Exercise-1

Marked Questions can be used as Revision Questions.

OBJECTIVE QUESTIONS

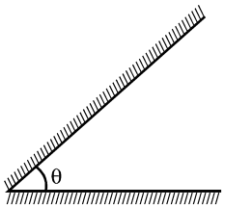
Section (A) : Plane Mirror

A-1. A clock hung on a wall has marks instead of numbers on its dial. On the opposite wall there is a mirror, and the image of the clock in the mirror if read, indicates the time as 8 : 20. What is the time in the clock-
(1) 3 : 40 (2) 4 : 40 (3) 5 : 20 (4) 4 : 20

A-2. A ray of light incident on a plane miror at an angle of incidence of 30º. The deviation produced by the mirror is-
(1) 30º (2) 60º (3) 90º (4) 120º

A-3. The image of a real object formed by a plane mirror is-
(1) Erect, real and of equal size (2) Erect, virtual and of equal size
(3) Inverted, real and of equal size (4) Inverted, virtual and of equal size

A-4. Two mirrors are inclined at an angle θ as shown in the figure. Light ray is incident parallel to one of the mirrors. Light will start retracing its path after third reflection if :
(1) $\theta = 45°$ (2) $\theta = 30°$
(3) $\theta = 60°$ (4) all three



A-5. A plane mirror is moving with velocity $4\hat{i}+5\hat{j}+8\hat{k}$. A point object in front of the mirror moves with a velocity $3\hat{i}+4\hat{j}+5\hat{k}$. Here $\hat{k}$ is along the normal to the plane mirror and facing towards the object. The velocity of the image is :
(1) $-3\hat{i}-4\hat{j}+5\hat{k}$ (2) $3\hat{i}+4\hat{j}+11\hat{k}$ (3) $-3\hat{i}-4\hat{j}+11\hat{k}$ (4) $7\hat{i}+9\hat{j}+11\hat{k}$

A-6. If an object is placed symmetrically between two plane mirrors, inclined at an angle of 72°, then the total number of images formed is-
(1) 5 (2) 4 (3) 2 (4) Infinite

A-7. A man 180 cm high stands in front of a plane mirror. His eyes are at a height of 170 cm from the floor. Then the minimum length of plane mirror for him to see his full length image is-
(1) 90 cm (2) 180 cm (3) 45 cm (4) 360 cm

A-8. A thick plane mirror shows a number of images of the filament of an electric bulb. Of these, the brightest image is the-
(1) First (2) Second (3) Last (4) Fourth

A-9. Two plane mirrors are inclined to each other at an angle 60°. If a ray of light incident on the first mirror is parallel to the second mirror, it is reflected from the second mirror
(1) Perpendicular to the first mirror (2) Parallel to the first mirror
(3) Parallel to the second mirror (4) Perpendicular to the second mirror

Section (B) : Spherical Mirror

B-1. A convex mirror has a focal length f. A real object is placed at a distance f in front of it from the pole, then it produces an image at
(1) Infinity (2) f (3) f/2 (4) 2f

B-2. The image formed by convex mirror of focal length 30 cm is a quarter of the size of the object. Then the distance of the object from the mirror, is-
(1) 30 cm (2) 90 cm (3) 120 cm (4) 60 cm

B-3. The largest distance of the image of a real object from a convex mirror of focal length 10 cm can be-
(1) 20 cm (2) Infinite
(3) 10 cm (4) Depends on the position of the object

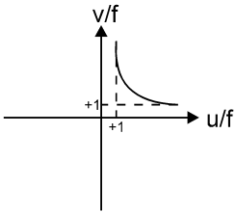
B-4. In case of concave mirror, the minimum distance between a real object and its real image is-
(1) f (2) 2f (3) 4f (4) Zero

B-5. A luminous point object is moving along the principal axis of a fixed concave mirror of focal length 12 cm towards it. When its distance from the mirror is 20 cm its velocity is 4 cm/s. The velocity of the image in cm/s at that instant is
(1) 6, towards the mirror (2) 6, away from the mirror
(3) 9, away from the mirror (4) 9, towards the mirror.

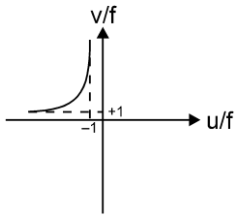
B-6. A point object on the principal axis at a distance 15 cm in front of a concave mirror of radius of curvature 20 cm has velocity 2 mm/s perpendicular to the principal axis. The magnitude of velocity of image at that instant will be:
(1) 2 mm/s (2) 4 mm/s (3) 8 mm/s (4) 16 mm/s

B-7. Which of the following can form erect, virtual, diminished image?
(1) plane mirror (2) concave mirror (3) convex mirror (4) none of these

B-8. A real inverted image in a concave mirror is represented by (u, v, f are coordinates)



(1)



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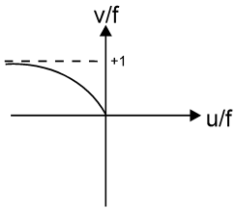

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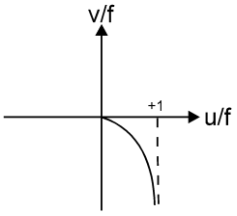
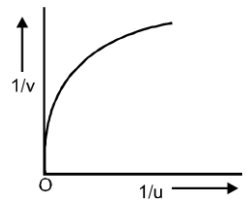


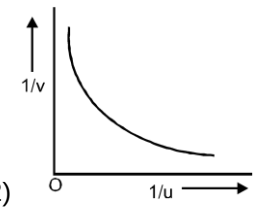
(4)

B-9. The focal length of a concave mirror is 20 cm. Determine where an object must be placed to form an image magnified two times when the image is real-
(1) 30cm from the mirror (2) 10cm from the mirror
(3) 20cm from the mirror (4) 15cm from the mirror

B-10. An object is placed at a distance u cm from a concave mirror of focal length f cm. The real image of the object is received on a screen placed at a distance of v cm form the mirror. The values of u are changed and the corresponding values of v are measured. Which one of the graphs shown in the figure represents the variation of $\frac{1}{v}$ with $\frac{1}{u}$ -



(1)



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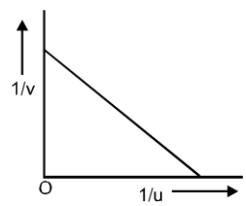

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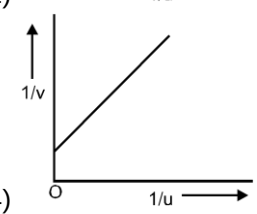


(4)

B-11. The distance of an object from the pole of a concave mirror is equal to its radius of curvature. The image must be:
(1) real (2) inverted (3) same sized (4) erect

Section (C) : Refraction in general , Refraction at plane surface and T.I.R.

C-1. Total internal reflection occurs in waves, when wave enters-
(1) Glass from air (2) Air from vaccum (3) Water from air (4) Air from water

C-2. An object is placed at 24 cm distance above the surface of a lake. If water has refractive index of 4/3, then at what distance from lake surface, a fish will sight the object-
(1) 32 cm above the surface of water (2) 18 cm over the surface of water
(3) 6 cm over the surface of water (4) 6 cm below the surface of water

C-3. Time taken to cross a 4 mm window glass of refractive index 1.5 will be-
(1) 2×10^{-8} sec (2) 2×10^{8} sec (3) 2×10^{-11} sec (4) 2×10^{11} sec

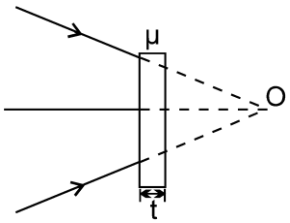
C-4. The total internal reflection of a beam of light occurs when beam of light enters [i_c = critical angle, i = angle of incidence]
(1) Rarer medium from a denser one and $i < i_c$ (2) Rarer medium from a denser $i > i_c$
(3) Denser medium from a rarer $i < i_c$ (4) Denser medium from a rarer $i > i_c$

C-5. A bubble in glass slab [$\mu = 1.5$] when viewed from one side appears at 5 cm and 2 cm from other side then thickness of slab is-
(1) 3.75 cm (2) 23 cm (3) 10.5 cm (4) 1.5 cm

C-6. A light wave travels from glass to water. The refractive index for glass and water are $\frac{3}{2}$ and $\frac{4}{3}$ respectively. The value of the critical angle will be:
(1) $\sin^{-1}\left(\frac{1}{2}\right)$ (2) $\sin^{-1}\left(\frac{9}{8}\right)$ (3) $\sin^{-1}\left(\frac{8}{9}\right)$ (4) $\sin^{-1}\left(\frac{5}{7}\right)$

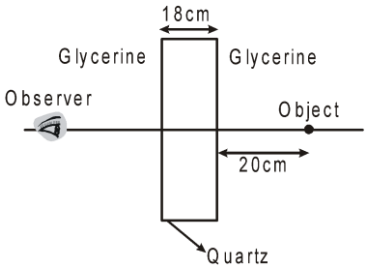
C-7. The wavelength of light in vacuum is 6000 Å and in a medium it is 4000 Å. The refractive index of the medium is:
(1) 2.4 (2) 1.5 (3) 1.2 (4) 0.67

C-8. A beam of light is converging towards a point. A plane parallel plate of glass of thickness t, refractive index μ is introduced in the path of the beam. The convergent point is shifted by (assume near normal incidence):



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

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



(1) 6 cm (2) 3.55 cm
(3) 9 cm (4) 2 cm

C-10. When a beam of light goes from denser medium (μ_d) to rarer medium (μ_r), then it is observed that magnitude of angle of incidence is half that of angle of refraction. Then magnitude of incident angle will be- (here $\mu = \mu_d/\mu_r$)

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

Section (D) : Refraction by Prism

D-1. A ray of light is incident normally on one of the faces of a prism apex angle 30º and refractive index . The angle of deviation of the ray is:

(1) 15º (2) 22.5º (3) 0º (4) 12.5º

D-2. The refractive index of the material of prism of 60º angle is $\sqrt{2}$. At what angle the ray of light be incident on it so that minimum deviation takes place?

