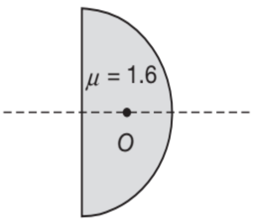
PRACTICE EXERCISES

SINGLE CORRECT CHOICE TYPE QUESTIONS

This section contains Single Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

1. A transparent hemisphere has a radius of curvature 8 cm and an index of refraction of 1.6. A small object O is placed on the axis halfway between the plane surface and the spherical surface i.e., 4 cm from each. The distance between the two images when viewed along the axis from the two sides of the hemisphere is approximately



(A) 7.5 cm (B) 8.5 cm
(C) 2.5 cm (D) 13.5 cm

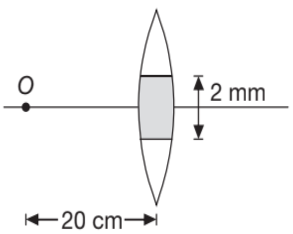
2. A square wire of side 3.0 cm is placed 25 cm in front of a concave mirror of focal length 10 cm with its centre on the axis of the mirror and its plane normal to the axis. The area enclosed by the image of the wire is

(A) 7.5 cm^2 (B) 6.0 cm^2
(C) 4.0 cm^2 (D) 3.0 cm^2

3. An object is placed at a distance $2f$ from the pole of a convex mirror of focal length f. The linear magnification is

(A) $\frac{1}{3}$ (B) $\frac{2}{3}$
(C) $\frac{3}{4}$ (D) 1

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



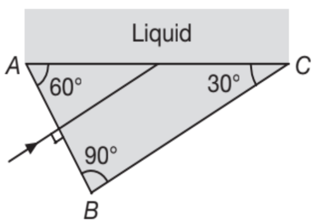
(A) the distance between the images is 2 mm
(B) the distance between the images is 4 mm
(C) the distance between the two images formed by such a lens is 6 mm
(D) only one image will be formed by the lens

5. An object is placed at 20 cm from a convex mirror of focal length 20 cm. The distance of the image from the pole of the mirror is
(A) infinity (B) 10 cm
(C) 15 cm (D) 40 cm

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

(A) 5 cm (B) 10 cm
(C) 15 cm (D) 20 cm

7. Light is incident normally on face AB of a prism as shown in figure. A liquid of refractive index μ is placed on face AC of the prism. The prism is made of glass of refractive index $\frac{3}{2}$. The limits of μ for which total internal reflection takes place at the face AC is



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

8. An object is placed in front of a convex mirror at a distance of 50 cm. 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, there is no parallax between the images formed by the two mirrors. The radius of curvature of the convex mirror is
(A) 60 cm (B) 50 cm
(C) 30 cm (D) 25 cm

9. A sharp image of an extended object which is placed perpendicular to the principal axis of a lens is η times that of the object for a particular position of object on a screen. Without disturbing the position of object and screen, by shifting the lens, a position can be obtained where the sharp image is $\frac{1}{\eta}$ times that of object. Ratio of difference between the two positions of lens to the focal length of lens is

(A) $\frac{\eta^2-1}{\eta}$ if $\eta > 1$

(B) $\frac{\eta^2-1}{\eta}$ if $\eta < 1$

(C) $\frac{\eta^2-1}{\eta}$ for all values of η

(D) η

10. A concave lens forms the image of an object such that the distance between the object and image is 10 cm and the magnification produced is $\frac{1}{4}$. The focal length of the lens will be

(A) 10 cm (B) 8.6 cm
(C) 6.2 cm (D) 4.4 cm

11. For a concave mirror, the magnification of a real image was found to be twice as great when the object was 15 cm from the mirror as it was when the object was 20 cm from the mirror. The focal length of the mirror is

(A) 5.0 cm (B) 7.5 cm
(C) 10 cm (D) 12.5 cm

12. The image formed by a convex mirror of focal length 20 cm is half the size of the object. The distance of the object from the mirror is

(A) 10 cm (B) 20 cm
(C) 30 cm (D) 40 cm

13. A concave mirror of focal length f in vacuum is placed in a medium of refractive index 2. Its focal length in the medium is

(A) $\frac{f}{2}$ (B) f
(C) $2f$ (D) $4f$

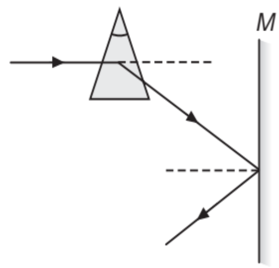
14. A spherical mirror forms an erect image three times the size of the object. If the distance between the object and the image is 80 cm, the nature and the focal length of the mirror are

(A) concave, 30 cm
(B) convex, 30 cm
(C) concave, 15 cm
(D) convex, 15 cm

15. A boy of height 1.5 m with his eye level at 1.4 m stands before a plane mirror of length 0.75 m fixed on the well. The height of the lower edge of the mirror above the floor is 0.8 m. Then

(A) the boy will see his full image.
(B) the boy cannot see his hair.
(C) the boy cannot see his feet.
(D) the boy cannot see both his hair and feet.

16. A horizontal ray of light passes through a prism of $\mu = 1.5$ whose apex angle is $4°$ and then strikes a vertical mirror M as shown. For the ray, after reflection to become horizontal, the mirror must be rotated through an angle of



(A) 1° (B) 2°
(C) 3° (D) 4°

17. A man of height 1.6 m wishes to see his full image in a plane mirror placed at a distance of 2 m. The minimum length of the mirror should be

(A) 0.4 m (B) 0.8 m
(C) 1.6 m (D) 2.4 m

18. A ray of light falls on a plane mirror. When the mirror is turned, about an axis which is at right angle to the plane of the mirror through $30°$, the angle between the incident ray and new reflected ray is $45°$. The angle between the incident ray and original reflected ray was

(A) 60° (B) 30°
(C) 60° or 30° (D) 45°

19. A plane mirror reflects a beam of light to form a real image. The incident beam is

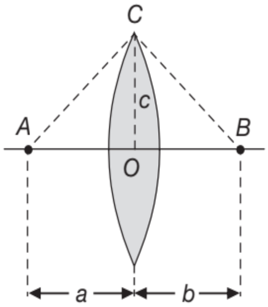
(A) parallel (B) convergent
(C) divergent (D) any one of the above

20. A plane mirror is approaching you at 10 cms^{-1}. You can see your image in it. The image will approach you with a speed

(A) 5 cms^{-1} (B) 10 cms^{-1}
(C) 15 cms^{-1} (D) 20 cms^{-1}

21. An object is placed at $A(OA > f)$, where, f is the focal length of the lens. The image is formed at B. A perpendicular is erected at O and C is chosen such

that $\angle BCA = 90°$. Then the value of f (in terms of a, b and c) is



(A) $\dfrac{(a+b)^3}{c^2}$ (B) $\dfrac{(a+b)c}{(a+c)}$

(C) $\dfrac{c^2}{a+b}$ (D) $\dfrac{a^2}{a+b+c}$

22. An observer moves towards a plane mirror with a speed of 2 ms^{-1}. The speed of the image with respect to the observer is

(A) 1 ms^{-1} (B) 2 ms^{-1}

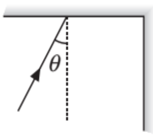
(C) 4 ms^{-1} (D) 8 ms^{-1}

23. A concave mirror of focal length f produces a real image n times the size of the object. The distance of the objet from the mirror is

(A) $(n-1)f$ (B) $(n+1)f$

(C) $\left(\dfrac{n+1}{n}\right)f$ (D) $\left(\dfrac{n-1}{n}\right)f$

24. 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 value of θ for which the ray emerges parallel to the incoming ray after reflection from the vertical mirror is



(A) 30° (B) 45°

(C) 60° (D) all of the above

25. A convex mirror of focal length f produces an image $\left(\dfrac{1}{n}\right)^{th}$ of the size of the object. The distance of the object from the mirror is

(A) nf (B) $\dfrac{f}{n}$

(C) $(n+1)f$ (D) $(n-1)f$

26. A real image formed by a concave mirror is 4.5 times the size of the object. If the mirror is 20 cm from the object, its focal length is

(A) $\dfrac{90}{11}$ cm (B) $\dfrac{120}{11}$ cm

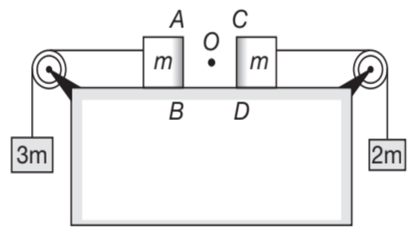
(C) $\dfrac{150}{11}$ cm (D) $\dfrac{180}{11}$ cm

27. An object is placed 10 cm in front of a convex mirror of focal length 20 cm. The distance of the image from the mirror is

(A) $\dfrac{10}{3}$ cm (B) $\dfrac{20}{3}$ cm

(C) 10 cm (D) $\dfrac{40}{3}$ cm

28. 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 and 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) $\dfrac{5g}{6}$ (B) $\dfrac{5g}{3}$

(C) $\dfrac{g}{3}$ (D) $\dfrac{17g}{6}$

29. A concave mirror forms the image of an object on a screen. If the lower half of the mirror is covered with an opaque card, the effect would be

(A) to make the image less bright.

(B) to make the lower half of the image disappear.

(C) to make the upper half of the image disappear.

(D) to make the image blurred.

30. Two plane mirrors are inclined at 70°. A ray incident on one mirror at angle θ, after reflection falls on the second mirror and is reflected from there parallel to the first mirror. θ is

(A) 45° (B) 50°

(C) 55° (D) 60°

31. A man stands in a room with his eyes at the centre of the room. The height of the ceiling is H. The length of the shortest plane mirror, fixed on the wall in front of the man, so that the man can see the full image of the wall behind him is

(A) $\frac{2H}{3}$ (B) $\frac{H}{2}$

(C) $\frac{H}{3}$ (D) $\frac{H}{4}$

32. An object is placed between two parallel mirrors. The number of images formed is

(A) 2 (B) 4

(C) 8 (D) infinite

33. A bulb is placed between two plane mirrors inclined at an angle of 60°. The number of images formed is

(A) 5 (B) 6

(C) 4 (D) 3

34. Two plane mirrors are placed perpendicular to each other. A ray strikes one mirror and after reflection falls on the second mirror. The ray after reflection from the second mirror will be

(A) perpendicular to the original ray.

(B) parallel to the original ray.

(C) at 45° to the original ray.

(D) can be at any angle to the original ray.

35. A real image is formed by a convex lens, then it is brought in contact with a concave lens such that again a real image is formed. This image will

(A) remain in its original position

(B) shift towards the lens system

(C) shift away from the lens system

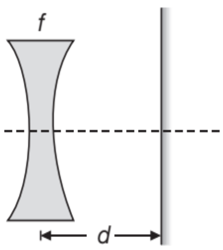
(D) shift to infinity

36. Plane mirrors A and B are kept at an angle θ with respect to each other. Light falls on A, is reflected, then falls on B and is reflected. The emergent ray is opposite to the incident direction. Then the angle θ is equal to

(A) 30° (B) 45°

(C) 60° (D) 90°

37. A diverging lens of focal length 10 cm is placed 10 cm in front of a plane mirror as shown in the figure. Light from a very far away source falls on the lens. The final image is at a distance



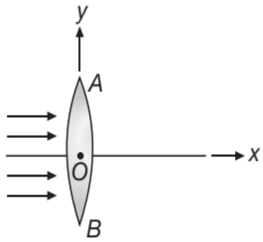
(A) 20 cm behind the mirror

(B) 7.5 cm in front of the mirror

(C) 7.5 cm behind the mirror

(D) 2.5 cm in front of the mirror

38. Monochromatic light rays parallel to x-axis strike a convex lens AB of refractive index 0.5. If the lens oscillates such that AB tilts upto a small angle θ (in radian) on either side of y-axis, then find the distance between extreme positions of oscillating image



(A) $f\sec\theta$

(B) $f\sec^2\theta$

(C) $f(\sec\theta - 1)$

(D) The image will not move

39. A thin rod of length $\frac{f}{3}$ lies along the axis of a concave mirror of focal length f. One end of its image touches an end of the rod. The length of the image is

(A) f (B) $\frac{f}{2}$

(C) $2f$ (D) $\frac{f}{4}$

40. How many images will be formed if two mirrors are fitted on adjacent walls and one mirror on ceiling?

(A) 5 (B) 7

(C) 11 (D) 2

41. The wavefront that represents the light waves travelling in vacuum along the y-axis is

(A) $x + y + z = \text{constant}$ (B) $x = \text{constant}$

(C) $y = \text{constant}$ (D) $z = \text{constant}$

42. A boy stands straight in front of a mirror at a distance of 30 cm from it. He sees his erect image whose height is $\frac{1}{5}$ of his real height. The mirror he is using is

(A) plane (B) convex

(C) concave (D) plano-concave

43. The image of an object placed in front of a concave mirror of focal length 12 cm is formed at a point which is 10 cm more distant from the mirror that the object. The magnification of the image is

(A) 1.5 (B) 2

(C) 2.5 (D) 3

44. The minimum value of the refractive index for a $90° - 45° - 45°$ prism which is used to deviate a beam through $90°$ by total internal reflection is

(A) $\frac{5}{\sqrt{3}}$ (B) $\sqrt{2}$

(C) $\frac{3}{2}$ (D) $\sqrt{3}$

45. An object is moving towards a concave mirror of focal length 24 cm. When it is at a distance of 60 cm from the mirror its speed is $9\ \text{cms}^{-1}$. The speed of its image at that instant, is

