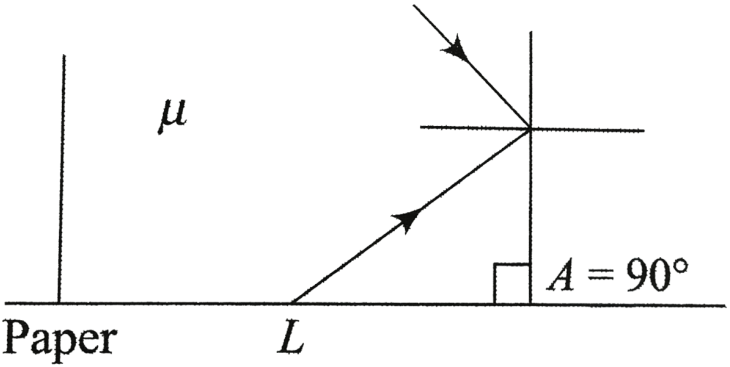
14. A rectangulat block of refractive index μ is placed on a printed page lying on a horizontal surface as shown in Fig. , Find the minimum value of μ so that the letter L on the page is not visible from any of the vertical sides.



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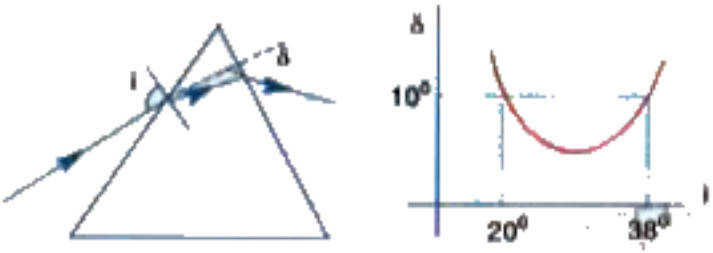
15. A ray is incident on prism at an angle i with normal. When it comes out of prism its angular deviation is δ. Graph between δ and i is given. Find the prism angle.



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16. The dispersive power of crown and flint glasses are 0.02 and 0.04 respectively. If the

difference between the refractive indices of blue and red colours is 0.012 for crown glass and 0.022 for flint glass, calculate the angle of the two prisms for a deviation of 8° (without dispersion).

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17. Two prisms of identical geometrical shape are combined with their refracting angles oppositely directed. The materials of the prisms have refractive indices 1.52 and 1.62 for

violet light. A violet ray is deviated by 1.0° when passes symmetrically through this combination. What is the angle of the prisms ?

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18. A thin prism of crown glass $(\mu_r = 1.515, \mu_v = 1.525)$ and a thin prism of flint glass $(\mu_r = 1.612, \mu_v = 1.632)$ are placed in contact with each other. Their refracting angles are 5.0° each and are

similarly directed. Calculate the angular dispersion produced by the combination.

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19. Two small angled prisms A and B deviate the blue rays by 7° and 9° and the red rays by 5° and 7° respectively. Which prism has a greater dispersive power?

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20. A beam of light converges towards a point O, behind a convex mirror of focal length 20cm.

Q. Similarly, as in above question when point O is 30cm behind the mirror.

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21. When an object is placed at a distance of 25 cm from a mirror, the magnification is m_1. The object is moved 15cm farther away with

respect to the earlier position, and the magnification becomes m_2. If $m_1/m_2 = 4$, then calculate the focal length of the mirror.

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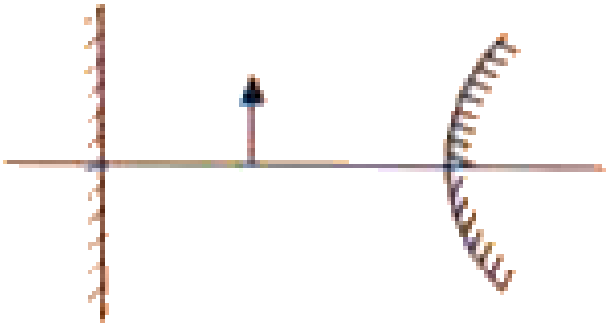
22. An object is placed between a plane mirror and a convex mirror as shown, Let I_1 and I_2 be the images formed by the plane mirror and the convex mirror respectively. It is found that distance between I_1 and I_2 is 100 cm, distance between the object and I_2 is 60 cm

and has magnification 1/2. Find focal length of the convex mirror and also the distance between the two mirrors.