(1) 45º (2) 60º (3) 30º (4) 75º

D-3. A ray of light is incident at angle of 60º on one face of a prism which has an apex angle of 30º. The ray emerging out of the prism makes an angle of 30º with the incident ray. The refractive index of the material of the prism is -

(1) $\sqrt{2}$ (2) $\sqrt{3}$ (3) 1.5 (4) 1.6

D-4. If the critical angle for the medium of prism is C and the angle of prism is A, then there will be no emergent ray when -

(1) A < 2C (2) A = 2C (3) A > 2C (4) A $\geq$ 2C

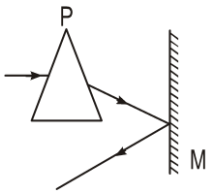
D-5. A ray of monochromatic light is incident on one refracting face of a prism of angle 75^0. It passes through the prism and is incident on the other face at the critical angle. If the refractive index of the material of the prism is $\sqrt{2}$, the angle of incidence on the first face of the prism is

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

D-6. A ray of light is incident at angle *i* on a surface of a prism of small angle A and emerges normally from the opposite surface. If the refractive index of the material of the prism is μ, the angle of incidence *i* is nearly equal to :

(1) A/μ (2) $A/(2\mu)$ (3) μA (4) $\mu A/2$

D-7. A prism having an apex angle of 4^0 and refractive index of 1.50 is located in front of a vertical plane mirror as shown. A horizontal ray of light is incident on the prism. The total angle through which the ray is deviated is:



(1) 4º clockwise (2) 178º clockwise
(3) 2º clockwise (4) 8º clockwise

Section (E) : Refraction by spherical Surface

E-1. An object is placed at a distance of 20 cm, in rarer medium, from the pole of a convex spherical refracting surface of radius of curvature 10 cm. If the refrective index of the rarer medium is 1 and of the refracting medium is 2, then the position of the image is at-

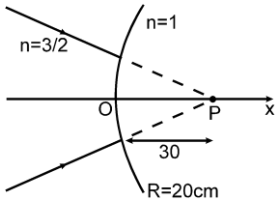
(1) (40/3) cm from the pole & inside the denser medium
(2) 40 cm from the pole & inside the denser medium.
(3) (40/3) cm from the pole & outside the denser medium
(4) 40 cm from the pole & outside the denser medium.

E-2. There is a small black dot at the centre C of a solid glass sphere of refractive index μ. When seen from outside, the dot will appear to be located:

(1) away from C for all values of μ (2) at C for all values of μ

(3) at C for μ = 1.5, but away from C for μ ≠ 1.5 (4) at C only for $\sqrt{2} \leq \mu \leq 1.5$.

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



(1) x = 40 cm (2) x = $\frac{40}{3}$ cm

(3) x = - $\frac{40}{3}$ cm (4) x = $\frac{180}{7}$ cm

E-4 A concave spherical surface of radius of curvature 10 cm separates two mediums X and Y of refractive indices 4/3 and 3/2 respectively. Centre of curvature of the surface lies in the medium X. An object is placed in medium X.

(1) Image is always real

(2) Image is real if the object distance is greater than 90 cm.

(3) Image is always virtual

(4) Image is virtual only if the object distance is less than 90 cm.

Section (F) : Lens

F-1. A convex lens is dipped in a liquid whose refractive index is equal to the refractive index of the lens. Then its focal length will -

(1) Become zero (2) Become infinite

(3) Become small, but non-zero (4) Remain unchanged

F-2. A biconvex lens with equal radii of curvature has refractive index 1.6 and focal length 10 cm. Its radius of curvature will be:

(1) 20 cm (2) 16 cm (3) 10 cm (4) 12 cm

F-3. A convex lens forms a real image 9 cm long on a screen. Without altering the position of the object and the screen, the lens is displaced and we get again a real image 4 cm long on the screen. Then the length of the object is-

(1) 9 cm (2) 4 cm (3) 6 cm (4) 36 cm

F-4. An object is placed at a distance of 5 cm from a convex lens of focal length 10 cm, then the image is-

(1) Real, diminished and at a distance of 10 cm from the lens.

(2) Real, enlarged and at a distance of 10 cm from the lens.

(3) Virtual, enlarged and at a distance of 10 cm from the lens.

(4) Virtual, diminished and at a distance of 10/3 cm from the lens.

F-5. Inside water, an air bubble behave-

(1) Always like a converging lens

(2) Always like a diverging lens

(3) Always like a slab of equal thickness

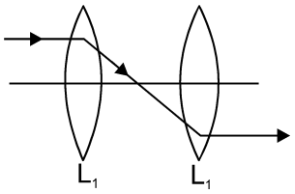
(4) Sometimes concave and sometimes like a convex lens

F-6. A lens behaves as a converging lens in air and a diverging lens in water. The refractive index of the material is (refractive index of water = 1.33)

(1) equal to unity (2) equal to 1.33

(3) between unity and 1.33 (4) greater than 1.33

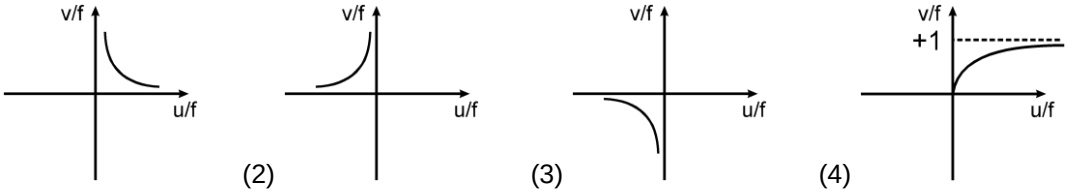
F-7. In the figure given below, there are two convex lens L_1 and L_2 having focal length of f_1 and f_2 respectively. The distance between L_1 and L_2 will be



(1) f_1 (2) f_2

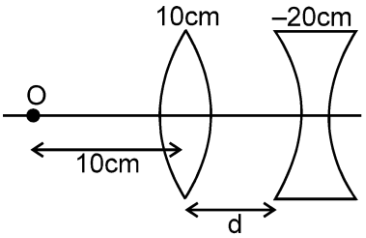
(3) $f_1 + f_2$ (4) $f_1 - f_2$

F-8. A virtual erect image by a **diverging lens** is represented by (u, v, f are coordinates)



(1) (2) (3) (4)

F-9. What should be the value of distance d so that final image is formed on the object itself. (focal lengths of the lenses are written on the lenses).



(1) 10 cm (2) 20 cm

(3) 5 cm (4) none of these

F-10. A thin linear object of size 1 mm is kept along the principal axis of a convex lens of focal length 10 cm. The object is at 15 cm from the lens. The length of the image is :

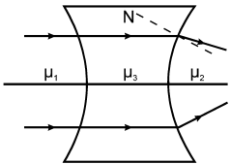
(1) 1 mm (2) 4 mm (3) 2 mm (4) 8 mm

F-11. A thin symmetrical double convex lens of power P is cut into three parts, as shown in the figure. Power of A is:

(1) 2 P (2) $\frac{P}{2}$

(3) $\frac{P}{3}$ (4) P

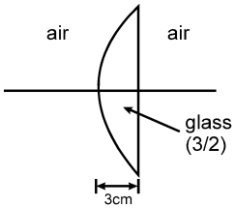
F-12. From the figure shown establish a relation between, μ_1, μ_2, μ_3.



(1) $\mu_3 > \mu_2 > \mu_1$ (2) $\mu_3 < \mu_2 < \mu_1$

(3) $\mu_2 > \mu_3$; $\mu_3 = \mu_1$ (4) $\mu_2 > \mu_1$; $\mu_3 = \mu_2$

F-13. A plano convex lens of radius of curvature 6 cm is placed in air. The thickness of this lens is 3 cm. The focal length of the lens is :



(1) 18 cm (2) 10 cm

(3) 12 cm (4) none of these

F-14. A diverging lens of focal length –10 cm is moving towards right with a velocity 5 m/s.An object ,placed on Principal axis is moving towards left with a velocity 3 m/s. The veocity of image at the instant when the lateral magification produced is 1/2 is : (All velocities are with respect to ground)

(1) 3 m/s towards right (2) 3 m/s towards left (3) 7 m/s towards right (4) 7 m/s towards left

Section (G) : Combination of thin Lens/Lens and Mirrors.

G-1. A convex lens of focal length 25 cm and a concave lens of focal length 20 cm are mounted coaxially separated by a distance d cm. If the power of the combination is zero, *d* is equal to

(1) 45 (2) 30 (3) 15 (4) 5

G-2. A convex lens of power 4D and a concave lens of power 3D are placed in contact, the equivalent power of combination:

(1) 1D (2) $\frac{3}{4}$ D (3) 7D (4) $\frac{4}{3}$ D

G-3. Two thin lenses of power +5D and –2D are placed in contact with each other. Focal length of the combination will behave like a-

(1) Convex lens of focal length 3m (2) Concave lens of focal length 0.33m
(3) Convex lens of focal length 0.33m (4) None of the above

G-4. The focal length of a plano-concave lens is –10 cm, then its focal length when its plane surface is polished is (n = 3/2):

(1) 20 cm (2) - 5 cm (3) 5 cm (4) none of these

G-5. The magnitude of focal length of a plano-convex lens is 10 cm, then its magnitude of focal length when its plane surface is polished (silvered) is:

(1) 20 cm (2) 5 cm (3) 10 cm (4) none of these

Section (H) : Dispersion of Light

H-1. Dispersive power of a prism depends on-

(1) Material (2) Prism angle (3) Shape of prism (4) Angle on incidence

H-2. When light is passed through a prism, the colour which deviates least is:

(1) Red (2) violet (3) Blue (4) Green

H-3. If refractive index of red, violet and yellow lights are 1.42, 1.62 and 1.50 respectively for a medium, its dispersive power will be -

(1) 0.4 (2) 0.3 (3) 0.2 (4) 0.1

H-4. Two thin lenses, one convex of focal length 30 cm and the other concave of focal length 10cm are put into contact. If this combination is equivalent to an achromatic lens then the ratio of dispersive powers (ω_1/ω_2) of above two lenses is -

(1) 1/3 (2) – 3 (3) 3 (4) – 1/3

H-5. The colour are characterised by which of following character of light-

(1) Frequency (2) Amplitude (3) Wavelength (4) Velocity

H-6. The dispersion of light in a medium implies that :

(1) lights of different wavelengths travel with different speeds in the medium
(2) lights of different frequencies travel with different speeds in the medium
(3) the refractive index of medium is different for different wavelengths
(4) all of the above.