(A) $4\ \text{cms}^{-1}$ towards the mirror

(B) $9\ \text{cms}^{-1}$ towards the mirror

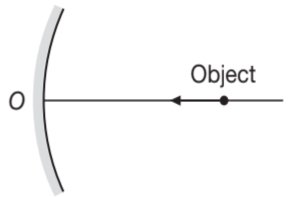
(C) $4\ \text{cms}^{-1}$ away from the mirror

(D) $9\ \text{cms}^{-1}$ away from the mirror

46. A ray of light passes through an equilateral prism such that the angle of emergence is equal to the angle of incidence and each is equal to $\left(\frac{3}{4}\right)^{\text{th}}$ of the angle of prism. The angle of deviation is

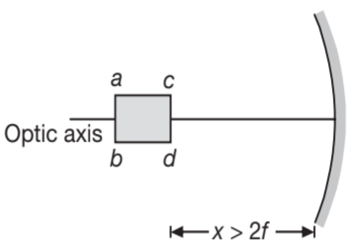
(A) 45° (B) 39°
(C) 20° (D) 30°

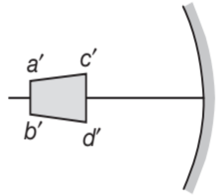
47. A point object is moving along principal axis of a concave mirror with uniform velocity towards pole. Initially the object is at infinite distance from pole on right side of the mirror as shown in the figure. Before the object collides with mirror, the number of times at which the distance between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

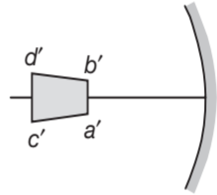


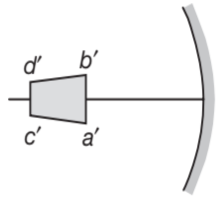
(A) One time
(B) Two times
(C) Three times
(D) Data insufficient

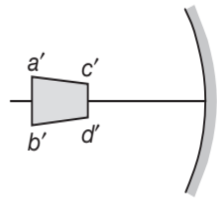
48. An object is placed in front of a concave mirror of focal length f as shown in figure. The correct shape of the image is represented by



(A)


(B)


(C)


(D)


49. The index of refraction of diamond is 2.0. Velocity of light in diamond in cms^{-1} is approximately

(A) 6×10^{10} (B) 3×10^{10}
(C) 2×10^{10} (D) 1.5×10^{10}

50. A plane mirror is placed at origin parallel of y-axis, facing the positive x-axis. An object starts from $(2, 0, 0)$ m with a velocity of $(2\hat{i} + 2\hat{j})\ \text{ms}^{-1}$. The relative velocity of image with respect to object is along

(A) positive x-axis (B) positive y-axis
(C) negative x-axis (D) negative y-axis

51. A ray of light passes from vacuum into a medium of refractive index n. If the angle of incidence is twice the angle of refraction, then the angle of incidence is

(A) $\cos^{-1}\left(\frac{n}{2}\right)$ (B) $\sin^{-1}\left(\frac{n}{2}\right)$

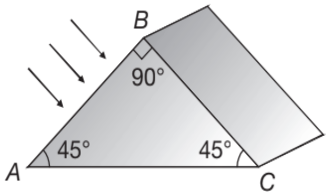
(C) $2\cos^{-1}\left(\frac{n}{2}\right)$ (D) $2\sin^{-1}\left(\frac{n}{2}\right)$

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

(A) $\frac{3}{2}$ cm (B) $\frac{4}{3}$ cm

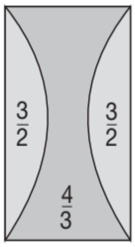
(C) $\frac{2}{3}$ cm (D) $\frac{3}{4}$ cm

53. A beam of light consisting of red, green and blue colours is incident on a right-angled prism as shown. The refractive index of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. The prism will



(A) separate part of the red colour from the green and blue colours.
(B) separate part of the blue colour from the red and green colours.
(C) separate all the three colours from one another.
(D) not separate even partially any colour from the other two colours.

54. Two plano-convex lenses each of focal length 10 cm and refractive index $\frac{3}{2}$ are placed as shown. Water $\left(\mu=\frac{4}{3}\right)$ is filled in the space between the two lenses. The whole arrangement is in air. The optical power of the system in diopters is



(A) 6.67 (B) −6.67 (C) 33.3 (D) 20

55. Total internal reflection of a ray of light is possible when the ray goes from
(A) denser to rarer medium and the angle of incidence is greater than the critical angle.
(B) denser to rarer medium and the angle of incidence is less than the critical angle.
(C) rarer to denser medium and the angle of incidence is greater than the critical angle.
(D) rarer to denser medium and the angle of incidence is less than the critical angle.

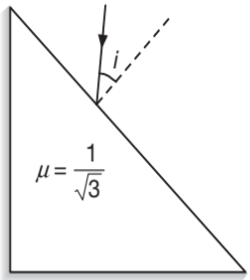
56. The critical angle of light going from medium A into medium B is θ. The speed of light in medium A is v. The speed of light in medium B is

(A) $\frac{v}{\sin\theta}$ (B) $v\sin\theta$
(C) $\frac{v}{\tan\theta}$ (D) $v\tan\theta$

57. Glass has refractive index $\frac{3}{2}$ and water has refractive index $\frac{4}{3}$. If the speed of light in glass is 2.00×10^8 ms^{-1}, the speed of light in water in ms^{-1} is

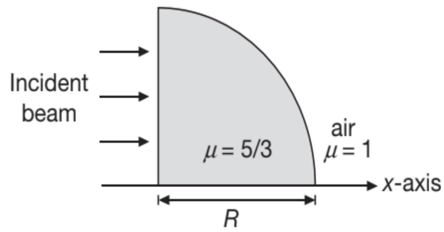
(A) 1.50×10^8 (B) 1.78×10^8
(C) 2.25×10^8 (D) 2.67×10^8

58. Two sides of an isosceles right prism are coated with a reflecting coating. A ray of light falls on the hypotenuse at an arbitrary angle i. The value of i for which the ray leaving the prism is parallel to the incident ray is



(A) 30°
(B) 60°
(C) 45°
(D) any arbitrary angle from $0<i<\frac{\pi}{2}$

59. A uniform, horizontal parallel beam of light is incident on a quarter cylinder, of radius 5 cm having refractive index $\frac{5}{3}$. The width of the region at which the incident rays after normal incidence on plane surface and subsequent refraction at curved surface intersect the x axis is (Neglect the ray which travels along x-axis)



(A) 4 cm (B) $\frac{5}{4}$ cm
(C) $\frac{9}{4}$ cm (D) $\frac{25}{4}$ cm

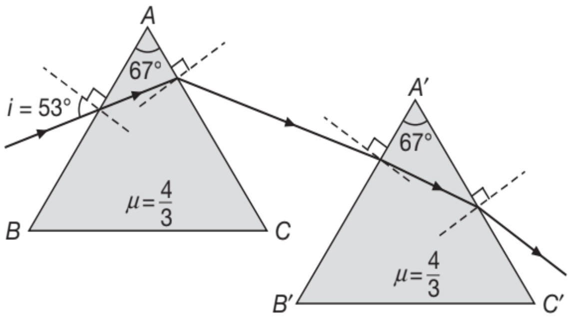
60. A diver in a lake wants to signal his distress to a person sitting on the edge of the lake flashing his water proof torch. He should direct the beam
(A) vertically upwards.
(B) horizontally.
(C) at an angle to the vertical which is slightly less than the critical angle.
(D) at an angle to the vertical which is slightly more than the critical angle.

61. Critical angle of light passing from a glass to water is minimum for

(A) red colour (B) green colour
(C) yellow colour (D) violet colour

62. Mirage is observed in a desert due to the phenomenon of
(A) interference
(B) total internal reflection
(C) scattering
(D) double refraction

63. A ray is incident on the first prism at an angle of incidence $53°$ as shown in the figure. The angle between side CA and $B'A'$ for the net deviation by both the prisms to be double of the deviation produced by the first prism, will be

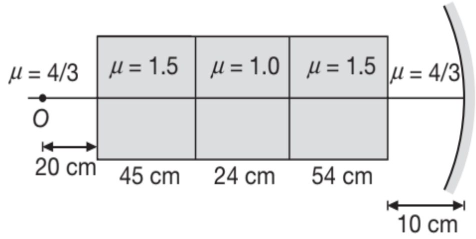


(A) $\sin^{-1}\left(\frac{2}{3}\right)+53°$ (B) $\sin^{-1}\left(\frac{2}{3}\right)+37°$
(C) $\cos^{-1}\left(\frac{2}{3}\right)+53°$ (D) $2\sin^{-1}\left(\frac{2}{3}\right)$

64. The distances of an object and its virtual image from the focus of a convex lens of focal length f are 1 cm each, then f is
(A) $(2+\sqrt{2})$ cm (B) $(\sqrt{2}+1)$ cm
(C) $2\sqrt{2}$ cm (D) 4 cm

65. Total internal reflection can occur when light tends to pass from
(A) a denser to a rarer medium.
(B) a rarer to a denser medium.
(C) one medium to another of different refractive index irrespective of which medium has greater refractive index.
(D) one medium to another of equal refractive index.

66. A composite slab consisting of different media is placed in front of a concave mirror of radius of curvature 150 cm. The whole arrangement is placed in water. An object O is placed at a distance 20 cm from the slab. The refractive indices of different media are given in the diagram shown in figure. The final image formed by the system lies



(A) to the left of object
(B) at the object
(C) To the right of object
(D) Data insufficient to arrive at a conclusion

67. A ray incident at an angle of incidence $60°$ 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) $40°$ (B) $60°$
(C) $70°$ (D) $90°$

68. A water film is formed on a glass block. A light ray is incident on water film from air at an angle 60°. What is the angle of incidence on glass block?
(Refractive Index of Glass = 1.5, Refractive Index of Water $= 4/3$)
(A) $\sin^{-1}\left(\frac{3\sqrt{3}}{8}\right)$ (B) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$
(C) $\sin^{-1}\left(\frac{4\sqrt{3}}{9}\right)$ (D) $\sin^{-1}\left(\frac{9\sqrt{3}}{16}\right)$

69. A stone lies at the bottom of a stream. A boy wants to hit it with a stick. Taking aim the boy holds the stick in the air at an angle of 45°. At what distance from the stone will the stick hit the bottom, if the depth is 32 cm (given ${}^{a}\mu_w = 4/3$)
(A) 8 cm (B) 12 cm
(C) 16 cm (D) $12\sqrt{2}$ cm

70. When the surface of the lake is calm, a fish submerged in water will see the entire out-side world within inverted cone whose apex is situated at the eye of the fish and the cone subtends an angle of
(A) 10° (B) 60°
(C) 98° (D) 30°

71. A ray of light strikes a glass slab of thickness t. It emerges on the opposite face, parallel to the incident ray but laterally displaced. The lateral displacement is Δx.
(A) $\Delta x=0$ (B) $\Delta x=t\sin(i-r)\cos r$
(C) $\Delta x=\dfrac{t\sin i}{\cos r}$ (D) $\Delta x=\dfrac{t\sin(i-r)}{\cos r}$

72. In cold countries the phenomenon of looming (i.e. ship appears in the sky) takes place because
(A) refractive index of air decreases with height.
(B) refractive index of air increases with height.
(C) refractive index does not change with height.
(D) refractive index becomes infinity at the surface.

73. If D is the deviation of a normally falling light beam on a thin prism of angle A and δ is the dispersive power of the same prism then
(A) D is independent of A.
(B) D is independent of refractive index.
(C) δ is independent of refractive index.
(D) δ is independent of A.

74. For an equilateral prism, it is observed that when a ray strikes grazingly at one face it emerges grazingly at the other. Its refractive index will be
(A) $\frac{\sqrt{3}}{2}$ (B) $\sqrt{\frac{3}{2}}$
(C) 2 (D) $\sqrt{2}$

75. A rectangular block of glass (refractive index $3/2$) is kept in water (refractive index $4/3$). The critical angle for total internal reflection is
(A) $\sin^{-1}\left(\frac{8}{9}\right)$ for a ray of light passing from glass to water.
(B) $\sin^{-1}\left(\frac{8}{9}\right)$ for a ray of light passing from water to glass.
(C) $\sin^{-1}\left(\frac{2}{3}\right)$ for a ray of light passing from water to glass.
(D) $\sin^{-1}\left(\frac{8}{9}\right)$ for a ray of light passing from glass to air.

76. The refractive index of a given piece of transparent quartz is greatest for
(A) red light (B) violet light
(C) green light (D) yellow light

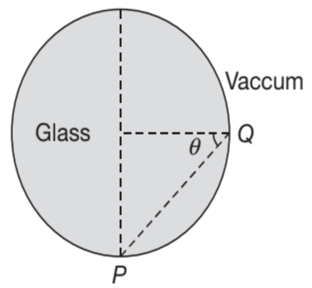
77. A well cut diamond appears bright because
(A) it emits light
(B) it is radioactive
(C) of total internal reflection
(D) of dispersion

78. The maximum refracting angle of a prism of refractive index 2 is
(A) 30^o (B) 45^o
(C) 60^o (D) 90^o

79. When light passes from one medium to another, the physical quantity that remains unchanged is
(A) velocity (B) wavelength
(C) frequency (D) None of these

80. A monochromatic beam of light passes from a denser to a rarer medium. As a result its
(A) velocity increases (B) velocity decreases
(C) frequency decreases (D) frequency increases

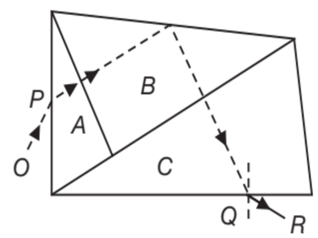
81. It is found that all electromagnetic signals sent from P towards Q reach point R. The speed of electromagnetic signals in glass can not be



(A) $1.0\times10^{8}\ ms^{-1}$ (B) $2.4\times10^{8}\ ms^{-1}$
(C) $2\times10^{7}\ ms^{-1}$ (D) $4\times10^{7}\ ms^{-1}$

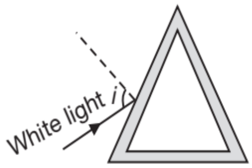
82. A number of images of a candle flame are seen in a thick mirror
(A) the first image is the brightest.
(B) the second image is the brightest.
(C) the last image is the brightest.
(D) all images are equally bright.