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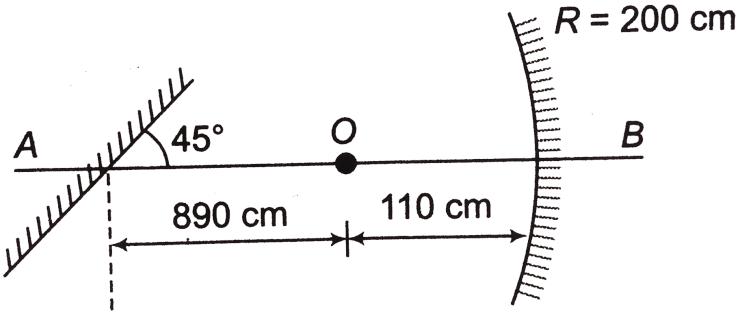
23. A plane mirror and a concave mirror are arranged as shown in figure and O is a point object, Find the position of image formed by

two reflection, first one talking place at concave mirror.



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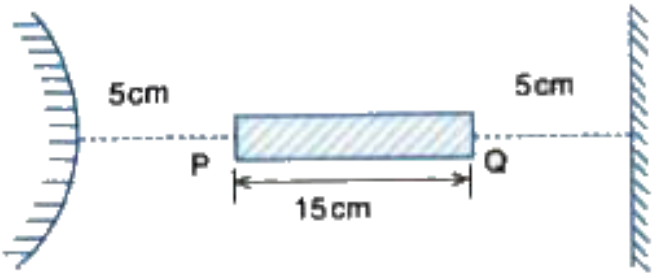
24. Describe the image in convex mirror, of the image of rod PQ in the plane mirror (radius of

curvature of mirror is 60 cm).



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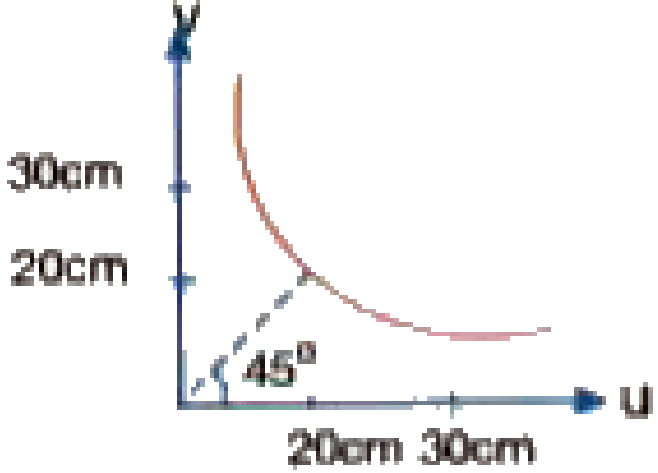
25. The u-v curve in a concave mirror as shown in figure.



Find the focal length and power of the mirror.

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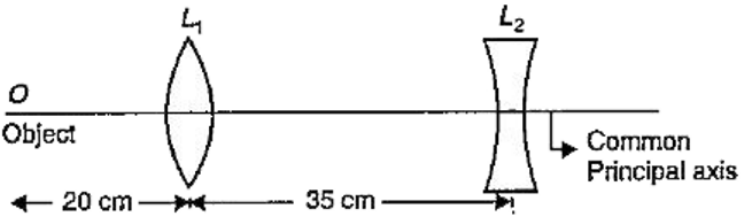
26. An illuminated point object O is kept 20 cm from a thin convex lens L_1 of focal length 15 cm as shown below. A thin diverging lens L_2 of focal length 25 cm is kept co - axial with the

first lens and 35cm from it, as shown in figure below :



Find the position of the final image formed by this combination of lenses.

