LECTURE SHEET

EXERCISE-I

(Reflection by plane and curved surfaces)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. A plane mirror is on y-z plane facing positive x-axis. A point object is present at (10,5). The mirror is translated by 2 units along positive x and 3 units along positive y-direction. Final image of the point object is at

   1) (–10,–5) 2) (–8, –3) 3) (–6,5) 4) (–6,–2)

2. An object is placed at 20cm from a convex mirror of focal length 10 cm. The image formed by a mirror is

   1) Real and at 20cm from the mirror 2) Virtual and at 20cm from the mirror

   3) Virtual and at 20/3cm from the mirror 4) Real and at 20/3cm from the mirror

3. An object 1 cm tall is placed 4 cm infront of a mirror. In order to produce an upright image of 3 cm height one needs a

   1) Convex mirror of radius of curvature 12cm 2) Concave mirror of radius of curvature 12 cm

   3) Concave mirror of radius of curvature 4 cm 4) Plane mirror of height 12 cm

4. Radius of concave mirror is 40 cm and the size of image (real) is twice as that of object, then the object distance is

   1) 60 cm 2) 20 cm 3) 40 cm 4) 30 cm

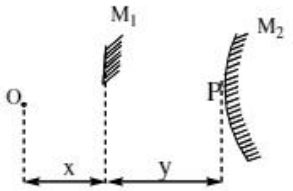
5. An object 'O' is placed in front of a small plane mirror M_1 and a large convex mirror M_2 of focal length 'f'. The distnace between 'O' and M_1 is x and the distance between M_1 and M_2 is y. The images of 'O' formed by M_1 and M_2 coincide. The magnitude of 'f' is

   1) $x-y$

   2) $\frac{x^2-y^2}{2y}$

   3) $\frac{x^2+y^2}{2y}$

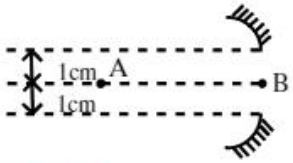
   4) $\frac{x^2+y^2}{x+y}$



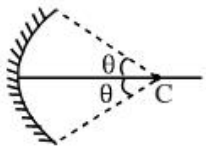
6. A concave mirror of focal length 20cm is cut into two parts from the middle and the two parts are moved perpendicularly by a distance 1cm from the previous principle axis AB. The distance between the images formed by the two parts, if the object is kept at a distance of 10cm from the pole of the original principal axis is

   1) 2 cm 2) 6 cm

   3) 3 cm 4) 4 cm



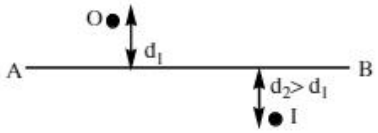
7. The circular boundary of the concave mirror subtends a cone of half angle θ at its centre of curvature. The minimum value of θ for which ray incident on this mirror parallel to the principle axis suffers reflection more than one is



1) 30° 2) 45°

3) 60° 4) 75°

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

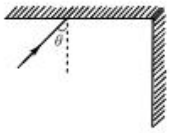


1) concave & placed towards right I
2) concave & placed towards left of I
3) convex and placed towards right of I
4) convex & placed towards left of I

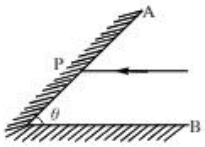
Numerical value type Questions

9. Two plane mirrors are inclined at an angle of 60^0 with each other. An incident ray hits one of the mirror at an angle of 80^0 with the normal. Its angle of deviation after two reflections is

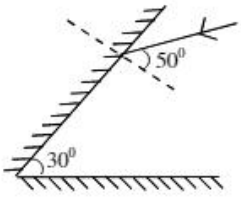
10. Two plane mirrors are arranged at right angles to each other as shown in figure. A ray of light is incident on the horizontal mirror at an angle θ. The ray emerges parallel to the incoming ray after reflection from the vertical mirror then the value of θ is ——— degree



11. Two plane mirrors are inclined at angle 'θ' as shown in figure. If a ray parallel to OB strikes the other mirror at P and finally emerges parallel to OA after two reflections then θ is equal to ——— ——— degree



12. The deviation suffered by incident ray in situation as shown in figure after three successive reflections is ——— degree in clock wise

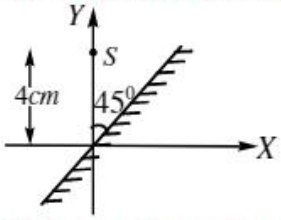


13. A rod of length 10cm lies along the principal axis of a concave mirror of focal length 10cm in such a way that the end closer to the pole is 20 cm away from it. The length of the image is ——— cm

LEVEL-II (ADVANCED)

Straight Objective Type Questions

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



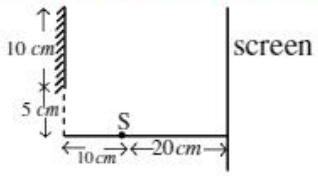
a) (4 cm, 0)

b) (–4 cm, 0)

c) $(4\sqrt{2}$ cm,0)

d) (0, 4 cm)

2. A luminous point source 's' is placed between a plane mirror and a screen in the situation as shown in figure. Then the length of screen which will receive direct light as well as reflected light is



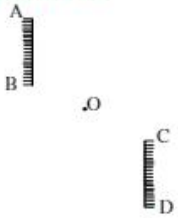
a) 50 cm

b) 60 cm

c) 70 cm

d) 40 cm

3. Two mirrors AB and CD are arranged along two parallel lines. The maximum number of images of object O that can be seen by any observer is



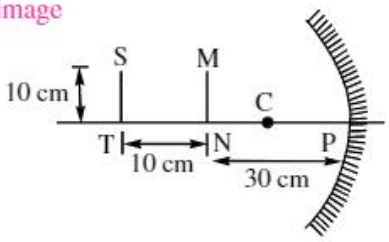
a) One

b) Two

c) Four

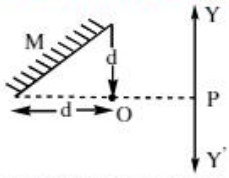
d) Infinite

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



a) 2cm b) 10cm c) 8cm d) 14cm

5. As shown in the figure, a particle is placed at O in front of a plane mirror M. A man at P can move along path PY and PY'. Then which of the following is true ?



a) For all point on PY, the man can see the image of O

b) For all point on PY', the man can see the image, but for no point on PY he can see the image of O

c) For all point on PY' he can see the image but on PY he can see the image only upto a distance d from P

d) He can see the image only upto a distance d on either side of P

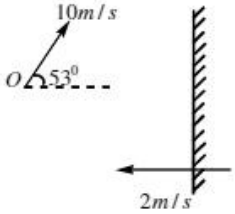
6. Find the velocity of image of a moving particle 'O' in the situation as shown in the figure.

a) $\sqrt{164}$ m/s, at $\tan^{-1}$ (4/5) with horizontal

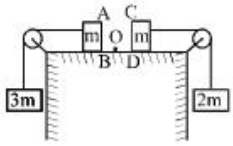
b) 10 m/s, at 53^0 with horizontal

c) $\sqrt{68}$ m/s, at $\tan^{-1}\left(\frac{1}{2}\right)$ with vertical

d) $\sqrt{104}$ m/s, at $\tan^{-1}\left(\frac{1}{2}\right)$ with vertical



*7. Two blocks each of mass m lie on a smooth table. They are attached to two other masses as shown in the figure. The pulleys and strings are light. An object O is kept at rest on the table. The sides AB & CD of the two blocks are made reflecting. The acceleration of two images formed in those two reflecting surfaces w.r.t. each other is:



a) 5g / 6 b) 5g/3 c) g/3 d) 17g / 6

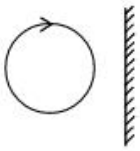
8. A particle is moving in a circle in front of a plane mirror in the situation as shown in figure. The plane of motion of the particle is perpendicular to the plane of mirror. Then the motion of image of particle with respected to the particle is

a) along a parabola

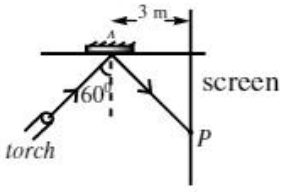
b) oscillating normal to the mirror

c) oscillating parallel to the mirror

d) along a circle



9. Figure shows a torch producing a straight light beam falling on a plane mirror at an angle 60^0. The reflected beam makes a spot P on the screen along y-axis. If at t=0, the mirror starts rotating about the hinge A with an angular velocity $\omega = 1^0$ per second clockwise, find the speed of the spot on screen after time t = 15 s.



a) $\frac{\pi}{15}$ m/s b) $\frac{\pi}{30}$ m/s c) $\frac{2\pi}{15}$ m/s d) $\frac{\pi}{60}$ m/s

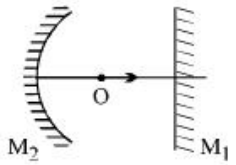
10. In the figure shown if the object 'O' moves towards the plane mirror, then the image (which is formed after successive reflections from M_1 & M_2 respectively) will move :

a) towards right

b) towards left

c) with zero velocity

d) cannot be determined



11. A candle flame 1.6 cm high is imaged in a ballbearing of diameter 0.4 cm. If the ball bearing is 20 cm away from the flame, find the location and the height of the image.

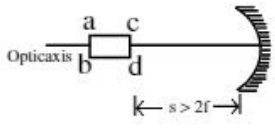
a) 1.0 mm inside the ball bearing, 0.08 mm

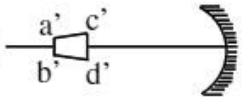
b) 1.0 mm outside The ball bearing 0.06 cm

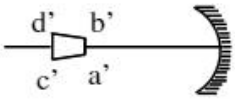
c) 2 m inside The ball bearing 0.08 cm

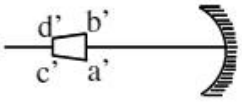
d) 1 m outside The ballbearig 0.05 mm

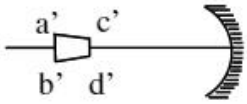
12. An object is placed in front of a concave mirror of focal length f as shown if figure. Choose the correct shape of the image :



a) 

b) 

c) 

d) 

13. A small block of mass *m* and a concave mirror of radius *R* fitted with a stand, lie on a smooth horizontal table with a separation *d* between them. The mirror together with its stand has a mass *m*. The block is pushed at t = 0 towards the the mirror so that it starts moving towards the mirror at a constant speed *V* and collides with it. The collision is perfectly elastic. Find the velocity of the image (a) at a time $t < d/V$ (b) at a time t > d/V.

a) $\dfrac{-R^2V}{\left[2(d-Vt)-R\right]^2}, V\left(1+\dfrac{R^2}{\left[2(Vt-d)-R\right]^2}\right)$

b) $\dfrac{R^2V}{\left[2(d+Vt)+R\right]^2}, V\left(1+\dfrac{R^2}{\left(2(Vt-d)-R\right)^2}\right)$

c) $\dfrac{-R^2V}{\left[2(d-Vt)+R\right]^2}, V\left[1-\dfrac{R^2}{\left[2(Vt-d)+R\right]^2}\right]$

d) $\dfrac{-R^2V}{\left[(d-Vt)-R\right]^2}, V\left[1-\dfrac{R^2}{\left[2(Vt+d)-R\right]^2}\right]$

14. A ball is kept at a height h above the surface of a heavy transparent sphere made of a material of refractive index μ. The radius of the sphere is R. At t = 0, the ball is dropped to fall normally on the sphere. For $t < \sqrt{\frac{2h}{g}}$ and by a single refraction, what is the speed of image as a function of time ?

a) $\frac{\mu R^2 gt}{\left[(\mu-1)\left(h-\frac{1}{2}gt^2\right)-R\right]^2}$ b) $\left[\frac{\mu R^2 gt}{(\mu-1)\left(h-\frac{1}{2}gt^2\right)}\right]$ c) $\frac{\mu R^2 gt}{(\mu-1)\left(h-\frac{1}{2}gt^2\right)-R}$ d) $\frac{\mu R^2 gt}{\mu\left(h-\frac{1}{2}gt^2\right)}$

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

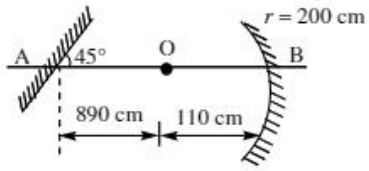
a) 5 cm behind the convex mirror and is virtual

b) 6 cm in front of the convex mirror is and is real

c) 6 cm behind the convex mirror and is virtual

d) 8 cm in front of the concave mirror and is real

16. A plane mirror and a concave mirror are arranged as shown in figure and O is a point object. Find the position of image by two reflections, first one taking place at concave mirror.



a) 100 cm vertically below the point A

b) 100 cm vertically below the point O

c) 50 cm vertically below the point A

d) 50 cm vertically below the point O

More than One correct answer Type Questions

17. Two plane mirrors at an angle such that a ray incident on a mirror undergoes a total deviation of 240° after two reflections.

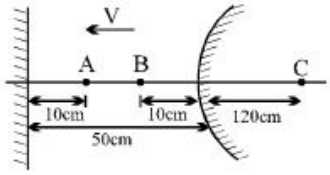
a) the angle between the mirror is 60°

b) the number of images formed by this system will be 5, if an object is placed symmetrically between the mirrors

c) the no. of images will be 6 if an object is kept unsymmetrically between the mirrors

d) a ray will retrace its path after 2 successive reflections, if the angle of incidence on one mirror is 60°

18. In the figure shown consider the first reflection at the plane mirror and second at the convex mirror. AB is object.



a) the second image is real , inverted of 1/5 th magnification

b) the second image is virtual and erect with magnification1/5

c) the second image moves towards the convex mirror

d) the second image moves away from the convex mirror

19. A magnified image of real object is to be obtained on a large screen 1 m from it. This can be achieved by

a) using a convex mirror of focal length less than 0.25 m

b) using a concave mirror of focal length less than 0.25 m

c) using a convex lens of focal length less than 0.25 m

d) using a concave lens of focal length less than 0.25 m

20. A reflecting surface is represented by the equation $Y=\frac{2L}{\pi}\sin\left(\frac{\pi x}{L}\right)$, $0 \le x \le L$. A ray travelling horizontally becomes vertical after reflection. The coordinates of the point (s) where this ray is incident is

a) $\left(\frac{L}{4},\frac{\sqrt{2}L}{\pi}\right)$ b) $\left(\frac{L}{3},\frac{\sqrt{3}L}{\pi}\right)$

c) $\left(\frac{3L}{4},\frac{\sqrt{2}L}{\pi}\right)$ d) $\left(\frac{2L}{3},\frac{\sqrt{3}L}{\pi}\right)$

21. All of the following statements are correct except (for real object):

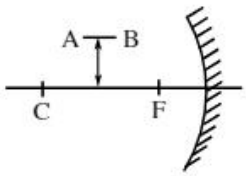
a) the magnification produced by a convex mirror is always less than or equal to one

b) a virtual, erect, same sized image can be obtained using a plane mirror

c) a virtual, erect, magnified image can be formed using a concave mirror

d) a real, inverted, same sized image can be formed using a convex mirror

22. An object AB is placed parallel and close to the optical axis between focus f and center of curvature C of a coverging mirror of focal length f as shown in the figure. Then



a) Image of A will be closer then that of B from the mirror

b) Image of AB will be parallel to optical axis

c) Image of AB will be stratight - line inclined to the optical axis

d) Image of AB will not be a straight line

Linked Comprehension Type Questions

Passage - I :

A point object is placed infront of a plane mirror as shown in figure.