83. Three glass prisms A, B and C of same refractive index are placed in contact with each other as shown in figure with no air gap between the prisms. Monochromatic ray of light OP passes through the prism assembly and emerges as QR. The condition of minimum deviation is satisfied in the prisms



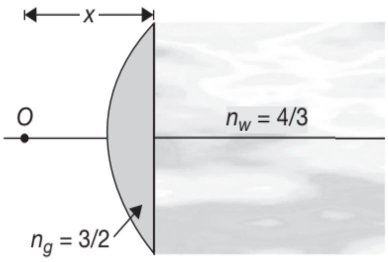
(A) A and C
(B) B and C
(C) A and B
(D) in all prisms A, B and C

84. A beam of white light is incident on a hollow prism of glass. Then



(A) the light emerging from prism gives no spectrum.
(B) the light emerging from prism gives spectrum but the bending of all colours is away from base.
(C) the light emerging from prism gives spectrum, all the colours bend towards base, the violet most and red the least.
(D) the light emerging from prism gives spectrum, all the colours bend towards base, the violet the least and red the most.

85. An object O is kept in air in front of a thin plano-convex lens of radius of curvature 10 cm. It's refractive index is $\frac{3}{2}$ and the medium towards right of plane surface is water of refractive index $\frac{4}{3}$. What should be the distance x of the object so that the rays become parallel finally.



(A) 5 cm (B) 10 cm
(C) 20 cm (D) 40 cm

86. If the critical angle for the medium of a prism is C and the angle of prism is A, then there will be no emergent ray when
(A) $A < 2C$ (B) $A = 2C$
(C) $A > 2C$ (D) $A \le 2C$

87. The angle of a prism is 60°. What is the angle of incidence for minimum deviation? The refractive index of the material of the prism is $\sqrt{2}$.
(A) 45° (B) 60°
(C) 30° (D) $\sin^{-1}\left(\frac{2}{3}\right)$

88. A ray of light is incident at angle i on one 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
(A) $\frac{A}{\mu}$ (B) $\frac{A}{2\mu}$
(C) μA (D) $\frac{\mu A}{2}$

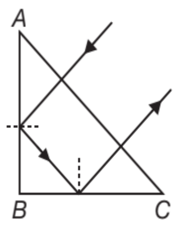
89. If ${}^i\mu_j$ represents the refractive index when a ray of light goes from medium i to medium j, then the product ${}^2\mu_1 \times {}^3\mu_2 \times {}^4\mu_3$ is equal to
(A) ${}^3\mu_1$ (B) ${}^3\mu_2$
(C) $\frac{1}{{}^1\mu_4}$ (D) ${}^4\mu_2$

90. An air bubble inside a glass slab $\left(\mu = \frac{3}{2}\right)$ appears to be 6 cm deep when viewed from one side and 4 cm deep when viewed from the opposite side. The thickness of the slab is
(A) 10 cm (B) 6.67 cm
(C) 15 cm (D) None of the above

91. 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 is
(A) $180° - 3A$ (B) $180° + 2A$
(C) $90° - A$ (D) $180° - 2A$

92. The angle of a prism is 30°. The rays incident at 60° at one refracting face suffer a deviation of 30°. The angle of emergence is
(A) 0° (B) 30°
(C) 60° (D) 90°

93. A ray falls on a prism $ABC(AB = BC)$ and travels as shown in the figure. The minimum refractive index of the prism material should be



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

94. Critical angle is minimum when a light ray passes from
(A) air to glass (B) glass to air
(C) glass to water (D) water to glass

95. A point source of light is placed 4 m below the surface of a liquid of refractive index $\frac{5}{3}$. The minimum diameter of a disc, which should be placed over the source, on the surface of the liquid to cut off all light coming out of water, is

(A) ∞ (B) 6 m
(C) 4 m (D) 3 m

96. A man standing in a swimming pool looks at a stone lying at the bottom. The depth of the swimming pool is h. At what distance from the surface of water is the image of the stone formed? Line of vision is normal. Refractive index of water is n.

(A) $\frac{h}{n}$ (B) $\frac{n}{h}$
(C) h (D) hn

97. The path of a refracted ray of light in a prism is parallel to the base of the prism only when the

(A) light is of a particular wavelength.
(B) ray is incident normally at one face.
(C) ray undergoes minimum deviation.
(D) prism is made of a particular type of glass.

98. A convex lens forms a real image three times larger than the object on a screen. The object and screen are moved until the image becomes twice the size of the object. If the shift of the object is 6 cm then the screen has to be shifted by

(A) 9 cm (B) 18 cm
(C) 36 cm (D) 72 cm

99. A vessel of depth d is half filled with a liquid of refractive index μ_1 and the other half is filled with a liquid of refractive index μ_2. The apparent depth of the vessel, when looked at normally, is

(A) $d(\mu_1+\mu_2)$ (B) $d\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}\right)$
(C) $\frac{d}{2}(\mu_1+\mu_2)$ (D) $\frac{d}{2}\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}\right)$

100. Two point sources S_1 and S_2 are 24 cm apart. Where should a convex lens of focal length 9 cm be placed in between them so that the images of both sources are formed at the same place?

(A) 6 cm from S_1 (B) 10 cm from S_1
(C) 12 cm from S_1 (D) 15 cm from S_1

101. Light travels through a glass plate of thickness t and having refractive index n. If c is the velocity of light in vacuum, the time taken by light to travel this thickness of glass is

(A) $\frac{t}{nc}$ (B) $\frac{t}{n^2c}$
(C) $\frac{nt}{c}$ (D) $\frac{n^2t}{c}$

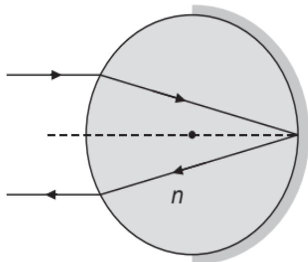
102. A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is $\frac{4}{3}$ and the fish is 12 cm below the surface of water, the radius of the circle in cm is

(A) $36\sqrt{5}$ (B) $36\sqrt{7}$
(C) $\frac{36}{\sqrt{7}}$ (D) $4\sqrt{5}$

103. A diver inside water sees the setting sun at

(A) 41° to the horizon (B) 49° to the horizon
(C) 0° to the horizon (D) 45° to the horizon

104. A transparent cylinder has its right half polished so as to act as a mirror. A paraxial light ray is incident from left, that is parallel to principal axis, exits parallel to the incident ray as shown. The refractive index n of the material of the cylinder is



(A) 1.2 (B) 1.5
(C) 1.8 (D) 2.0

105. If the refractive index of water is $\frac{4}{3}$ and that of glass is $\frac{5}{3}$, then the critical angle of incidence for light tending to go from glass to water is

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

106. Two media A and B of refractive indices $\mu_1 = 1.5$ and $\mu_2 = 2$ are separated by x-z plane. A ray of light travels from A to B. The incident ray and the reflected ray are represented by unit vectors $\vec{u}_1 = a\hat{i}+b\hat{j}$ and $\vec{u}_2 = c\hat{i}+d\hat{j}$. Then

(A) $\frac{a}{c}=\frac{3}{4}$ (B) $\frac{a}{c}=\frac{4}{3}$

(C) $\frac{b}{d}=\frac{3}{4}$ (D) $\frac{b}{d}=\frac{4}{3}$

107. The speed of light in medium A is $2.0\times10^{8}\ \text{ms}^{-1}$ and that in medium B is $2.4\times10^{8}\ \text{ms}^{-1}$. The critical angle of incidence for light tending to go from medium A to medium B is

(A) $\sin^{-1}\left(\frac{5}{12}\right)$ (B) $\sin^{-1}\left(\frac{5}{6}\right)$

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

108. The speed of light in glass of refractive index 1.5 is $2\times10^{8}\ \text{ms}^{-1}$. In a certain liquid the speed of light is $2.5\times10^{8}\ \text{ms}^{-1}$. The refractive index of the liquid is

(A) 0.64 (B) 0.80

(C) 1.20 (D) 1.44

109. A ray of light travelling inside a rectangular glass block of refractive index $\sqrt{2}$ is incident on the glass-air surface at an angle of incidence of 45°. The refractive index of air is 1. The ray will

(A) emerge into air without any deviation.

(B) be reflected back into glass.

(C) be absorbed.

(D) emerge into air with an angle of refraction equal to 90°.

110. A fish in water sees an object which is 24 cm above the surface of water. The height of the object above the surface of water that will appear to the fish is

(A) 24 cm (B) 32 cm

(C) 18 cm (D) 48 cm

111. The angle of minimum deviation equals the angle of prism A of an equilateral glass prism. The angle of incidence at which minimum deviation will be obtained is

(A) $\sin^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (B) 30°

(C) 60° (D) 45°

112. Light is incident at an angle α on one planar end of a transparent cylindrical rod of refractive index n. The least value of n for which the light entering the rod will not emerge from the curved surface of rod, irrespective of value of α is

(A) $\frac{1}{\sqrt{2}}$ (B) $\sqrt{2}$

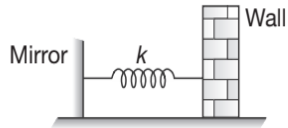
(C) $\frac{1}{\sqrt{3}}$ (D) $\sqrt{3}$

113. For a prism the refractive index (μ) is related to wavelength (λ) as $\mu = A+\frac{B}{\lambda^2}$. The dispersive power is large if

(A) A is large (B) B is large

(C) μ is large (D) A and μ are large

114. A plane mirror having a mass m is tied to the free end of a massless spring of spring constant k. The other end of the spring is attached to a wall. The spring with the mirror held vertically to the floor on which it can slide smoothly. When the spring is at its natural length, the mirror is found to be moving at a speed of $v\ \text{cms}^{-1}$. The separation between the images of a man standing before the mirror, when the mirror is in its extreme positions



(A) $v\sqrt{\frac{m}{k}}$ (B) $\frac{v}{2}\sqrt{\frac{m}{k}}$

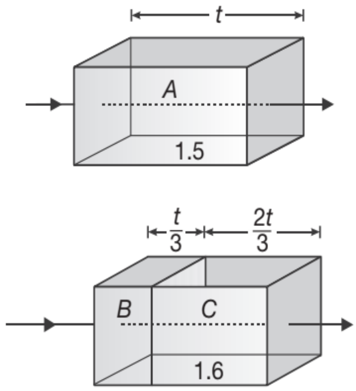
(C) $2v\sqrt{\frac{m}{k}}$ (D) $4v\sqrt{\frac{m}{k}}$

115. 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. The length of the image of the rod is

(A) $\frac{uf}{u+f}$ (B) $\frac{f^2}{u+f}$

(C) $\frac{f^2}{u-f}$ (D) $\frac{uf}{u-f}$

116. Two transparent slabs have the same thickness as shown in figure. One is made of material X of refractive index 1.5. The other is made of two materials Y and Z having thicknesses in the ratio 1 : 2. The refractive index of Z is 1.6. If a monochoromatic parallel beam passing through the slabs has the same number of wavelengths inside both, the refractive index of Y is



(A) 1.1 (B) 1.2
(C) 1.3 (D) 1.4

117. A curved mirror of focal length f (in vacuum) is placed in a medium of refractive index 2. Its new focal length in the medium is f'.

(A) $f' < f$ (B) $f' > f$

(C) $f' = f$ (D) $f' \cong f$

118. If ε_0 is the absolute permittivity of free space, μ_0 is absolute permeability of free space, ε is the permittivity of medium, μ is permeability of medium and n is the refractive index of medium then,

(A) $n = \sqrt{\dfrac{\mu_0 \mu}{\varepsilon_0 \varepsilon}}$ (B) $n = \sqrt{\dfrac{\mu \varepsilon}{\mu_0 \varepsilon_0}}$

(C) $n = \sqrt{\dfrac{\mu_0 \varepsilon_0}{\mu \varepsilon}}$ (D) $n = \dfrac{\mu \varepsilon}{\mu_0 \varepsilon_0}$

119. The critical angle of glass $\left(\mu_g = \dfrac{3}{2}\right)$ is θ_1 and that of water $\left(\mu_w = \dfrac{4}{3}\right)$ is θ_2. The critical angle for water-glass interface is

(A) less than θ_1 (B) less than θ_2

(C) between θ_1 and θ_2 (D) greater than θ_2

120. Two plane mirrors M_1 and M_2 are inclined to each other at $70°$. A ray incident on the mirror M_1 at an angle θ falls on M_2 and is then reflected parallel to M_1 for

(A) $\theta = 45°$ (B) $\theta = 50°$

(C) $\theta = 55°$ (D) $\theta = 60°$

121. An object is placed at 20 cm from a convex mirror of focal length 20 cm. The distance of the image from the pole of the mirror is

(A) infinite (B) 10 cm
(C) 15 cm (D) 40 cm

122. The sun (diameter D) subtends an angle θ radian at the pole of a concave mirror of focal length f. The diameter of the image of the sun formed by the mirror is

(A) $f\theta$ (B) $2f\theta$

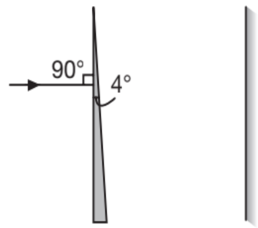
(C) $\dfrac{2f\theta}{D}$ (D) $D\theta$

123. Inside a solid glass sphere of radius R, a point source of light is embedded at a distance $x(<R)$ from centre of the sphere. The solid sphere is surrounded by air of refractive index 1. The maximum angle of incidence for rays incident on the spherical glass-air interface directly from the point source is