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27. A thief is running away in a car with velocity of 20 m/s . A police jeep is following him, which is sighted by thief in his rear view

mirror which is a convex which is a convex mirror of focal length 10 m . He observes that the image of jeep is moving towards him with velocity of 1 cm/s . if the magnification of the mirror for the jeep at that time is 1/10 . find (a) actual speed of jeep (b) rate at which magnification is changing . Assume that police jeep is on axis of the mirror.

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28. One face of a rectangular glass plate of 8 cm thickness is silvered. An object held 10 cm in front of the unsilvered fave an image 12 cm behind the silvered face. What is the refractive index of the glass?

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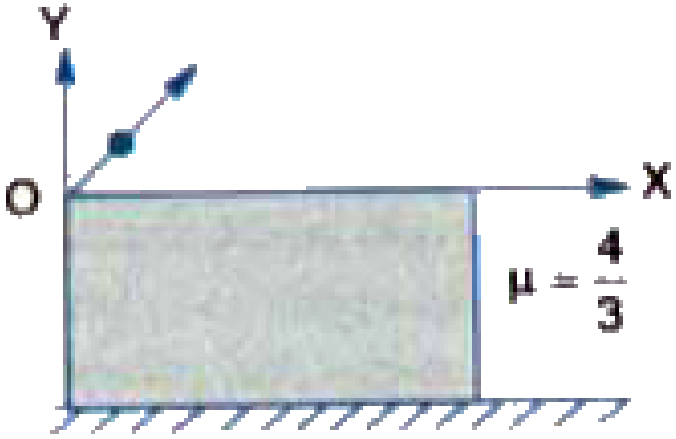
29. The bottom of water tank is lined with a plane mirror.A particle is projected from the origin O under gravity. The equation of the

trajectory is $y = a\left(x - x^2\right)$. The depth of the tank is 4a and this is completely filled. Find the distance of image with respect to mirror after reflection of rays from it.



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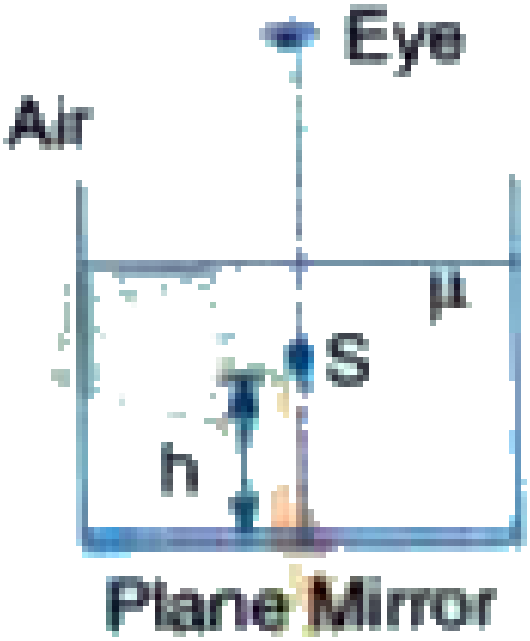
30. In figure a point source S is placed at a height h above the plane mirror in a medium of refractive index μ.



Find the number of images seen for normal view.

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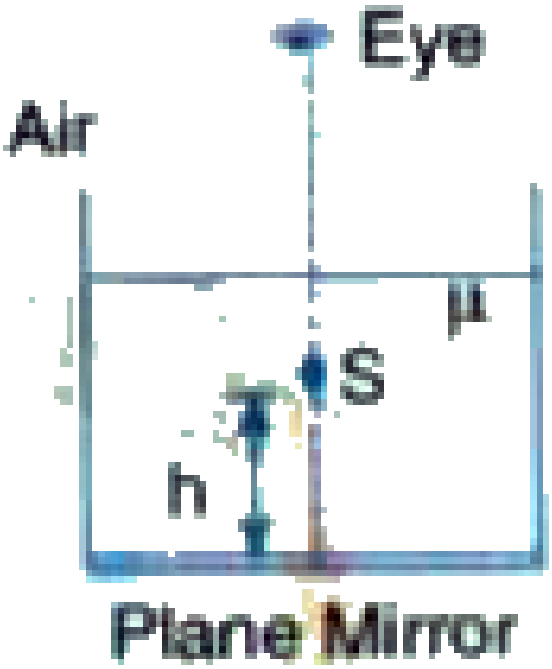
31. In figure a point source S is placed at a height h above the plane mirror in a medium of refractive index μ.