H-7. Critical angle of light passing from glass to air is minimum for

(1) red (2) green (3) yellow (4) violet

H-8. A plane glass slab is placed over various coloured letters. The letter which appears to be raised the least is:

(1) violet (2) yellow (3) red (4) green

H-9. A medium has $n_v = 1.56$, $n_r = 1.44$. Then its dispersive power is:

(1) 3/50 (2) 6/25 (3) 0.03 (4) none of these

H-10. All the listed things below are made of flint glass. Which one of these have greatest dispersive power (ω).

(1) prism (2) glass slab (3) biconvex lens (4) all have same ω

H-11. Light of wavelength 4000 Å is incident at small angle on a prism of apex angle 4º. The prism has $n_v = 1.5$ & $n_r = 1.48$. The angle of dispersion produced by the prism in this light is:
(1) 0.2º (2) 0.08º (3) 0.192º (4) None of these

Section (I) : Defects of vision

I-1. A shortsighted person can read a book clearly at a distance of 10 cm from the eyes. The lenses required to read the book kept at 60cm are :
(1) Convex lenses of focal length 30 cm (2) convex lenses of focal length 30 cm
(3) convex lenses of focal length 12 cm (4) concave lenses of focal length 12 cm

I-2. A person can't see the objects clearly placed at a distance more than 40 cm. He is advised to use a lens of power -
(1) + 2.5 D (2) – 2.5 D (3) + 0.4 D (4) – 0.4 D

I-3. A person can see clearly only upto a distance of 25cm. He wants to read a book placed at a distance of 50cm. What kind of lens does he required for his spectacles and what must be its power ?
(1) concave, – 1.0 D (2) Convex, + 1. 5 D
(3) Concave, – 2.0 D (4) Convex, + 2.0 D

Section (J) : Optical instruments

J-1. A simple microscope has a focal length of 5 cm. The magnification at the least distance of distinct vision is
(1) 1 (2) 5 (3) 4 (4) 6

J-2. In a compound microscope, the intermediate image is -
(1) virtual, erect and magnified (2) real, erect and magnified
(3) real, inverted and magnified (4) virtual, erect and reduced

J-3. A Galileo telescope has an objective of focal length 100 cm & magnifying power 50. The distance between the two lenses in normal adjustment will be
(1) 150 cm (2) 100 cm (3) 98 cm (4) 200 cm

J-4. The convex lens is used in-
(1) Simple microscope (2) Telescope (3) compound microscope (4) All of the above

J-5. The magnifying power of a simple microscope can be increased if an eyepiece of :
(1) shorter focal length is used (2) longer focal length is used
(3) shorter diameter is used (4) longer diameter is used

J-6. The focal length of the objective of a microscope is
(1) arbitrary (2) less than the focal length of eyepiece
(3) equal to the focal length of eyepiece (4) greater than the focal length of eyepiece

J-7. Resolving power of a microscope depends upon
(1) the focal length and aperture of the eye lens
(2) the focal lengths of the objective and the eye lens
(3) the apertures of the objective and the eye lens
(4) the wavelength of light illuminating the object

J-8. An astronomical telescope has an eyepiece of focal-length 5 cm. If the angular magnification in normal adjustment is 10, when final image is at least distance of distinct vision (25cm) from eye piece, then angular magnification will be :
(1) 10 (2) 12 (3) 50 (4) 60

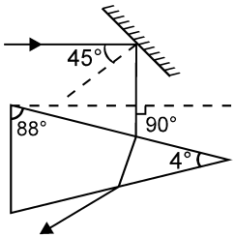
J-9. A person with a defective sight is using a lens having a power of +2D. The lens he is using is
(1) concave lens with $f = 0.5$ m (2) convex lens with $f = 2.0$ m
(3) concave lens with $f = 0.2$ m (4) convex lens with $f = 0.5$ m

Exercise-2

Marked Questions can be used as Revision Questions.

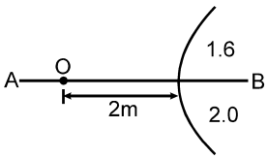
PART - I : OBJECTIVE QUESTIONS

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



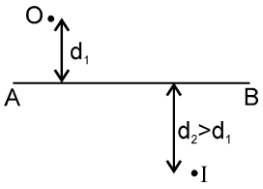
(1) 1^0 clockwise (2) 1^0 anticlockwise
(3) 2^0 clockwise (4) 2^0 anticlockwise

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



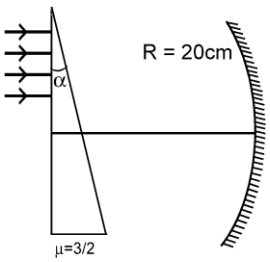
(1) 12 m (2) 20 m
(3) 14 m (4) 10 m

3. 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 :



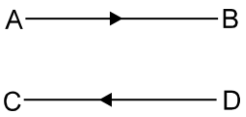
(1) concave and placed towards right of I
(2) concave and placed towards left of O
(3) convex and placed towards right of I
(4) convex and placed towards left of I.

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



(1) 9 cm (2) 1.57 mm
(3) 3.14 mm (4) none of these

5. AB is an incident beam of light and DC is a reflected beam (the number of reflections for this may be 1 or more than 1) of light. AB & DC are separated by some distance (may be large). It is possible by placing what type of mirror on the right side.



(1) one plane mirror (2) one concave mirror
(3) one convex mirror (4) none of these

6. An object is kept between a plane mirror and a concave mirror facing each other. The distance between the mirrors is 30 cm. The radius of curvature of the concave mirror is 40 cm. What should be the distance of the object from the plane mirror so that after two successive reflections the final image is formed on the object itself : [consider first reflection on plane mirror]

(1) 5 cm (2) 20 cm (3) 10 cm (4) none of these

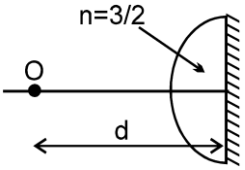
7. A point object ' O ' is at the centre of curvature of a concave mirror. The mirror starts to move at a speed u, in a direction perpendicular to the principal axis. Then the initial velocity of the image is :

(1) 2 u, in the direction opposite to that of mirror's velocity
(2) 2 u, in the direction same as that of mirror's velocity
(3) zero
(4) u, in the direction same as that of mirror's velocity.

8. A concave spherical surface of radius of curvature 10 cm separates two mediums X and Y of refractive indices 4/3 and 3/2 respectively. Centre of curvature of the surface lies in the medium X. An object is placed in medium X.

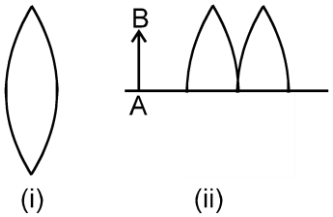
(1) Image is always real
(2) Image is real if the object distance is greater than 90 cm.
(3) Image is always virtual
(4) Image is virtual only if the object distance is less than 90 cm.

9. A plano-convex lens of focal length 10 cm is silvered at its plane face. The distance d at which an object must be placed in order to get its image on itself is :



(1) 5 cm (2) 20 cm
(3) 10 cm (4) 2.5 cm

10. In the figure (i) a thin lens of focal length 10 cm is shown. The lens is cut into two equal parts, and the parts are arranged as shown in the figure (ii). An object AB of height 1 cm is placed at distance of 7.5 cm from the arrangement. The height of the final image will be:

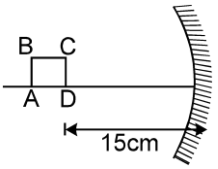


(1) 0.5 cm (2) 2 cm
(3) 1 cm (4) 4 cm

11. Two plane mirrors are inclined to each other at an angle 60°. If a ray of light incident on the first mirror is parallel to the second mirror, it is reflected from the second mirror
(1) Perpendicular to the first mirror (2) Parallel to the first mirror
(3) Parallel to the second mirror (4) Perpendicular to the second mirror

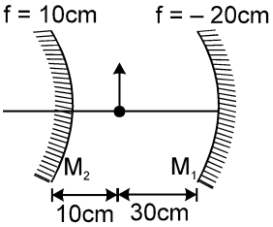
12. A person's eye is at a height of 1.5 m. He stands infront of a 0.3m long plane mirror which is 0.8 m above the ground. The length of the image he sees of himself is:
(1) 1.5m (2) 1.0m (3) 0.8m (4) 0.6m

13. A square ABCD of side 1mm is kept at distance 15 cm infront of the concave mirror as shown in the figure. The focal length of the mirror is 10 cm. The length of the perimeter of its image will be(nearly):



(1) 8 mm (2) 2 mm
(3) 12 mm (4) 6 mm

14. In the figure shown find the total magnification after two successive reflections first on M_1 and then on M_2 .



(1) + 1 (2) – 2
(3) + 2 (4) – 1

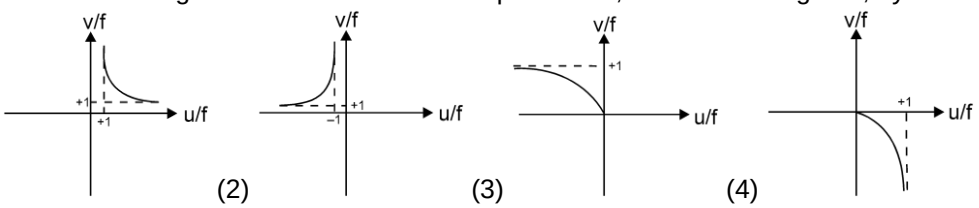
15. A ray of light is incident on a parallel slab of thickness *t* and refractive index *n*. If the angle of incidence θ is small, then the displacement in the incident and emergent ray will be:

(1) $\frac{t\theta(n-1)}{n}$ (2) $\frac{t\theta}{n}$ (3) $\frac{t\theta n}{n-1}$ (4) none

16. The maximum refractive index of a material, of a prism of apex angle 90º, for which light may be transmitted is :

(1) $\sqrt{3}$ (2) 1.5 (3) $\sqrt{2}$ (4) None of these

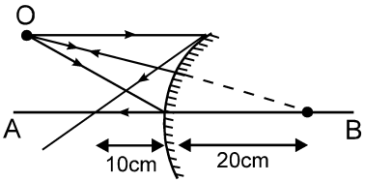
17. A virtual erect image in a concave mirror is represented, in the above figures, by



(1) (2) (3) (4)

(1) 1 (2) 2 (3) 3 (4) 4

18. In the figure shown a convex mirror of radius of curvature 20 cm is shown. An object O is placed in front of this mirror. Its ray diagram is shown. How many mistakes are there in the ray diagram (AB is its principal axis) :



(1) 3 (2) 2
(3) 1 (4) 0

19. A convex mirror of radius of curvature 18 cm forms image of the sun. The diameter of the sun subtends an angle 1º on the earth. Then the diameter of the image is (in cm) :

(1) 1.57 mm (2) 0.735 mm (3) 20 cm (4) none of these

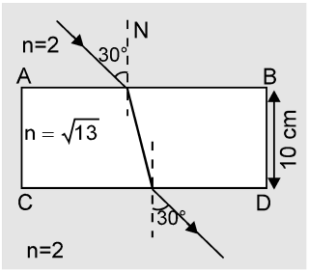
20. A converging beam of light is incident on the concave mirror. Then the reflected light:

(1) forms real image (2) it may form virtual image
(3) forms virtual image (4) none of these.

21. A point object is moving along principal axis of a concave mirror with uniform velocity towards pole. Initially the object is at infinite distance from pole on right side of the mirror as shown. Before the object collides with mirror, the number of times at which the distance between object and its image is 40 cm are .

(1) one time
(2) two times
(3) three times
(4) Data insufficient

22. Find the displacement of the ray after it imerges from CD



(1) 2.5 cm

(2) 5 cm

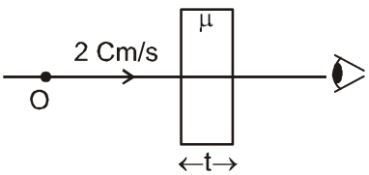
(3) 1 cm

(4) $\frac{\sqrt{13}}{3}$ cm

23. A mango tree is at the bank of a river and one of the branch of tree extends over the river. A tortoise lives in river. A mango falls just above the tortoise. The acceleration of the mango falling from tree appearing to the tortoise is (Refractive index of water is 4/3 and the tortoise is stationary)

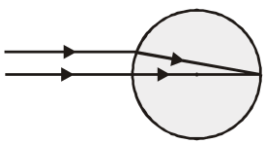
(1) g (2) $\frac{3g}{4}$ (3) $\frac{4g}{3}$ (4)None of these

24. A glass slab of width 't', refractive index 'μ' is placed as shown in the figure. If the point object, moves with a speed 2cm/sec towards the slab the observed speed by the observer will be :



(1) 2 cm/sec
(2) less than 2 cm/sec
(3) greater than 2 cm/sec
(4) (2/μ) cm/sec

25. A thin beam of light, incident on a transparent sphere from air, gets focussed on opposite surface of the sphere as shown in figure then refractive index of the material of the sphere is :

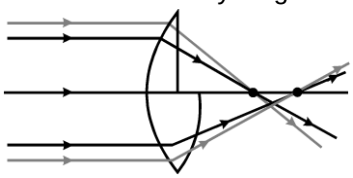
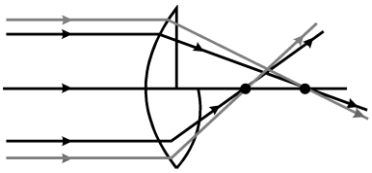
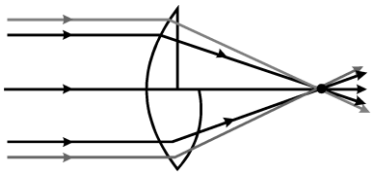
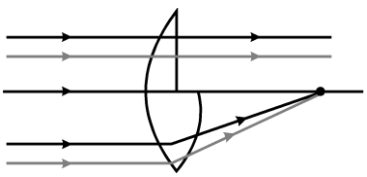


(1) 1.5 (2) 2.0
(3) 2.5 (4) 3.0

26. Refractive index of a prism is $\sqrt{\frac{7}{3}}$ and the angle of prism is 60º. The minimum angle of incidence of a ray that will be transmitted through the prism is :
(1) 30º (2) 45º (3) 15º (4) 50º

27. Light travelling in air falls at an incidence angle of 2° on one refracting surface of a prism of refractive index 1.5 and angle of refraction 4º. The medium on the other side is water (n = 4/3). Find the deviation produced by the prism.
(1) 1º (2) 2º (3) 3º (4) 4º

28. A lens is placed between a source of light and a wall. It forms images of area A_1 and A_2 on the wall, for its two different positions. The area of the source of light is (source and wall are fixed)-
(1) $(A_1A_2)^{1/2}$ (2) $\frac{A_1+A_2}{2}$ (3) $\left(\frac{1}{A_1}+\frac{1}{A_2}\right)^{-1}$ (4) $\left(\frac{\sqrt{A_1}+\sqrt{A_2}}{2}\right)^2$

29. Choose the correct ray diagram of an equi convex lens which is cut as shown.
(1) 
(2) 
(3) 
(4) 

30. A prism produces same deviation 40º for two different angles of incidence 37º and 42º in same surrounding medium on both sides. Then prism angle is :
(1) 30º (2) 31º (3) 39º (4) 35º

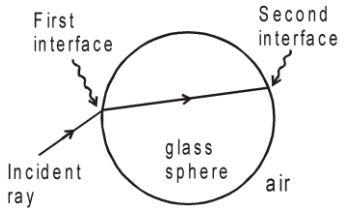
31. The focal lengths of the objective & the eyepiece of a compound microscope are 1 cm & 5 cm respectively. An object placed at a distance of 1.1 cm from the objective has its final image formed at 25 cm from the eye piece. The length of the microscope tube is :
(1) 6.1 cm (2) 49/8 cm (3) 6 cm (4) 91/6 cm

32. Which of the following statement(s) about a simple telescope (astronomical) is false
(1) the objective lens forms a real image. (2) The eyepiece acts as a magnifying glass
(3) the focal length of the objective lens is short (4) the final image is inverted

PART - II : MISCELLANEOUS QUESTIONS

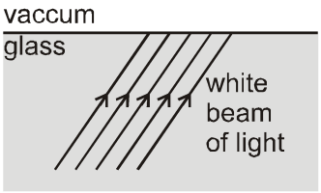
Section (A) : Assertion/Reasoning

A-1. **STATEMENT-1 :** A ray is incident from outside on a glass sphere surrounded by air as shown. This ray may suffer total internal reflection at second interface.
STATEMENT 2 : For a ray going from denser to rarer medium, the ray may suffer total internal reflection.



(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True.

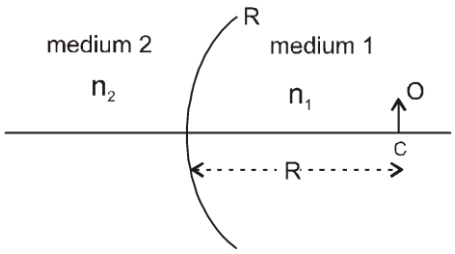
A-2. **STATEMENT – 1:** A white parallel beam of light is incident on a plane glass- vacuum interface as shown. The beam may not undergo dispersion after suffering deviation at the interface (The beam is not incident normally on the interface.)



STATEMENT – 2: Vacuum has same refractive index for all colours of white light.

(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True.

A-3. **STATEMENT-1 :** A spherical surface of radius of curvature R separates two media of refractive index n_1 and n_2 as shown. If an object O (a thin small rod) is placed upright on principal axis at a distance R from pole (i.e., placed at centre of curvature), then the size of image is same as size of object.



STATEMENT-2 : If a point object is placed at centre of curvature of spherical surface separating two media of different refractive index, then the image is also formed at centre of curvature, i.e., image distance is equal to object distance.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

A-4. **STATEMENT-1 :** If a plane glass slab is placed on the letters of different colours all the letters appear to be raised up to the same height.

STATEMENT-2 : Different colours have same wavelengths.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Both Statement-1 and Statement-2 are false.

A-5. **STATEMENT-1 :** Higher is the refractive index of a medium or denser the medium, lesser is the velocity of light in that medium.

STATEMENT-2 : Refractive index is inversely proportional to velcity.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Both Statement-1 and Statement-2 are false.

A-6. **STATEMENT-1 :** By increasing the diameter of the objective of telescope, we can increase its range.

STATEMENT-2 : The range of a telescope tells us how far away a star of some standard brightness can be spotted by telescope.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Both Statement-1 and Statement-2 are false.

A-7. **STATEMENT-1 :** If objective and eye lenses of a microscope are interchanged then it can work as telescope.

STATEMENT-2 : The objective of telescope has small focal length.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Both Statement-1 and Statement-2 are false.