(A) $\cos^{-1}\left(\dfrac{x}{R}\right)$ (B) $\sin^{-1}\left(\dfrac{x}{R}\right)$

(C) $\cos^{-1}\left(\sqrt{\dfrac{x}{R}}\right)$ (D) $\sin^{-1}\left(\sqrt{\dfrac{x}{R}}\right)$

124. A prism having an apex angle $4°$ and refractive index 1.5 is located in front of a vertical plane mirror as shown in figure. The total angle through which the ray is deviated after reflection from the mirror is given by

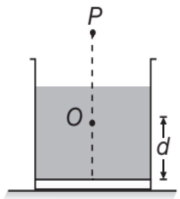


(A) 176° (B) 4°
(C) 178° (D) 2°

125. A slab of glass of thickness 3 cm and refractive index $\dfrac{3}{2}$ is placed with its face perpendicular to the principal axis of the concave mirror. If the radius of mirror is 10 cm, the distance at which an object must be placed from the mirror so that the image coincides with the object is

(A) 9 cm (B) 10 cm
(C) 11 cm (D) 12 cm

126. A tank contains a transparent liquid of refractive index n the bottom of which is made of a mirror as shown. An object O lies at a height d above the mirror. A person P vertically above the object sees O and its image in the mirror and finds the apparent separation to be



(A) $2nd$ (B) $\frac{2d}{n-1}$

(C) $\frac{2d}{n}$ (D) $\frac{d}{n}(1+n)$

127. A ray of light enters an anisotropic medium from vacuum at grazing incidence. If θ is the angle made by the reflected ray inside the medium with the interface and $n(\theta)$ is the refractive index of the medium then,

(A) $n(\theta)\sin\theta = 1$ (B) $n(\theta)\cos\theta = 1$

(C) $\frac{n(\theta)}{\sin\theta} = 1$ (D) $\frac{n(\theta)}{\cos\theta} = 1$

128. A person runs with a speed u towards a bicycle moving away from him with speed v. The person approaches his image in the mirror fixed at the rear of bicycle with a speed of

(A) $u - v$ (B) $u - 2v$
(C) $2u - v$ (D) $2(u - v)$

129. Light travels through a glass plate of thickness t having refractive index μ. If c is the velocity of light in vacuum, the time taken by the light to travel this thickness of glass is

(A) $\frac{t}{\mu c}$ (B) $\frac{t}{\mu^2 c}$

(C) $\frac{\mu t}{c}$ (D) $\frac{\mu^2 t}{c}$

130. A real image I is formed by a converging lens L on its optic axis. On introduction of a rectangular glass slab of thickness d and refractive index μ between the image and lens the image displaces it by

(A) $d(\mu - 1)$ away from L

(B) $d(\mu - 1)$ towards L

(C) $d\left(1 - \frac{1}{\mu}\right)$ away from L

(D) $d\left(1 - \frac{1}{\mu}\right)$ towards L

131. When a ray is refracted from one medium to another, the wavelength changes from $6000\ \text{Å}$ to $4000\ \text{Å}$. The critical angle for the interface will be

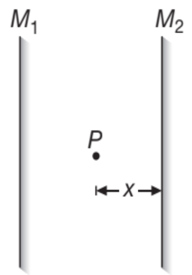
(A) $\cos^{-1}\left(\frac{2}{3}\right)$ (B) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$

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

132. A boy stands straight in front of a mirror at a distance of 30 cm away from it. He sees his erect image whose height is one fifth of the original height. The mirror used by him is

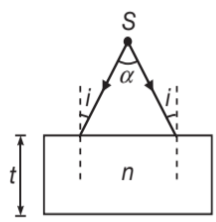
(A) plane (B) convex
(C) concave (D) plano concave

133. Two plane mirrors M_1 and M_2 are parallel to each other and 3 m part. A person P standing x metre from the right mirror M_2 looks into this mirror and sees a series of images. The distance between the first and second image is 4 m. Then the value of x is



(A) 4 m (B) 3 m
(C) 1 m (D) 2 m

134. A diverging beam of light from a point source S having divergence angle α, falls symmetrically on a glass slab as shown. The angles of incidence of two extreme rays are equal. If the thickness of the glass slab is t and the refractive index n, then the divergence angle of the emergent beam is



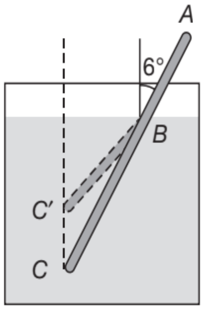
(A) Zero (B) α

(C) $\sin^{-1}\left(\frac{1}{n}\right)$ (D) $2\sin^{-1}\left(\frac{1}{n}\right)$

135. The light on reflection from a plane mirror can give a real image when

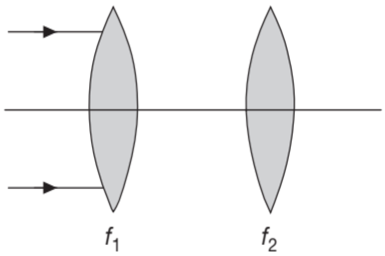
(A) the convergent rays are incident on the mirror.
(B) the divergent rays are incident on the mirror.
(C) an object is placed very close to the mirror.
(D) an object is placed very far away from the mirror.

136. A small rod ABC is put in water making an angle $6°$ with vertical. If it is viewed paraxially from above, it will look like bent shaped ABC'. The angle of bending $(\angle CBC')$ will be in degree is $\left(n_w = \frac{4}{3}\right)$.



(A) $2°$ (B) $3°$
(C) $4°$ (D) $4.5°$

137. Parallel beam of light is incident on the system of two convex lenses of focal length $f_1 = 20$ cm and $f_2 = 10$ cm. The distance between the two lenses, so that rays after refraction from both the lenses pass undeviated is



(A) 30 cm (B) 40 cm
(C) 60 cm (D) 90 cm

138. The plane faces of two identical plano convex lenses, each with focal length f are pressed against each other using an optical glue to form a usual convex lens. The distance from the optical centre at which an object must be placed to obtain the image same as the size of object is

(A) $\frac{f}{4}$ (B) $\frac{f}{2}$
(C) f (D) $2f$

139. A parallel beam of light incident on a concave lens of focal length 10 cm emerges as a parallel beam from a convex lens placed coaxially, the separation between the lenses being 10 cm. The focal length of the convex lens in cm is
(A) 10 (B) 20
(C) 15 (D) 30

140. A ray of light is incident on a glass sphere of refractive index $\frac{3}{2}$. The angle of incidence for which a ray that enters the sphere does not come out of the sphere is

(A) $\tan^{-1}\left(\frac{2}{3}\right)$ (B) $\sin^{-1}\left(\frac{2}{3}\right)$
(C) $45°$ (D) $90°$

141. A thin prism P_1 of angle $4°$ and made from glass of refractive index 1.54, is combined with another thin prism P_2 made from a glass with refractive index 1.72, to produce dispersion without deviation. The angle of P_2 is

(A) $5.33°$ (B) $4°$
(C) $3°$ (D) $2.6°$

142. A transparent sphere of radius R made of material of refractive index $\frac{3}{2}$ is kept in air. The distance from the centre of the sphere must a point object be placed so as to form a real image at the same distance from the sphere is

(A) R (B) $2R$
(C) $3R$ (D) $4R$

143. An air bubble in water is to be placed in a way such that a real image is obtained at the same distance from bubble. Taking $\mu_{\text{water}} = \frac{4}{3}$ we have the distance of object from the air bubble as

(A) R
(B) $2R$
(C) $3R$
(D) An air bubble is incapable to form a real image.

144. An object is placed at a distance of 12 cm from a convex lens on its principal axis and a virtual image of certain size is formed. On moving the object 8 cm away from the lens, a real image of the same size as that of virtual image is formed. The focal length of the lens in cm is
(A) 15 (B) 16
(C) 17 (D) 18

145. An air bubble inside a glass slab appears to be 6 cm deep when viewed from one side and 4 cm deep when viewed from the other side. Assuming $\mu_{\text{glass}} = \frac{3}{2}$, the thickness of slab is

(A) 10 cm (B) $\frac{20}{3}$ cm

(C) 15 cm (D) 20 cm

146. On two sides of an oily paper screen, two bulbs A and B are placed at a distance of 20 cm and 30 cm, so that equal intensity is obtained on both sides of screen. If P_A and P_B be the powers of the bulbs A and B respectively then $\frac{P_A}{P_B}$ is

(A) 0.44 (B) 2.25
(C) 1.5 (D) 0.67

147. An achromatic combination pair of a telescope objective will be

(A) lenses of $f = -50$ cm and power $+2$ D
(B) lenses of powers 3 D and –5 D respectively
(C) lenses of $f = +20$ cm and power -4.5 D
(D) lenses of $f = +40$ cm and power $+2$ D

148. A ray of light enters the face of a glass prism of refracting angle A, refractive index μ at an angle of incidence i. It is observed that no ray emerges from the other face. For this the minimum value of i should be

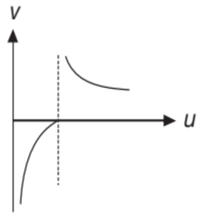
(A) $\mu \sin A - \cos A$
(B) $\sin^{-1}(\sin A - \mu \cos A)$
(C) $\sin^{-1}\left[\sqrt{\mu^2 - 1}\sin A - \cos A\right]$
(D) $\sqrt{\mu^2 - 1}\sin A - \cos A$

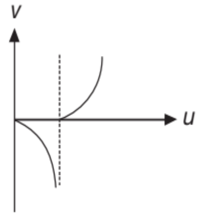
149. A beaker containing liquid is placed on the table underneath a microscope which can be moved along a vertical scale. The microscope is focussed, through the liquid onto a mark on the table when the reading on the scale is a. It is next focussed on the upper surface of liquid and the reading is b. More liquid is added and the observations are repeated. The corresponding readings are c and d. The refractive index of liquid is

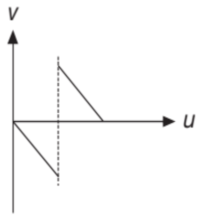
(A) $\frac{d-b}{d-c-b+a}$ (B) $\frac{d-c-b+a}{d-b}$

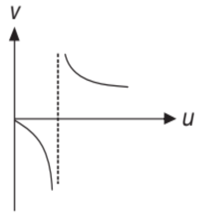
(C) $\frac{b-d}{d-c-b+a}$ (D) $\frac{d-c-b+a}{b-d}$

150. As the position of an object (u) reflected from a concave mirror is varied, the position of the image (v) also varies. By allowing the u to change from 0 to $+\infty$, the graph between v versus u will be

(A)


(B)


(C)


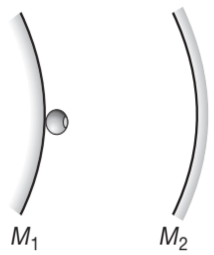
(D)


151. A parallel beam of light emerges from the opposite surface of the sphere when a point source of light lies at the surface of the sphere. The refractive index of the sphere is

(A) $\frac{3}{2}$ (B) $\frac{5}{3}$

(C) 2 (D) $\frac{5}{2}$

152. Two spherical mirrors M_1 and M_2, one convex and other concave having same radius of curvature R are arranged coaxially at a distance $2R$ (consider their pole separation to be $2R$). A bead of radius a is placed at the pole of the convex mirror as shown. The ratio of the sizes of the first three images of the bead is



(A) 1 : 2: 3 (B) $1 : \frac{1}{2} : \frac{1}{3}$

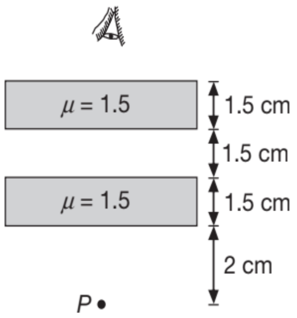
(C) $\frac{1}{3} : \frac{1}{11} : \frac{1}{41}$ (D) 3 : 11 : 41

153. A ray of light is incident on one face of prism with refracting angle $A\,(<90^\circ)$. The incident ray is normal to the other face of the prism. If C is the critical angle for prism-air interface, then the ray will emerge from this face only if

(A) $\cot C < \cot A + 1$ (B) $\cot C > \cot A + 1$

(C) $\cot A < \cot C + 1$ (D) $\cot A > \cot C + 1$

154. The image of point P when viewed from top of the glass slabs is

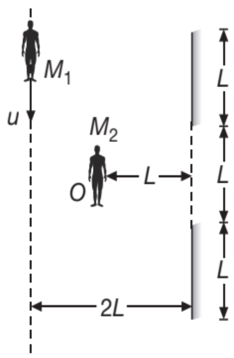


(A) 2 cm above P (B) 0.5 cm above P
(C) 0.5 cm below P (D) 1 cm above P

155. An isosceles prism has refracting angle A. Its one face is silvered (other than the base). A ray of light falling normally on the face not silvered emerges through the base of the prism normal to it.

(A) $A = 45°$ (B) $A = 90°$
(C) $A = 36°$ (D) $A = 72°$

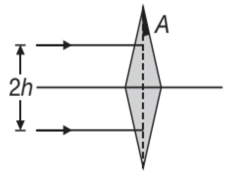
156. Two plane mirrors of length L are separated by distance L and a man M_2 is standing at distance L from the connecting line of mirrors as shown in figure.



