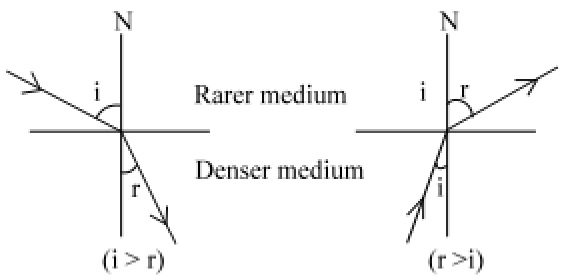
CHAPTER - 16
RAY OPTICS

SYNOPSIS

Refraction

The phenomenon of bending of light when it travels from one medium to another medium is known as refraction.



When the ray passes from rarer to denser medium, the refracted by bends towards the normal and when it passes from denser to rarer medium, the refracted ray bends away from the normal. When light passes from one medium to another medium, the frequency and colour of light remains same but the wave length and velocity of light changes.

Laws of refraction

(i) The incident ray, the refracted ray and the normal at the point of incidence are in same plane

(ii) The ratio sin of angle incidence to sin of angle of refraction is a constant for a given pair or media and for a given colour of light

ie $\frac{\sin i}{\sin r}$ = a constant (n). This is known as Snell's law

If light passes from medium (1) to (2), the constant is ${}_1n_2 = \frac{n_2}{n_1}$

$${}_2n_1 = \frac{n_1}{n_2}$$

Also we can write ${}_1n_2 = \frac{1}{{}_2n_1}$

What happen if ray of light falls normally at the surface of separation of two media

The ray goes undeviate, ie. no refraction possible

$$n = \frac{\text{Sin} i}{\text{Sin} r} \text{ Here } i = 0; \qquad \text{Sin } r = \frac{\text{Sin } i}{n} = \frac{\text{Sin}0}{n} = 0 \therefore r = 0$$

Absolute refractive index

Refractive index of a medium with respect to air or vacuum is called absolute refractive Index, denoted by n or μ

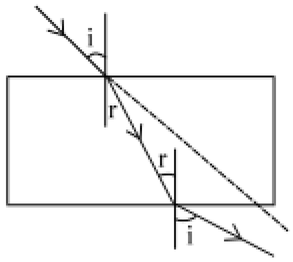
Absolute refractive index of a medium is the ratio of the sine of angle of incidence to the sine of angle of refraction when refraction takes place from air or vacuum to the medium.

$$n = \frac{\sin i}{\sin r}$$

Since there is a change in the direction of light as it goes from one medium into another depends on the speeds of light in the two media.

Refractive index of medium = $\dfrac{\text{velocity of light in vaccum}}{\text{velocity of light in medium}} = \dfrac{c}{v}$

Expression for the lateral shift when a ray of monochromatic light passing through a parallel sided glass slab.

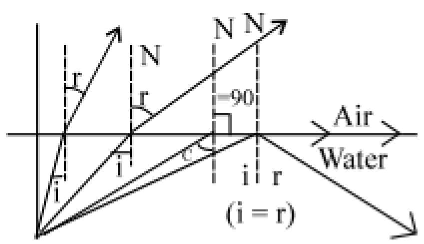


$$L.S = \frac{t}{\cos r} \sin(i - r)$$

t = thickness i = angle of incidence

r = angle of refraction

Critical angle



When a ray of light passes from denser to rarer medium, the refracted ray bends away from the normal (as i increases, r also increases). At a particular angle of incidence, the refracted ray just grazes the surface of separation. This angle of incidence is known as critical angle (C). At this case angle of refraction is 90^0. At critical angle , r = 90

$$n = \frac{\text{Sin}90}{\text{SinC}} = \frac{1}{\text{SinC}}$$

Relative critical angle

The critical angle of a medium B with respect to a rarer medium A is related to the refractive index by the formula.

$$_A n_B = \frac{1}{\text{Sin}\,_A C_B}$$

where $_A C_B$ is the critical angle of medium B with respect to A.

Some typical critical angles are listed below

Substance	Refractive index	Critical angle
Water	1.33	48.75^o
Crown glass	1.52	41.14^o
Dense flint glass	1.65	37.31^o
Diamond	2.42	24.41^o

Total internal reflection

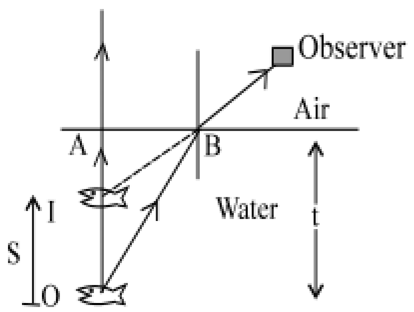
If the angle of incidence is increased beyond the critical angle, the incident ray is reflected back to the same medium obeying the laws of reflection (i = r). This is known as total internal reflection

The conditions for total internal reflection are

i) The light must travel from denser to rarer medium

ii) The angle of incidence must be greater than the critical angle

(c). Real and apparent depth: A fish at the bottom of a lake appears to be raised due to refraction. Let I is the apparent position of the fish. AO is the real depth; AI is the apparent depth OI is the displacement or shift of the image. (The fish is really at 0O.