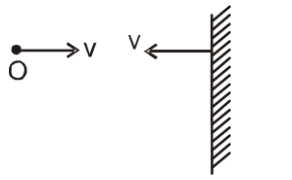
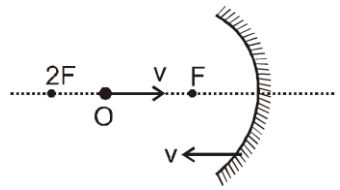
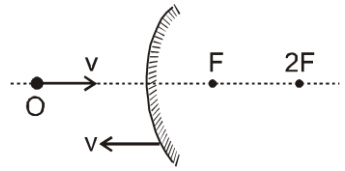
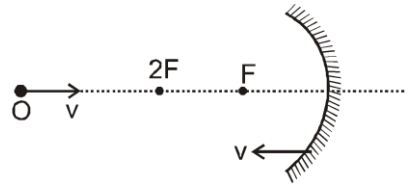
A-8. **STATEMENT-1 :** The resolving power of both microscope and telescope depends on the wavelength of light used.

STATEMENT-2 : The resolving power of a lens is the ability to resolve the two image so they are distinctly identified.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Both Statement-1 and Statement-2 are false.

Section (B) : Match the column

B-1. Column–I shows velocity of a point object 'O' (along principal axis in case of convex or concave mirror) and mirrors with respect to ground. Here speed of mirror and object 'O' is v and F is the focus of mirror. Mathc the Column -I and Column-II for given instant.

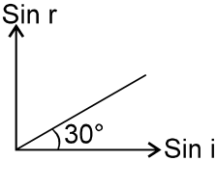
Column - I	**Column - II**
(1) 	(p) Speed of image with respect to mirror is same as speed of object with respect to mirror.
(2) 	(q) Speed of image with respect to mirror is greater than as speed of object with respect to mirror.
(3) 	(r) Speed of image with respect to mirror is less than as speed of object with respect to mirror.
(4) 	(s) Distance between image and mirror decreases.

Section (C) : One or more than one options correct

C-1. The image (of a real object) formed by a concave mirror is twice the size of the object. The focal length of the mirror is 20 cm. The distance of the object from the mirror is (are)
(1) 10 cm (2) 30 cm (3) 25 cm (4) 15 cm

C-2. Which of the following statements are **incorrect** for spherical mirrors.
(1) a concave mirror forms only virtual images for any position of real object
(2) a convex mirror forms only virtual images for any position of a real object
(3) a concave mirror forms only a virtual diminished image of an object placed between its pole and the focus
(4) a convex mirror forms a virtual enlarged image of an object if it lies between its pole and the focus.

C-3. 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 r and sin i.



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

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

C-5. An equilateral prism deviates a ray through 40º for two angles of incidence differing by 20º. The possible angles of incidences are:
(1) 40^0 (2) 50^0 (3) 20^0 (4) 60^0

Exercise-3

Marked Questions can be used as Revision Questions.

PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. An astronomical telescope has a large aperture to **[AIEEE-2002, 4/300]**
(1) reduce spherical aberration (2) have high resolution
(3) increase span of observation (4) have low dispersion

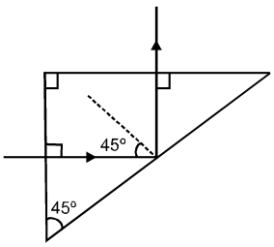
2. If two mirrors are kept at 60º to each other, then the number of images formed by them is **[AIEEE-2002, 4/300]**
(1) 5 (2) 6 (3) 7 (4) 8

3. Which of the following is used in optical fibers ? **[AIEEE-2002, 4/300]**
(1) total internal reflection (2) scattering
(3) diffraction (4) refraction

4. The image formed by an objective of a compound microscope is **[AIEEE-2003, 4/300]**
(1) virtual and diminished (2) real and diminished
(3) real and enlarged (4) virtual and enlarged

5. To get three images of a single object, one should have two plane mirrors at an angle of **[AIEEE-2003, 4/300]**
(1) 60º (2) 90º (3) 120º (4) 30º

6. A light ray is incident perpendicularly to one face to a 90º prism and is totally internally reflected at the glass-air interface. If the angle of reflection is 45º, we conclude that the refractive index n is **[AIEEE-2004, 4/300]**



(1) $n < \frac{1}{\sqrt{2}}$ (2) $n > \sqrt{2}$ (3) $n > \frac{1}{\sqrt{2}}$ (4) $n < \sqrt{2}$

7. A plano convex lens of refractive index 1.5 and radius of curvature 30 cm is silvered at the curved surface. Now this lens has been used to from the image of an object. At what distance from this lens an object be placed in order to have a real image of the size of the object. **[AIEEE-2004, 4/300]**

(1) 20 cm (2) 30 cm (3) 60 cm (4) 80 cm

8. The refractive index of glass is 1.520 for red light and 1.525 for blue light. Let D_1 and D_2 be angles of minimum deviation for red and blue light respectively in a prism of this glass. Then,**[AIEEE-2006, 3/180]**

(1) D_1 can be less than or greater than D_2 depending upon the angle of prism

(2) $D_1 > D_2$

(3) $D_1 < D_2$

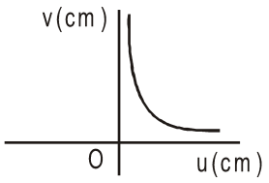
(4) $D_1 = D_2$

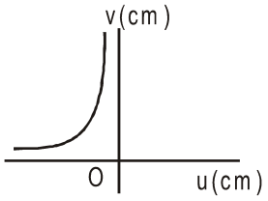
9. An experiment is performed to find the refractive index of glass using a travelling microscope. In this experiment distances are measured by - **[AIEEE-2008, 3/105]**

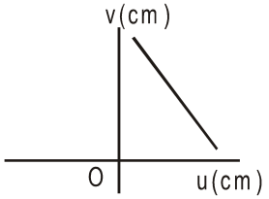
(1) a standard laboratory scale (2) a meter scale provided on the microscope

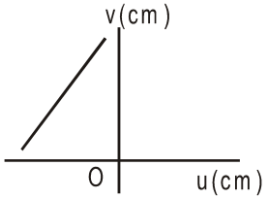
(3) a screw gauge provided on the microscope (4) a vernier scale provided on the microscope

10. A student measures the focal length of a convex lens by putting an object pin at a distance |u| from the lens and measuring the distance 'v' of the image pin. The graph between 'u' and 'v' plotted by the student should look like **[AIEEE-2008, 3/105]**

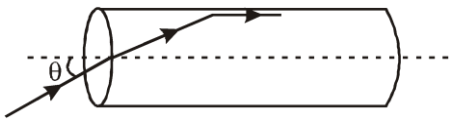
(1) 

(2) 

(3) 

(4) 

11. A transparent solid cylindrical rod has a refractive index of $\frac{2}{\sqrt{3}}$. It is surrounded by air. A light ray is incident at the mid-point of one end of the rod as shown in the figure.



The incident angle (θ) for which the light ray grazes along the wall of the rod is: **[AIEEE-2009, 4/144]**

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

12. In an optics 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 angle of 45° with the x-axis meets the experimental curve at P. The coordinates of P will be : **[AIEEE-2009, 4/144]**

(1) $\left(\frac{f}{2}, \frac{f}{2}\right)$ (2) (f, f) (3) (4f, 4f) (4) (2f, 2f)

Paragraph for Question 13 to 15

An initially parallel cylindrical beam travels in a medium of refractive index $\mu(I) = \mu_0 + \mu_2 I$, where μ_0 and μ_2 are positive constants and I is the intensity of the light beam. The intensity of the beam is decreasing with increasing radius. **[AIEEE-2010, 4/144, – 1]**

13. As the beam enters the medium, it will

(1) diverge

(2) converge
(3) diverge near the axis and converge near the periphery
(4) travel as a cylindrical beam

14. The initial shape of the wavefront of the beam is :
(1) convex
(2) concave
(3) convex near the axis and concave near the periphery
(4) planar

15. The speed of light in the medium is
(1) minimum on the axis of the beam
(2) the same everywhere in the beam
(3) directly proportional to the intensity I
(4) maximum on the axis of the beam

16. A car is fitted with a convex side–view mirror of focal length 20 cm. A second car 2.8 m behind the first car is overtaking the first car at a relative speed of 15 m/s. The speed of the image of the second car as seen in the mirror of the first one is : **[AIEEE - 2011, 4/120, –1]**

(1) $\frac{1}{10}$ m/s (2) $\frac{1}{15}$ m/s (3) 10 m/s (4) 15 m/s

17. Let the x - y plane be the boundary between two transparent media. Medium 1 in $z \geq 0$ has 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 $\vec{A} = 6\sqrt{3}\,\hat{i} + 8\sqrt{3}\,\hat{j} - 10\hat{k}$ in incident on the plane of separation. The angle of refraction in medium 2 is : **[AIEEE - 2011, 4/120, –1]**

(1) 30º (2) 45º (3) 60º (4) 75º

18. A beaker contains water up to a height h_1 and kerosene of height h_2 above water so that the total height of (water + kerosene) is $(h_1 + h_2)$. Refractive index of water is μ_1 and that of kerosene is μ_2. The apparent shift in the position of the bottom of the beaker when viewed from above is : **[AIEEE 2011, 11 MAY; 4, –1]**

(1) $\left(1+\frac{1}{\mu_1}\right)h_1 - \left(1+\frac{1}{\mu_2}\right)h_2$ (2) $\left(1-\frac{1}{\mu_1}\right)h_1 + \left(1-\frac{1}{\mu_2}\right)h_2$

(3) $\left(1+\frac{1}{\mu_1}\right)h_2 - \left(1+\frac{1}{\mu_2}\right)h_1$ (4) $\left(1-\frac{1}{\mu_1}\right)h_2 + \left(1-\frac{1}{\mu_2}\right)h_1$

19. When monochromatic red light is used instead of blue light in a convex lens, its focal length will : **[AIEEE 2011, 11 MAY; 4, –1]**