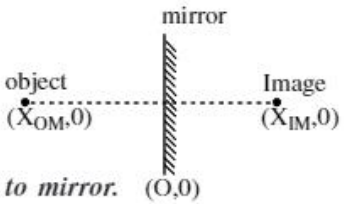
$X_{OM} \Rightarrow x-$***co-ordinate of object relative to mirror***

$X_{IM} \Rightarrow x$ – co-ordinate of image relative to mirror

$X_{IM} = -X_{OM}$

differentiating $V_{IM} = -V_{OM}$

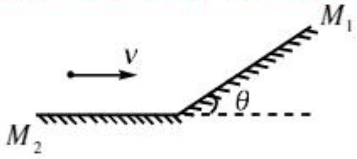
$V_I - V_M = -(V_0 - V_M)$



Velocity if image relative to mirror = velocity of object relative to mirror.

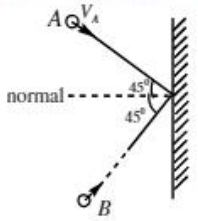
basing on this information answer the questions2

23. A point object is moving with a speed v before an arrangement of two mirrors as shown in figure. The magnitude of velocity of image in mirror M_1 with respected to image in mirror M_2 is



a) $v\sin\theta$ b) $2v\sin\theta$ c) 0 d) v

24. Two bodies A and B are moving towards a plane mirror with speeds V_A and V_B respectively as shown in fig. The speed of image of A with respect to the body B is



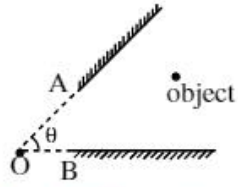
a) $V_A + V_B$ b) $V_A - V_B$ c) $\sqrt{V_A^2 + V_B^2}$ d) $\sqrt{V_A^2 - V_B^2}$

25. The reflection surface of a plane mirror is vertical. A particle is projected in a vertical plane which is also perpendicular to the mirror. The initial velocity of the particle is 10 m/s and the angle of projection is 60°. The point of projection is at a distance 5 m from the mirror. The particle moves towards the mirror. Just before the particle touches the mirror, the magnitude of relative velocity of approach of the particle and its image is

a) 10 m/s b) 5 m/s c) $10\sqrt{3}$ m/s d) $5\sqrt{3}$ m/s

Passage - II :

A point object is placed in front of two plane mirrors as shown in figure



26. Total number of images formed, if OA = b, OB = a, $\theta = 90^0$

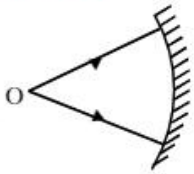
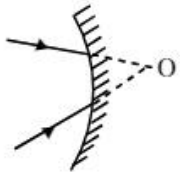
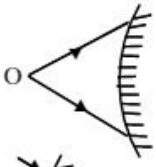
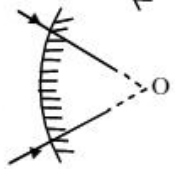
a) 3 b) 2 c) 1 d) 4

27. Total number of images formed, If OA = 0, OB = 0, and $\theta = 110^0$

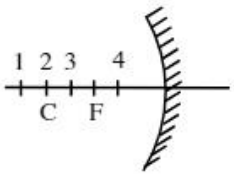
a) 3 or 4 b) 3 only c) 4 only d) 2

Matrix Matching Type Questions

28. The given situations in Column - I, choose the possible options from Column - II regarding the image formed when $u \neq \infty$. (u is the object distance from the pole of the mirror)

Column - I	Column - II
A) 	p) Real
B) 	q) Virtual
C) 	r) Image distance = focal length
D) 	s) Image at infinity

29. An extended object can be kept in front of a concave mirror at points1, 2,3 and 4 and images are formed at different points. C and F have their usual meanings. Point 2 is centre of curvature of the mirror

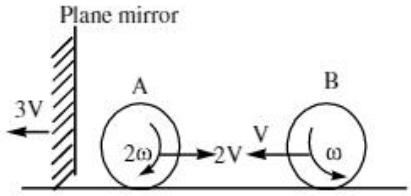


Column - I	Column - II
A) Object at point 1, then image is	p) real
B) Object at point 2, then image is	q) virtual
C) Object at point 3, then image is	r) enlarge
D) Object at point 4, then image is	s) diminish

Integer Type Questions

30. A point object is kept in front of a plane mirror. The plane mirror is doing SHM of amplitude 2 cm. The plane mirror moves along the x-axis and x-axis is normal to the mirror. The amplitude of the mirror is such that the object is always infront of the mirror. The amplitude of SHM of the image is

31. Two identical balls are rolling without slipping on a horizontal plane as shown in figure. They undergo a perfect elastic collision. Just after collision, the velocity of image of the bottom point of A with respect to the plane mirroris xV, then x = ____



EXERCISE-II

(Plane surface refraction, total internal reflection, prism)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. Absolute refractive index of a medium is 'X'. Refractive index of same medium w.r.t. to air is 'Y' and absolute refractive index of air is 'Z'. Then, the relation between them is

   1) X = Y/Z 2) Y = X/Z 3) Z = Y/X 4) Y = 1/XZ

2. The refractive indices of glycerine and diamond with respect to air are 1.4 and 2.4 respectively. Calculate the speed of light in glycerine and diamond. From these results, calculate the refractive index of diamond with respect to glycerine. ($c = 3 \times 10^8$ m/s)

   1) 2.143×10^8 m/s; 1.250×10^8 m/s; 1.714 2) 1.143×10^8 m/s; 1.250×10^8 m/s; 1.714

   3) 2.143×10^8 m/s; 2.250×10^8 m/s; 1.714 4) 2.143×10^8 m/s; 1.250×10^8 m/s; 1.514

3. A glass slab of thickness 8 cms contains the same number of waves as 10 cms long path of water when both are traversed by the same monochromatic light. If the refractive index of water is 4/3, the refractive index of glass is

   1) $\frac{5}{3}$ 2) $\frac{5}{4}$ 3) $\frac{16}{15}$ 4) $\frac{3}{2}$

4. If $\hat{i}$ denotes a unit vector along an incident ray, $\hat{r}$ a unit vector along the refracted ray into a medium of refractive index 'μ' and $\hat{n}$ a unit vector normal to the boundary of the media directed towards the incident medium, then the law of refraction can be written as

   1) $\hat{i}.\hat{n} = \mu\left(\hat{r}.\hat{n}\right)$ 2) $\hat{i}\times\hat{n} = \mu\left(\hat{n}\times\hat{r}\right)$ 3) $\hat{i}\times\hat{n} = \mu\left(\hat{r}\times\hat{n}\right)$ 4) $\mu\left(\hat{i}\times\hat{n}\right) = \hat{r}\times\hat{n}$

5. 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

   1) $\sin^{-1}\left(\frac{1}{5}\right)$ 2) $\sin^{-1}\left(\frac{4}{5}\right)$ 3) $\sin^{-1}\left(\frac{1}{2}\right)$ 4) $\sin^{-1}\left(\frac{1}{4}\right)$

6. Light takes time t_1 to travel a distance x_1 in vacuum and the same light takes time t_2 to travel a distance x_2 in a medium. The critical angle for that medium is

1) $\sin^{-1}\left(\frac{x_2 t_2}{x_1 t_1}\right)$ 2) $\sin^{-1}\left(\frac{x_1 t_2}{x_2 t_1}\right)$ 3) $\sin^{-1}\left(\frac{x_1 t_1}{x_2 t_2}\right)$ 4) $\sin^{-1}\left(\frac{x_2 t_1}{x_1 t_2}\right)$

7. A ray of light from a denser medium strikes a rarer medium. The reflected and refracted rays make an angle of 90^0 with each other. The angles of reflection and refraction are r and r^1. The critical angle would be

1) $\sin^{-1}(\tan r)$ 2) $\tan^{-1}(\sin r)$ 3) $\sin^{-1}(\tan r^1)$ 4) $\tan^{-1}(\sin r^1)$

8. The refractive index of the core of an optical fibre is μ_2 and that of the cladding is μ_1. The angle of incidence on the face of the core so that the light ray just under goes total internal reflection at the cladding is

1) $\sin^{-1}\left(\frac{\mu_1}{\mu_2}\right)$ 2) $\sin^{-1}\sqrt{\mu_2^2 - \mu_1^2}$ 3) $\sin^{-1}\sqrt{\mu_2 - \mu_1}$ 4) $\sin^{-1}\sqrt{\mu_1^2 + \mu_2^2}$

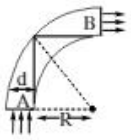
9. Under minimum deviation condition in a prism, if a ray is incident at an angle 30^0, the angle between the emergent ray and the second refracting surface of the prism is

1) 0^0 2) 30^0 3) 45^0 4) 60^0

10. A ray of light passes through an equilateral prism in such a manner that the angle of incidance is equal to the angle of emergence and each of these angles equal to 3/4 of angle of the prism. The angle of deviation is

1) 45^0 2) 39^0 3) 60^0 4) 30^0

11. A rod of glass ($\mu = 1.5$) and of square cross section is bent into the shape shown in figure. A parallel beam of light falls on the plane flat surface A as shown in figure. If a is the width of a side and R is the radius of circular arc then for what maximium value of $\frac{d}{R}$ light entering the glass slab through surface A emerges from the glass through B



1) 1.5 2) 0.5

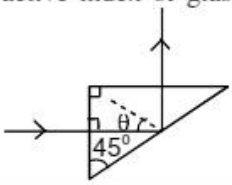
3) 1.3 4) None of these

Numerical value type Questions

12. A monochromatic light passes through a glass slab ($\mu = 1.5$) of thickness 9 cm in time t_1. If it takes a time t_2 to travel the same distance through water ($\mu = 4/3$). The value of $(t_1 - t_2)$is_____10^{-11} sec

13. The optical path of a monochromatic light is the same if it goes through 2.00cm of glass or x cm of ruby. If the refractive index of glass is 1.510 and that of ruby is 1.760. The value of x is ——— cm

14. A triangular prism of glass is shown in the figure. A ray incident normally to one face is totally reflected . If $\theta = 45°$, the refractive index of glass is greater than ____



15. The refractive indices of violet and red light are 1.54 and 1.52 respectively. If the angle of prism is 10^0, then the angular dispersion is

16. The refractive indicies of crown glass prism for C,D and F lines are 1.527, 1.530 and 1.535 respectively. Then the dispersive power of the crown glass prism is

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. Let the x-y plane be the boundary between two trasparent media. Medium 1 in $Z \geq 0$ has a refractive index of $\sqrt{2}$ and medium 2 with $z < 0$ has a refractive index of $\sqrt{3}$. A ray of light in medium 1 given by the vector $\vec{A} = 6\sqrt{3}\hat{i} + 8\sqrt{3}\hat{j} - 10\hat{k}$ is incident on the plane of separation. The angle of refraction in medium 2 is

a) 45° b) 60° c) 75° d) 30°

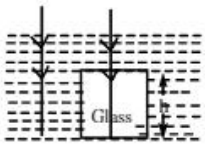
2. A ray of light is incident on a rectangular plate at an angle of incidence 60^0. The light ray suffers a deviation which is 25% of the angle of incidence. The refractive index of the glass will be

a) $\sqrt{3}$ b) $\sqrt{2}$ c) $\sqrt{3/2}$ d) 1.5

3. Two beams of light are incident normally on water $(\mu = 4/3)$. If one of the beams passes through a glass $(\mu = 3/2)$ slab of height 'h' has shown in the figure, the time difference for both the beams for reaching the bottom is (C is velocity of light is vacuum)

a) Zero b) $\frac{h}{3C}$

c) $\frac{6h}{C}$ d) $\frac{h}{6C}$



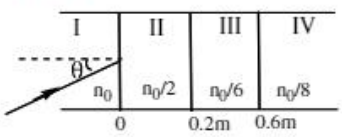
4. A ray of light entering from air to glass $(\mu = 1.5)$ is partly reflected and partly refracted. If the reflected and refracted rays are at right angles to each other, the angle of refraction is

a) $\sin^{-1}\left(\sqrt{\frac{2}{13}}\right)$ b) $\sin^{-1}\left(\frac{\sqrt{2}}{13}\right)$ c) $\sin^{-1}\left(\frac{2}{\sqrt{13}}\right)$ d) $\sin^{-1}\left(\frac{3}{\sqrt{13}}\right)$

5. A glass cube of edge 1 cm and $\mu = 1.5$ has a spot at the centre. The area of the cube face that must be covered to prevent the spot from being seen is (in cm^2)

a) $\sqrt{5}\pi$ b) 5π c) $\frac{\pi}{\sqrt{5}}$ d) $\frac{\pi}{5}$

6. A light beam is traveling from region I to region IV (refer fig.). The refractive index in region, I, II, III and IV are $n_0, \frac{n_0}{2}, \frac{n_0}{6}, \frac{n_0}{8}$ ..... respectively. The angle of incidence θ for which the beam just misses entering region IV is $\sin^{-1}\left(\frac{1}{p}\right)$. The value of p is

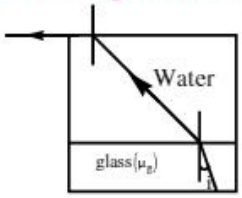


a) 6 b) 8 c) 4 d) 2

7. A ray of light travels in the way as shown in the figure. After passing through water, the ray grazes along the water air interface. The value of μ_g interms of 'i' is $(\mu_w = 4/3)$

a) $\frac{1}{\sin i}$ b) $\frac{3}{4\sin i}$

c) $\frac{4}{3\sin i}$ d) sin i



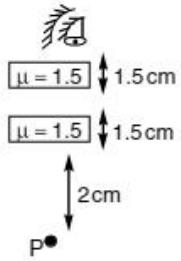
8. The image of point 'P' when viewed from top of the slabs will be

a) 2 cm above P

b) 1.5 cm above P

c) 2 cm below P

d) 1 cm above P



9. The angle of minimum deviation for a 75^0 prism of dense glass is found to be 45^0 when in air and 15^0 when immersed in certain liquid. The refractive index of the liqud is,

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

10. A certain prism of refracting angle 60^0 and of refractive index '2' is immersed in a liquid of refractive index $\sqrt{2}$, then the angle of minimum deviation will be

a) 30^0 b) 45^0 c) 60^0 d) 75^0

11. A ray of monochromatic light is incident on one refracting face of a prism of angle 75^0. It passes through the prism and is incident on the other face at the critical angle. If the refractive index of the material of the prism is $\sqrt{2}$, the angle of incidence on the first face of the prism is,

a) 30^0 b) 45^0 c) 60^0 d) 0^0

12. The light ray is incident at an angle of 60^0 on a prism of angle 45^0. When the light ray falls on the other surface at 90^0, the refractive index of the material of the prism μ and angle of deviation 'd' are given by