Refractive index of the medium

$$n = \frac{\text{Real depth}}{\text{App.depth}} = \frac{AO}{AI} \text{ or } AI = \frac{AO}{n}$$

To find the shifts(S) in the position of the images

S = AO – AI

$$S = AO - \frac{AO}{n} = AO(1 - 1/n)$$

But AO = t, the real depth

$$S = t\left(1 - \frac{1}{n}\right)$$

Expression for refractive index of prism

$$n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin(A/2)} \text{ where}$$

n = refractive index A = angle of prism D = angle of minimum deviation

Deviation produced by a thin prism

A thin prism is a prism of small refracting angle. For a prism $d = i_1 + i_2 - A$

$$n = \frac{\sin i_1}{\sin r_1} = \frac{\sin i_2}{\sin r_2}$$ $r_1 + r_2 = A$

When A is small r_1 and r_2 are small. When r_1 and r_2 are small i_1 and i_2 will be small (sinq = q when q is small)

$$n = \frac{\sin i_1}{\sin r_1} = \frac{i_1}{r_1} \quad \therefore i_1 = nr_1$$

Similarly $i_2 = nr_2$ Substituting $d = nr_1 + nr_2 - A$

$= n(r_1 + r_2) - A$ $[r_1 + r_2 = A]$ $d = A(n-1)$

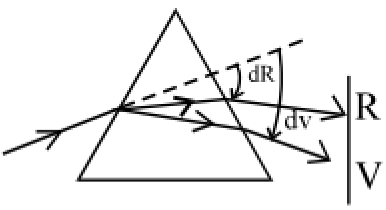
Thus deviation is independent of the angle of incidence.

The factors on which the angle of deviation produced by a thin prism depends are

d = A (n – 1)

1. Refractive index of the medium
2. Surrounding medium
3. Angle of prism

Dispersive power of a prism



Dispersive power of a medium is defined as the ratio of difference in deviation between the most and least deviated colours to its mean deviation.

If d_v and d_R are the deviations for violet and red colours and 'd' its mean deviation.

∴ Dispersive power

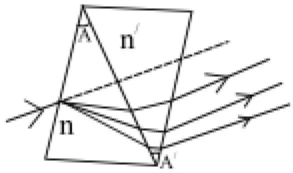
$$: \omega = \frac{d_v - d_R}{d} \text{ where } d = \frac{d_v + d_R}{2}$$

OR

If n_v and n_R are the refractive indices for violet and red colours for a medium and n the average refractive index,

The $\omega = \dfrac{n_v - n_R}{(n-1)}$ where $n = \dfrac{n_v + n_R}{2}$

Dispersion without deviation



For getting dispersion without deviation for the mean ray (yellow colour)

(1) Two small angled prisms of different materials are so combined with their bases opposite to each other (or the refracting angles in opposite direction).

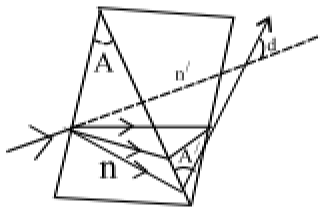
(2) If A and A′ be the angles, n and n′ the refractive indices of the two prisms then the condition for dispersion without deviation for the mean ray is

$A(n-1) = -A'(n'-1)$ OR $\dfrac{A}{A'} = \dfrac{-(n'-1)}{n-1}$

The negative sign shows that deviation caused by the I[st] prism is just cancelled by the 2[nd] one. Such a combination is used in the construction of direct vision spectroscope.

Deviation without dispersion

For getting deviation without dispersion for the mean ray (yellow colour):



1) Two small angled prisms of different angles and different materials are so combined with their bases opposite to each other. (or the refracting angles in opposite direction)

2). Let A and A' the angles n_v and n_R, n'_v and n'_R the refractive indices for violet and red colours for the prisms. Then the condition for deviation without dispersion for the mean ray is

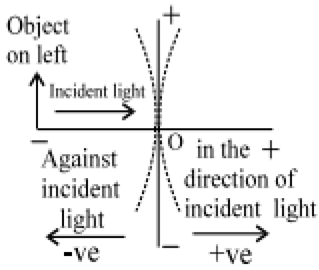
$A(n_v - n_R) = -A'(n'_v - n'_R)$

OR $\dfrac{A}{A'} = \dfrac{-(n'_v - n'_R)}{(n_v - n_R)}$

The negative sign shows that dispersion caused by the i[st] prism is just cancelled by the 2[nd] prism. The combination is called achromatic combination.

The new Cartesian sign convention for reflection and refraction at spherical surfaces

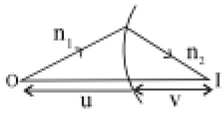
This convention borrows the technique of fixing signs from co - ordinate geometry



1. The pole of the spherical surface will be the origin O and the principal axis along the X - axis
2. All distances are measured from the pole. Distances measured in the direction of incidence will be positive and opposite to the direction of incidence negative.
3. Distances measured perpendicular to the principal axis will be positive if measured upwards and negative if measured downwards.

   One advantage of this system is that, if the object is placed to the left of the spherical surface, Cartesian convention of sign comes into operation.