(1) increase
(2) decrease
(3) remain same
(4) does not depend on colour of light

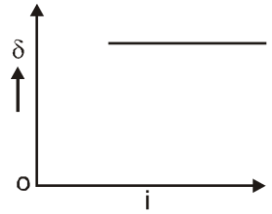
20. An object 2.4 m in front of a lens forms a sharp image on a film 12 cm behind the lens. A glass plate 1 cm thick, of refractive index 1.50 is interposed between lens and film with its plane faces parallel to film. At what distance (from lens) should object shifted to be in sharp focus on film ? **[AIEEE 2012 ; 4/120, –1]**

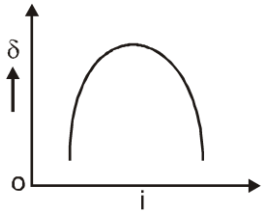
(1) 7.2 m (2) 2.4 m (3) 3.2 m (4) 5.6 m

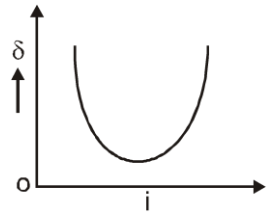
21. Diameter of a plano - convex lens is 6 cm and thickness at the centre is 3 mm. If speed of light in material of lens is 2×10^8 m/s, the focal length of the lens is : **[JEE(Main)-2013 ; 4/120, –1]**

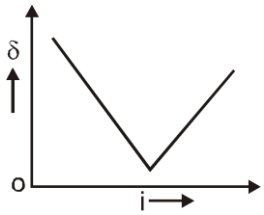
(1) 15 cm (2) 20 cm (3) 30 cm (4) 10 cm

22. The graph between angle of deviation (δ) and angle of incidence (i) for a triangular prism is represented by : **[JEE(Main)-2013 ; 4/120, –1]**

(1)


(2)


(3) 

(4) 

23. A thin convex lens made from crown glass $\left(\mu = \frac{3}{2}\right)$ has focal length f. When it is measured in two different liquids having refractive indices $\frac{4}{3}$ and $\frac{5}{3}$, it has the focal lengths f_1 and f_2 respectively. The correct relation between the focal length is : **[JEE(Main)-2014 ; 4/120. –1]**

(1) $f_1 = f_2 < f$
(2) $f_1 > f$ and f_2 becomes negative
(3) $f_2 > f$ and f_1 becomes negative
(4) f_1 and f_2 both become negative

24. A green light is incident from the water to the air - water interface at the critical angle (θ). Select the correct statement. **[JEE(Main)-2014 ; 4/120. –1]**

(1) The entire spectrum of visible light will come out of the water at an angle of 90º to the normal.
(2) The spectrum of visible light whose frequency is less than that of green light will come out ot the air medium.
(3) The spectrum of visible light whose frequency is more than that of green light will come out to the air medium.
(4) The entire spectrum of visible light will come out of the water at various angles to the normal.

25. An observer looks at a distant tree of height 10 m with a telescope of magnifying power of 20. To the observer the tree appears: **[JEE(Main)-2016; 4/120, –1]**

(1) 10 times nearer
(2) 20 times taller
(3) 20 times nearer
(4) 10 times taller

26. In an experiment for determination of refractive index of glass of a prism by i – δ, plot, it was found that a ray incident at angle 35°, suffers a deviation of 40° and that it emerges at angle 79°. In that case which of the following is closest to the maximum possible value of the refractive index ? **[JEE(Main)-2016; 4/120, –1]**

(1) 1.6 (2) 1.7 (3) 1.8 (4) 1.5

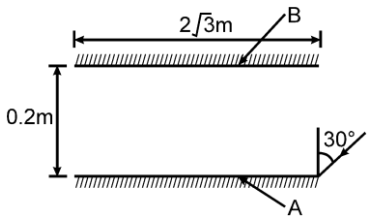
27. A diverging lens with magnitude of focal length 25cm is placed at a distance of 15 cm from a converging lens of magnitude of focal length 20 cm. A beam of parallel light falls on the diverging lens. The final image formed is : **[JEE(Main)-2017, 4/120, –1]**

(1) real and at a distance of 6 cm from the convergent lens
(2) real and at a distance of 40 cm from convergent lens.
(3) virtual and at a distance of 40 cm from convergent lens
(4) real and at distance of 40 cm from the divergent lens.

PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

*** Marked Questions may have more than one correct option.**

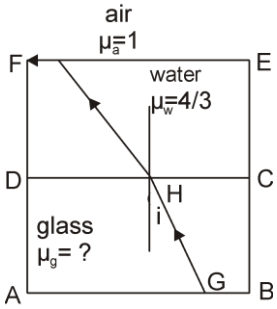
1. Two plane mirrors A & B are aligned parallel to each other, as shown in the figure. A light ray is incident to an angle of 30º at a point just inside one end of A. The plane of incidence coincides with the plane of the figure. The maximum number of times the ray undergoes reflections (including the first one) before it emerges out is: **[IIT–JEE- 2002]**



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

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

[JEE-2003(Mains) 2/60]



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

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

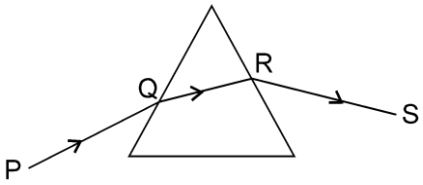
(ii) A thin convex lens of focal length 30 cm forms an image 2 cm high, of an object at infinity. A thin concave lens of focal length 20 cm is placed 26 cm from the convex lens on the side of the image. The height of the image now is :

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

3. A point object is situated at the centre of a solid glass sphere of radius 6cm and refractive index 1.5 . The distance of its virtual image from the surface of the sphere is. **[JEE-2004(Scr.) 3/84, –1]**

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

4. An equilateral prism is kept on a horizontal surface. A typical ray of light PQRS is shown in the figure. For minimum deviation **[JEE-2004(Scr.), 3/84, –1]**

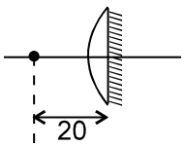


(A) the ray PQ must be horizontal
(B) the ray RS must be horizontal
(C) the ray QR must be horizontal
(D) any one of them can be horizontal

5. A ray of white light is incident on an interface between glass and air from glass towards air. The angle of incidence is such that the green light just suffers total internal reflection. The ray of light emerging from glass to air contains : **[JEE-2004(Scr.), 3/84, –1]**

(A) red, orange and yellow colours (B) violet, indigo and blue colour
(C) all colours (D) all colours except green

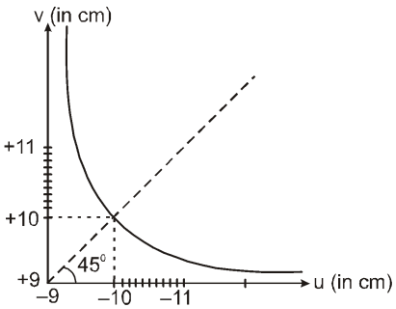
6. A point object is placed at a distance of 20 cm from a thin plano-convex lens of focal length 15 cm. The plane surface of the lens is now silvered. The image created by the system is at : **[JEE-2006, 3/184]**



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

7. The graph between object coordinate u and image coordinate v for a lens is given below. The focal length of the lens is:

[JEE-2006, 3 /184]



(A) 5 ± 0.1
(B) 5 ± 0.05
(C) 0.5 ± 0.1
(D) 0.5 ± 0.05

8. A biconvex lens of focal length f forms a circular image of radius r of sun in focal plane. Then which option is correct : **[JEE-2006, 3/184]**

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

9. A ray of light traveling in water is incident on its surface open to air. The angle of incidence is θ, which is less than the critical angle. Then there will be : **[JEE-2007' 3/81]**

(A) only a reflected ray and no refracted ray

(B) only a refracted ray and no reflected ray

(C) a reflected ray and a refracted ray and the angle between them would be less than $180^o - 2\theta$

(D) a reflected ray and a refracted ray and the angle between them would be greater than $180^o - 2\theta$.

10. **STATEMENT-1** **[JEE - 2007' 3/81]**

The formula connecting u, v and f for a spherical mirror is valid only for mirrors whose sizes are very small compared to their radii of curvature.

because

STATEMENT-2

Laws of reflection are strictly valid for plane surfaces, but not for large spherical surfaces.

(A) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

(B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True.

11. Two beams of red and violet colours are made to pass separately through a prism (angle of the prism is 60^o). In the position of minimum deviation, the angle of refraction will be **[JEE-2008, 3/163]**

(A) 30^o for both the colours

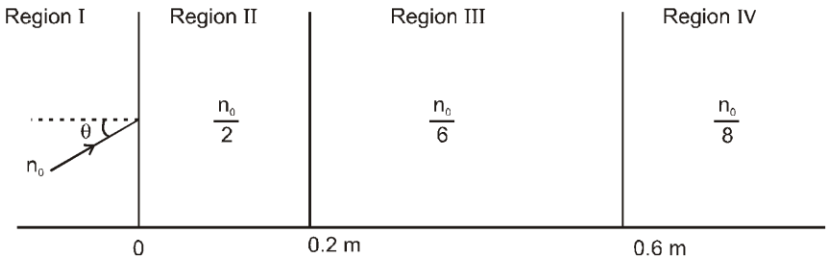
(B) greater for the violet colour

(C) greater for the red colour

(D) equal but not 30^o for both the colours

12. A light beam is traveling from Region I to Region IV (Refer Figure). The refractive index in Regions I, II, III and IV are n_0, $\frac{n_0}{2}$, and $\frac{n_0}{8}$, respectively. The angle of incidence θ for which the beam just misses entering Region IV is **[JEE-2008, 3/163]**

Figure :



(A) $\sin^{-1}\left(\frac{3}{4}\right)$ (B) $\sin^{-1}\left(\frac{1}{8}\right)$ (C) $\sin^{-1}\left(\frac{1}{4}\right)$ (D) $\sin^{-1}\left(\frac{1}{3}\right)$

13. A ball is dropped from a height of 20 m above the surface of water in a lake. The refractive index of water is 4/3. A fish inside the lake, in the line of fall of the ball, is looking at the ball. At an instant, When the ball is 12.8 m above the water surface, the fish sees the speed of ball as [Take g = 10 m/s^2] **[JEE-2009; 3/160, –1]**