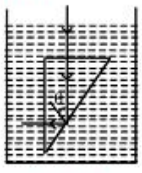
a) $\mu = \sqrt{2}, d = 30^0$ b) $\mu = 1.5, d = 15^0$

c) $\mu = \frac{\sqrt{3}}{2}, d = 30^0$ d) $\mu = \sqrt{\frac{3}{2}}, d = 15^0$

13. A prism of glass $(\mu = 1.5)$ is dipped in to water as shown in the figure. If the refractive index of water is 4/3, then the incident ray will be totally reflected if

a) $\sin\theta > \frac{8}{9}$ b) $\sin\theta < \frac{8}{9}$

c) $\sin\theta = \frac{9}{8}$ d) $\sin\theta = \frac{8}{9}$



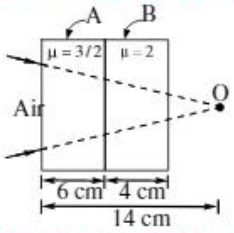
14. The principle section of a glass prism is an isosceles triangle ABC with AB = AC, the face AC is silvered. A ray of light is incident normally on the face AB and after two reflections, it emerges from the base BC perpendicular to the base. Angle of BAC of the prism is

a) 30^0 b) 36^0 c) 18^0 d) 72^0

15. Two prisms A and B are in contact with each other have angular dispersions of 2^0 and 4^0 respectively. The dispersive power of 'A' is 0.002. If the combination produces dispersion without deviation, the dispersive power of 'B' is

a) 0.001 b) 0.004 c) 0.002 d) 0.006

16. A convergent beam is incident on two slabs placed in contact as shown in Fig. Finally the rays are converge at a distance (from left face of slab A is)



a) 10 cm

b) 18 cm

c) 8 cm

d) 6 cm

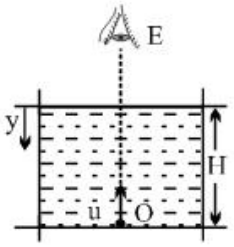
17. An insect starts moving up in a liquid from point O of variable refractive index $\mu = \mu_0(1 + ay)$ where y is depth of liquid from the surface. If u is the speed of insect, its apparent speed to the observer E is

a) u ln(1 + aH)

b) $\frac{u}{(1+aH)\mu_0}$

c) $\frac{u}{\ln(1+aH)}$

d) none



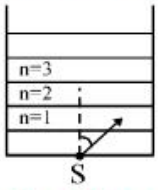
18. A point source S is placed at the bottom of different layers as shown in the figure. The refractive index of bottom most layer is μ_0. The refractive index of any other upper layer is $\mu(n) = \mu_0 - \frac{\mu_0}{4n-18}$ where n = 1, 2, ... A ray of light with angle i slightly more than 30° starts from the source S. Total internal reflection takes place at the upper surface of a layer having n equal to

a) 3

b) 5

c) 4

d) 6



19. A person looking through a telescope focuses lens at a point on the edge of the bottom of an empty cylindrical vessel. Next he fills the entire vessel with a liquid of refractive index μ, without disturbing the telescope. Now, he observes the mid point of the vessel. Determine the radius to depth ratio of the vessel.

a) $\frac{1}{2}\sqrt{\frac{1-\mu^2}{\mu^2+1}}$ b) $\frac{1}{2}\sqrt{\frac{4-\mu^2}{\mu^2-1}}$ c) $\frac{1}{2}\sqrt{\frac{4+\mu^2}{\mu^2+1}}$ d) $\frac{1}{2}\sqrt{\frac{4+\mu}{\mu+1}}$

20. x-y plane separates two media. $z \geq 0$ contains a medium of refractive index 1 and $z \leq 0$ contains a medium of refractive index 2. A ray of light is incident from first medium along a vector $\hat{i}+\hat{j}-\hat{k}$, the unit vector along refracted ray is :

a) $\frac{1}{2\sqrt{3}}\hat{i}+\frac{1}{2\sqrt{3}}\hat{j}-\sqrt{\frac{5}{6}}\hat{k}$

b) $\frac{1}{2\sqrt{3}}\hat{i}+\frac{1}{2\sqrt{3}}\hat{j}-\frac{1}{2\sqrt{3}}\hat{k}$

c) $\hat{i}+\hat{j}-\hat{k}$

d) None of these

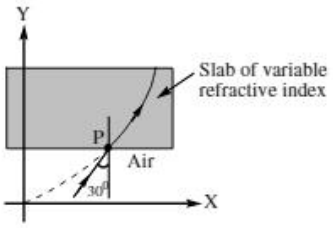
21. A ray of light travelling in air is incident at angle of incidence 30^0 on one surface of a slab in which refractive index varies with y. The light travels along the curve $y = 4x^2$ (y and x are in meter) in the slab. Find out the refractive index μ of the slab at y = 1/2 m in the slab.

a) 1.5

b) 1.7

c) $\frac{\sqrt{3}}{2}$

d) $\frac{2}{\sqrt{3}}$



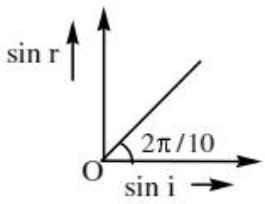
22. The graph between sine of angle of refraction (sin r) in medium 2 and sin of angle of incidence (sin *i*) in medium 1 indicates that $\left(\tan 36^0 = \frac{3}{4}\right)$

a) Total internal reflection can take place

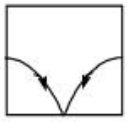
b) Total internal reflection cannot take place

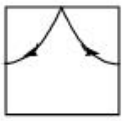
c) Any of (a) and (b)

d) Data is incomplete

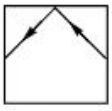


23. A cubical container is filled with a liquid whose refractive index increase linearly from top to bottom. Which of the following represents the path of a ray of light inside the liquid :

a) 

b) 

c) 

d) 

24. A light rays is incident upon a prism minimum deviation position and suffers a deviation of 34^0. If the shaded half of the prism is knocked off, the ray will

a) Suffer a deviation of 34^0

b) Suffer a deviation of 68^0

c) Suffer a deviation of 17^0

d) Not come out of the prism

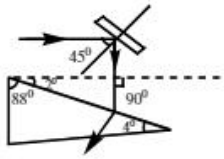
25. A ray of light strikes a plane mirror at an angle of incidence 45^0 as shown in the figure. After reflection, the ray passes through a prism of refractive index 1.50, whose apex angle is 4^0. The angle through which the mirror should be rotated if the total deviation of the ray is to be 90^0 is :

a) 1^0 clockwise

b) 1^0 anticlockwise

c) 2^0 clockwise

d) 2^0 anticlocwise



26. The x-z plane separates two media A and B with refractive indices μ_1 and μ_2 respectively. A ray of light travels from A to B. Its directions in the two media are given by the unit vectors, $\vec{r}_A = a\hat{i} + b\hat{j}$ & $\vec{r}_B = \alpha\hat{i} + \beta\hat{j}$ respectively where $\hat{i}$ & $\hat{j}$ are unit vectors in the x and y directions. Then

a) $\mu_1 a = \mu_2 \alpha$

b) $\mu_1 \alpha = \mu_2 a$

c) $\mu_1 b = \mu_2 \beta$

d) $\mu_1 \beta = \mu_2 b$

27. A microscope is focussed on a point object, and then its objective is raised through a height of 2cm when a glass slab of refractive index 1.5 is placed over this point object such that it is focussed again. The thickness of the glass slab is :

a) 6 cm

b) 3 cm

c) 2 cm

d) 1.5 cm

28. A light ray is incident on a transparent slab of refractive index $\mu = \sqrt{2}$, at an angle of incidence $\pi/4$. Find the ratio of the lateral displacement suffered by the light ray to the maximum value which it could have suffered.

a) $\frac{\sqrt{3}-1}{\sqrt{6}}$

b) $\frac{\sqrt{3}-2}{\sqrt{5}}$

c) $\frac{\sqrt{1}-2}{\sqrt{5}}$

d) $\frac{\sqrt{1}-2}{\sqrt{7}}$

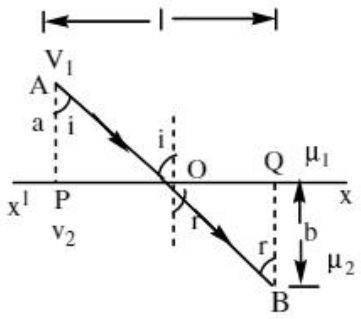
29. The time required for the light to go from A to B, when a ray of light goes from point A in a medium where the speed of light is v_1 to a point B in a medium where the speed of light is v_2 as shown in figure, is :

a) $t = \frac{a\sec i}{v_1} + \frac{b\sec r}{v_2}$

b) $t = \frac{a\sec i}{v_2} + \frac{b\sec r}{v_1}$

c) $t = \frac{a\sec i}{v_1} - \frac{b\sec r}{v_2}$

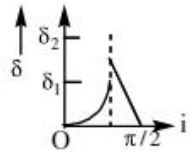
d) $t = \frac{a\sec i}{v_2} - \frac{b\sec r}{v_1}$

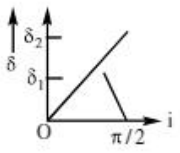


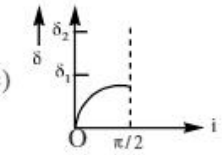
30. The apparent depth of water in cylindrical water tank of diameter 2R cm is reducing at the rate of x cm/minute when water drained out at a constant rate. The amount of water drained in c.c. per minute is (n_1= refractive index of air, n_2= refractive index of water)

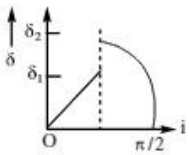
a) $x\pi R^2 n_1 / n_2$ b) $x\pi R^2 n_2 / n_1$ c) $2\pi R n_1 / n_2$ d) $\pi R^2 x$

31. A ray of light travels from a medium of refractive index μ to air. Its angle of incidence in the medium is *i*, measured from the normal to the boundary, and its angle of deviation is δ. δ is plotted against *i* which of the following best represents the resulting curve

a) 

b) 

c) 

d) 

32. A man of height 1.47 m stands on a straight road on a hot day. The vertical temperature in the air results in a variation of refractive index with height y as $\mu = \mu_0\sqrt{(1+ay)}$ where μ_0 is the refractive index of air near the road $a = 1.5\times10^{-6}/m$. What is the apparent length of the road man is able to see ?

a) 700 m b) 2000 m c) $700\sqrt{2}$ d) inifinite distance

33. A glass slab of thickness 3 cm and refractive index 3/2 is placed on ink mark on a piece of paper. For a person looking at the mark at a distance 2 cm above it, the distance of the mark will appear to be in cm

a) 4 cm b) 3 cm c) 2 cm d) 4m

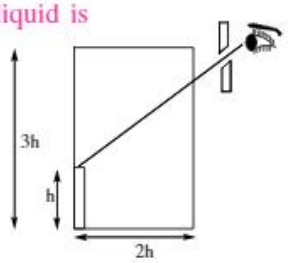
34. Solar rays are incident at 45^0 on the surface of water $(\mu = 4/3)$. The length of the shadow of a pole of length 1.2 m formed at the bottom of the pond is $\frac{3.3}{n}$ where 'n' is. (If the pole is vertical assuming that 0.2 m of the pole is above the water surface)

a) 40 b) 4 c) 3 d) 0

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

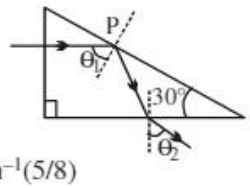
a) $\frac{5}{2}$ b) $\sqrt{\frac{5}{2}}$

c) $\sqrt{\frac{3}{2}}$ d) $\frac{3}{2}$



More than One correct answer Type Questions

36. A ray of light is incident normally on one face of 30°– 60°– 90° prism of refractive index 5/3 immersed in water of refractive index 4/3 as shown in figure.



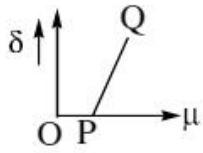
a) The exit angle θ_2 of the ray is $\sin^{-1}(5/8)$

b) The exit angle θ_2 of the ray is $\sin^{-1}(5/4\sqrt{3})$

c) Total internal reflection at point P ceases if the refractive index of water is increased to $5/2\sqrt{3}$ by dissolving some substance.

d) Total internal reflection at point P ceases if the refractive index of water is increased to 5/6 by dissolving some substance.

37. For a small angled prism, angle of minimum deviation (δ) varies with the refractive index of the prism as shown in the graph



a) Point *p* corresponds to $\mu = 1$

b) Slope of the line PQ = A/2

c) Slope = A

d) None of the above statements is true

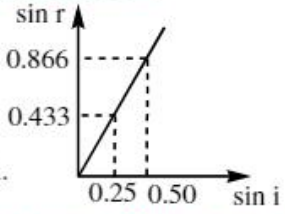
38. Light is incident from a medium A to medium B. The graph of sine of angle of incidence i versus sine of angle of refraction r is shown in fig. which of the following is/are correct ?

a) Total internal reflection ocurs above a certain value of i.

b) Total internal reflection will not occur for any value of i

c) Wavelength of light in medium B is $\sqrt{3}$ times that in medium A.

d) Wavelength of light in medium B is $1/\sqrt{3}$ times that in medium A.



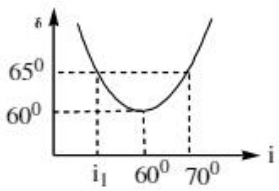
39. The angle of deviation (δ) vs angle of incidence (i) is plotted for a prism. Pick up the correct statements.

a) The angle of prism is 60°

b) The refractive index of the prism is $n = \sqrt{3}$

c) For deviation to be 65° the angle of incidence $i_1 = 55°$

d) The curve of 'δ' vs 'i' is parabolic

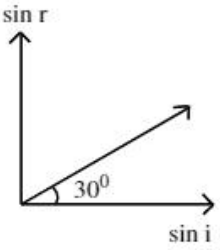


40. For maximum deviation D_{max} :

a) emergent ray must graze the surface (face) b) incident ray must graze the surface

c) $D_{max} = 90^\circ + e - A$ d) $D_{min} = 90^\circ + i - A$

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



a) The speed of light in the medium y is $\sqrt{3}$ times than in medium x

b) The speed of light in the medium y is $\frac{1}{\sqrt{3}}$ times than in medium x

c) Total internal reflection can take place when the incidence is in x

d) Total internal reflection can take place when the incidence is in y

42. 

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

a) if n=2m, deviation through n prisms is zero

b) if n=2m+1, deviation through system of n prism is δ

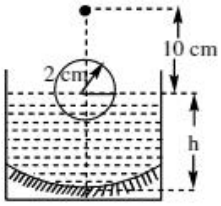
c) if n=2m, deviation through system of n prism is δ

d) if n=2m+1, deviation through system of n prism is zero

Linked Comprehension Type Questions

Passage - I :

A transparent solid sphere of radius 2 cm and density ρ floats in a transparent liquid of density 2ρ kept in a beaker. The bottom of the beaker is spherical in shape with its radius of curvature 8 cm and is silvered to make it a concave mirror as shown in Fig. When an object is placed at a distance of 10 cm directly above the centre of the sphere its final image coincide with it. If 'h' is the height of liquid surface from the apex of the bottom as shown in figure. Consider paraxial rays only for image formation.



The refractive index of the sphere is $\frac{3}{2}$ and that of the liquid is $\frac{4}{3}$.

Answer the following questions.