Relation between u, v and R



$$\frac{n_2}{v}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$$

R, +ve for convex surface

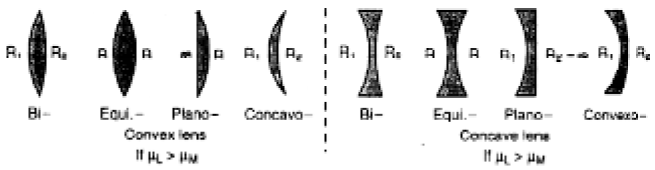
R_1–ve for concave surface

n_1 – Refractive index of the medium where the object is placed

The lens

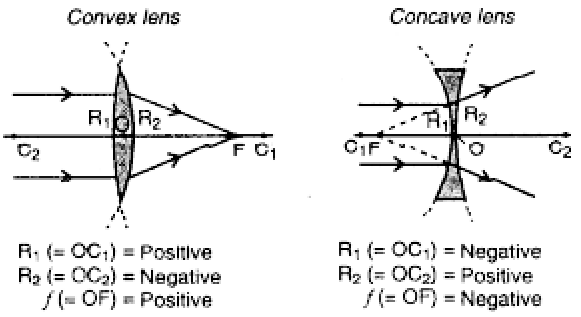
A lens is a piece of transparent material with two refracting surfaces such that at least one is curved and refractive index of its material is different from that of the surroundings.

Different types of lenses



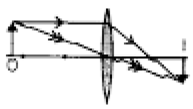
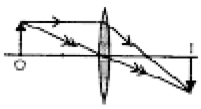
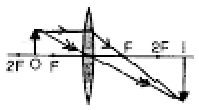
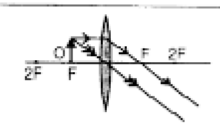
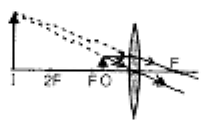
Sign Convention

1. Whenever and where ever possible, rays of light are taken to travel from left to right
2. Transverse distances measured above the principal axis are taken to be positive while those below it negative
3. Longitudinal distances are measured from optical centre and are taken to be positive if in the direction of light propagation and negative if opposite to it.e.g., according to our convention in case of (A)

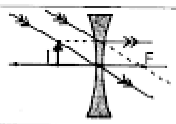
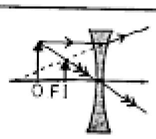


(A) (B)

Ray diagrams

S. No.	Position of Object	Ray-Diagram	Details of Image
1.	At infinity		Real, inverted Diminished ($m \ll -1$) At F
2.	Between ∞ and $2F$		Real, inverted Diminished ($m < -1$) Between F and $2F$
3.	At $2F$		Real, inverted Equal ($m = -1$) At $2F$
4.	Between $2F$ and F		Real, inverted Enlarged ($m > -1$) Between $2F$ and ∞
5.	At F		Real, inverted Enlarged ($m \gg -1$) At infinity
6.	Between F and O		Virtual, erect Enlarged ($m > +1$) Between ∞ and object on same side.

(b) For Divergent or Concave Lens

S. No.	Position of Object	Ray-Diagram	Details of Image
1.	At infinity		Virtual, erect Diminished ($m \ll +1$) At F
2.	In front of lens		Virtual, erect Diminished ($m < +1$) Between F and optical centre.

Formula for thin lens (Len's maker's formula)

$\therefore \frac{1}{f}=(n-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ -(4) and it is known as Len's maker's formula from (4) and (3) , $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$

This is known as the Lens formula or the law of distances for a lens

Power of a lens

It is the reciprocal of focal length. $P=\frac{1}{f\,(m)}$ and $\frac{100}{f\,(cm)}$ is measured in dioptre (D). Power is positive for the converging lens and negative for diverging lens.

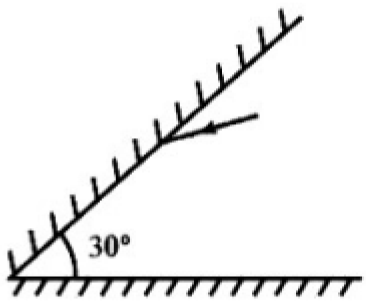
PART I - (JEEMAIN)

SECTION - I - Straight objective type questions

1. A ray of light is incident at 50^0 on one of the two plane mirrors arranged at an angle of 60^0 between them, The ray then touches the second mirror, get reflected back to the first mirror, makes an angle of incidence θ. The value of θ is :

1) 50^0 2) 60^0 3) 70^0 4) 80^0

2. Two plane mirrors are inclined at 30^0. A ray of light incident on the 1st mirror at 50^0 and escapes after three successive reflections. The total deviation suffered by the ray



1) 220^0 2) 200^0 3) 160^0 4) 180^0

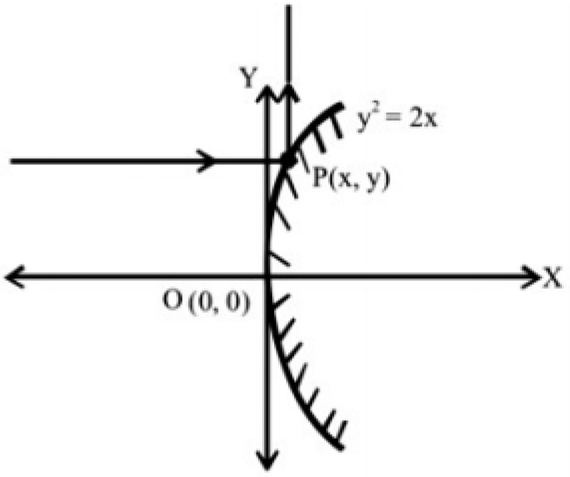
3. A car has a rear view mirror of radius of curvature 2m. A motorcycle is approaching the car at 15m/s. If the car is stationary how fast is the image of the bike approaching the car when the bike is 40m away.