(A) 9 m/s (B) 12 m/s (C) 16 m/s (D) 21.33 m/s

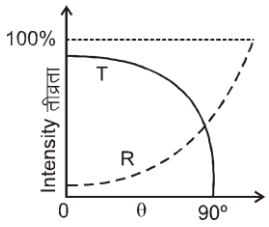
14*. A student performed the experiment of determination of focal length of a concave mirror by u-v method using an optical bench of length 1.5 meter. The focal length of the mirror used is 24 cm. The maximum error in the location of the image can be 0.2 cm. The 5 sets of (u, v) values recorded by the student (in cm) are : (42, 56), (48, 48), (60, 40), (66, 33), (78, 39). The data set(s) that **cannot** come from experiment and is (are) incorrectly recorded, is (are) **[JEE-2009; 4/160, –1]**

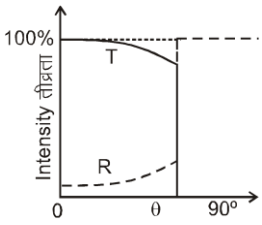
(A) (42, 56) (B) (48, 48) (C) (66, 33) (D) (78, 39)

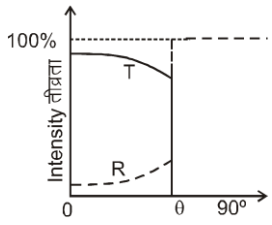
15. A biconvex lens of focal length 15 cm is in front of a plane mirror. The distance between the lens and the mirror is 10 cm. A small object is kept at a distance of 30 cm from the lens. The final image is **[JEE-2010; 5/163, –2]**

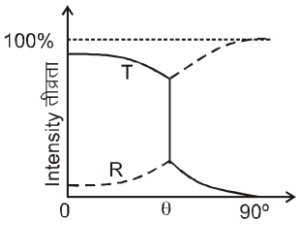
(A) Virtual and at a distance of 16 cm from mirror
(B) Real and at distance of 16 cm from the mirror
(C) Virtual and at a distance of 20 cm form the mirror
(D) Real and at a distance of 20 cm from the mirror

16. A light ray traveling in glass medium is incident on glass-air interface at an angle of incidence θ. The reflected (R) and transmitted (T) intensities, both as function of θ, are plotted. The correct sketch is **[JEE-2011; 3/160, –1]**

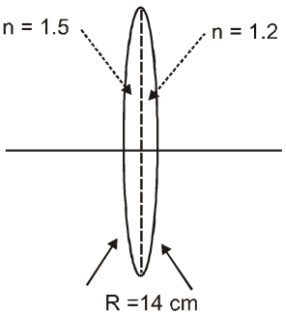
(A) 

(B) 

(C) 

(D) 

17. A bi-convex lens is formed with two thin plano-convex lenses as shown in the figure. Refractive index n of the first lens is 1.5 and that of the second lens is 1.2. Both the curved surfaces are of the same radius of curvature R = 14 cm. For this bi-convex lens, for an object distance of 40 cm, the image distance will be **[IIT-JEE-2012; Paper-1 : 3/70, –1]**



(A) –280.0 cm (B) 40.0 cm
(C) 21.5 cm (D) 13.3 cm

Paragraph for Question 18 and 19

Most materials have the refractive index, n > 1. So, when a light ray from air enters a naturally occurring material, then by Snells' law, $\frac{\sin\theta_1}{\sin\theta_2}=\frac{n_2}{n_1}$, it is understood that the refracted ray bends towards the normal. But it never emerges on the same side of the normal as the incident ray. According to electromagnetism, the refractive index of the medium is given by the relation, $n=\left(\frac{c}{v}\right)=\pm\sqrt{\varepsilon_r\mu_r}$ where c is the speed of electromagnetic waves in vacuum, v its speed in the medium, ε_r and μ_r are negative, one must choose the negative root of n. Such negative refractive index materials can now be artificially prepared and are called meta-materials. They exhibit significantly different optical behavior, without violating any physical laws. Since n is negative, it results in a change in the direction of propagation of the refracted light. However, similar to normal materials, the frequency of light remains unchanged upon refraction even in meta-materials.

18. Choose the correct statement. **[IIT-JEE-2012, Paper-2 : 3/66, –1]**

(A) The speed of light in the meta-material is v = c|n|

(B) The speed of light in the meta-material is $v = \frac{c}{|n|}$

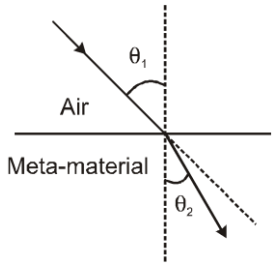
(C) The speed of light in the meta-material is v = c.

(D) The wavelength of the light in the meta-material (λ_m) is given by $\lambda_m = \lambda_{air}\,|n|$, where λ_{air} is the wavelength of the light in air.

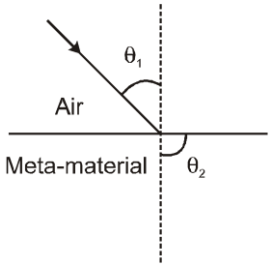
19. For light incident from air on a meta-material, the appropriate ray diagram is :

[IIT-JEE-2012, Paper-2 : 3/66, –1]

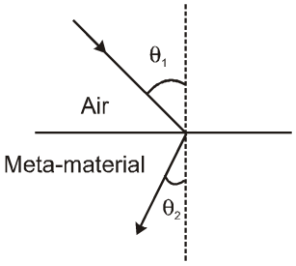
(A)



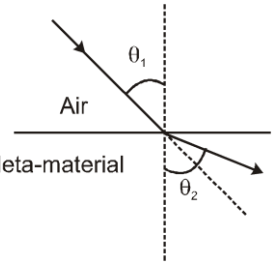
(B)



(C)



(D)



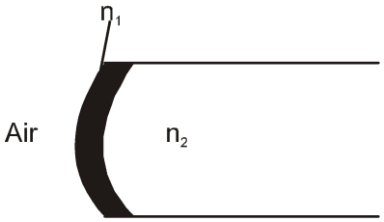
20. The image of an object, formed by a plano-convex lens at a distance of 8 m behind the lens, is real and is one-third the size of the object. The wavelength of light inside the lens is $\frac{2}{3}$ times the wavelength in free space. The radius of the curved surface of the lens is : **[JEE(Advanced)-2013); 3/60, –1]**

(A) 1 m (B) 2 m (C) 3 m (D) 6 m

21. A ray of light travelling in the direction $\frac{1}{2}\left(\hat{i}+\sqrt{3}\hat{j}\right)$ is incident on a plane mirror. After reflection, it travels along the direction $\frac{1}{2}\left(\hat{i}-\sqrt{3}\hat{j}\right)$. The angle of incidence is : **[JEE-2013 (Advanced); 3/60, –1]**

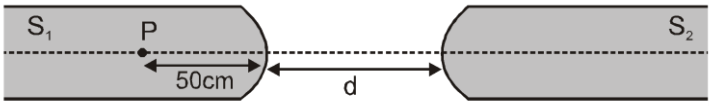
(A) 30º (B) 45º (C) 60º (D) 75º

22*. A transparent thin film of uniform thickness and refractive index $n_1 = 1.4$ is coated on the convex spherical surface of radius R at one end of a long solid glass cylinder of refractive index $n_2 = 1.5$. as shown in the figure. Rays of light parallel to the axis of the cylinder traversing through the film from air to glass get focused at distance f_1 from the film, while rays of light traversing from glass to air get focused at distance f_2 from the film. Then **[JEE(Advanced)-2014,P-1, 3/60]**



(A) $|f_1| = 3R$ (B) $|f_1| = 2.8R$ (C) $|f_2| = 2R$ (D) $|f_2| = 1.4R$

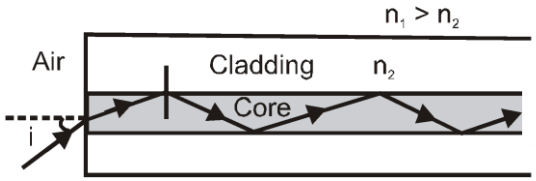
23. Two idenctical glass rods S_1 and S_2 (refractive index = 1.5) have one convex end of radius of curvature 10 cm. They are placed with the curved surfaces at a distance d as shown in the figure, with their axes (shown by the dashed line) aligned. When a point source of light P is placed inside rod S_1 on its axis at a distance of 50 cm from the curved face, the light rays emanating from it are found to be parallel to the axis inside S_2. The distance d is : **[JEE(Advanced)-2015 ; P-1,4/88, –2]**



(A) 60 cm (B) 70 cm (C) 80 cm (D) 90 cm

Paragraph for Q. No. 24 & 25

Light guidance in an optical fiber can be understood by considering a structure comprising of thin solid glass cylinder of refractive index n_1 surrounded by a medium of lower refractive index n_2. The light guidance in the structure takes place due to successive total internal reflections at the interface of the media n_1 and n_2 as shown in the figure. All rays with the angle of incidence i less than a particular value i_m are confined in the medium of refractive index n_1. The numerical aperture (NA) of the structure is defined as sin i_m.