43. The image formed by the top spherical portion of sphere is (as measured from top of spherical ball)

a) 6 cm b) 8 cm c) 12 cm d) 16 cm

44. The image formed by transparent solid sphere (measured from the bottom point of the sphere) is nearly equal to

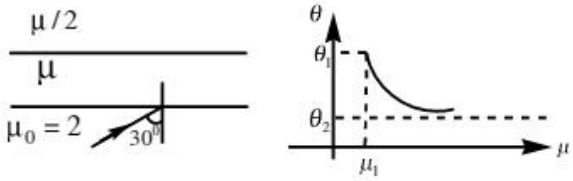
a) 2 cm b) 5 cm c) 6 cm d) 9 cm

45. The value of h is (nearly equal to)

a) 8 cm b) 9 cm c) 14 cm d) 15 cm

Passage - II :

In the diagram shown ray of light is incident on the first medium boundary at angle 30^0 the medium has refractive index 2.



The second layer has refraction index $\mu/2$. A graph is given between deviation and refractive index 'μ'. The deviation is measured by considering the final emergent ray and the incident ray.

Answer the following questions.

46. Value μ_1 will be

a) 1 b) 2 c) 3 d) 1.5

47. Value of θ_1 will be

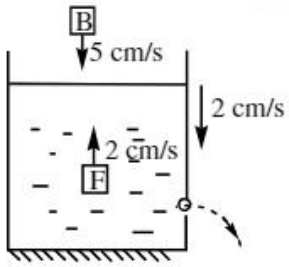
a) 30^0 b) 60^0 c) 45^0 d) 0^0

48. Value of θ_2 will be

a) 30^0 b) 60^0 c) 45^0 d) 15^0

Matrix Matching Type Questions

49. A bird 'B' in air is diving vertically downwards over a water tank with speed 5 cm/s. Base of the tank is silvered. A fish 'F' in the tank is rising vertically upwards along the same line with speed 2 cm/s. Water level is lowered at the rate of 2 cm/s. Take $\mu_{water} = 4/3$



Match the following two columns.

Column - I	Column - II
A) Speed of image of fish as seen by the bird directly in cm/s	p) 4
B) Speed of image of fish formed after reflection in the mirror as seen by the bird in cm/s	q) 8
C) Speed of image of bird as seen by the fish looking upwards in cm/s	r) 3
D) Speed of image of bird as seen by the fish looking downwards in cm/s	s) 6

Integer Type Questions

50. A beam of light falls on a glass plate ($\mu = 3/2$) of thickness 6.0 cm at an angle of 60°. Find the deflection of the beam on passing through the plate. [in cm].

51. The flat bottom of cylinder tank is silvered and water $\left(\mu = \frac{4}{3}\right)$ is filled in the tank upto a height *h*. A small bird is hovering at a height 3*h* from the bottom of the tank. When a small hole is opened near the bottom of the tank, the water level falls at the rate of 1 cm/s. The bird will perceive that his velocity of image is 1/x cm/sec (in downword directions) where x is

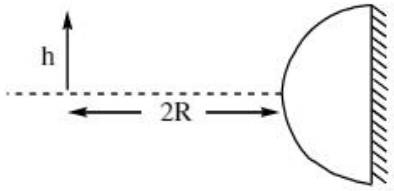
EXERCISE-III

(Refraction through curved surface and lenses)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. A glass hemisphere of radius R and of material having refractive index 1.5 is silvered on its flat face as shown in Fig. A small object of height h is located at distance 2R from the surface of hemisphere as shown in the figure. The final image will form

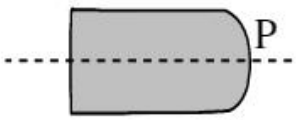


1) at a distance of R from silvered surface, on the right side
2) on the object itself
3) at hemisphere surface
4) at a distance of 2R from he silvered surface, on left side.

2. Consider a sphere of radius R made of glass of refractive index μ. A small object moves along the diameter with a constant velocity u. Find the velocity of the image as seen by an observer outside when the object passes through center.

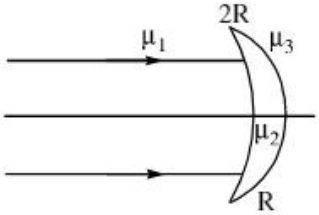
1) u 2) μ u 3) u/μ 4) zero

3. Find the distance of object placed in the slab of refractive index μ from point P of the curved surface of radius R so that image is formed at infinity :



1) $\frac{(\mu-1)R}{\mu}$ 2) $\frac{\mu R}{(\mu-1)}$ 3) $\frac{R}{(\mu-1)}$ 4) $\frac{(\mu-1)R}{2\mu}$

4. Fig. Shows a concavo-convex lens. What is the condition on the refractive indices so that the lens is diverging ?

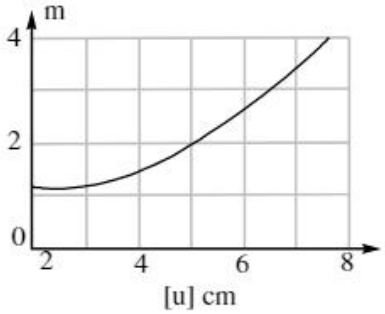


The refractive index of th lens is μ_2

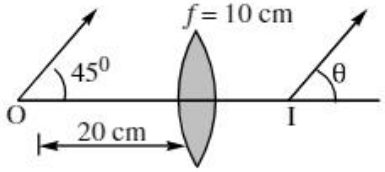
1) $2\mu_3 < \mu_1 + \mu_2$ 2) $2\mu_3 > \mu_1 + \mu_2$ 3) $\mu_3 > 2(\mu_1 - \mu_2)$ 4) None of these

Numerical value type Questions

5. An object kept on the principal axis and in front of a spherical mirror, is moved along the axis itself. If lateral magnification m is measured and plotted versus object distance $|u|$ for a range of u, as shown fig. The magnification of the object when it is placed at a distance 20cm in front of the mirror is

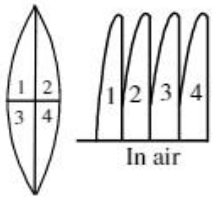


6. An object starts ,moving at an angle of 45^0 with the principal axis as shown in fig. in front of a biconvex lens of focal length + 10cm. If $\theta = \frac{-\pi}{n}$ denotes the angle at which image starts to move with principal axis then n is

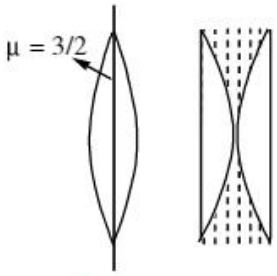


7. The distance between an object and the screen is 100cm. A lens produces an image on the screen when the lens is placed at either of the positions 40 cm apart. The power of the lens is nearly_____ diopters

8. The given lens is broken into four parts and rearranged as shown. If the initial focal length is 'f' then after rearrangement the equivalent focal length is $\frac{f}{x}$. Then X is



9. A thin equiconvex lens ($\mu = 3/2$) of focal length 10cm is cut and separated and a material of refractive index 3 is filled between them. What is the focal length of the combination_____ cm



LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. A glass sphere ($\mu = 1.5$) of radius 20cm has a small air bubble 4 cm below its centre. The sphere is viewed from outside and along a vertical line through the bubble. The apparent depth of the bubble below the surface of sphere is (in cm)

   a) 13.33 b) 26.67 c) 15 d) 30

2. A ray incident at an angle of incidence 60^0 enters a glass sphere of refractive index $\mu = \sqrt{3}$. This ray is reflected and refracted at the farther surface of the sphere. The angle between reflected and refracted rays at this surface is

   a) 90^0 b) 60^0 c) 70^0 d) 40^0

3. A ray of light is incident on a glass sphere of refractive index 3/2. What should be the angle of incidence so that the ray which enters the sphere does not come out of the sphere ?

   a) $\tan^{-1}(2/3)$ b) $\sin^{-1}(2/3)$ c) 90^0 d) $\cos^{-1}(1/3)$

4. Radius of curvature of first surface of double convex lens is three times that of the other. If focal length of the lens is 30 cm and refractive index of the lens is 3/2, then radius of curvature of the first surface is

   a) 20 cm b) 40 cm c) 60 cm d) 80 cm

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

   a) $\frac{17}{8}$ b) $\frac{15}{8}$ c) $\frac{13}{8}$ d) $\frac{9}{8}$

6. A thin double convex lens is cut into two equal pieces A and B by a plane containing principal axis. The piece 'B' is further cut into two more pieces 'C' and 'D' by another plane perpendicular to the principal axis. If the focal power of the original lens is 'P', then those of A and C are

   a) $P, \frac{P}{4}$ b) $P, \frac{P}{2}$ c) $\frac{P}{2}, 2P$ d) $\frac{P}{2}, \frac{P}{4}$

7. Two plano concave lenses of glass of refractive index 1.5 have radii of curvature 20 cm and 30 cm respectively. They are placed in contact with the curved surface towards each other and the space between them is filled with a liquid of refractive index 5/2. The focal length of the combination is (in cm)

   a) 6 b) – 92 c) 108 d) 12.

8. The two surfaces of a biconvex lens has same radii of curvatures. This lens is made of glass of refractive index 1.5 and has a focal length 10 cm in air. The lens is cut into two equal halves along a plane perpendicular to its principal axis to yield two plano–convex lenses. The two pieces are glued such that the convex surfaces touch each other. If this combination lens is immersed in water of refractive index 4/3 its focal length (in cm) is

   a) 5 b) 10 c) 20 d) 40

9. Two converging glass lenses 'A' and 'B' have focal lengths in the ratio 2 : 1. The radius of curvature of first surface of lens 'A' is 1/4th of the second surface where as the radius of curvature of first surface of lens 'B' is twice that of second surface. Then the ratio between the radii of the first surfaces of A and B is

a) 5 : 3 b) 3 : 5 c) 1 : 2 d) 5 : 6

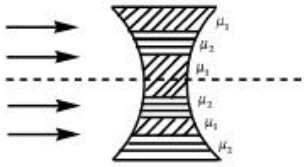
10. Two thin symmetrical lenses one converging and other of diverging nature are made from different material have equal radii of curvature R = 15 cm, the lenses are put in contact and immersed in water ($\mu_W = 4/3$). The focal length of the system in water is 30 cm. Then the difference between refractive indices of the two lenses is

a) $\frac{1}{2}$ b) $\frac{1}{4}$ c) $\frac{1}{3}$ d) $\frac{3}{4}$

11. A symmetrical biconcave lens having radius of curvature R is made up of two different materials as shown in figure. A parallel beam of light passing through the lens appear to diverge from two different points. Find the distance between them.

a) $\frac{2}{R}(\mu_1 - \mu_2)$ b) $\frac{R}{2}\frac{(\mu_2 - \mu_1)}{(\mu_1 - 1)(\mu_2 - 1)}$

c) $\frac{R}{2}\left(\frac{\mu_2 - 1}{\mu_1 - 1}\right)$ d) $\frac{R}{2}\left(\frac{\mu_1 - 1}{\mu_2 - 1}\right)$

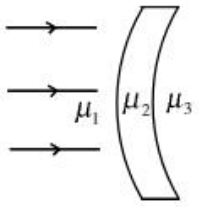


12. Light is incident on the thin lens as shown in figure. The refractive index of the material of the lens is μ_2. The radii of curvature of both of the surfaces are R. The refractive index of the medium of left side is μ_1, while that of right side is μ_3. What is the focal length of the lens?

a) $\frac{\mu_2 R}{\mu_3 - \mu_1}$

b) $\frac{\mu_1 R}{\mu_3 - \mu_1}$

c) $\frac{\mu_2 R}{\mu_2 - \mu_1}$ d) $\frac{\mu_3 R}{\mu_3 - \mu_1}$



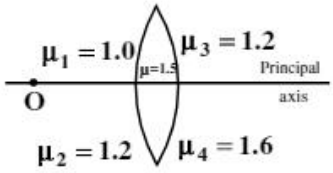
13. A convex lens of focal length 24 cm in air is surrounded by different mediums as shown in the fig. A point object O is placed along the principle axis at a distance 30 cm from the lens. Find the number and position of the images formed.

a) 1 image, at infinity and 4 cm

b) 2 images at infinity and 960/19cm

c) 2 image both at infinity

d) 4 images, all at infinity



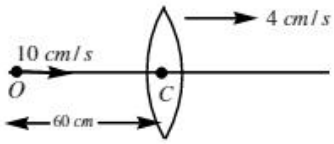
14. A point object 'O' approaches a biconvex lens of focal length 40 cm along its optic axis with a speed of 10 cm/s while the later receeds away from the former with a speed of 4 cm/s. Find the speed and direction of motion of the image when the object is at a distance of 60 cm from the lens.

a) 10 cm/s, lef twards

b) 10 cm/s, right wards

c) 28 cm/s right wards

d) 28 cm/s leftwards



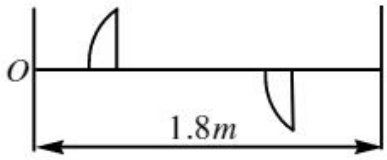
15. A thin plano convex lens is split into two halves. One of the haves is shifted along the optical axis. The separation between object and image planes is 1.8 m. The magnification of the image formed by one half of lens is 2. Find the focal length of the lens and separation between the halves.

a) (0.3 m, 0.2 m)

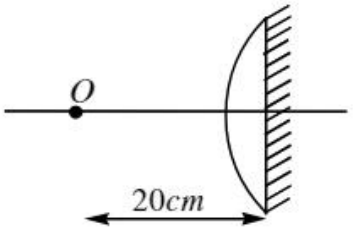
b) (0.4 m, 0.6 m)

c) (0.1 m, 0.6 m)

d) (0.4 m, 0.2 m)



16. An object is placed at a distance of 20 cm from a thin plano convex lens of focal length 15 cm. The plane surface of lens is now silvered. What is the position of image?



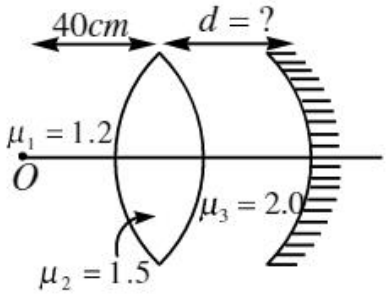
a) 12 cm to the left of lens system

b) 20 cm to the right of lens system

c) 12 cm to the right of lens system

d) 20 cm to the left of lens system

17. Figure shows an arrangement of an equiconvex lens (f = 20 cm in air) and a concave mirror (R = 80 cm). A point object 'O' is placed on the principal axis at a distance 40 cm from the lens such that the final image is also formed at the position of object. Find d.



a) 20 cm

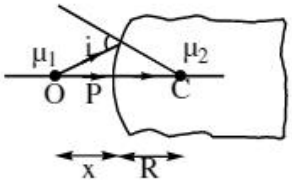
b) 30 cm

c) 40 cm

d) 50 cm

More than One correct answer Type Questions

18. A curved surface of radius R separates two medium of refractive indices μ_1 and μ_2 as shown in figure



Choose the correct statement(s) related to the virtual image formed by object O placed at a distance x, as shown in figure.