1) 0.003m/s 2) 0.006m/s 3) 0.009 m/s 4) 0.012 m/s

4. A candle flame 3cm is placed at distance of 3m from a wall. How far from wall must a concave mirror be placed in order that it may from an image of flame 9cm high on the wall

1) 225 cm 2) 300 cm 3) 450 cm 4) 650 cm

5. The curve of a reflecting curved surface is represented by the equation $y^2 = 2x$ is shown in figure. A ray of light pareallel to x-axis is incident on the curve at P(x,y) and after relection the ray is paralle to y-axis then which of the following options is correct about x and y



1) x=0, y = 0

2) x = 2, y=2

3) $x = 1, y = \sqrt{2}$

4) $x = \frac{1}{2}, y = 1$

6. A concave mirror of focal length 10cm and 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 at 15cm from the concave mirror. The position and nature of the image produced by the successive reflections first of the concave mirror and then at the convex mirror is

1) 6 cm behind the convex mirror and real

2) 6 cm behind the convex mirror and virtual

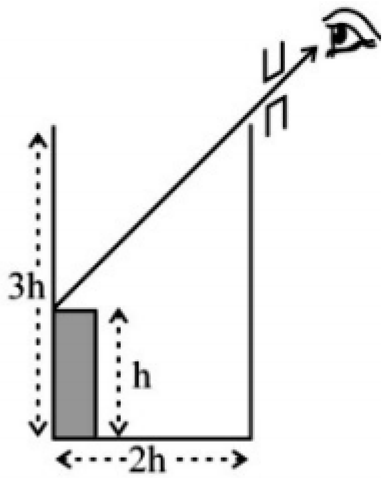
3) 30 cm behind the convex mirror and real

4) 30 cm behind the convex mirror and virtual

7. A small air bubble is inside a glass cube of side 32 cm. When viewed from one face, the bubble appears to be at 15cm and viewed from the opposite face it appears to be at 5cm. The refractive index of the material of the cube is

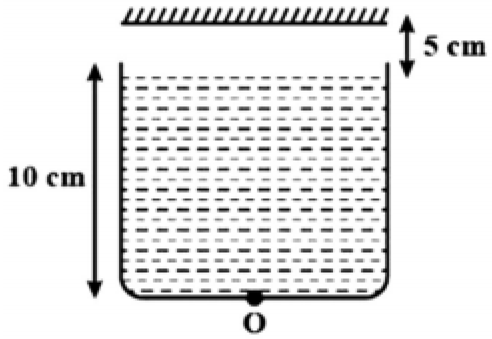
1) 1.5 2) 1.6 3) 1.7 4) 1.45

8. An observer can see through a pinhole the top and of a thin rod of height h placed as shown in figure. The beaker height is 3h and its radius h. When beaker is filled with a liquid upto 2h, he can see the lower and of the rod. The refractive index of the liquid is



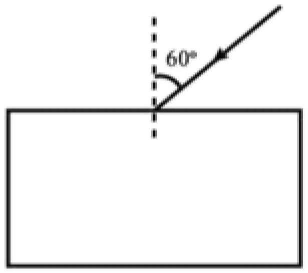
1) $\frac{5}{2}$ 2) $\sqrt{\frac{5}{2}}$ 3) $\sqrt{\frac{3}{2}}$ 4) $\frac{3}{2}$

9. Consider the situation shown in figure. Water $\left(\mu_w = \frac{4}{3}\right)$ is filled in a beaker upto a height of 10cm. A plane mirror fixed at a height of 5cm from the surface of water. DIstance of image from the mirror after reflection from it of an object O at the bottom of the beaker is



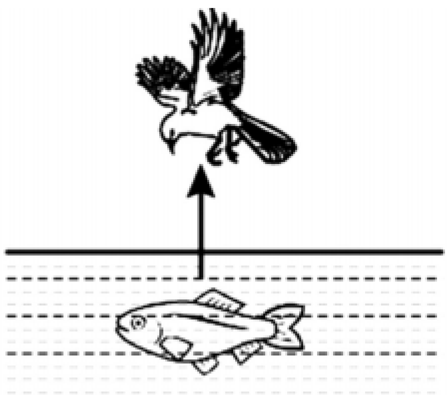
1) 15 cm 2) 12.5 cm 3) 7.5 cm 4) 10 cm

10. A slab of refractive index μ is placed in air and light is incident at angle 60^0 from vertical. The minimum value of μ for which total internal reflection takes place at the vertical surface