Find the distance between the images.

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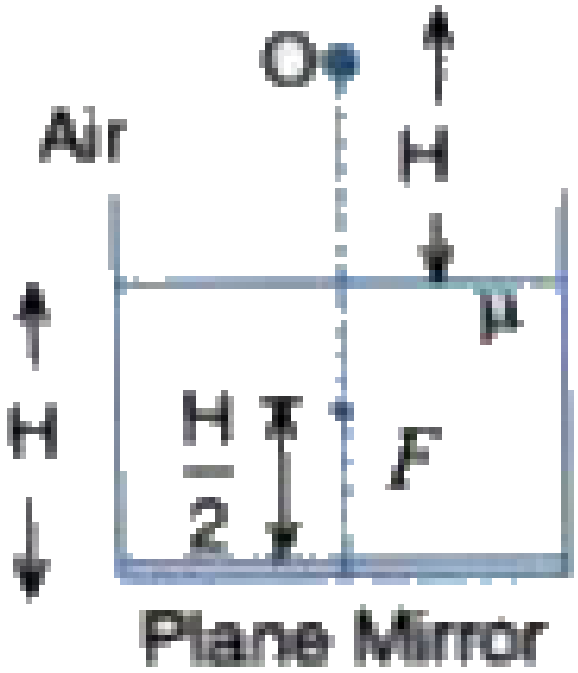
32. Consider situation in figure. The bottom of the pot is reflecting plane mimor, Fis a small fish and is an object. Refractive index of water is μ. Find the distances from it self the fish can

see the image (s) of the object O.



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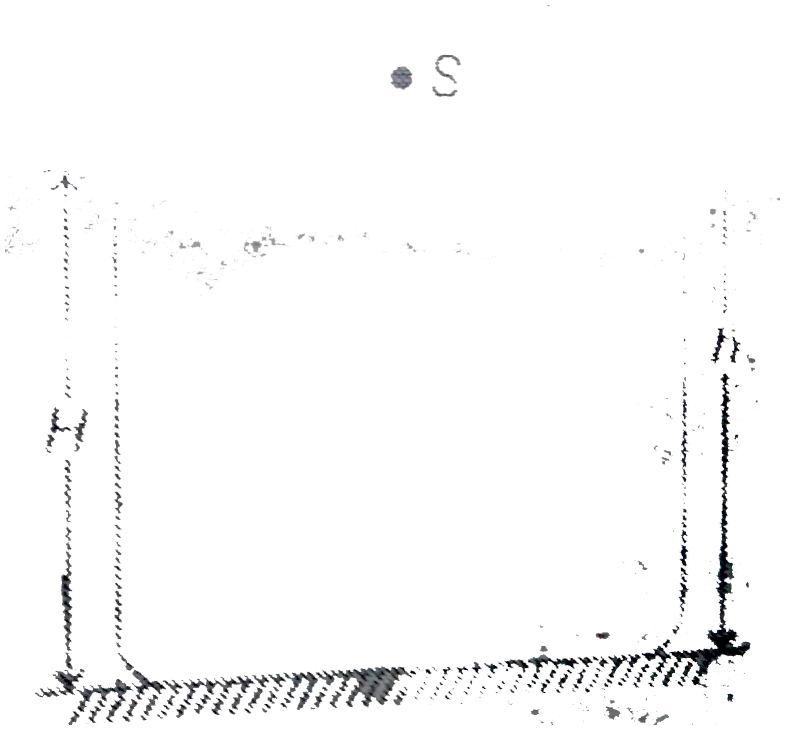
33. A point source S is placed at a height h from the bottom of a vessel of height

$H(<h)$. The vessel is polished at the base. Water is polished at the base. Water is gradually filled in the vessel at a constant rate $\alpha m^3/s$. The distance d of image of the source after reflection from mirror from the bottom of the vessel varies with time t as



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34. A concave mirror with its optic axis vertical and mirror facinig upward is placed at the bottom of the water tank. The radius of curvature of the mirror is 40 cm and refractive index for water $\mu = 4/3$. The tank is 20 cm deep and if a bird is flying over the tank at a height of 60 cm above the surface of water, find the position of image of the bird.