A man M_1 is walking in a straight line at distance $2L$ parallel to mirrors at speed u, then man M_2 at O will be able to see image of M_1 for total time

(A) $\frac{4L}{u}$ (B) $\frac{3L}{u}$
(C) $\frac{6L}{u}$ (D) $\frac{9L}{u}$

157. Two identical thin isosceles prisms of refracting angle A and refractive index μ are placed with their bases touching each other and this system can collectively act as a crude converging lens. A parallel beam of light is incident on this system as shown. The focal length of this so called converging lens is

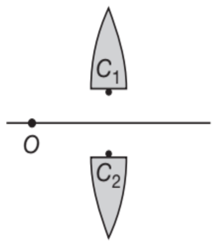


(A) $f = \frac{h}{\mu A}$ (B) $f = \frac{h}{A}$
(C) $f = \frac{h}{(\mu - 1)A}$ (D) $f = \frac{\mu h}{\mu - 1}$

158. Rays of light from a luminous object are brought to focus at a point A. The rays are intercepted, before meeting at A by a convex lens of focal length 20 cm placed at 24 cm from A and are forced to meet at B. Then AB equals (in cm)

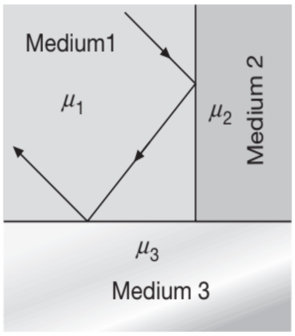
(A) 12 (B) 24
(C) 6 (D) 48

159. A point object is placed at a distance of 0.3 m from a convex lens of focal length 0.2 m cut into two equal halves, each of which is displaced by 0.0005 m, as shown in figure. If C_1 and C_2 be their optical centres then,



(A) an image is formed at a distance of 0.6 m from C_1 or C_2 along principal axis.
(B) two images are formed, one at a distance of 0.6 m and other at a distance of 1.2 m from C_1 or C_2 along principal axis.
(C) an image is formed at a distance of 0.12 m from C_1 or C_2 along principal axis.
(D) two images are formed at a distance of 0.6 m from C_1 or C_2 along principal axis at a separation of 0.003 m.

160. In the figure shown, light is incident on the interface between medium 1 (refractive index μ_1) and 2 (refractive index μ_2) at angle slightly greater than the critical angle, and is totally reflected. The light is then also totally reflected at the interface between medium 1 and 3 (refractive index μ_3), after which it travels in a direction opposite to its initial direction. The medium must have a refractive indices such that



(A) $\mu_1 < \mu_2 < \mu_3$ (B) $\mu_1^2 - \mu_3^2 > \mu_2^2$

(C) $\mu_1^2 - \mu_2^2 < \mu_3^2$ (D) $\mu_1^2 + \mu_2^2 > \mu_3^2$

161. All of the following statements are correct except that

(A) the magnification produced by a convex mirror is always less than one.

(B) a virtual, erect, same sized image can be obtained by using the plane mirror.

(C) a virtual, erect, magnified image can be formed by using the concave mirror.

(D) a real, inverted, same sized image can be formed by using a convex mirror.

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

(A) $0°$ (B) $15°$

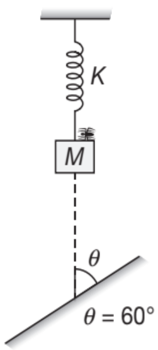
(C) $30°$ (D) $45°$

163. A convex lens of focal length f forms an image of a heavenly body. The area of the image formed is proportional to

(A) f^0 (B) f^1

(C) f^2 (D) f^3

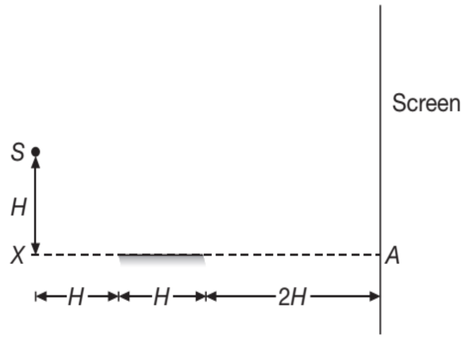
164. An insect of negligible mass is sitting on a block of mass M, tied with a spring of force constant k. The block performs simple harmonic motion with amplitude A in front of a plane mirror placed as shown in figure. The maximum speed of insect relative to its image will be



(A) $A\sqrt{\frac{k}{M}}$ (B) $\frac{A\sqrt{3}}{2}\sqrt{\frac{k}{M}}$

(C) $A\sqrt{3}\sqrt{\frac{k}{M}}$ (D) $2A\sqrt{\frac{M}{k}}$

165. A point source has been placed as shown in the figure. The length on the screen that will receive reflected light from the mirror is



(A) $2H$ (B) $3H$

(C) $4H$ (D) H

166. A plano convex lens has a thickness of 4 cm. When placed on a horizontal table with 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 centre of plane face is found to be $\frac{25}{8}$ cm. The focal length of the lens is

(A) 50 cm (B) 75 cm

(C) 100 cm (D) 150 cm

167. If an object is placed between two parallel mirrors, an infinite number of images are formed. If the mirrors are at a distance $2b$ and an object is placed at the middle of the two mirrors, the distance of the nth image from the object is

(A) nb (B) $\frac{1}{2}nb$

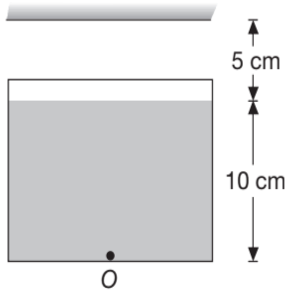
(C) $2nb$ (D) $\frac{1}{4}nb$

168. A ray of light is incident on the plane mirror at rest. The mirror starts turning at a uniform acceleration of 2π rads^{-2}. The reflected ray, at the end of $\frac{1}{4}$ s must have turned through

(A) $90°$ (B) $45°$

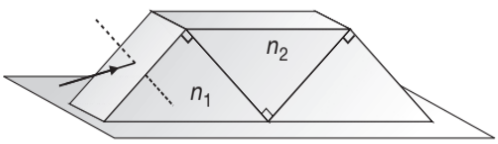
(C) $22.5°$ (D) $11.25°$

169. In the situation shown in figure, water $\left(\mu_w = \frac{4}{3}\right)$ 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) 7.5 cm (B) 10 cm
(C) 12.5 cm (D) 15 cm

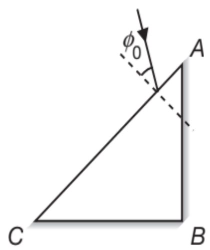
170. Three right angled prisms of refractive indices n_1, n_2 and n_3 are fixed together using an optical glue as shown in figure. If a ray passes through the prisms without suffering any deviation, then



(A) $n_1 = n_2 = n_3$ (B) $n_1 = n_2 \neq n_3$
(C) $1 + n_1 = n_2 + n_3$ (D) $1 + n_2^2 = n_1^2 + n_3^2$

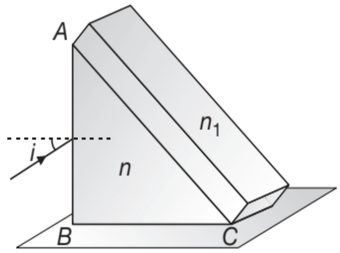
171. Four lenses are made from same type of glass. The radius of curvature of each face is given . Out of these, the lens having the greatest positive power is
(A) 10 cm convex and 15 cm convex.
(B) 20 cm convex and 30 cm concave.
(C) 15 cm convex and plane.
(D) 5 cm convex and 10 cm concave.

172. The sides of an isosceles right angled prism are silvered. A ray of light falls on the hypotenuse of the prism at an angle ϕ_0 as shown. The ray leaving the prism will



(A) graze the face AC.
(B) emerge normally to the face AC.
(C) be parallel to the incident ray.
(D) make an angle of $30°$ with incident ray.

173. A right angled prism $(45°\text{-}90°\text{-}45°)$ of refractive index n has a plate of refractive index $n_1 (n_1 < n)$ cemented to its diagonal face. The assembly is in air. A ray is incident on AB as shown. If the ray strikes the diagonal face AC at critical angle then



(A) $\sin i = \left(\frac{n_1}{n}\right)$

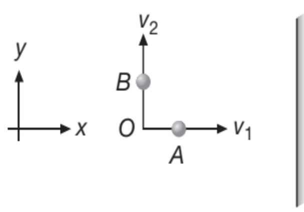
(B) $\sin i = \left(\frac{n}{n_1}\right)$

(C) $\sin i = \sqrt{\frac{n^2 - n_1^2}{2}}$

(D) $\sin i = \frac{\sqrt{n^2 - n_1^2} - n_1}{\sqrt{2}}$

174. A fish in near the centre of a spherical fish bowl filled with water of refractive index $\frac{4}{3}$. A child stands in air at a distance $2R$ (R is the radius of curvature of the sphere) from the centre of the bowl. At what distance from the centre would the child's nose appear to the fish situated at the centre
(A) R (B) $2R$
(C) $3R$ (D) $4R$

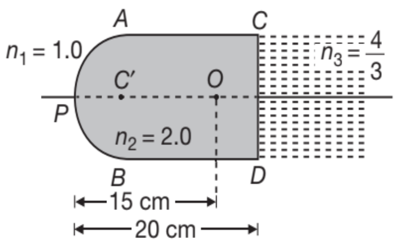
175. Two particles A and B of mass m_1 and m_2 respectively start moving from O with speeds v_1 and v_2. A moves towards the plane mirror and B moves parallel to mirror horizontally. The mirror is in y-z plane. The absolute-speed of image of centre of mass of the system (image of A + image of B) is



(A) Zero (B) $\dfrac{m_1 v_1}{m_2}$

(C) $\dfrac{m_2 v_2}{m_1}$ (D) $\dfrac{\sqrt{m_1^2 v_1^2 + m_2^2 v_2^2}}{m_1 + m_2}$

176. The slab of a material of refractive index 2 shown in figure has a curved surface APB of radius of curvature 10 cm and a plane surface CD. On the left of APB is air and on the right of CD is water with refractive indices as given in figure. An object O is placed at a distance of 15 cm from pole P as shown. The distance of the final image of O from P, as viewed from the left is



(A) 20 cm (B) 30 cm
(C) 40 cm (D) 50 cm

177. A thin rod of length $\frac{1}{3}f$ is placed along the optic axis of a concave mirror of focal length f such that its image which is real and elongated just touches the rod. The magnification is

(A) $\dfrac{4}{3}$ (B) $\dfrac{5}{3}$

(C) $\dfrac{3}{2}$ (D) None of above

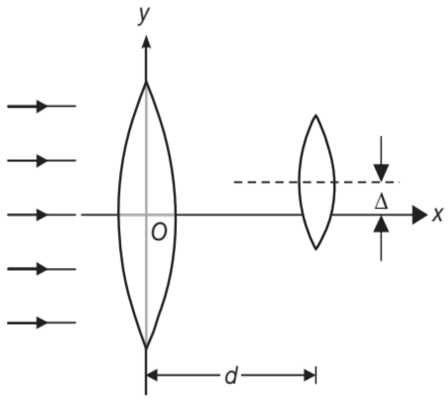
178. A 2 cm diameter coin lies flat at the bottom of a bowl in which the water $\left(\mu_w = \frac{4}{3}\right)$, is 20 cm deep. If the coin is viewed directly from above, the apparent diameter of the coin is

(A) 1.67 cm (B) 1.5 cm
(C) 2.67 cm (D) 2 cm

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

(A) $30°$ (B) $45°$
(C) $60°$ (D) $0°$

180. Two thin convex lenses of focal lengths f_1 and f_2 are separated by a horizontal distance d (where $d < f_1$ and $d < f_2$) and their centres are displaced by a vertical separation Δ as shown. Taking the origin of coordinates O, at the centre of the first lens, the x and y coordinates of the focal point of this lens system, for a parallel beam of rays coming from the left, are given by



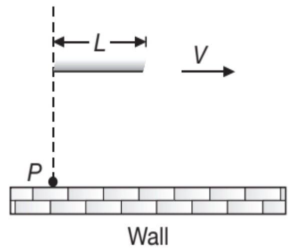
(A) $x = \dfrac{f_1 f_2}{f_1 + f_2}, \quad y = \Delta$

(B) $x = \dfrac{f_1(f_2 + d)}{f_1 + f_2 - d}, \quad y = \dfrac{\Delta^2}{f_1 + f_2}$

(C) $x = \dfrac{f_1 f_2 + d(f_1 - d)}{f_1 + f_2 - d}, \quad y = \dfrac{\Delta(f_1 - d)}{f_1 + f_2 - d}$

(D) $x = \dfrac{f_1 f_2 + d(f_1 - d)}{f_1 + f_2 - d}, \quad y = 0$

181. The mirror of length L moves horizontally as shown in the figure with a velocity v. The mirror is illuminated by a point source of light P placed on the ground. The rate at which the length of the light spot on the ground increases is



(A) v (B) zero
(C) $2v$ (D) $3v$

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

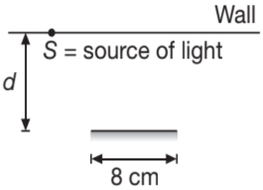
(A) $40°$ (B) $45°$
(C) $30°$ (D) $49°$

183. A circular beam of light of diameter $d = 2$ cm falls on a plane surface of a glass slab. The angle of incidence is 60° and refractive index of glass is $\mu = \frac{3}{2}$. The diameter of the refracted beam is
(A) 2.52 cm (B) 3 cm
(C) 3.26 cm (D) 4 cm

184. Two thin lenses, when in contact, produce a combination of power $+10$ D. When they are 0.25 m apart, the power reduces to $+6$ D. The focal lengths of the lenses (in m) are
(A) 0.125 and 0.5 (B) 0.125 and 0.125
(C) 0.5 and 0.75 (D) 0.125 and 0.75