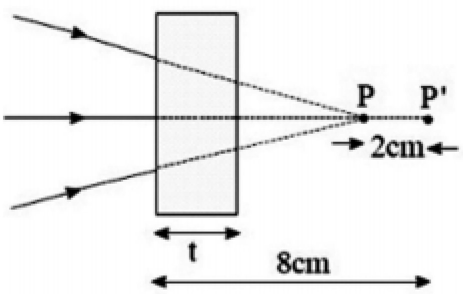
1) $\sqrt{\frac{3}{2}}$ 2) $\sqrt{\frac{3}{2}}$ 3) $\frac{\sqrt{7}}{2}$ 4) 2

11. A fish rising vertically up toward the surface of water with speed 3 ms^{-1} observes a bird diving vertically down towards it with speed 9 ms^{-1}. The actual velocity of bird is : ($n_w = 4/3$)



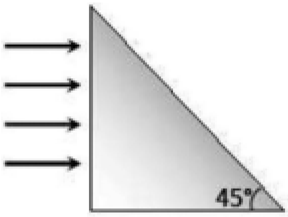
1) 4.5 ms^{-1} 2) 5.4 ms^{-1} 3) 3.0 ms^{-1} 4) 3.4 ms^{-1}

12. Raysfrom a lens are converging towards a point image P as shown in figure A glass plate of thickness t cm and refractive index 1.5 is placed in the path of the rays, as a result , the image is formed at P'. The value of t is



1) 5 cm 2) 8 cm 3) 6 cm 4) 4 cm

13. A beam of light consisting of red, green and blue colours is incident on a right angled prism. The refractive indices of the material of the prism for the above red, green and blue wavelength are 1.39, 1.44 and 1.47 respectively. The prism will



1) Separate part of red colour from the green and the blue colours

2) Separated part of the blue colour from the red and green colours

3) Seperate all teh colours from one another

4) Not separate even partially any colour form the other two colours

14. Angle of a prism is 30^0 and its refractive index is $\sqrt{2}$ and one of the suirface is silvered. At what angle of incidence, a ray shoule be incident on one surface so that after reflection from the silvered surface. It retraces its path

1) 30^0 2) 60^0 3) 45^0 4) $\sin^{-1}\sqrt{1.5}$

15. A thin prism P_1 of angle 4^0 and refractive index 1.54 is combined with another thin prism P_2 whose refractive index is 1.72 to produce dispersion without deviation. The angle of P_2 is:

1) 4^0 2) 5.33^0 3) 2.6^0 4) 3^0

16. Light from a point source in air falls on a convex spherical glass surface $(\mu = 1.5,\ R = 20\text{cm})$. The distance of light source from glass surface is 100cm. At what position is the image formed

1) 25 cm 2) 50 cm 3) 100 cm 4) 200 cm

17. A source of light is located at double focal length from a convergent lens. The focal length of the lens is f = 30 cm. 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?

1) 60 cm 2) 30 cm 3) 45 cm 4) 15 cm

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

1) 25 cm 2) 12.5 cm 3) 50 cm 4) Infinity

19. The focal lengths of the objective and the eye-piece of a compound microscrope are 2.0 cm and 3.0 cm respectively. The distance between the objective and the eye-piece is 15.0 cm. The final image formed by the eye-piece is at infinity. The two lenses are thin. The distances in cm of the object and the image produced by the obhective measured from the objective lens are respectively

1) 2.4 and 12.0 2) 2.4 and 15.0 3) 2.3 and 12.0 4) 2.3 and 3.0

20. An astronomical telescope has an angular magnification 5 for distant objects. The separation between the lenses is 36 cm and final image is formed at infinity. determine the focal length of objective and eyepiece.

1) 32 cm, 4 cm 2) 30 cm, 6cm 3) 26 cm, 10 cm 4) 20 cm, 16 cm

SECTION - II

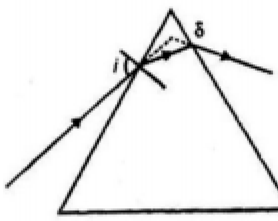
Numerical Type Questions

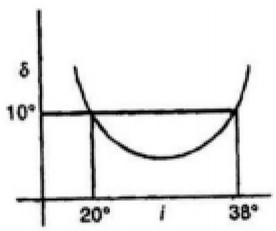
21. An object is placed at a distance of 20cm on the axis of a convex mirror and a plane mirror is placed between them at a distance of 5 cm from the convex mirror such that the image formed by both the mirrors coincide. Focal length of the convex mirror is (in cm)

22. The focal length of a thin biconvex lens is 20 cm. When an object is moved from a distance of 25 cm in front of it to 50 cm, the magnification of its image changes from m_{25} to m_{50}. The ratio m_{25}/m_{50} is

23. A large glass slab $(\mu = 5/3)$ of thickness 8 cm is placed over a point source of light on a plane surface. It is seen that light emerges out of the top surface of the slab from a circular area of radius R cm. What is the value of R (in cm)

24. 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. Prism angle in degree is