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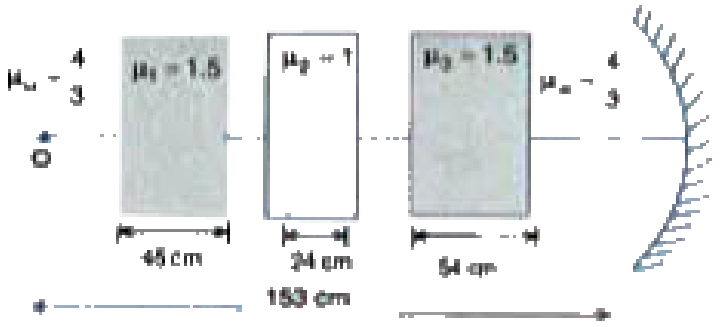
35. Three different slabs consisting of different media are placed in front of a concave mirror of radius of curvature 150 cm. The whole arrangement is placed in water ($\mu = 4/3$). An object O is placed at a distance 153 cm from the mirror. The refractive index of different media are given in the diagram. Find the position of final image formed by the system.



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36. A cylindrical vessel of depth 4m is fully filled with non homogenious liquid whose refractive index (μ) varies with depth y (in meters) a $\mu = 1 + \frac{y}{4}$. Find the depth of the bottom of vessel as seen by an observer just above the top of the vessel.

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37. If a point source is placed at a depth h in a liquid of refractive index $\frac{4}{3}$. Find percentage of energy of light that escapes from liquid. (assuming $100\,\%$ transmission of emerging light)

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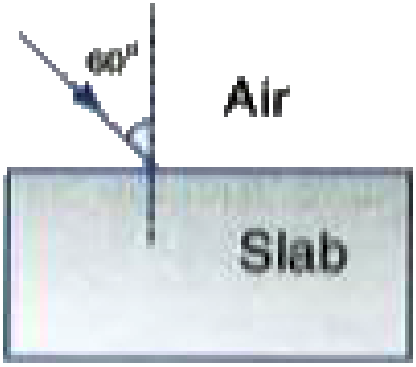
38. A ray of light enters a glass slab from air as shown in figure. If refractive index of glass slab is given by $\mu = A - Bt$, where A and B are

constants and t is the thickness of slab measured from the top surface. Find the maximum depth travelled by ray in the slab. Assume thickness of slab to be sufficiently large.



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39. A ray enters a glass sphere of refractive index $\mu = (\sqrt{3})$ at an angle of incidence of 60°, ray is reflected and refracted at the farther surface of the sphere. The angle between the reflected and refracted rays at this surface is

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40. A hemisphere (made of material of refractive index $\sqrt{3})$ of radius ris placed on a

horizontal surface with its base touching the surface. A vertical beam of cross sectional radius $\frac{\sqrt{3}}{2}r$is incident symmetrically on its curved surface. Find the radius of the spot of light formed on the horizontal surface

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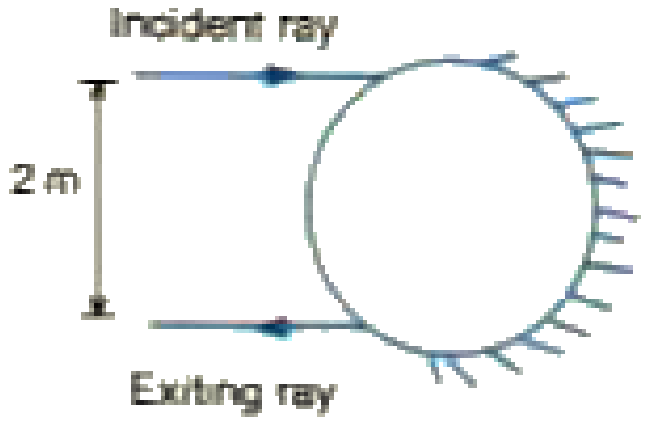
41. A transparent cylinder of radius 2m has a mirrored surface on its right half as shown in figure. A light ray travelling in air is incident on the left side of the cylinder.