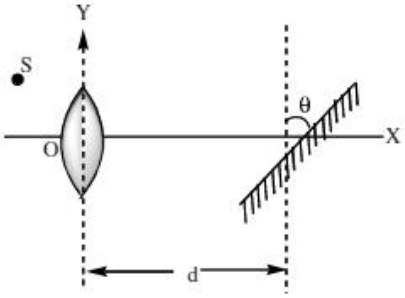
a) Virtual image is formed for any position of O if $\mu_2 < \mu_1$

b) Virtual image can be formed if $x > R$ and $\mu_2 < \mu_1$

c) Virtual image is formed if $x < R$ and $\mu_2 > \mu_1$

d) None of these

19. A thin converging lens of focal length f = 1.5 m is placed along y-axis such that its optical centre coincides with the origin, A small light source S is placed at (–2.0 m, 0.1 m). A plane mirror inclined at an angle θ is placed such that y co-ordinate of final image is 0.3m. ($\tan\theta = 0.3$).



a) The value of d is 4.0m

b) The value of d is 5.0m

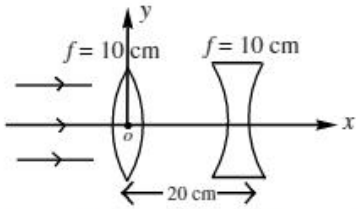
c) x co-ordinate of final image = 4.0

d) x co-ordinate of final image = 5.0

Linked Comprehension Type Questions

Passage - I :

A convex lens of focal length 10 cm and a concave lens of same focal length in value are placed co-axially at a separation of 20 cm as shown in figure. A point object is at infinity on the principal axis. Take the optic center of convex lens as origin of co-ordinate system and the principal axis as x-axis as shown in figure.



20. The co-ordinates of the image formed after refraction through both the lenses is

a) (10 cm, 0) b) (25 cm, 0) c) (-5 cm, 0) d) (15 cm, 0)

21. If the concave lens is moved vertically downwards through a distance of 5 mm, then the co-ordinates of the final image after refraction through the two lenses is

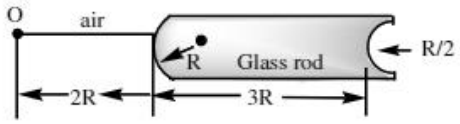
a) (15 cm, -0.25 cm) b) (10 cm, +0.25 cm) c) (25 cm, -0.5 cm) d) (15 cm, +0.5 cm)

22. In the initial position (as given in the passage) if the concave lens has a velocity of 9 cm/s towards the convex lens, the velocity of the final image will be

a) 10 cm/s along positive x-axis
b) 6.75 cm/s along negative x-axis
c) 8 cm/s along negative x-axis
d) 8 cm/s along positive x-axis

Passage - II :

A glass rod has ends as shown in figure. The refractive index of glass is μ. The object O is at a distance 2R from the surface of larger radius of curvature. The distance between apexes of ends is 3R.



23. The distance of image formed of the point object from right hand vertex is

a) $\frac{R(9-4\mu)}{(10\mu-9)(\mu-2)}$ b) $\frac{R(5-4\mu)}{(10\mu-9)(\mu-2)}$ c) $\frac{R(9-4\mu)}{(5\mu-9)(\mu-2)}$ d) $\frac{R(9-4\mu)}{(10\mu-9)(\mu-1)}$

24. The condition to be satisfied if the image is to be real is

a) $2<\mu<3$ b) $1<\mu<2$ c) $2<\mu<2.25$ d) $2<\mu<2.75$

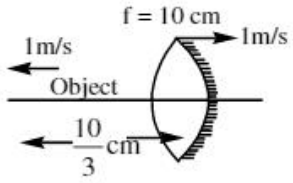
Matrix Matching Type Questions

25. Thin lenses made of materials $\mu = 1.5$ with which are silvered at one surface are given in column - I and their focal powers are given is column - II. Radius of curvature of each spherical surface is R. Match the two columns.

Column -I	**Column -II**
A) 	p) $-\frac{3}{R}$
B) 	q) $\frac{1}{R}$
C) 	r) $\frac{4}{R}$
D) 	s) $\frac{2}{R}$

Integer Type Questions

26. One of the surfaces of a biconvex lens of focal length 10 cm is silvered as shown in figure. Radius of curvature of silvered surface is 10 cm. At a given instant, if speed of object is 1 m/s, then the speed of image at that instant is $(10+\alpha)$ m/s. What will be the value of α ? $(\mu = 1.5)$



27. An object is kept at a distance of 4 cm form the first focus of a convex lens. A real image is formed at a distance of 9 cm from its second focus. What is the focal length of that lens is_____ (in cm)

KEY SHEET (LECTURE SHEET)

EXERCISE - I

LEVEL-I

1) **3** 2) **3** 3) **2** 4) **4** 5) **2** 6) **1** 7) **2** 8) **2**
9) **120°** 10) **60** 11) **60** 12) **5cm** 13) **120**

LEVEL-II

1) **a** 2) **d** 3) **a** 4) **c** 5) **a** 6) **d** 7) **b** 8) **c**
9) **b** 10) **a** 11) **b** 12) **a** 13) **a** 14) **c** 15) **a** 16) **a**
17) **abcd** 18) **bc** 19) **bc** 20) **bd** 21) **ad** 22) **ac** 23) **b** 24) **a**
25) **a** 26) **a** 27) **a** 28) **A-pqs; B-p; C-q; D-pqs**
29) **A-ps; B-p; C-pr; D-qr** 30) **4** 31) **0**

EXERCISE - II

LEVEL-I

1) **2** 2) **1** 3) **1** 4) **3** 5) **2** 6) **4** 7) **1** 8) **4**
9) **4** 10) **4** 11) **2** 12) **5** 13) **1.716** 14) **1.41** 15) **0.2**
16) **0.01509**

LEVEL-II

1) **a** 2) **c** 3) **d** 4) **c** 5) **d** 6) **b** 7) **a** 8) **d**
9) **c** 10) **a** 11) **b** 12) **d** 13) **a** 14) **b** 15) **b** 16) **b**
17) **b** 18) **c** 19) **b** 20) **a** 21) **a** 22) **b** 23) **a** 24) **c**
25) **b** 26) **a** 27) **a** 28) **a** 29) **a** 30) **b** 31) **a** 32) **b**
33) **a** 34) **b** 35) **b** 36) **ac** 37) **ac** 38) **ac** 39) **abc** 40) **c**
41) **bd** 42) **ab** 43) **c** 44) **b** 45) **d** 46) **b** 47) **b** 48) **a**
49) **A-s; B-r; C-q; D-p** 50) **3** 51) **2**

EXERCISE - III

LEVEL-I

1) 2 2) 2 3) 2 4) 2 5) –1 6) 4 7) 5
8) 2 9) $\left(-\frac{10}{3}\right)$ (or) .333cm

LEVEL-II

1) b 2) a 3) c 4) c 5) b 6) b 7) d 8) d
9) d 10) c 11) b 12) d 13) b 14) c 15) d 16) a
17) b 18) ab 19) bc 20) d 21) a 22) b 23) a 24) c
25) A-r; B-p; C-s; D-q 26) 9 27) 6

PRACTICE SHEET

EXERCISE-I

(Reflection by plane and curved surfaces)

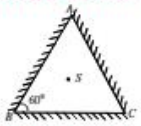
LEVEL-I (MAIN)

Straight Objective Type Questions

1. An infinitely long rod lies along the axis of a concave mirror of focal length 'f'. The near end of the rod is at a distance u > f from the mirror. Its image will have a length.
   1) $\frac{uf}{u-f}$ 2) $\frac{uf}{u+f}$ 3) $\frac{f^2}{u+f}$ 4) $\frac{f^2}{u-f}$

2. A spherical surface of radius of curvature R, separates air (refractive index 1.0) from glass (refractive index 1.5). The centre of curvature is in the glass. A point object P placed in air is found to have a real image Q in the galss. The line PQ cuts the surface at a point O and PO = OQ. The distnace PO is equal to
   1) 5R 2) 3R 3) 2R 4) 1.5 R

3. Three identical plane mirrors AB, BC, AC are arranged as shown in the figure. Find the total number of images of a point object 'S' formed by the three mirrors. (S is at the centre of the system)
   1) 18 2) 12
   3) 5 4) infinity



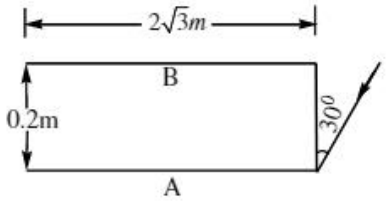
4. Two plane mirrors are placed parallel to each other at a distance L apart. A point object O is placed between them, at a distance L / 3 from one mirror. Both mirrors form multiple images. The distance between any two images cannot be
   1) 3L / 2 2) 2L / 3 3) 2L 4) None

5. 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 ?
   1) Concave 20 cm from the miurror 2) Convex 20 m from the mirror
   3) Concave 10 cm from the mirror 4) Convex 20 cm from the mirror

6. A plane mirror is placed 22.5 cm in front of a concave mirror of focal length 10 cm. Find where an object a can be placed between the two mirrors, so that the first image in both the mirrors coincides.
   1) 15 cm from the concave mirror
   2) 15 cm from the plane mirror
   3) 10 cm from the concave mirror
   4) 10 cm from the plane mirror

Numerical value type Questions

7. Two plane mirrors A and B aligned parallel to each other, as shown in the figure. A light ray is incident at an angle 30^0 at a point just inside one end of A. The plane of incidence coincides with the plane of the figure. The maximum number of times the ray undergoes reflections (including the first one) before it emerges out is



8. A concave mirror has a focal length 20cm. The distance between the two positions of the object for which the image size is double of the object size is _____cm

9. Two plane mirrors are inclined at 70^0 . A ray incident on one mirror at angle θ, after reflection falls on the second mirror and after reflected from there it moves parallel to the first mirror. Then θ is _____ degree

10. A light ray strikes a horizontal plane mirror and gets deviated by $\frac{\pi}{3}$ the reflected ray becomes verticals, when the angle of mirror is $\frac{\pi}{x}$. The value of X is

11. A narrow beam of light after reflection by a plane mirror falls on a scale at a distance 100cm from the mirror. When the mirror is rotated a little, the light spot moves through 2 cm. The angle through which the mirror is rotated is _____rad

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. A man of height 'h' is walking away from a street lamp with a constant speed 'v'. The height of the street lamp is 3h. The rate at which the length of the man's shadow is increasing when he is at a distance 10h from the base of the street lamp is :

   a) v/2 b) v/3 c) 2v d) v/6

2. A point source of light is 60 cm from a screen and is kept at the focus of a concave mirror which reflects light on the screen. The focal length of the mirror is 20 cm. The ratio of average intensities of the illumination on the screen when the mirror is present and when the mirror is removed is :

   a) 36 : 1 b) 37 : 1 c) 49 : 1 d) 10:1

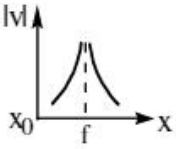
3. A police inspector is chasing a thief who is running away in a car with a speed 3 m/s. The speed of police jeep is 12 m/s. Then the speed of image of police jeep as seen by thief in the rear view mirror when the police jeep is at a distance of 30 m is (value of focal length of the rear view mirror is 15 m)

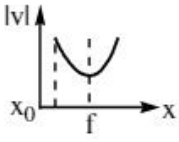
a) 2 m/s b) 3 m/s c) 4 m/s d) 1 m/s

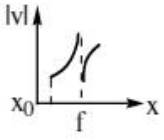
4. A particle moves in a circular path of radius 5 cm in a plane perpendicular to the principal axis of a concave mirror with radius of curvature 20 cm. The center of circle lies onthe principal axis at distance of 15 cm in front of the mirror. The radius of the circular path of the image is

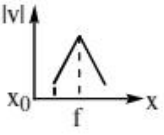
a) 15 cm b) 20 cm c) 10 cm d) 40 cm

5. A point source is situated at a distance x < f from the pole of the concave mirror of focal length f. At time t = 0, the point source starts moving away from the mirror with constant velocity. Which of the graphs below represents best, variation of image distance | v | with the distance x between the pole of mirror and the source.

a) 

b) 

c) 

d) 

6. When an object is placed at a distance of 25 cm from a concave mirror, the magnification is m_1. The object is moved 15 cm farhter away with respect to the earlier position, and the magnification becomes m_2. If $m_1/m_2 = 4$ the focal length of the mirror is (Assume that image is real and m_1, m_2 are numerical values)

a) 10 cm b) 30 cm c) 15 cm d) 20 cm

More than One correct answer Type Questions

7. Which of the following are correct about spherical mirrors

a) concave mirror forms virtual image of real object some times

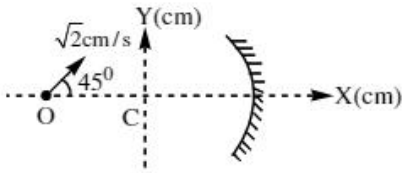
b) convex mirror forms real image of virtual object some times

c) convex mirror forms real image of virtual object always

d) convex mirror virtual image of real object always

Linked Comprehension Type Questions

Passage -I :



A concave mirror of radius of curvature '10 cm' whose principal axis co-incides with x-axis and its centre of curvature at origin. A point object 'O' with its initial co-ordinates (–2, 0), is moving with a constant speed $\sqrt{2}$ cm/ sec making an angle 45° with the x-axis as shown figure.

8. The image co-ordinates at time t = 0

a) $\left(\frac{10}{7},0\right)$ b) $\left(\frac{60}{7},0\right)$

c) $\left(\frac{-60}{7},0\right)$ d) $\left(\frac{-10}{7},0\right)$

9. After time t = 2sec, the magnitude of relative velocity between object and its image along the x-axis is

a) Zero b) 0.5 cm/s

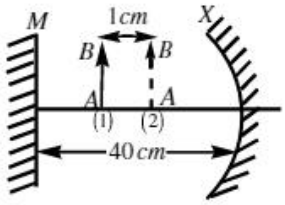
c) 1 cm/s d) 2 cm/s

10. The time after which, the magnification of the mirror is unity

a) 1s b) 2s c) 3s d) 4 s

Passage - II :

A plane mirror 'M' and a concave mirror 'X' are kept at a seperation of 40 cm with their reflecting faces facing each other as shown in figure. An object AB is kept perpendicular to the principal axis in position (1). Considering successive reflections first at mirror 'X' and then at 'M', a real image is formed infront of 'M at a normal distance 8 cm form it. If the object is moved to new position (2), the real image is formed at 20 cm from 'M' with the reflections as described earlier.



11. Distance of position (2) of the object from the pole of concave mirror is

a) 11 cm b) 12 cm c) 14 cm d) 15 cm

12. Focal length of mirror 'X' is

a) –18 cm b) –12 cm c) –6 cm d) –24 cm

13. Keeping the object in position (1), if the plane mirror is replaced with a convex mirror 'Y' of focal length 20 cm facing the mirror 'X' after successive reflections first at 'X' and then at 'Y', the final image will be

a) at distance of $\frac{80}{3}$cm from the pole of mirror X and in front of its reflecting surface.