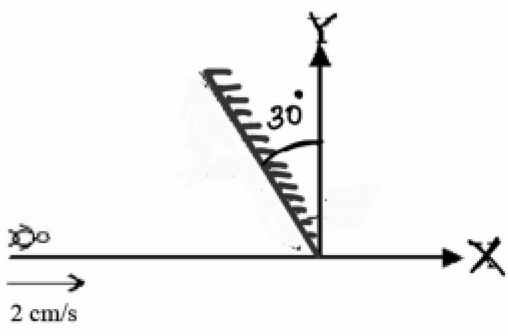


25. A point object is placed at a distance of 23 cm from a convex lens of focal length 20 cm. If a glass slab of thickness t and refractive index 1.5 is inserted between the lens and object. The image is formed at infinity. The thickness t in cm is:

PART - II (JEE ADVANCED)

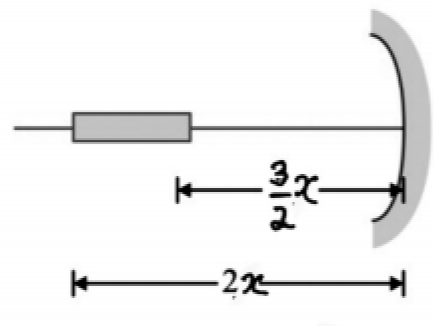
SECTION - III (Only one option correct type)

26. A plane mirror is placed with its plane at an angle of 30^0 with the y-axis. Plane of the mirror is perpendicular to the xy plane and the length of the mirror is 3 m. An insect moves along x - axis starting from a distant point with a speed 2 cm/s, the duration of the time for which the insect can see its own image in the mirror is



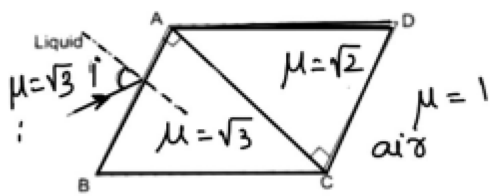
A) 300 s B) 400 s C) 500 s D) 600 s

27. A linear object is placed along the axis of a mirror as shown in figure. If x is the focal length of the mirror then the length of image is



A) $\frac{2x}{3}$ B) x C) $\frac{x}{3}$ D) $\frac{x}{2}$

28. A ray of light from a liquid $\left(\mu = \sqrt{3}\right)$ is incident on a system of two right-angled prisms of refractive indices $\sqrt{3}$ and $\sqrt{2}$ as shown. The ray suffers zero deviation when emerges into air from CD compared to initial ray. The angle of incidence i is

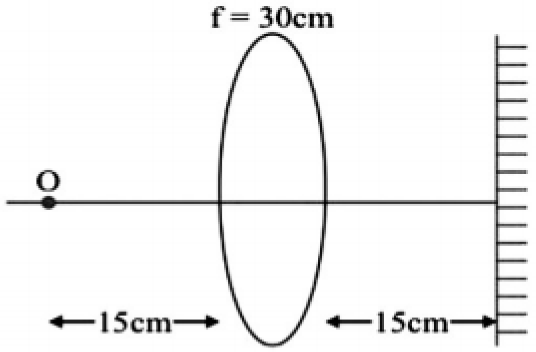


A) 45^0 B) 35^0 C) 20^0 D) 10^0

29. The diameter of plano convex lens is 6 cm and thickness at the centre is 3 mm. If the speed of light in the material of the lens is $2\times10^{8}\,\mathrm{m/s}$. The focal length of the lens is

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

30. An object 'O' is kept infront of a converging lens of focal length 30 cm, behind the lens a plane mirror kept at distance 15 cm



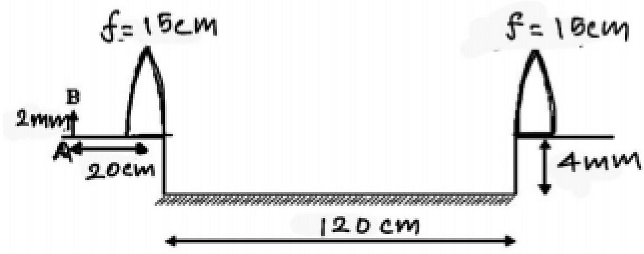
A) final image is formed at 60 cm from the lens towards right of it

B) final image is at 60 cm from lens towards left of it

C) the final image at 50 cm from lens to the left of it

D) the final image is virtual

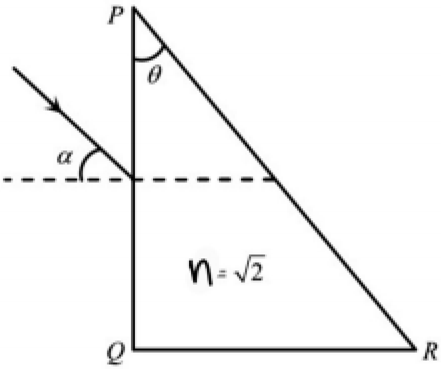
31. A convex lens of focal length 15 cm is split into two halves and the two halves are placed at a separation of 120 cm. Between the two halves of convex lens a plane mirror is placed horizontally and at a distance of 4 mm below the principal axis of the lens halves. An object AB of length 2 mm is placed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



The final image of the point A is formed at a distance of $\frac{n}{3}\,\mathrm{mm}$ from the principle axis. Determine the value of n.