The incident ray and the exiting ray are parallel and at a distance 2m. Determine the refractive index of the material of the cylinder.

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42. A point object is placed on the optic axis of a convex lens of focal length f at a distance of

2f to the left it. The diameter of the lens d. An eye is placed are distance of 3f to the right of the lens and a distance below the optic axis. The maximum value of h to the image is

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43. A beam of light converges at a point P. Now a lens is placed in the path of the convergent beam 12cm form P. At what point does the beam converge if the lens is a) convex lens of

focal length 20 cm, and b) a convex lens of focal length 16cm?

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44. A beam of light converges at a point P. Now a lens is placed in the path of the convergent beam 12cm form P. At what point does the beam converge if the lens is a) convex lens of focal length 20 cm, and b) a convex lens of focal length 16cm?

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45. 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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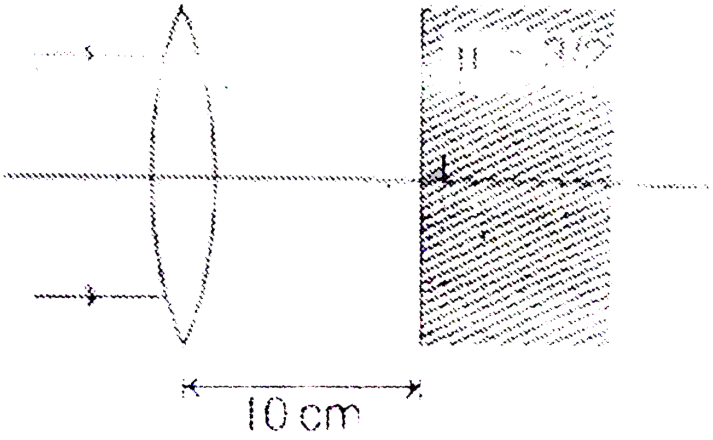
46. Focal length of a thin convex lens is 30 cm. At distance of 10 cm from the lens there is a plan refracting surface of refractive index $3/2$.

Where w the parallel rays incident on lens converge ?



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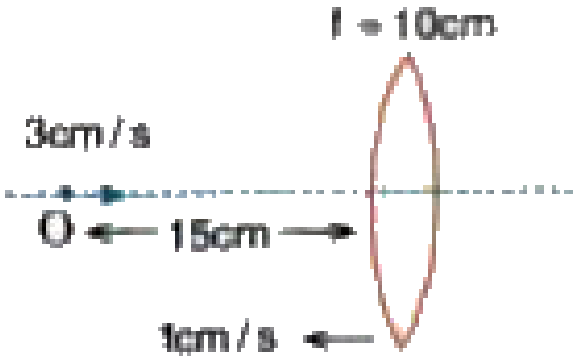
47. Both object and convex lens are approaching each other along the principal axis as shown. Find the speed of image relative

to object at the given instant as shown in the figure.



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48. A converging lens of focal length 12 cm and a diverging mirror of focal length 7.5 cm are placed 5.0 cm apart with their principal axes

coinciding. Where should an object be placed so that its image falls on itself ?

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49. A converging lens of focal length 15 cm and a converging mirror of focal length 10 cm are placed 50 cm apart with common principal axis. A point source is placed in between the lens and the mirror at a distance of 40 cm from the lens. Find the locations of the two images formed.

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50. A convex lens of focal length 15 cm and concave mirror of focal length 30 cm are kept their optical axes PQ and RS parallel but separated in vertical direction by 0.6 m, as shown. The distance between the lens and mirror is 30 cm. An upright object AB of height 1.2 m is placed on the optic axic PQ of the lens at a distance of 20 cm from the lens.

Find the linear magnification of the first image after refraction from the lens.