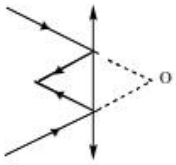
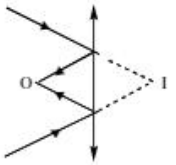
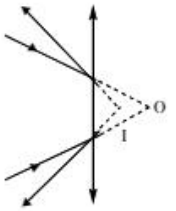
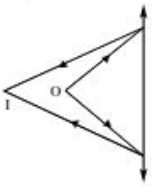
b) at a distance of $\frac{40}{3}$cm from the pole of mirror X and in front of its reflecting surface.

c) mid point between X and Y

d) at any position between X and pole

Matrix Matching Type Questions

14. Column-I contains the path traced by light rays and the positions of object and image, with a reflecting spherical mirror. Choose the possible options for type of mirror and the nature of image rom Column-II to each case in Column-I

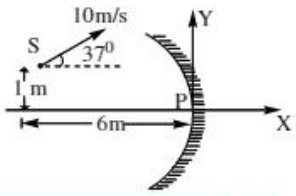
Column - I	Column - II
A) 	p) concex mirror
B) 	q) concave mirror
C) 	r) Image is real
D) 	s) Image is virtual

Integer Type Questions

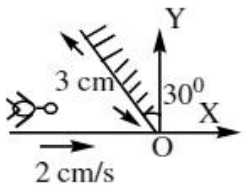
15. Two identical point particles A and B are placed in front of a concave mirror of focal length 20 cm, at distances 10 cm and 30 cm respectively. The particles oscillate perpendicular to the principal axis, such that the displacement equation for both the particles is given by $Y_A=Y_B=0.1\sin(\pi t)$ cm. Find the maximum separation between the images of A and B measured perpendicular to the principal axis in mm.

16. Two plane mirrors are making an angle of 60° to each other. A light ray falls on one of the mirrors. The light ray is incident parallel to angular bisector of mirrors. How many reflection does the light ray undergo ?

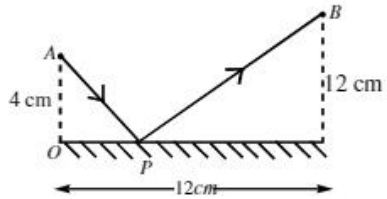
17. A point source S is moving with a speed of 10 m/s in XY plane as shown in figure. The radius of curvature of the concave mirror is 4 m. If the speed of the image is $2\sqrt{x}$ m/s, then find x. [The rays in the question are paraxial rays]



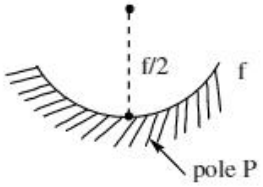
18. A plane mirror is placed with its plane at an angle of 30^0 with the y-axis. Plane of the mirror is perpendicular to the xy plane and the length of the mirror is 3 cm. An insect moves along x-axis starting from a distant point with a speed 2cm/s. Find the duration of the time for which the insect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



19. A ray of light is to travel from point A to point B in figure in the shortest possible time after reflecting from P. Then OP is ..... cm .



20. A particle is dropped along the axis from a height f/2 on a concave mirror of focal length f as shown in the figure. The acceleration due to gravity is g. Then the maximum speed of the image is givenby $\frac{3}{4}\sqrt{xfg}$ where x = ...



EXERCISE-II

(Plane surface refraction, total internal reflection, prism)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. A fish rising vertically to the surface of water in a lake uniformly at the rate of 3 ms^{-1} observes a bird diving vertically towards the water at a rate of 9 ms^{-1} vertically above it. If the refractive index of water is 4/3, the actual velocity of the dive of the bird is (in ms^{-1})

1) 6 2) 4.5 3) 1.5 4) 2

2. Angle of prism is 'A' and its one surface is silvered. Light rays falling at an angle of incidence 2 A on first surface return back through the same path after suffering reflection at second silvered surface. Refractive index of the material of the prism is

1) 2 SinA 2) 2 CosA 3) 1/2 CosA 4) tanA

3. A glass plate has a thickness '*t*' and refractive index μ. The angle of incidence of a ray from air into the plate is equal to the critical angle for glass-air intrerface. The lateral shift (perpendicular distance between incident ray and emergent ray) of ray is given by

1) $t\left(1-\frac{1}{\sqrt{\mu^2+1}}\right)$ 2) $\mu\left(t-\frac{1}{\sqrt{\mu^2+1}}\right)$

3) $\frac{t}{\mu}\left(1-\frac{1}{\sqrt{\mu^2+1}}\right)$ 4) $\left(t-\frac{\mu}{\sqrt{\mu^2-1}}\right)$

4. The refracting angle of a prism is A and the refractive index of the material of the prism is $\cot\left(\frac{A}{2}\right)$. The angle of minimum deviation of the prism is

1) $\pi+2A$ 2) $\pi-2A$ 3) $\frac{\pi}{2}+A$ 4) $\frac{\pi}{2}-A$

Numerical value type Questions

5. A layer of oil 3cm thick is floating on a layer of coloured water 5cm thick. The refractive index of the coloured water is 5/3 and the apparent depth of the two liquids is 36/7cm. Then the refractive index of the oil is _____

6. A ray of light is incident on one face of a transparent slab of thickness 15cm. The angle of incidence is 60^0. If the lateral displacement of the ray on emerging from the parallel plane is $5\sqrt{3}$cm, the refractive index of the material of the slab is

7. The minimum deviation produced by a hollow prism filled with a certain liquid to be 30^0. The light ray is also found to be refracted at angle 30^0. The refractive index of the liquid is

8. A point source of light is placed at the bottom of a water lake. If the area of the illuminated circle on the surface is equal to 3 times the square of the depth of the lake. The refractive index of water is $\sqrt{\frac{\pi}{n}+1}$ where n = ___

LEVEL-II (ADVANCED)

Straight Objective Type Questions

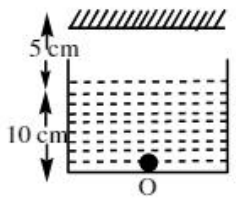
1. Consider the situation shown in figure. Water $(\mu_w = 4/3)$ is filled in a beaker upto a height of 10 cm. A plane mirror is fixed at a height of 5 cm from the surface of water. Distance of image from the mirror after reflection from it of an object *O* at the bottom of the beaker is:

a) 15 cm

b) 12.5 cm

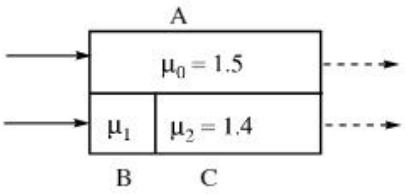
c) 7.5

d) 10 cm



More than One correct answer Type Questions

2. A slab of transparent materials is made as shown in the figure. Monochromatic parallel beams of light are normally incident on the slabs. The thickness of C is twice the thickness of B. The number of waves in A = the number of waves in the combination of B and C. The refractive index of material A is $\mu_0 = 1.5$ and that of C is $\mu_2 = 1.4$



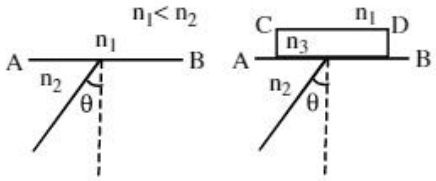
a) The refractive index of B is 1.6

b) The frequency of light in B is two times the frequency of light in C.

c) The refractive index of B is 1.7

d) The frequency of light in B is the same as the frequency of light in C.

3. In the figure light is incident at an angle θ which is slightly greater than the critical angle. Now, keeping the incident fixed a parallel slab of refractive index n_3 is placed on surface AB. Which of the following statements are correct:



a) total internal reflection occurs at AB for $n_3 < n_1$

b) total internal reflection occurs at AB for $n_3 > n_1$

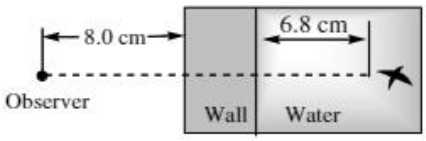
c) the ray will return back to the same medium for all values of n_3

d) total internal reflection occurs at CD for $n_3 < n_1$

Linked Comprehension Type Questions

Passage - I :

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



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

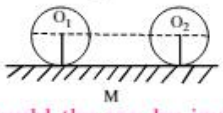
a) 10 cm b) 20 cm c) 30 cm d) 5 cm

5. To the watcher, hwo far away does the fish appear to be (nearly) ?

a) 10 cm b) 20 cm c) 15 cm d) 5 cm

Passage - III :

A cylindrical glass rod of radius 0.1 m and RI $\sqrt{3}$ lies on a horizontal plane mirror. A horizontal ray of light goind perpendicular to the axis of rod is incident on it



6. At wh3at height from plane mirror should the ray be incident so that it emerges from the rod at a height 0.1 m above the mirror.

a) $18\frac{2}{3}$cm b) $15\frac{1}{3}$cm c) $6\frac{2}{3}$cm d) $9\frac{1}{3}$cm

7. At what distance a second identical rod be placed on the mirror such that emergent ray from the second rod is in line with incident ray on 1st rod.

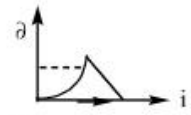
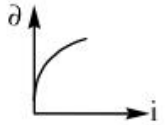
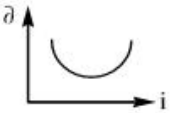
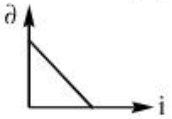
a) 21.5 cm b) 31.5 cm c) 11.5 cm d) 41.5 cm

8. Deviation suffered by ray in second rod is

a) 30° b) 45° c) 75° d) 60°

Matrix Matching Type Questions

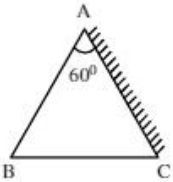
9. Matrix – Matching :

Column - I	**Column - II**
Describes the path of rays	Deviation(∂)and angle (i) of incidence plots
A) Ray is falling on a plane smooth mirror	p) 
B) A ray is going from rarer to denser medium	q) 
C) A ray is going from denser to rarer medium	r) 
D) A ray is falling on a prism.	s) 

Integer Type Questions

10. A ray of light undergoes deviation of 30^0 when incident on as an equilateral prism of refractive index $\sqrt{2}$. Find the angle made by the ray inside the prism with the base of the prism.

11. One face AC of an equilateral prism ABC is silvered as shown in fig. The angle of incidence of a light ray in order that it eventually leaves the prism in the opposite direction from base of prism is $n \times 15°$ where 'n' is $\left(\mu = \sqrt{2}\right)$



12. Light passes symmetrically through an equilateral prism. After emergence, it is incident on a plane mirror fixed to the base of the prism extending beyond it. Find the deviation produced. (μ of the prism material is $\sqrt{2}$).

EXERCISE-III

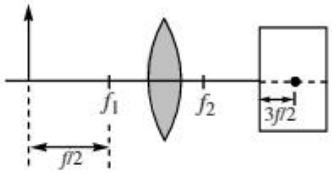
(Refraction through curved surface and lenses)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. A convex spherical refracting surface with radius R separates a medium having refractive index 5/2 from air. As an object is moved towards the surface from far away from the surface along the principle axis, its image
   1) Changes from real to virtual when it is at a distance R from the surface
   2) Changes from virtual to real when it is at a distance R from the surface
   3) changes from real to virtual when it is at a distance 2R/3 from the surface
   4) changes from virtual to real when it is at a distance 2R/3 from the surface

2. An object is placed at $f/2$ away from first focus of convex lens where f is the focal length of the lens. Its image is formed at a distance $3f/2$ in a slab of refractive index 3/2, from the face of the slab facing the lens. Find the distance of this face of the slab from the second focus of the lens.
   1) $f/2$
   2) $3f/2$
   3) $2f$
   4) f

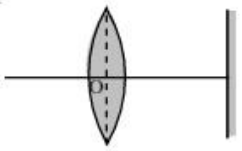


3. A ray of light falls on the surface of a spherical glass paper weight making an angle α with the normal and is refracted in the medium at an angle β. The angle of deviation of the emergent ray from the direction of the incident ray
   1) $(\alpha-\beta)$ 2) $2(\alpha-\beta)$ 3) $(\alpha-\beta)/2$ 4) $(\beta-\alpha)$

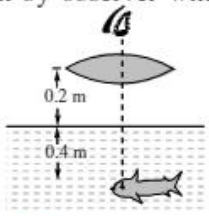
Numerical value type Questions

4. An object is placed at a distance of 15cm from a convex lens of focal length 10cm. on the other side of the lens, a convex mirror is placed at its focus such that the image formed by the combination coincides with the object itself. The focal length of the convex mirror is _____cm

5. The distance between a convex lens and a plane mirror is 10cm. The parallel rays incident on the convex lens after reflection from the mirror form image at the optical centre of the lens. Focal length of lens will be _____cm



6. A small fish 0.4m below the surface of a lake is viewed through a simple converging lens of focal length3m. The lens is kept at 0.2m above the water surface such that fish lies on the optical axis of the lens. The image of the fish seen by observer will be at $\left(\mu_{water}=\frac{4}{3}\right)$____m



7. A thin plano – convex lens acts like a concave mirror of focal length 0.2m when silvered from its plane surface. The refractive index of the material of the lens is 1.5. The radius of curvature of the convex surface of the lens will be___m

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. The focal length of a convex lens of refractive index 1.5 is 'f' when it is placed in air. When it is immersed in a liquid it behaves as a converging lens and its focal length becomes xf (x > 1). The refractive index of the liquid is

   a) > 3/2 b) < 3/2 and > 1 c) < 3/2 d) = 3/2

2. A thin equiconvex lens is made of = glass of refractive index 1.5 and its focal length in air is 0.2 m. If it acts as a concave lens of 0.5 m focal length when dipped in a liquid, the velocity of light in the liquid is

   a) $1.2\times10^8 ms^{-1}$ b) $1.6\times10^8 ms^{-1}$

   c) $1.8\times10^8 ms^{-1}$ d) $2.4\times10^8 ms^{-1}$

3. In an experiment, with the position of the object fixed, a student varies the position of a convex lens and for each position, the screen is adjusted to get a clear image of the object. A graph between the object distance u and the image distance v, from the lens, is plotted using the same scale for the two axes. A straight line passing through the origin and making an an angle of 45^0 with the x-axis meets the experimental curve at P. The coordinates of P will be:

   a) $\left(\frac{f}{2},\frac{f}{2}\right)$ b) (f,f) c) $(4f,4f)$ d) $(2f,2f)$

4. A thin converging lens is placed between a fixed object and a screen. There are two positions of the lens for which a sharp image is formed on the screen. The height of one of the images is 2 cm while the magnification of the other image is 3. What is the height of the object?

   a) 6 cm b) 9 cm c) 10 cm d) 4 cm

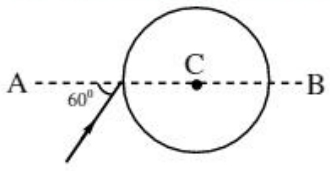
5. A ray of light falls on a transparent sphere with centre at C as shown in figure. The ray emerges from the sphere parallel to line AB. The refractive index of the sphere is

   a) $\sqrt{2}$

   b) $\sqrt{3}$

   c) 3/2

   d) 1/2



6. A glass sphere of diameter 50 cm and $\mu = 1.5$ has a small air bubble. Looking from outside the diameter, the bubble appears to be at a distance 10 cm from the surface. Find the apparent position of the bubble when it is viewed from the diametrically opposite position.

   a) real image, at the pole of 2nd face

   b) real image, at the pole of 1st face

   c) virtual image, at the pole of 1st face

   d) virtual image, at the centre of the sphere

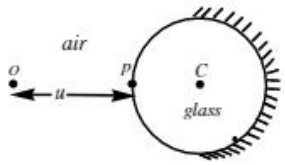
7. A transparent glass sphere of radius 10 cm and refractive index $\mu = 1.5$ has its one half silvered so that it acts like a concave mirror. Find the position of final image for an object 'O' at (a) 30 cm to the left of the front surface of the ball.