A) 5 B) 6 C) 7 D) 8

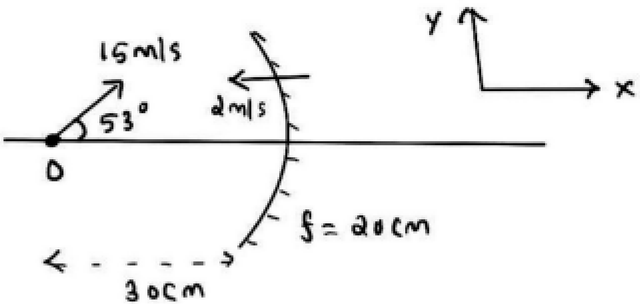
32. A parallel beam of light is incident from air at an angle α on the side PQ of a right angled triangular prism of refractive index $n=\sqrt{2}$. Light undergoes total internal reflection in the prism at the face PR when α has a minimum value of 45^0. The angle of θ of the prism is:



A) 15^0 B) 22.5^0 C) 30^0 D) 45^0

SECTION - IV (More than one correct answer)

33. Consider the situation shown in figure



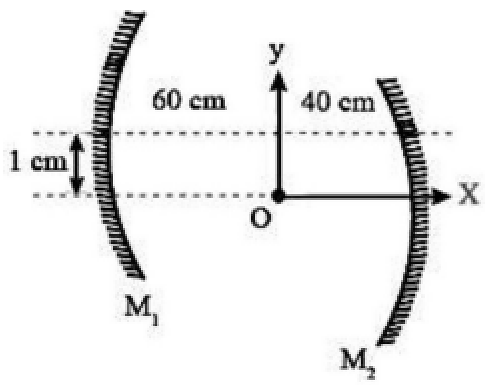
A) Velocity of image with respect to mirror is $-22\hat{i}-24\hat{j}$

B) Velocity of image with respect to mirror is $-44\hat{i}-24\hat{j}$

C) Velocity of image with respect to ground is $-46\hat{i}-24\hat{j}$

D) Velocity of image with respect to ground is $-24\hat{i}-24\hat{j}$

34. Two concave mirrors each of radius of curvature 40 cm are placed such that their principal axes are parallel to each other and at a distance of 1 cm to each other. Both the mirrors are at a distance of 100 cm to each other. Consider first reflection at M_1 and then at M_2.



Location of object O is taken as origin

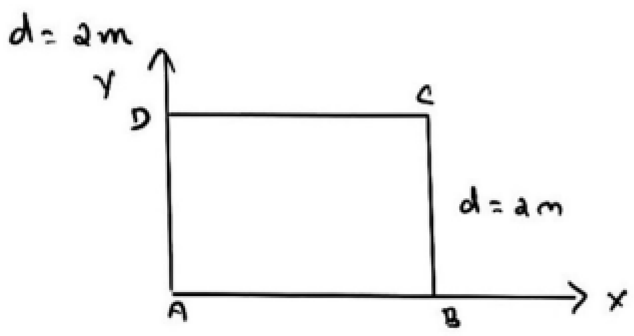
A) Height of first image front X-axis is 1.5 cm

B) Height of second image from X-axis is 0.6 cm

C) X co-ordinate of second image is +12 cm

D) Y co-ordinate of second image is -0.6 cm

35. A ray of light is incident on a glass-slab at a grazing incidence. The refractive index of the material of slab is given by $\mu = \sqrt{1+y}$. The thickness of slab is d = 2 m



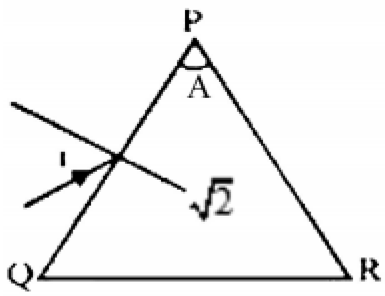
A) The ray will undergo continuous refractions white passing through slab

B) The ray will become more and more parallel to face AB as it travels through slab

C) The equation of the trajectory of the ray inside the slab is $y = \frac{x^2}{4}$

D) The ray will exit the slab at $\left(2\sqrt{2}, 2\right)$m

36. A prism of refractive index $\sqrt{2}$ and apex angle A is shown. Light is incident from PQ side at angle of incidence $i\left(0 < i \le 90^0\right)$



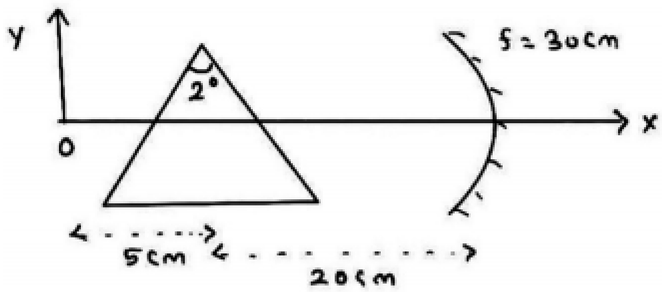
A) if A = 40^0 then light incident at all angles will emerge from surface PR

B) if A = 80^0 then light incident at some angles will emerge from surface PR and at some other angles light will suffer TIR at surface PR

C) if A = 100^0 then light incident at all angles will be reflected back from surface PR

D) whatever is the value of A, light will emerge from the surface PR for some value of i