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51. Magnification by a lens of an object at distance 10 cm from it is -2. now a seconnd lens is placed exactly at the same positon where first was kept, without changing the distance between object and lens. The magnification by this second lens is -3.

Now both the lenses are kept in contact at the

same place. what will be the new magnification ?

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52. The curved surface of a concave spherical mirror with a radius of curvature of 0.2 m is silvered. What is the focal power of this system? Refractive index of water is 4/3.

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53. A thin equiconvex lens of glass$(\mu = 1.5)$ with radius of curvature 4m is placed on a horizontal plane mirror. When the space between the lens and mirror is filled with a liquid, an object held at a distance 6m vertically above the lens is found to coincide with its own image. What is the refractive index of the liquid.

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54. 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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55. An equiconvex lens of refractive index 1.5 and focal length 10 cm is held with its axis vertical and its lower surface immersed in water, the upper surface being in air. At what distance from the lens will a vertical beam of parallel rays incident on the lens be focussed? $\mu. = 4/3.$

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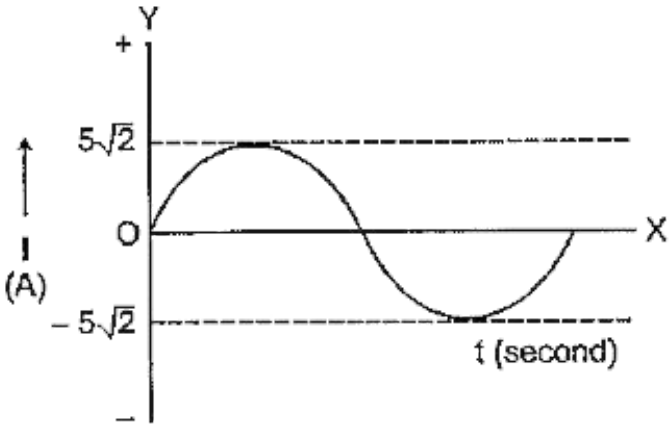
56. Variation of alternating current .I. with time .t. is shown in the graph below.



What is ther.m.s.value of this current ?

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57. 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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58. A plano-convex lens behaves as a concave mirror of focal length 30 cm when its plane surface is silvered and as a concave mirror of focal length 10 cm when its curved surface is silvered. What is the radius of curvature of curved surface and μ of the material of lens?

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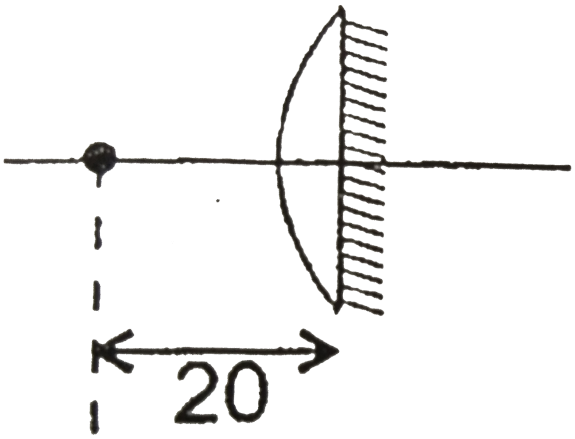
59. A point object is placed at a distance of $20cm$ from a thin plano-concex lens of focal

length $15cm$. The plane surface of the lens is now silvered. The image created by the is at :



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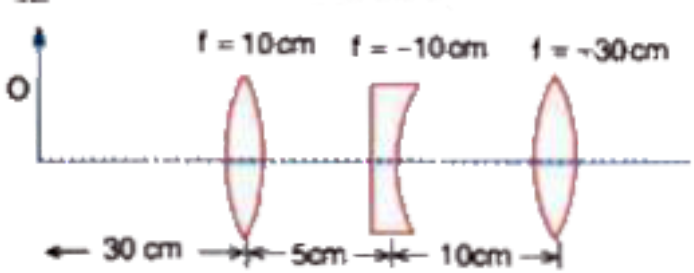
60. Find the position of the final image formed by the lens combination given in the figure



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