a) 30 cm to the right of P; at the pole of mirrored surface

b) 20 cm to the left of P; at the center of sphere

c) 20.9 cm to the right of P ; at the pole P.

d) 20.9 cm to the left of P; at the pole of mirrored surface



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

a) $\frac{R}{\mu_1 - \mu_2}$ b) $\frac{2R}{\mu_1 - \mu_2}$ c) $\frac{R}{2(\mu_1 - \mu_2)}$ d) $\frac{R}{\mu_1 + \mu_2}$

9. Two plano concave lenses of glass of refractive index 1.5 have radii of curvature of 20cm and 30cm. If they are placed in contact with curved surfaces towards each other and the space between them is filled with water $\left(\mu_w = \frac{4}{3}\right)$, find the focal length of the system.

a) -50 cm b) 95 cm

c) -72 cm d) 40 cm

10. An equiconvex lens of focal length 20 cm is cut into two equal halves perpendicular to the principal axis and kept at a separation of 10 cm co-axially. What is the focal length of the system?

a) 35 cm b) 20 cm

c) 22.9 cm d) 15 cm

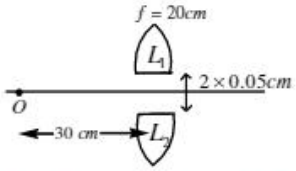
11. A point object 'O' is placed at a distance of 30 cm from a convex lens (f=20 cm) cut into two equal haves each of which is displaced by 0.05 cm as shown in figure. Find the position of image? If more than one image is formed, find their number and distance between them.

a) 30 cm, 2 images, 0.5 cm

b) 40 cm, 2 images, 0.3 cm

c) 50 cm, 2 images, 0.4 cm

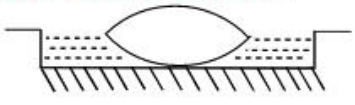
d) 60 cm, 2 images, 0.3 cm



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

a) 1.4 b) 1.5

c) 1.6 d) 1.7



More than One correct answer Type Questions

13. A thin equiconvex spherical glass lens ($\mu = 3/2$) of radius of curvature 30 cm is placed on the x-axis with its optical centre at x = 40 cm and principal axis coinciding with the x-axis. A light ray given by the equation 39y = –x + 1(x and y are is incident on the lens, in the direction of positive (in cm) X-axis. Then choose the correct alternative(s)

a) The equation of refracted ray is 39y = x + 1

b) The equation of refracted ray is 130y = x – 170

c) The equation of refracted ray if space on right side of the lens is filled with a liquid of refractive index 4/3 is 390y + x + 350 = 0

d) The equation of refracted ray if space on right side of the lens is filled with a liquid of refractive index 4/3 is 390y – x + 350 = 0

Linked Comprehension Type Questions

Passage - I :

Three diagrams are given each has equal radial of curvature of the curved surfaces. All the lenses have refractive index $\mu = 1.5$.

(P) *(Q)* *(R)* *(Combination of P & R)* *(S)*

14. The ratio of focal lengths of P, Q, R is

a) 1 : -2 : 1 b) -1 : 2 : 1 c) -2 : 1 : 1 d) 1 : 2 : -1

15. The arrangement P behaves like ..... (Focal length of Q is 20 cm)

a) Convex mirror of focal length 40 cm b) Plane mirror

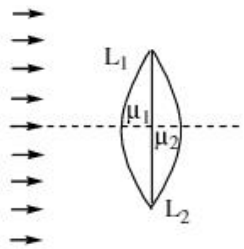
c) Concave mirror of focal length 10 cm d) None of these

16. If P and R are used in combination as shown in the diagram (S), then ratio of magnitude of the focal length of P and S is

a) 1 : 2 b) 2 : 1 c) 1 : 1 d) 3 : 2

Passage - III:

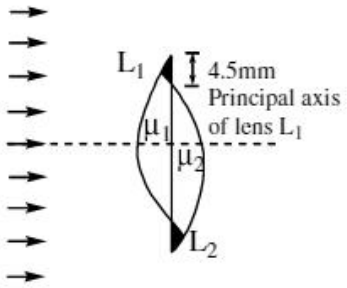
Two identical plano-convex lenses $L_1(\mu_1 = 1.4)$ ***and*** $L_2(\mu_2 = 1.5)$ ***of radii of curvature R = 20cm are placed as shown in Fig.***



17. Find the position of the image of the parallel beam of light relative to the common principal axis.

a) 100/7 cm b) 200/9 cm c) 31.2 cm d) 21.8 cm

18. Now, the second lens is shifted vertically downward by a small distance 4.5mm and the extended parts of L_1 and L_2 are blackened as shown in fig. Find the new position of the image of the parallel beam



a) 200/9 cm behind the lens 2.5mm below the principal axis of L_1

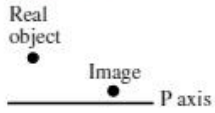
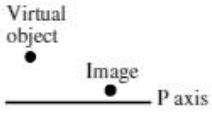
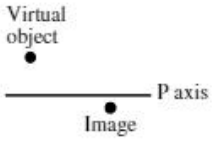
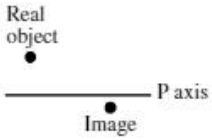
b) 100/9 cm front the lens 2mm below the principal axis of L_1

c) 200/9 cm in front of the lens 2.5mm below the principal axis of L_1

d) 100/9 cm behind the lens 2mm below the principal axis of L_1

Matrix Matching Type Questions

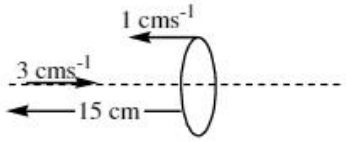
19. In the column-1, optical systems are given. Match the optical system with the image and object combination possible. The nature of image is not known and the optical system can be at any position.

Column - I		Column - II
A) Convex mirror	p)	
B) Concave mirror	q)	
C) Converging lens	r)	
D) Diverging lens	s)	

Integer Type Questions

20. A small air bubble is situated at a distance of 3 cm from the center of a glass sphere of radius 9 cm. When viewed from the nearest side, the bubble appears to be at a distance of 5 cm from the surface. Its apparent distance when viewed from the farthest side is n×5cm where 'n' is?

21. An object and a convex lens are approaching each other with speeds $3cm^{-1}$and $1cm^{-1}$ along the principal axis as shown focal length of lens is 10 cm. If the speed of image relative to ground frame of reference is 5x. Then find x.



KEY SHEET (PRACTICE SHEET)

EXERCISE - I

LEVEL-I

1) **4** 2) **1** 3) **4** 4) **1** 5) **4** 6) **1** 7) **30** 8) **20**
9) **50°** 10) **6** 11) **0.01 rad**

LEVEL-II

1) **a** 2) **d** 3) **d** 4) **c** 5) **a** 6) **d** 7) **abcd** 8) **a**
9) **d** 10) **b** 11) **d** 12) **b** 13) **a** 14) **A-pqr; B-pqs; C-ps; D-qr**
15) **4** 16) **3** 17) **5** 18) **3** 19) **3** 20) **3**

EXERCISE - II

LEVEL-I

1) **2** 2) **2** 3) **3** 4) **2** 5) **3** 6) **1.732** 7) **1.414** 8) **3**

LEVEL-II

1) **b** 2) **cd** 3) **ac** 4) **b** 5) **c** 6) **a** 7) **b** 8) **d**
9) **A-s; B-q; C-p; D-r** 10) **0** 11) **4** 12) **0**

EXERCISE - III

LEVEL-I

1) **3** 2) **4** 3) **2** 4) **10** 5) **20** 6) **0.4m** 7) **0.2**

LEVEL-II

1) **b** 2) **b** 3) **d** 4) **a** 5) **a** 6) **c** 7) **d** 8) **a**
9) **c** 10) **c** 11) **d** 12) **c** 13) **bc** 14) **a** 15) **c** 16) **c**
17) **b** 18) **a** 19) **A-pr; B-qr; C-qr; D-pr** 20) **3** 21) **3**

ADDITIONAL PRACTICE EXERCISE

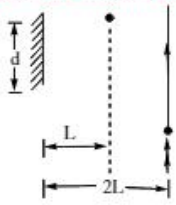
LEVEL-I (MAIN)

Straight Objective Type Questions

1. A thin liquid convex lens is formed in glass.Refractive index of liquid is 4/3 and that of glass is 3/2. If 'f' is the focal length of the liquid lens in air, its focal length and nature in the glass is

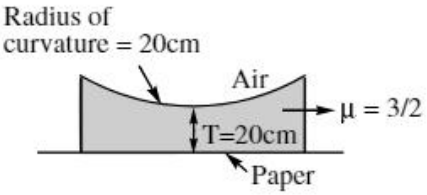
   1) f, convex 2) f, concave 3) 2f, concave 4) 3f, concave

2. A point source of light B is placed at a distance L in front of the center of a mirror of width d hung vertically on a wall. A man walks in front of the mirror along a line parallel to the mirror at a distance 2L from it as shown in Fig. 1.404. the greatest distance over which he can see the image of the light source in the mirror is

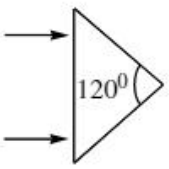
   1) d/2
   2) d
   3) 2d
   4) 3d

3. A plano-concave lens is placed on a paper on which a flower is drawn. How far above its actual position does the flower appear to be ?

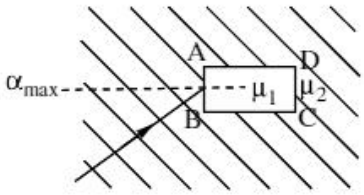
   1) 10 cm
   2) 15cm
   3) 50 cm
   4) None of these

4. An isosceles prism of angle 120^0 has a refract-ive index 1.44. Two parallel monochromatic rays enter the prism parallel to each other in air as shown in Fig. The rays emerging from the opposite faces

   1) are parallel to each other
   2) are diverging
   3) make an angle of $2[\sin^{-1}(0.72) - 30^0]$ with each other
   4) make an angle of $2\sin^{-1}(0.72)$ with each other

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

   1) $\sin^{-1}\left[\frac{n_1}{n_2}\cos\left(\sin^{1}\left(\frac{n_2}{n_1}\right)\right)\right]$
   2) $\sin^{-1}\left[n_1\cos\left(\sin^{1}\left(\frac{1}{n_2}\right)\right)\right]$
   3) $\sin^{-1}\left(\frac{n_1}{n_2}\right)$
   4) $\sin^{-1}\left(\frac{n_2}{n_1}\right)$

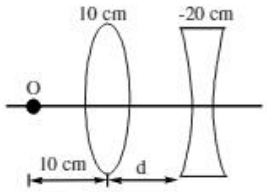
Numerical value type Questions

6. A plano – convex lens of refratctive index 1.5 and radius of curvature 30cm is silvered at the curved surface. Now this lens has been used to form the image of an object. The distance from this lens and object be placed in order to have a real image of the size of the object is ___ cm

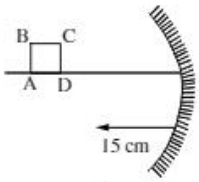
7. A concave mirror forms a real image three times larger than he object on a screen. Object and screen are moved until the image becomes twice the size of object. If the shift of object is 6cm, the shift of the screen is _____cm

8. 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 30 cm, it is found that there is no gap between the images formed by the two mirrors. The radius of the convex mirror is___cm

9. The value of distance d so that final image is formed on the object itself. (Focal lengths of the lenses are written on the lenses) is _____cm



10. A square ABCD of side 1mm is kept at distance 15cm in front of the concave mirror as shown in fig. The focal length of the mirror is 10cm. The length of the perimeter of its image will be_____mm



LEVEL-II

LECTURE SHEET (ADVANCED)

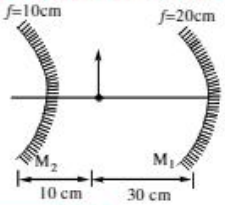
Straight Objective Type Questions

1. A concave mirror of focal length 10 cm and a convex mirror of focal length 15 cm 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.

a) 12cm behind convex mirror, real
b) 9cm behind convex mirror, real
c) 6 cm behind convex mirror, virtual
d) 3 cm behind convex mirror, virtual

2. In Fig., find the total magnification after two successive reflections first on M_1 and then on M_2.

a) + 1
b) – 2
c) + 2
d) – 1



3. A ring of radius 1 cm is placed at 1.0 m infront of a spherical glass ball of radius 25 cm with $\mu = 1.5$. Determine the position of the final image of the ring and its magnification.

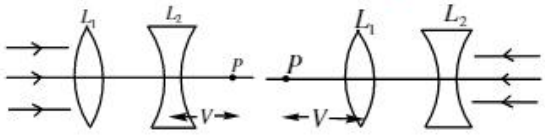
a) at 29 cm to the right of 2nd face; m = –0.44

b) at 10 cm to the right of 2nd face ; m = –0.3

c) at 10 cm to the left of 2nd face; m = –0.3

d) at 29 cm to the left of 2nd face ; m = –0.44

4. A converging lens L_1 of focal length 20 cm is separated by 8 cm from a diverging lens L_2 of focal length 30cm. A parallel beam of light falls on L_1 after passing through L_2 is focussed at point P. Calculate V. Repeat the calculation for the case when the parallel beam first falls on L_2.