37. A point O is placed at the origin. The refractive index of the thin prism is $\frac{3}{2}$



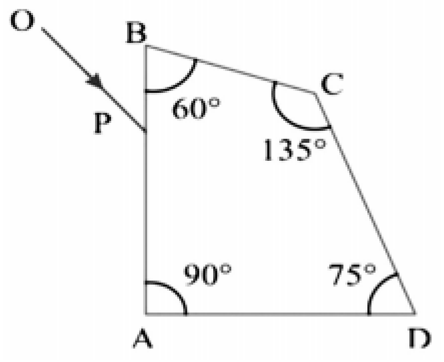
A) The coordinates of image O, formed due to first refraction through prism is $\left(0, \frac{\pi}{36}\text{cm}\right)$

B) O, behaves as object at a distance 25 cm on the left for the mirror

C) The x-coordinate of image formed by concave mirror is 175 cm

D) The y-coordinate of image formed by concave mirror is $\frac{\pi}{6}\text{cm}$

38. A ray OP of monochromatic light is incident on the face AB of prism ABCD near vertex B at an indicent angle of 60^0 (see figure). if the refractive index of the material of the prism is $\sqrt{3}$, which of the following is (are) correct? Light ray doesn't travel directly from BA to AD



A) The ray gets totally internally reflected at face CD

B) The ray comes out through face AD

C) The angle between the incident ray and the emergent ray is 90^0

D) The angle between the incident ray and the emergent ray is 120^0

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

A) air and placed in air

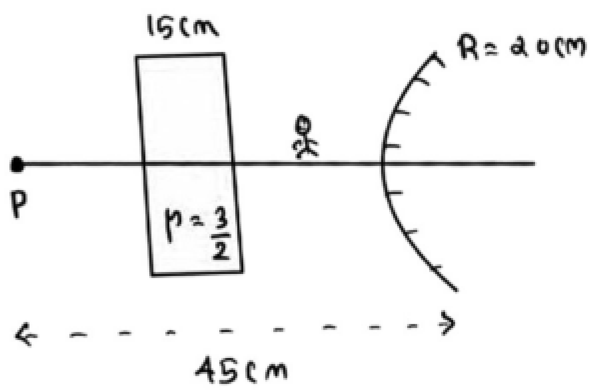
B) L_1 and immersed in L_2

C) L_1 and placed in air

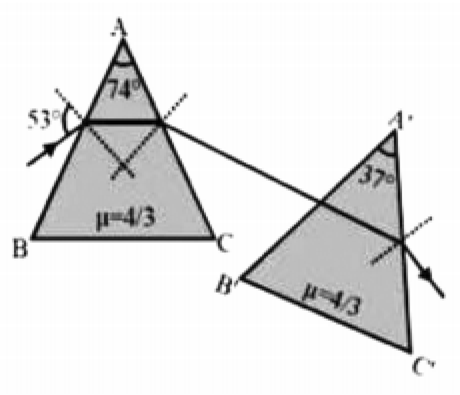
D) L_2 and immersed in L_1

SECTION - V (Numerical Type - Upto two decimal place)

40. In the given figure, find the distance between two images seen by observer in cm



41. A light ray is incident on face AB of prism ABC as shown in figure. The second prism is kept in such a manner that emergent ray from prism ABC is falling normally on face $A'B'$ of prism $A'B'C'$. The net deviation produced by the optical system of the two prisms is (in degrees)

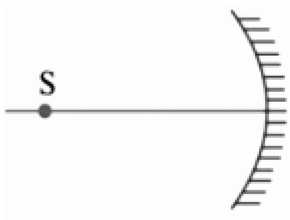


42. A light ray incident along vector $2\hat{i}+4\hat{j}+\sqrt{5}\hat{k}$ strikes on the x-z plane from medium-1 of refractive index 2 and enters into medium -II of refractive index μ_2. The value of μ_2 for which the ray is just totally reflected from the boundary, is

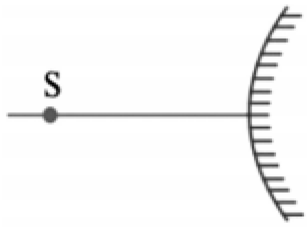
SECTION - VI (Matrix Matching)

43. An optical component and an object S placed along its optic axis are given in Column I, The distance between the object and the component can be varied. The properties of images are given in Column II. Match all the properties of images from Column-II with the appropriate components given in Column I

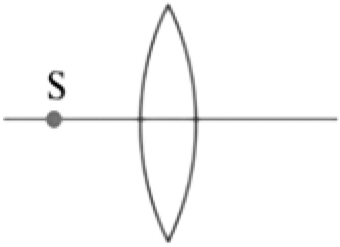
Column I **Column II**

A) 

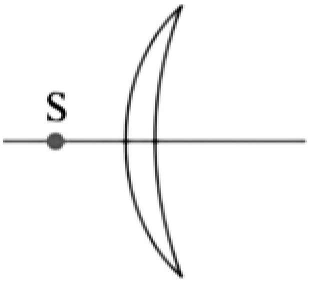
p) Real image

B) 

q) Virtual image

C) 

r) Magnified image

D) 

s) Image at infinity