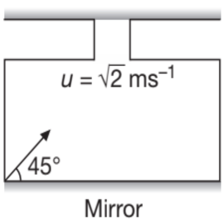
185. A luminous point object is moving along the principal axis of a concave mirror of focal length 12 cm towards it. When its distance from the mirror is 20 cm its velocity is 4 cms^{-1}. The velocity of the image $\left(\text{in cms}^{-1}\right)$ at that instant is
(A) 6, towards the mirror
(B) 6, away from the mirror
(C) 9, away from the mirror
(D) 9, towards the mirror

186. A plane mirror of length 8 cm is present near a wall in situation as shown in figure. The length of spot formed on the wall is



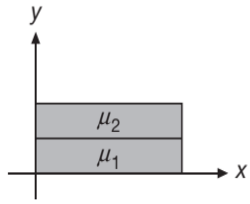
(A) 4 cm (B) 8 cm
(C) 16 cm (D) 32 cm

187. An elevator at rest which is at tenth floor of a building is having a plane mirror fixed to its floor. A particle is projected with a speed $\sqrt{2}$ ms^{-1} and at 45° with the horizontal as shown in the figure. At the very instant of projection, the cable of the elevator breaks and the elevator starts falling freely. The separation between the particle and its image, 0.5 s after the instant of projection is



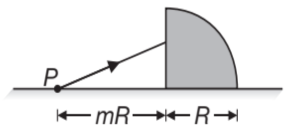
(A) 0.5 m (B) 1 m
(C) 1.5 m (D) 2 m

188. Two thin slabs of refractive indices μ_1 and μ_2 are placed parallel to each other in the x-z plane. If the direction of propagation of a ray in the two media are along the vectors $\vec{r}_1 = a\hat{i} + b\hat{j}$ and $\vec{r}_2 = c\hat{i} + d\hat{j}$ then we have



(A) $\mu_1 a = \mu_2 b$
(B) $\frac{\mu_1 a}{\sqrt{a^2+b^2}} = \frac{\mu_2 a}{\sqrt{c^2+d^2}}$
(C) $\mu_1\left(a^2+b^2\right) = \mu_2\left(c^2+d^2\right)$
(D) None of these

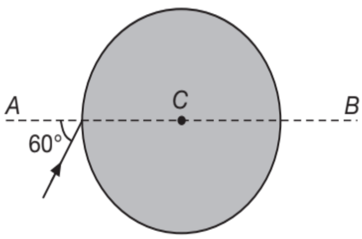
189. A quarter cylinder of radius R and refractive index 1.5 is placed on a table. A point object P is kept at a distance of mR from it. The value of m for which a ray from P will emerge parallel to the table is



(A) $\frac{1}{3}$ (B) $\frac{2}{3}$
(C) 1 (D) $\frac{4}{3}$

190. A light ray is incident on a prism of angle $A = 60^\circ$ and refractive index $\mu = \sqrt{2}$. The angle of incidence at which the emergent ray grazes the surface is given by
(A) $\sin^{-1}\left(\frac{\sqrt{3}-1}{2}\right)$ (B) $\sin^{-1}\left(\frac{1-\sqrt{3}}{2}\right)$
(C) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$ (D) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$

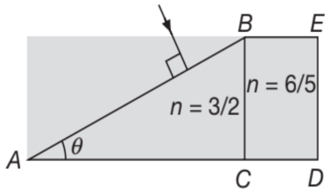
191. A ray of light falls on a transparent sphere of refractive index μ, having centre at C as shown in figure. The ray emerges from the sphere parallel to line AB, then



(A) $\mu = \sqrt{2}$ (B) $\mu = \frac{3}{2}$

(C) $\mu = \sqrt{3}$ (D) $\mu = 2$

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



(A) $\theta \le 37°$ (B) $\theta < 37°$

(C) $\theta \le 53°$ (D) $\theta < 53°$

193. The curvature radii of a concavo-convex glass lens are 20 cm and 60 cm. The convex surface of the lens is silvered. With the lens horizontal, the concave surface is filled with water. The focal length of the effective mirror is (μ of glass $= 1.5$, μ of water $= \frac{4}{3}$)

(A) $\frac{90}{13}$ cm (B) $\frac{80}{13}$ cm

(C) $\frac{20}{3}$ cm (D) $\frac{45}{8}$ cm

194. A beaker is filled with water as shown in Figure I. The bottom surface of the beaker is a concave mirror of large radius of curvature and small aperture. The height of water is $h = 40\text{ cm}$. It is found that when an object is placed 4 cm above the water surface, the image coincides with the object. Now the water level h is reduced to zero but there will still be some water left in the concave part of the mirror as shown in Figure II. The new height of the object h' above the new water surface so that the image again coincides with the object, will be (Refractive index of water $= \frac{4}{3}$)

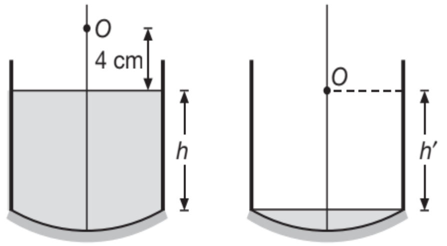


Figure I Figure II

(A) 34 cm (B) 10 cm

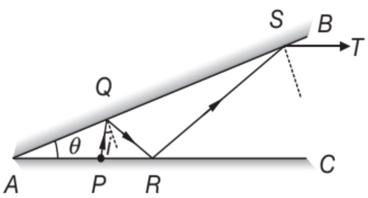
(C) 74 cm (D) Zero

195. Two identical equiconvex lenses of focal length f, made of glass $\left(\mu_g = \frac{3}{2}\right)$ are kept in contact. The space between the two lenses is filled with water $\left(\mu_w = \frac{4}{3}\right)$. The focal length of the combination is

(A) $\frac{f}{2}$ (B) $\frac{3f}{4}$

(C) f (D) $\frac{4f}{3}$

196. Two plane mirrors AB and AC are inclined at an angle $\theta = 20°$. A ray of light starting from point P is incident at point Q on the mirror AB, then at R on mirror AC and again on S on AB. Finally the ray ST goes parallel to mirror AC. The angle which the ray makes with the normal at point Q on mirror AB is



(A) 20° (B) 30°

(C) 40° (D) 60°

197. A thin lens of focal length f and its aperture has a diameter d. It forms an image of intensity I. Now the central part of the aperture upto diameter $\left(\frac{d}{2}\right)$ is blocked by an opaque paper. The focal length and image intensity would change to

(A) $\frac{f}{2}, \frac{I}{2}$ (B) $f, \frac{I}{4}$

(C) $\frac{3f}{4}, \frac{I}{2}$ (D) $f, \frac{3I}{4}$

198. A certain prism is found to produce a minimum deviation of $38°$. It produces a deviation of $44°$ when the angle of incidence is either $42°$ or $62°$. What will be the angle of incidence when it undergoes minimum deviation?

(A) 45° (B) 49°

(C) 40° (D) 55°

199. Critical angle for a prism is $36°$. The maximum angle of prism for which the emergent ray is possible is

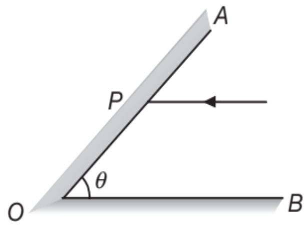
(A) 18° (B) 36°

(C) 72° (D) 144°

200. A screen is placed 90 cm from an object. The image of the object on the screen is formed by a convex lens at two different positions separated from each other by 20 cm. The lens has a focal length of
(A) 32.1 cm (B) 15.8 cm
(C) 21.4 cm (D) 10.7 cm

201. A prism, having refractive index $\sqrt{2}$ and refracting angle 30°, has one of the refracting surfaces polished. A beam of light incident on the other refracting surface will retrace its path if the angle of incidence is
(A) 0° (B) 30°
(C) 45° (D) 60°

202. 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 equals



(A) 30° (B) 45°
(C) 60° (D) 90°

203. An object is placed 20 cm in front of a block of glass 10 cm thick having its farther side silvered. The image is formed 23.2 cm behind the silvered face. The refractive index of glass is
(A) 1.41 (B) 1.46
(C) 1.51 (D) 1.61

204. Two parallel rays are travelling in a medium of refractive index $\mu_1 = \frac{4}{3}$. However, one of the rays passes through a parallel glass slab of thickness t and refractive index $\mu_2 = \frac{3}{2}$. The path difference between the two rays due to the glass slab is
(A) $\frac{t}{8}$ (B) $\frac{t}{6}$
(C) $\frac{4t}{3}$ (D) $\frac{3t}{2}$

205. A ray of light entering from air to glass (refractive index 1.5) is partly reflected and partly refracted. If the incident and the reflected rays are at right angles to each other, the angle of refraction is
(A) $\sin^{-1}\left(\sqrt{\frac{2}{3}}\right)$ (B) $\sin^{-1}\left(\frac{\sqrt{2}}{3}\right)$
(C) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (D) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$

206. A beam of light is converging towards a point on a screen. A plane parallel sided plate of glass of thickness t and refractive index μ is introduced in the path of the beam. The convergence point is shifted by
(A) $t\left(1-\frac{1}{\mu}\right)$ away (B) $t\left(1+\frac{1}{\mu}\right)$ away
(C) $t\left(1-\frac{1}{\mu}\right)$ nearer (D) $t\left(1+\frac{1}{\mu}\right)$ nearer

207. The distance of an object from the first focus of an equiconvex lens is 10 cm and the distance of its real image from the second focus is 40 cm. The focal length of the lens is
(A) 10 cm (B) 20 cm
(C) 25 cm (D) 40 cm

208. A beam of monochromatic light is incident on one face of an equilateral prism, the angle of incidence being 55°. If the angle of emergence is 46° then the angle of minimum deviation is
(A) 41° (B) $< 41°$
(C) $> 41°$ (D) $\geq 41°$

209. When a ray of light is refracted by a prism such that the angle of deviation is minimum, then
(A) the angle of emergence is equal to the angle of incidence.
(B) the angle of emergence is greater than the angle of incidence.
(C) the angle of emergence is smaller than the angle of incidence.
(D) the sum of the angle of incidence and the angle of emergence is equal to 90°.

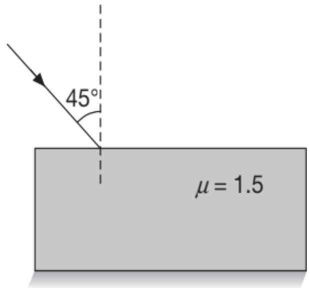
210. The image of a square hole in a screen illuminated by light is obtained on another screen with the help of a converging lens. The distance of the hole from the lens is 40 cm. If the area of the image is nine times that of the hole, the focal length of the lens is
(A) 30 cm (B) 50 cm
(C) 60 cm (D) 75 cm

211. A short linear object of length b lies along the axis of a concave mirror of focal length f at a distance u from the pole of the mirror. The size of the image is approximately equal to

(A) $b\sqrt{\dfrac{u-f}{f}}$ (B) $b\left(\dfrac{u-f}{f}\right)^2$

(C) $b\sqrt{\dfrac{f}{u-f}}$ (D) $b\left(\dfrac{f}{\mu-f}\right)^2$

212. One side of a glass slab of refractive index 1.5 is silvered as shown. A ray of light is incident on the other side at angle of incidence $i = 45°$. The deviation of the ray of light from its initial path when it comes out of the slab is

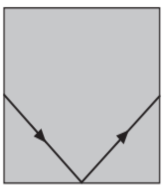


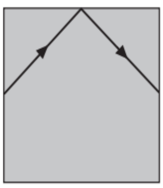
(A) 45° (B) 90°
(C) 120° (D) 180°

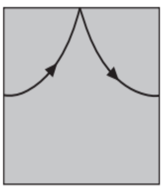
213. If f_B and f_R are the focal lengths of a convex lens for blue and red lights respectively and F_B and F_R are the respective values for a concave lens, then

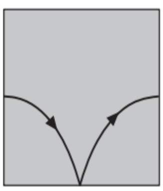
(A) $f_B > f_R$ and $F_B > F_R$ (B) $f_B < f_R$ and $F_B > F_R$
(C) $f_B > f_R$ and $F_B > F_R$ (D) $f_B < f_R$ and $F_B < F_R$

214. A cubic container is filled with a liquid whose refractive index increases linearly from top to bottom. The path of a ray of light inside the liquid is best represented by

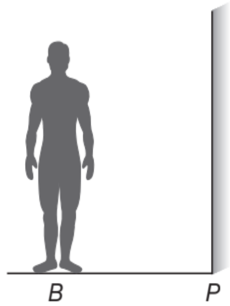
(A) 

(B) 

(C) 

(D) 

215. A person AB of height 170 cm is standing in front of a plane mirror. His eyes are at height 164 cm. At what distance from P should a hole be made in the mirror so that he cannot see the top of his head



(A) 167 cm (B) 161 cm
(C) 163 cm (D) None of these

216. The focal length of a convex lens is f and the distance of an object from the principal focus is x. The ratio of the size of the real image to the size of the object is

(A) $\dfrac{f}{x}$ (B) $\dfrac{x}{f}$

(C) $\dfrac{f+x}{f}$ (D) $\dfrac{f}{f+x}$

217. Focal length of a convex mirror is 10 cm

(A) image of an object placed at 20 cm is also at 20 cm
(B) image of an object placed at 10 cm is at infinity
(C) both (A) and (B) are correct
(D) both (A) and (B) are incorrect

218. An object is placed at a distance x_1 from the principal focus of a lens and its real image is formed at a distance x_2 from the principal focus. The focal length of the lens is

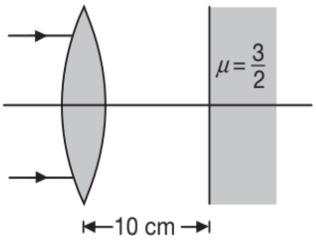
(A) x_1x_2 (B) $\dfrac{x_1x_2}{2}$

(C) $\dfrac{x_1+x_2}{2}$ (D) $\sqrt{x_1x_2}$

219. The plane faces of two identical planoconvex lenses, each having focal length of 40 cm, are pressed against each other to form a usual convex lens. The distance in cm from this lens, at which an object must be placed to obtain a real image with magnification unity is

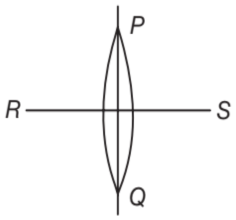
(A) 10 (B) 20
(C) 40 (D) 80

220. A plane refracting surface of refractive index $\dfrac{3}{2}$ is placed at a distance of 10 cm from a thin convex lens of focal length 30 cm. The parallel rays incident on lens will converge at a distance of



(A) 30 cm from the lens. (B) 25 cm from the lens.
(C) 20 cm from the lens. (D) 40 cm from the lens.