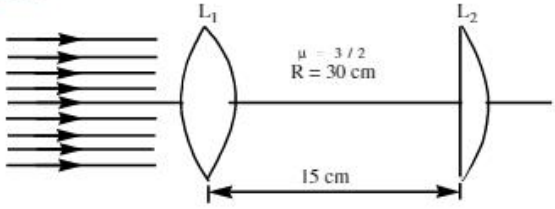


a) (40 cm, 30 cm) b) (20 cm, 35.3 cm) c) (20 cm, 42.2 cm) d) (60 cm, 20 cm)

5. A plano convex lens has a thickness of 4 cm. When placed on a horizontal table with the curved surface in contact with it, the apparent depth of the bottom most point of the lens is found to be 3 cm. If the lens is inverted such that the plane face is in contact with the table, the apparent depth of the center of plane face is found to be 25/8 cm. Find the focal length of lens. Assume the thickness to be negligible while finding its focal length.

a) 75 cm b) 60 cm c) 20 cm d) 100 cm

6. In the given diagram find the position where the equivalent lens can be placed for image formation by rays takes place at same place as in the given diagram. Assume that all the curved surfaces have same radii and same optical axis for both the lenses.



a) 2.5 cm from lens L_1

b) 3.0 cm from L_1

c) 7.5 cm from L_1

d) 10.0 cm from L_1

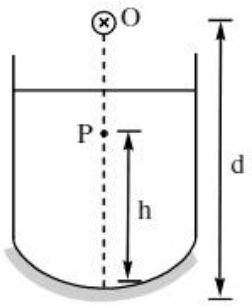
7. A concave mirror of radius of curvature h is placed at the bottom of a tank containing a liquid of refractive index μ upto a depth d. An object P is placed at height h above the bottom of the mirror. Outside the liquid, an observer O views the object and its image in the mirror. The apparent distance between these two will be

a) $h\left(1-\frac{1}{\mu}\right)$

b) $\frac{2h}{\mu-1}$

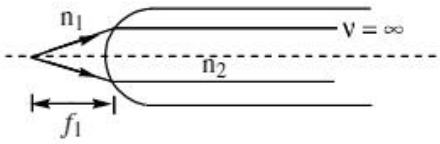
c) zero

d) $\frac{2h}{\mu}$



More than One correct answer Type Questions

8. The first factor length f_1 for refraction at a spherical surface is defined as the value of u corresponding to $v = \infty$ (as shown) with refractive indices of two mediums, as n_1 and n_2. The second focal length f_2 is defined as value of v for $u = \infty$.



a) f_2 is equal to $\frac{n_2R}{(n_2 - n_1)}$

b) f_1 is equal to $\frac{n_2R}{(n_2 - n_1)}$

c) f_2 is equal to $(-)\frac{n_1R}{(n_2 - n_1)}$

d) f_1 is equal to $\frac{n_1R}{(n_2 - n_1)}$

9. A biconvex thin lens is prepared from glass of refractive index $\mu_2 = \frac{3}{2}$. The two conducting surfaces have equal radii of 20cm each. One of the surface is silvered from outside to make it reflecting. It is placed in a medium of refractive index $\mu_1 = \frac{5}{3}$. It acts as a

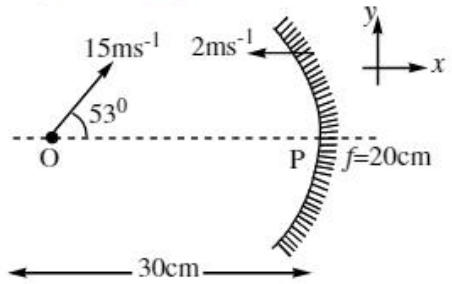
a) converting mirror

b) diverging mirror

c) concave mirror of focal length 12.5 cm

d) convex mirror of focal length 12.5 cm

10. In the situation as shown in Fig. $\left(\cos 53^0 = \frac{3}{5}\right)$



a) velocity of image wrt mirror is $-22\hat{i} - 24\hat{j}$

b) velocity of image wrt mirror is $-44\hat{i} - 24\hat{j}$

c) velocity of image wrt mirror is $-46\hat{i} - 24\hat{j}$

d) velocity of image wrt mirror is $-24\hat{i} - 24\hat{j}$

Linked Comprehension Type Questions

Passage - I :

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

11. Find the position and nature of the final image when the distance x shown in figure, is 5cm.

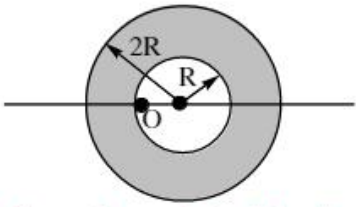
a) 11cm, virtual b) 17cm, real c) 14cm, real d) 20cm, virtual

12. Find the position and nature of the final image when the distance x shown in figure, is 20cm.

a) 17cm, virtual b) 17cm, real c) 12cm, virtual d) 15cm, virtual

Passage - II :

A glass sphere of radius 2R and refractive index n has a spherical cavity of radius R, concentric with it.



13. When view is on left side of the hollow sphere, what will be the shift in position of the object ?

a) $\frac{(n+1)}{(n-1)}$R, right b) $\frac{(n-1)}{(n+1)}$R, left c) $\frac{(2n-1)}{(2n+1)}$R, left d) $\frac{(2n-1)}{(n+1)}$R, left

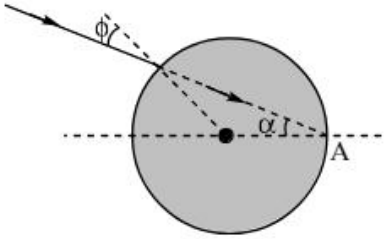
14. When viewer is on right side of the hollow sphere, what will be the apparent change in position of the object ?

a) $\frac{(n-1)}{(3n+1)}$R, toward left b) $\frac{(n+1)}{(3n-1)}$R, toward left

c) $\frac{(n+1)}{(3n+1)}$R, toward right d) $\frac{(n-1)}{(3n-1)}$R, toward right

Passage-III :

A ray of light enters a spherical drop of water of refractive index μ as shown in fig.

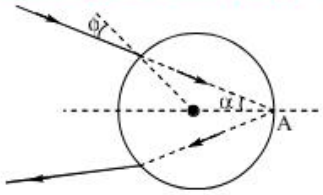


15. Select the correct statement :

a) Incident rays are partially reflected at point A b) Incident rays are totally reflected at point A

c) Incident rays are totally transmitted through A d) None of these

16. An expression of the angle between incident ray and emergent ray (angle of deviation) as shown in fig. is



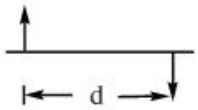
a) 0^0 b) ϕ c) $\alpha - \phi$ d) $\pi - 4\alpha + 2\phi$

17. Consider the figure of question 60, the angle ϕ for which minimum deviation is produced will be given by

a) $\cos^2\phi = \frac{\mu^2+1}{3}$ b) $\cos^2\phi = \frac{\mu^2-1}{3}$ c) $\sin^2\phi = \frac{\mu^2+1}{3}$ d) $\sin^2\phi = \frac{\mu^2-1}{3}$

Matrix Matching Type Questions

18. Real and inverted image of an object is formed at a distance d = 40 cm from the object. The size of the image is hall of that of object.



Column - I	Column - II
A) The nature of lens used should be	p) concave
B) focal length of the lens	q) convex
C) distance of object from the lens	r) 80/3 cm
D) If mirror were used, then nature of mirror should be	s) 80/9 cm

Integer Type Questions

19. The magnification of an object placed in front of a convex lens is +2. The focal length of the lens is 2.0 meters. Find the distance by which object has to be moved to obtain a magnification of – 2 (in meters)

20. Where should a convex lens of focal length 9 cm be placed (in cm) between two point sources S_1 and S_2 which are 24 cm apart, so that images of both the sources are formed at the same place. You have to find distance of lens from S_1 or S_2 which ever is lesser.

PRACTICE SHEET (ADVANCED)

Straight Objective Type Questions

1. A ray of light is incident on the face AB of a glass prism ABC having the vertex angle A equal to 30^0. The face AC is silvered and a ray of light incident on the face AB retraces its path. If the refractive index of the material of prism is $\sqrt{3}$ find the angle of incidence on the face AB.

a) 60^0 b) 30^0 c) 45^0 d) 25^0

2. A parallel beam falls on solid glass sphere of radius R and refractive index μ. What is the distance of final image after refraction from two surfaces of sphere? What is the condition for the image to be real?

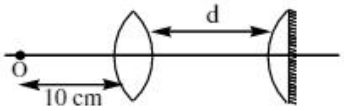
a) $\frac{R(\mu-2)}{2(\mu-1)}$ from 2nd surface ; $\mu > 2$ b) $\frac{R(2-\mu)}{2(\mu-1)}$ from 2nd surface ; $\mu < 2$

c) $\frac{R(\mu-1)}{(2-\mu)}$ from 2nd surfce; $\mu < 2$ d) $\frac{R}{2}\left(\frac{\mu+2}{\mu-1}\right)$ from 2nd surface; $\mu < 2$ for any value of μ

3. A ray of light incident on the hypotenuse of a right angled prism after travelling parallel to the base inside the prism is incident on second refracting surface. If 'μ' is the refractive index of material of prism, the maximum value of the base angle for which light is totally reflected from the hypotenuse is

a) $\sin^{-1}\left(\frac{1}{\mu}\right)$ b) $\tan^{-1}\left(\frac{1}{\mu}\right)$ c) $sin^{-1}\left(\frac{\mu-1}{\mu}\right)$ d) $\cos^{-1}\left(\frac{1}{\mu}\right)$

4. A convex lens of focal length 20 cm and another plano-convex lens of focal length 40 cm are placed co-axially (see figure). The plano-convex lens is silvered on plane surface. What should be the distance d (in cm) so that final image of the object 'O' is formed on O itself.



a) 10 b) 15 c) 20 d) 25

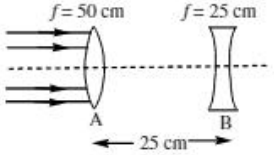
5. Two lenses shown are illuminated by a beam of parallel light from the left. Lens B is then moved slowly toward lens A. The beam emerging from lens B is

a) always diverging

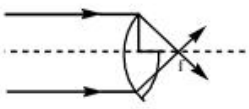
b) initially parallel and then diverging

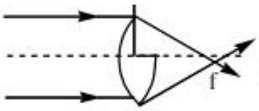
c) always parallel

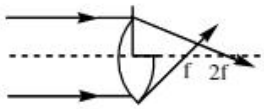
d) initially converging and then parallel

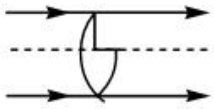


6. Choose the correct ray diagram of a thin equi-convex lens which is cut from upper half as shown in the figure

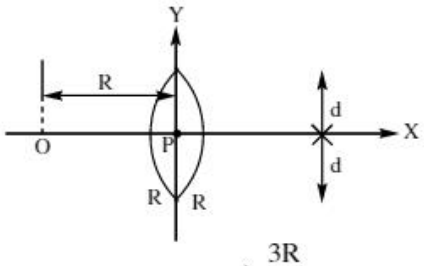
a) 

b) 

c) 

d) 

7. A biconvex thin lens of radius of curvature R is made up of variable refractive index $\mu = 2\left(1+\frac{r}{d}\right)$. Assume 2d << R. There are infinite images of the point object O, which is placed at a distance R on the principal axis from the lens as shown in the figure. The image is spread along the principal axis in a length of (r is the radial distance from P measured perpendicular to principal axis)



a) $\frac{R}{5}$ b) $\frac{2R}{5}$ c) $\frac{3R}{5}$ d) $\frac{4R}{5}$

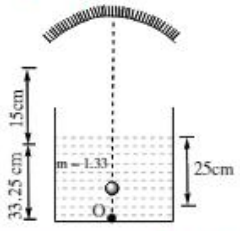
8. A container is filled with water (μ=1.33) upto a height of 33.25cm. A convex mirror is placed 15cm above the water level and the image of an object placed at the bottom is formed 25cm below the water level. Focal length of the mirror is

a) 15 cm

b) 20 cm

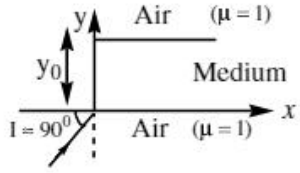
c) –18.31 cm

d) 10 cm



More than One correct answer Type Questions

9. A ray of light travelling in air is incident at angle of incidence $I = 90^\circ$ on a long rectangular slab of a transparent medium of thickness y_0. The medium has a variable refractive index of $\mu(x) = \sqrt{1 + e^{2x/a}}$; $x \geq 0$, where 'a' is a positive constant.



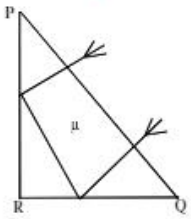
a) In the above situation if y_0 = a/2, the co-ordinates of the point where the ray intersects the upper surface of the slab-air boundary are $\left[a\ln 2, \frac{a}{2}\right]$

b) In the above situation if y_0 = a/2, the co-ordinates of the point where the ray intersects the upper surface of the slab-air boundary are $\left[\frac{a}{2}\ln 2, \frac{a}{2}\right]$

c) the angle made by light ray with +ve x-axis, at the upper surface of slab air boundary, inside the medium is $\pi/3$

d) the angle made by light ray with +ve x-axis, at the upper surface of slab air boundary, inside the medium is $\tan^{-1}\left(\frac{1}{2}\right)$

10. A right angled prism is made up of a material of refractive index μ. It is desired that a light ray incident normally on PQ emerges parallel to the incident direction after suffering two total internal reflection. In which of the following conditions is this possible ?



a) $\mu = \sqrt{2}$

b) $\mu = 2/\sqrt{3}$

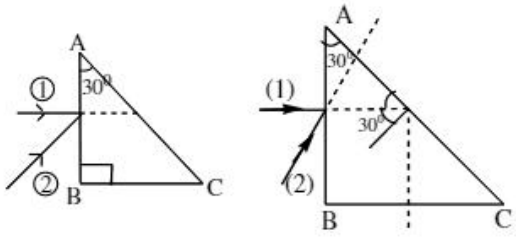
c) $\mu = 1.3$

d) Never possible

Linked Comprehension Type Questions

Passage - I:

ABC is right angled prism kept in air. A ray (1) is incident on the face AB along the normal. Another ray (2) is incident on the face AB such that it emerges normally form the face AC. Then



11. The minimum value of refractive index of the material of the prism for which the ray (1) under goes total internal reflection on the face AC is

a) $\sqrt{2}$ b) 2 c) 1.5 d) 2.2

12. The angle of incidence of the ray (2) on the face AB is

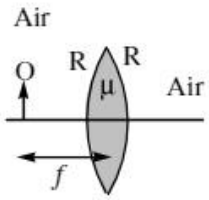
a) 0^0 b) 45^0 c) 30^0 d) 90^0

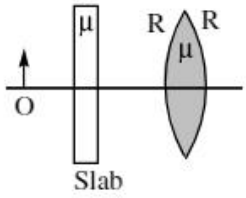
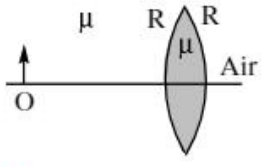
13. The deviation suffered by the light ray (2) is

a) 60^0 b) 45^0 c) 30^0 d) 90^0

Matrix Matching Type Questions

14. An object O (real) is placed at focus of an equi-biconvex lens as shown in Fig. The refractive index of the lens is $\mu = 1.5$ and the radius of curvature of either surface of lens is R. The lens is surrounded by air. I each statement of column-I, some changes are made to situation given above and information regarding final image formed as a result is given in column-II. The distance between lens and object is unchanged in all statements of column-I. Match the statements in column-I with resulting image in column-II.



Column - I	Column - II
A) If the refractive index of the lens is doubled (that is, made 2μ,) then	p) Final image is real
B) If the radius of curvature is doubled (that is ,made 2R,) then	q) final image is virtual
C) If a glass slab of refractive index $\mu = 1.5$ is introduced between the object and lens as shown, then 	r) final image becomes smaller in size in comparison to size of image before the change was made
D) If the left side of lens is filled with a medium of refractive index $\mu = 1.5$ as shown, then 	s) final image is of same size as the object

Integer Type Questions

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

16. An extended object of size 2 mm is placed on the principal axis of a converging lens of focal length 10 cm. It is found that when the object is placed perpendicular to the principal axis the image formed is 4mm in size. The size of image when it is placed along the principal axis is ..... mm.

KEY SHEET (ADDITIONAL PRACTICE EXERCISE)

LEVEL-I (MAIN)

1) **4** 2) **1** 3) **1** 4) **4** 5) **1** 6) **20** 7) **36 cm** 8) **25** 9) **10**

10) **12**

LEVEL-II

LECTURE SHEET (ADVANCED)

1) **c** 2) **c** 3) **a** 4) **c** 5) **a** 6) **b** 7) **c** 8) **ad** 9) **ac** 10) **bc**

11) **b** 12) **a** 13) **b** 14) **d** 15) **a** 16) **d** 17) **b** 18) **A-q, B-s, C-r, D-p**

19) **2** 20) **2**

PRACTICE SHEET (ADVANCED)

1) **a** 2) **b** 3) **d** 4) **c** 5) **b** 6) **c** 7) **d** 8) c 9) **ad** 10) **abc**

11) **b** 12) **d** 13) **a** 14) **A-pr, B-qr, C-qr, D-qr** 15) **3** 16) **8**