24*. For two structures namely S_1 with $n_1 = \sqrt{45}/4$ and $n_2 = 3/2$, and S_2 with $n_1 = 8/5$ and $n_2 = 7/5$ and taking the refractive index of water to be 4/3 and that of air to be 1, the correct option(s) is (are) **[JEE(Advanced)-2015 ; P-2,4/88, –2]**

(A) NA of S_1 immersed in water is the same as that of S_2 immersed in a liquid of refractive index $\frac{16}{3\sqrt{15}}$

(B) NA of S_1 immersed in liquid of refractive index $\frac{6}{\sqrt{15}}$ is that as that of S_2 immersed in water

(C) NA of S_1 placed in air is the same as that of S_2 immersed in liquid of refractive index $\frac{4}{\sqrt{15}}$

(D) NA of S_1 placed in air is the same as that of S_2 placed in water

25. If two structures of same cross-sectional area, but different numerical apertures NA_1 and NA_2 ($NA_2 < NA_1$) are joined longitudinally, the numerical aperture of the combined structure is **[JEE(Advanced)-2015 ; P-2,4/88, –2]**

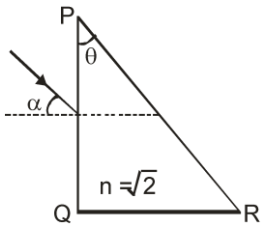
(A) $\frac{NA_1\ NA_2}{NA_1 + NA_2}$

(B) $NA_1 + NA_2$

(C) NA_1

(D) NA_2

26. A parallel beam of light is incident from air at an angle α on the side PQ of a right angled triangular prism of refractive index $n = \sqrt{2}$. Light undergoes total internal reflection in the prism at the face PR when α has a minimum value of 45º. The angle θ of the prism is **[JEE(Advanced)-2016; P-1, 3/62, –1]**



(A) 15º
(B) 22.5º
(C) 30º
(D) 45º

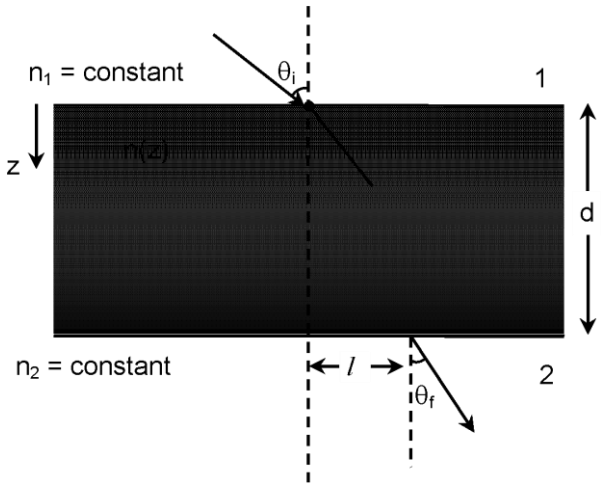
27.* A plano-convex lens is made of a material of refractive index n. When a small object is placed 30 cm away in from of the curved surface of the lens, an image of double the size of the object is produced. Due to reflection from the convex surface of the lens, another faint image is observed at a distance of 10 cm away from the lens. Which of the following statement (s) is(are) true?

[JEE(Advanced)-2016 ; P-1, 4/62, –2]

(A) The refractive index of the lens is 2.5
(B) The radius of curvature of the convex surface is 45 cm
(C) The faint image is erect and real
(D) The focal length of the lens is 20 cm

28*. A transparent slab of thickness d has a refractive index n(z) that increases with z. Here z is the vertical distance inside the slab, measured from the top. The slab is placed between two media with uniform refractive indices n_1 and n_2 ($> n_1$), as shown in the figure. A ray of light is incident with angle θ_i from medium 1 and emerges in medium 2 with refraction angle θ_f with a lateral displacement l :

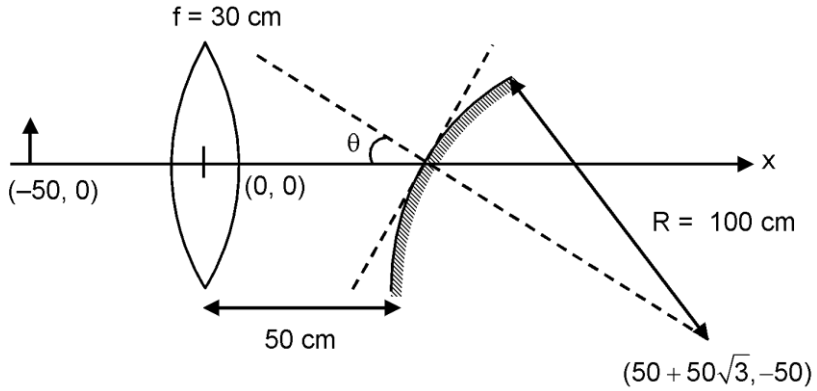
[JEE(Advanced)-2016;P-1, 4/62, –2]



Which of the following statement(s) is (are) true ?
(A) $n_1 \sin\theta_i = n_2 \sin\theta_f$
(B) $n_1 \sin\theta_i = (n_2 - n_1) \sin\theta_f$
(C) l is independent of n_2
(D) l is dependent of n(z)

29. A smaller object is placed 50 cm to the left of a thin convex lens of focal length 30 cm. A convex spherical mirror of radius of curvature 100 cm is placed to the right of the lens at a distance of 50 cm. The mirror is tilted such that the axis of the mirror is at an angle $\theta = 30^\circ$ to the axis of the lens, as shown in the figure.

[JEE(Advanced)-2016; P-2, 3/62, –1]



If the origin of the coordinate system is taken to be at the centre of the lens, the coordinates (in cm) of the point (x, y) at which the image is formed are

(A) (125/3, $25/\sqrt{3}$)

(B) $(25, 25\sqrt{3})$

(C) $(50-25\sqrt{3}, 25)$

(D) (0, 0)

Answers

EXERCISE # 1

Section (A) :

A-1.	(1)	**A-2.**	(4)	**A-3.**	(2)
A-4.	(2)	**A-5.**	(2)	**A-6.**	(2)
A-7.	(1)	**A-8.**	(2)	**A-9.**	(2)

Section (B) :

B-1.	(4)	**B-2.**	(2)	**B-3.**	(3)
B-4.	(4)	**B-5.**	(3)	**B-6.**	(2)
B-7.	(3)	**B-8.**	(1)	**B-9.**	(1)
B-10.	(3)	**B-11.**	(1)		

Section (C) :

C-1.	(4)	**C-2.**	(1)	**C-3.**	(3)
C-4.	(2)	**C-5.**	(3)	**C-6.**	(3)
C-7.	(2)	**C-8.**	(1)	**C-9.**	(1)
C-10.	(3)				

Section (D) :

D-1.	(1)	**D-2.**	(1)	**D-3.**	(2)
D-4.	(3)	**D-5.**	(2)	**D-6.**	(3)
D-7.	(2)				

Section (E) :

E-1.	(2)	**E-2.**	(2)	**E-3.**	(1)
E-4	(3)				

Section (F) :

F-1.	(2)	**F-2.**	(4)	**F-3.**	(3)
F-4.	(3)	**F-5.**	(2)	**F-6.**	(3)
F-7.	(3)	**F-8.**	(4)	**F-9.**	(1)
F-10.	(2)	**F-11.**	(4)	**F-12.**	(3)
F-13.	(2)	**F-14.**	(1)		

Section (G) :

G-1.	(4)	**G-2.**	(1)	**G-3.**	(3)
G-4.	(3)	**G-5.**	(2)		

Section (H) :

H-1.	(1)	**H-2.**	(1)	**H-3.**	(1)
H-4.	(3)	**H-5.**	(1)	**H-6.**	(4)
H-7.	(4)	**H-8.**	(3)	**H-9.**	(2)
H-10.	(4)	**H-11.**	(4)		

Section (I) :

I-1.	(4)	**I-2.**	(2)	**I-3.**	(3)

Section (J) :

J-1.	(4)	**J-2.**	(3)	**J-3.**	(3)
J-4.	(4)	**J-5.**	(1)	**J-6.**	(2)
J-7.	(4)	**J-8.**	(2)	**J-9.**	(4)

EXERCISE # 2

PART-I

1.	(2)	**2.**	(1)	**3.**	(2)
4.	(2)	**5.**	(2)	**6.**	(4)
7.	(2)	**8.**	(3)	**9.**	(3)
10.	(2)	**11.**	(2)	**12.**	(4)
13.	(3)	**14.**	(3)	**15.**	(1)
16.	(3)	**17.**	(4)	**18.**	(2)
19.	(1)	**20.**	(1)	**21.**	(3)
22.	(1)	**23.**	(3)	**24.**	(1)
25.	(2)	**26.**	(1)	**27.**	(1)
28.	(1)	**29.**	(2)	**30.**	(3)
31.	(4)	**32.**	(3)		

PART-II

Section (A) :

A-1.	(4)	**A-2.**	(2)	**A-3.**	(4)
A-4.	(4)	**A-5.**	(1)	**A-6.**	(2)
A-7.	(4)	**A-8.**	(2)		

Section (B) :

B-1. (1 → p, s); (2 → q) ; (3 → r, s); (4 → r)

Section (C) :

C-1.	(1,2)	**C-2.**	(1,3,4)	**C-3.**	(2)
C-4.	(3,4)	**C-5.**	(1,4)		

EXERCISE # 3

PART-I

1.	(2)	**2.**	(1)	**3.**	(1)
4.	(3)	**5.**	(2)	**6.**	(2)
7.	(1)	**8.**	(3)	**9.**	(4)
10.	(2)	**11.**	(3)	**12.**	(4)
13.	(4)	**14.**	(4)	**15.**	(1)
16.	(2)	**17.**	(2)	**18.**	(2)
19.	(1)	**20.**	(4)	**21.**	(3)
22.	(3)	**23.**	(2)	**24.**	(2)
25.	(3)	**26.**	(4)	**27.**	(2)

PART-II

1.	(B)	**2.(i)**	(B)	**(ii)**	(D)
3.	(B)	**4.**	(C)	**5.**	(A)
6.	(C)	**7.**	(B)	**8.**	(B)
9.	(C)	**10.**	(C)	**11.**	(A)
12.	(B)	**13.**	(C)	**14.**	(CD)
15.	(B)	**16.**	(C)	**17.**	(B)
18.	(B)	**19.**	(C)	**20.**	(C)
21.	(A)	**22.**	(AC)	**23.**	(B)
24.	(AC)	**25.**	(D)	**26.**	(A)
27.	(AD)	**28.**	(ACD)	**29.**	(B)