221. The figure shows an equiconvex lens of focal length f. If the lens is cut along PQ, the focal length of each half will be

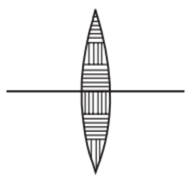


(A) $\frac{f}{2}$ (B) f
(C) $2f$ (D) $4f$

222. In PROBLEM 221, if the lens is cut along PQ and RS simultaneously, the focal length of each part will be

(A) $\frac{f}{2}$ (B) f
(C) $2f$ (D) $4f$

223. The layered lens as shown is made of two types of transparent materials-one indicated by horizontal lines and the other by vertical lines. The number of images formed of an object will be



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

224. The distance between an object and its real image formed by a convex lens cannot be
(A) greater than $2f$ (B) less than $2f$
(C) greater than $4f$ (D) less than $4f$

225. Two thin symmetrical lenses of different nature and of different material have equal radii of curvature $R = 15$ cm are placed close together and immersed in water $\left(\mu_w = \frac{4}{3}\right)$. The focal length of the system in water is 30 cm. The difference between refractive indices of the two lenses is

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$
(C) $\frac{1}{4}$ (D) $\frac{3}{4}$

226. A needle of length 5 cm, placed 45 cm from a lens forms an image on a screen placed 90 cm on the other side of the lens. The type of lens and its focal length are
(A) convex, 30 cm (B) concave, 30 cm
(C) convex, 60 cm (D) concave, 60 cm

227. In PROBLEM 226, the nature and size of the image are
(A) real, 20 cm (B) real, 10 cm
(C) virtual, 20 cm (D) virtual, 10 cm

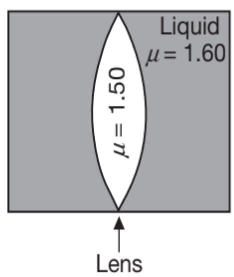
228. An object is placed 50 cm in front of a convex surface of radius 20 cm. If the surface separates air from glass of refractive index 1.5, the distance of the image from the lens and its nature are
(A) 30 cm, real (B) 30 cm, virtual
(C) 300 cm, real (D) 300 cm, virtual

229. One of the refracting surfaces of a prism of angle $30°$ is silvered. A ray of light incident at an angle of $60°$ retraces its path. The refractive index of the material of prism is

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

230. A slab of glass of refractive index 1.5 and thickness 3 cm is placed with the faces perpendicular to the principal axis of a concave mirror. If the radius of curvature of the mirror is 10 cm, the distance at which an object must be placed from the mirror so that the image coincides with the object is
(A) 9 cm (B) 10 cm
(C) 11 cm (D) 12 cm

231. Figure represents a convergent lens placed inside a cell filled with a liquid. The lens has a focal length +20 cm when in air and its material has refractive index 1.50. If the liquid has a refractive index 1.60, the focal length of the lens in the new system is



(A) –80 cm (B) +80 cm

(C) –160 cm (D) –24 cm

232. A point object O is placed on the principal axis of a convex lens of focal length 20 cm at a distance of 40 cm to the left of it. The diameter of the lens is 10 cm. If the eye is placed 60 cm to the right of the lens at a distance h below the principal axis, then the maximum value of h to see the image will be

(A) 0 cm (B) 5 cm

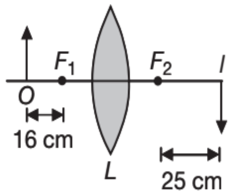
(C) 2.5 cm (D) 10 cm

233. For two positions of a lens, the images are obtained on a fixed screen. If the size of object is 2 cm and the size of diminished image is 0.5 cm, the size of the other image will be

(A) 1 cm (B) 4 cm

(C) 8 cm (D) 16 cm

234. The medium on both sides of lens is air. The distances of object O, image I from first and second foci F_1 and F_2 are shown in figure. The focal length of lens is



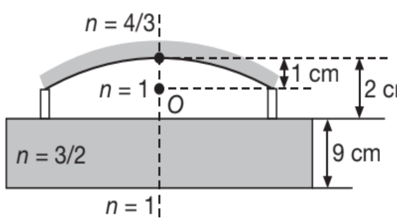
(A) 16 cm

(B) 25 cm

(C) 20 cm

(D) cannot be estimated with given data

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



(A) virtual and will be at 2 cm from the pole of the concave mirror

(B) virtual and formed on the pole of the mirror

(C) real and on the object itself

(D) None of these

236. A plane mirror is moving with velocity $4\hat{i}+4\hat{j}+8\hat{k}$. 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

(A) $-3\hat{i}-4\hat{j}+5\hat{k}$ (B) $3\hat{i}+4\hat{j}+11\hat{k}$

(C) $-4\hat{i}+5\hat{j}+11\hat{k}$ (D) $7\hat{i}+9\hat{j}+3\hat{k}$

237. 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 $\frac{4}{3}$ and the tortoise is stationary)

(A) g (B) $\frac{3g}{4}$

(C) $\frac{4g}{3}$ (D) $\frac{7g}{3}$

238. An equiconvex lens, having radius of curvature 33 cm, is placed on a horizontal plane mirror and a pin held 20 cm above the lens coincides with its image. Now the space between the lens and the mirror is filled with a liquid. In order to coincide with the image the pin has to be raised by 5 cm. The refractive index of the liquid is

(A) 1.33 (B) 1.53

(C) 2.33 (D) 2.66

239. A real image is formed by a convex lens. If we put a concave lens in contact with it, the combination again forms a real image. The new image

(A) is closer to the lens system.

(B) is farther from the lens system.

(C) is at the original position.

(D) may be anywhere depending on the focal length of the concave lens.

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

(A) 60 cm (B) 40 cm

(C) 30 cm (D) 20 cm

241. A light ray gets reflected from a pair of mutually perpendicular mirrors, not necessarily along axes. The intersection point of mirrors is at origin. The incident light ray is along $y=x+2$. If the light ray strikes both mirrors in succession, then it may get reflected finally along the line

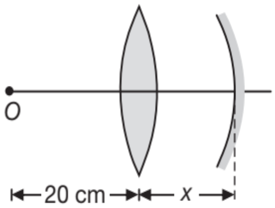
(A) $y=2x-2$ (B) $y=-x+2$

(C) $y=-x-2$ (D) $y=x-4$

242. Two lenses of powers +12 D and –2 D are in contact. The focal length of the combination is

(A) 10 cm (B) 12.5 cm
(C) 16.6 cm (D) 8.33 cm

243. A point object O is placed at a distance of 20 cm from a convex lens of focal length 10 cm as shown in figure. The distance x from the lens where a concave mirror of focal length 60 cm has to be placed so that final image coincides with the object is



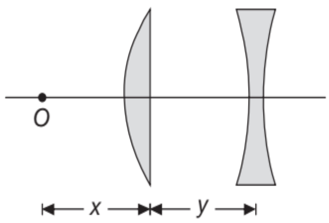
(A) 10 cm
(B) 20 cm
(C) 40 cm
(D) final image can never coincide with the object under the conditions provided.

244. A lens forms a sharp image on a screen. On inserting a parallel sided glass slab between the lens and the screen, it is found necessary to move the screen a distance d away from the lens in order for the image to be sharp again. If the refractive index of the material of the slab is n, the thickness of the slab is

(A) nd (B) $\dfrac{d}{n}$

(C) $\dfrac{(n-1)d}{n}$ (D) $\dfrac{nd}{n-1}$

245. A plano convex glass lens $\left(\mu_g = \dfrac{3}{2}\right)$ of radius of curvature $R = 10 \text{ cm}$ is placed at a distance of y from a concave lens of focal length 20 cm. The distance x of a point object O from the plano convex lens so that the position of final image is independent of y is



(A) 20 cm (B) 30 cm
(C) 40 cm (D) 60 cm

246. A thin lens has focal length f, and its aperture has diameter D. It forms an image of intensity I. If the central part of the aperture, of diameter $\dfrac{D}{2}$, is blocked by an opaque paper, the focal length of the lens and the intensity of image will become

(A) $\dfrac{f}{2}, \dfrac{I}{2}$ (B) $f, \dfrac{I}{4}$

(C) $\dfrac{3f}{4}, \dfrac{I}{2}$ (D) $f, \dfrac{3I}{4}$

247. When a ray of light goes from air to a glass slab, then
(A) its wavelength increases
(B) its wavelength decreases
(C) its frequency increases
(D) neither its wavelength nor its frequency changes

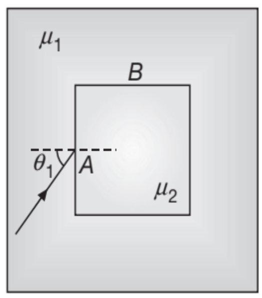
248. In the displacement method, a convex lens is placed in between an object and a screen. If the magnification in the two positions are m_1 and m_2 ($m_1 > m_2$), and the distance between the two positions of the lens is x, the focal length of the lens is

(A) $\dfrac{x}{m_1 + m_2}$ (B) $\dfrac{x}{m_1 - m_2}$

(C) $\dfrac{x}{(m_1 + m_2)^2}$ (D) $\dfrac{x}{(m_1 - m_2)^2}$

249. A screen is placed 90 cm from an object. The image of the object on the screen is formed by a convex lens at two different locations separated by 20 cm. The focal length of the lens is
(A) 10.7 cm (B) 21.4 cm
(C) 15.8 cm (D) 32.1 cm

250. A ray of light is incident on the left vertical face of a glass cube of refractive index μ_2, as shown in figure.



The plane of incidence is the plane of the page and the cube is surrounded by liquid of refractive index μ_1. What is the largest angle of incidence θ_1 for which total internal reflection occurs at the top surface is

(A) $\sin\theta_1 = \sqrt{\left(\dfrac{\mu_2}{\mu_1}\right)^2 - 1}$ (B) $\sin\theta_1 = \sqrt{\left(\dfrac{\mu_2}{\mu_1}\right)^2 + 1}$

(C) $\sin\theta_1 = \sqrt{\left(\dfrac{\mu_1}{\mu_2}\right)^2 + 1}$ (D) $\sin\theta_1 = \sqrt{\left(\dfrac{\mu_1}{\mu_2}\right)^2 - 1}$

251. A plano-convex lens, when silvered at its plane surface is equivalent to a concave mirror of focal length 28 cm. When its curved surface is silvered and the plane surface not silvered, it is equivalent to a concave mirror of focal length 10 cm, then the refractive index of the material of the lens is

(A) $\frac{9}{14}$ (B) $\frac{14}{9}$

(C) $\frac{17}{9}$ (D) None of these

252. A lens is placed between the 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

(A) $\sqrt{A_1A_2}$ (B) $\frac{A_1+A_2}{2}$

(C) $\sqrt{\left[\frac{\sqrt{A_1}+\sqrt{A_2}}{2}\right]^2}$ (D) $\left(\frac{1}{A_1}+\frac{1}{A_2}\right)^{-1}$

253. The plane face of a plano-convex lens is silvered. If μ be the refractive index and r the radius of curvature of the curved surface, then the system behaves like a concave mirror of radius

(A) $\frac{r}{\mu}$ (B) $\frac{r}{\mu-1}$

(C) $r\mu$ (D) $r(\mu-1)$

254. A ray of light falls on the surface of a spherical paper weight making an angle β with the normal and is refracted in the medium at an angle β. The angle of deviation of the emergent ray from the direction of the incident ray is

(A) $(\alpha-\beta)$ (B) $2(\alpha-\beta)$

(C) $\frac{(\alpha-\beta)}{2}$ (D) $\beta-\alpha$

255. The magnification of an object placed in front of a convex lens of focal length 20 cm is $+2$. To obtain a magnification of -2, the object has to be moved by a distance equal to

(A) 40 cm (B) 30 cm

(C) 20 cm (D) 10 cm

256. A concave mirror is placed on a horizontal table with its axis directed vertically upward. Let (O) be the pole of the mirror and C its centre of curvature. A point object is placed at C. It has a real image also located at C. If the mirror is now filled with water, the image will be

(A) real and will remain at C.

(B) real and located at a point between C and ∞.

(C) virtual and located at a point between C and O.

(D) real and located at a point between C and O.

257. All of the following statements are correct except

(A) the magnification produced by a convex mirror is always less than 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.

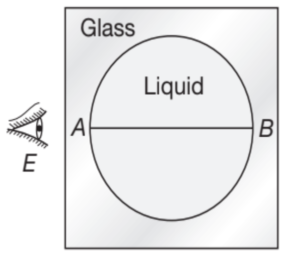
(D) a real, inverted, same-sized image can be formed using a convex mirror.

258. When an object is at distances x and y from a lens, a real image and a virtual image is formed respectively having same magnification. The focal length of the lens is given by

(A) $x-y$ (B) $x+y$

(C) $\sqrt{xy}$ (D) $\frac{x+y}{2}$

259. Figure shows a spherical cavity in a solid glass block. The cavity is filled with a liquid and from outside an observer sees the distance AB which is the diameter of the cavity and it appear as infinitely large to the observer. If refractive index of liquid is μ_1 and that of glass is μ_2, then $\frac{\mu_1}{\mu_2}$ is



(A) 2 (B) $\frac{1}{2}$

(C) 4 (D) None of these

260. If the central portion of a convex lens is wrapped in black paper as shown in the figure,

(A) no image will be formed by the remaining portion of the lens.

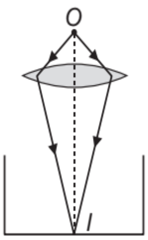
(B) full image will be formed, but it will be less bright.

(C) the central portion of the image will be missing.
(D) there will be two images, each produced by one of the exposed portions of the lens.

261. A plane mirror made of glass slab $(\mu_g = 1.5)$ is 2.5 cm thick and silvered at the back. A point object is placed 5 cm in front of the unsilvered face of the mirror. The position of the final image is
(A) $\frac{16}{3}$ cm from unsilvered face
(B) $\frac{25}{3}$ cm from unsilvered face
(C) 12 cm from unsilvered face
(D) 14 cm from unsilvered face

262. The distance between an object and the screen is 100 cm. A lens produces an image on the screen when placed at either of two positions 40 cm apart. The power of the lens is approximately
(A) 4.25 D (B) 4.50 D
(C) 4.75 D (D) 5.0 D

263. A real image of an object is formed by a convex lens at the bottom of an empty beaker. The beaker is now filled with a liquid of refractive index 1.4 to a depth of 7 cm. In order to get the image again at the bottom, the beaker should be moved



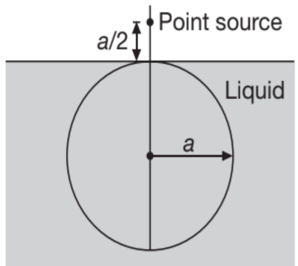
(A) downward by 2 cm
(B) upward by 2 cm
(C) downward by 3 cm
(D) upward by 3 cm

264. The convex surface of a thin concavo-convex lens (refractive index 1.5) has a radius of curvature 20 cm. The concave surface has a radius of curvature 60 cm. The convex side is silvered and placed on a horizontal surface. At what distance from the lens should a pin be placed on the optic axis such that its image is formed at the same place?
(A) 15 cm (B) 7.5 cm
(C) 22.5 cm (D) 30 cm

265. In PROBLEM 264, if the concave part is filled with water (refractive index $\frac{4}{3}$), the distance from the lens at which the pin should be placed to form the image at the same place is
(A) $\frac{90}{13}$ cm (B) $\frac{45}{13}$ cm
(C) $\frac{135}{13}$ cm (D) $\frac{180}{13}$ cm

266. An equiconvex lens of glass $(\mu_g = 1.5)$ of focal length 10 cm, silvered on one side behaves like a
(A) convex mirror of focal length 5 cm
(B) convex mirror of focal length 20 cm
(C) concave mirror of focal length 2.5 cm
(D) concave mirror of focal length 10 cm

267. An opaque sphere of radius a is just immersed in a transparent liquid as shown in figure. A point source is placed on the vertical diameter of the sphere at a distance $\frac{a}{2}$ from the top of the sphere. One ray originating from the point source after refraction from the air liquid interface forms tangent to the sphere. The angle of refraction for that particular ray is $30°$. The refractive index of the liquid is



(A) $\frac{2}{\sqrt{3}}$ (B) $\frac{3}{\sqrt{5}}$
(C) $\frac{4}{\sqrt{5}}$ (D) $\frac{4}{\sqrt{7}}$

268. A plano-convex lens of focal length 30 cm has its plane surface silvered. An object is placed 40 cm from the lens on the convex side. The distance of the image from the lens is
(A) 18 cm (B) 24 cm
(C) 30 cm (D) 40 cm

269. Refraction takes place at a concave spherical boundary separating glass air medium. If $\mu_g = \frac{3}{2}$, then for the image to be real, the object distance
(A) is independent of the radius of curvature of the refracting surface
(B) should be greater than the radius of curvature of the refracting surface
(C) should be greater than two times the radius of curvature of the refracting surface
(D) should be greater than three times the radius of curvature of the refracting surface

270. A parallel beam of light incident on a concave lens of focal length 10 cm emerges as a parallel beam from a convex lens placed coaxially, the distance between the lenses being 10 cm. The focal length of the convex lens in cm is

(A) 10 (B) 20
(C) 30 (D) 40

271. An object is placed at a distance of 12 cm from a convex lens on its principal axis and a virtual image of certain size is formed. If the object is moved 8 cm away from the lens, a real image of the same size as that of the virtual image is formed. The focal length of the lens in cm is

(A) 15 (B) 16
(C) 18 (D) 19

272. A thin converging lens of refractive index 1.5 has a power of $+0.5\,D$. When this lens is immersed in a liquid, it acts as a diverging lens of focal length 100 cm. The refractive index of the liquid is

(A) $\frac{4}{3}$ (B) $\frac{3}{2}$
(C) $\frac{5}{3}$ (D) 2

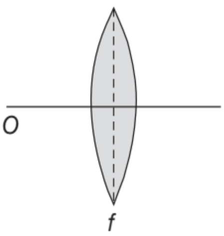
273. The distance between an object and its real image formed by a lens is D. If the magnification is m, the focal length of the lens is

(A) $\frac{(m-1)D}{m}$ (B) $\frac{mD}{m+1}$
(C) $\frac{(m-1)D}{m^2}$ (D) $\frac{mD}{(m+1)^2}$

274. A plano convex lens of focal length 16 cm, is to be made of glass of refractive index 1.5. The radius of curvature of the curved surface should be

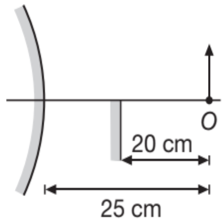
(A) 8 cm (B) 12 cm
(C) 16 cm (D) 24 cm

275. A real image of a point object O was formed by an equi-convex lens of focal length f and the magnification was found to be unity. Now the lens is cut into two symmetrical pieces as shown by the dotted line and the right part is removed. The position of the image formed by the remaining part is at



(A) f (B) $2f$
(C) $\frac{f}{2}$ (D) Infinity

276. In the figure, an object is placed 25 cm from the surface of a convex mirror, and a plane mirror is set so that the image formed by the two mirrors lie adjacent to each other in the same plane. The plane mirror is placed at 20 cm from the object. The radius of curvature of the convex mirror is

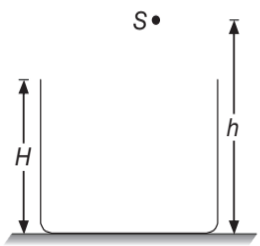


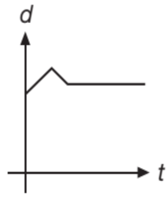
(A) $R = 25$ cm (B) $R = 50$ cm
(C) $R = 75$ cm (D) $R = 100$ cm

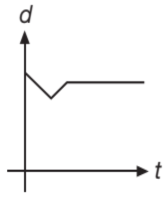
277. A convex lens, made of a material of refractive index 1.5 and having a focal length of 10 cm is immersed in a liquid of refractive index 3.0. The lens will behave as a

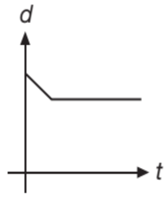
(A) converging lens of focal length 10 cm.
(B) diverging lens of focal length 10 cm.
(C) converging lens of focal length $\frac{10}{3}$ cm.
(D) diverging lens of focal length 30 cm.

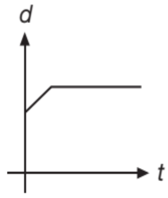
278. A point source S is placed at a height h from the bottom of a vessel of height $H(<h)$. The vessel is polished at the base. If the water is gradually filled in the vessel at a constant rate $\alpha\ \text{m}^3\text{s}^{-1}$, the distance d of image of the source from the bottom of the vessel varies with time t as



(A)


(B)


(C)


(D)


279. A convex lens of glass has power P in air. If it is immersed in water its power will be
(A) more than P
(B) less than P
(C) P
(D) more than P for some colours and less than P for others

280. A biconvex lens, made of a material of refractive index 1.5, has radius of curvature of each side equal to 0.5 m. The power of the lens is
(A) 0.5 D (B) 1.0 D
(C) 1.5 D (D) 2.0 D

281. A convex lens forms a real image 4 cm long on a screen. When the lens is shifted to a new position without disturbing the object or the screen, again real image is formed on the screen which is 16 cm long. The length of the object is
(A) 8 cm (B) 10 cm
(C) 12 cm (D) 6 cm

282. The maximum and minimum distances between a convex lens and an object, for the magnification of a real image to be greater than one are
(A) $2f$ and f (B) f and zero
(C) ∞ and $2f$ (D) $4f$ and $2f$

283. A point object is placed on the optic axis of a convex lens of focal length f at a distance of $2f$ to the left of it. The diameter of the lens is d. An observer has his eye at a distance of $3f$ to the right of the lens and a distance h below the optic axis. The maximum value of h to see the image is
(A) $\frac{d}{4}$ (B) $\frac{d}{3}$
(C) $\frac{d}{2}$ (D) d

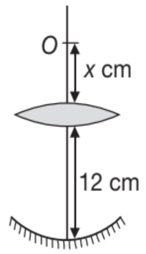
284. A convex lens is immersed in a liquid of refractive index greater than that of glass. It will behave as a
(A) convergent lens
(B) divergent lens
(C) plane glass
(D) homogeneous liquid

285. If the top half of a convex lens is covered with black paper,
(A) the bottom half of the image will disappear.
(B) the top half of the image will disappear.
(C) the magnification will be reduced to half.
(D) the intensity will be reduced to half.

286. In displacement method, the lengths of images in the two positions of the lens between the object and the screen are 9 cm and 4 cm respectively. The length of the object must be
(A) 6.25 cm (B) 1.5 cm
(C) 6 cm (D) 36 cm

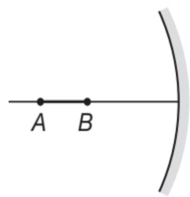
287. A convex lens of focal length 15 cm is placed on a plane mirror. An object is placed 20 cm from the lens. The image is formed
(A) 12 cm in front of the mirror
(B) 60 cm behind the mirror
(C) 60 cm in front of the mirror
(D) 30 cm in front of the mirror

288. A convex lens of focal length 40 cm is held coaxially 12 cm above a concave mirror of focal length 18 cm. An object held x cm above the lens gives rise to an image coincident with it. The x is equal to



(A) 12 cm (B) 15 cm
(C) 18 cm (D) 30 cm

289. A linear object AB is placed along the axis of a concave mirror. The object is moving towards the mirror with speed V. The speed of the image of the point A is $4V$ and the speed of the image of B is also 4 V. If centre of the line AB is at a distance L from the mirror then length of the object AB will be



(A) $\frac{3L}{2}$ (B) $\frac{5L}{3}$
(C) L (D) $\frac{4L}{3}$

290. Two thin lenses of powers 2 D and 3 D are placed in contact. An object is placed at a distance of 30 cm from the combination. The distance in cm of the image from the combination is
(A) 30 (B) 40
(C) 50 (D) 60

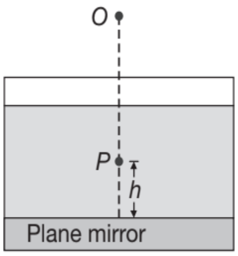
291. Two convex lenses of focal lengths f_1 and f_2 are mounted coaxially separated by a distance. If the power of the combination is zero, the distance between the lenses is

(A) $|f_1 - f_2|$ (B) $f_1 + f_2$

(C) $\dfrac{f_1 f_2}{|f_1 - f_2|}$ (D) $\dfrac{f_1 f_2}{f_1 + f_2}$

292. Chromatic aberration in a lens is caused by
(A) reflection (B) interference
(C) diffraction (D) dispersion

293. A plane mirror is placed at the bottom of a tank containing a liquid of refractive index μ. A small object P lies at a height h above the mirror. An observer O, vertically above P, outside the liquid, observe P and its image in the mirror. The apparent distance between these two will be

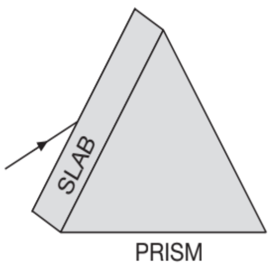


(A) $h\left(1+\dfrac{1}{\mu}\right)$ (B) $\dfrac{2h}{\mu - 1}$

(C) $2\mu h$ (D) $\dfrac{2h}{\mu}$

294. A person can see clearly between 1 m and 2 m. His corrective lenses should be
(A) bifocals with power –0.5 D and additional +3.5 D
(B) bifocals with power –1.0 D and additional +3.0 D
(C) concave with power 1.0 D
(D) convex with power 0.5 D

295. A parallel glass slab of refractive index $\sqrt{3}$ is placed in contact with an equilateral prism of refractive index $\sqrt{2}$. A ray is incident on left surface of slab as shown. The slab and prism combination is surrounded by air. The magnitude of minimum possible deviation of this ray by slab-prism combination is



(A) 30° (B) 45°

(C) 60° (D) $60° - \sin^{-1}\sqrt{\dfrac{2}{3}}$

296. Spherical aberration in a thin lens can be reduced by
(A) using a monochromatic light.
(B) using a doublet combination.
(C) using a circular annular mask over the lens.
(D) increasing the size of the lens.

297. A virtual image of an object is formed with a magnification of 2, when the object is placed infront of a concave mirror of focal length f. To obtain a real image of same magnification, the object has to moved by a distance

(A) $\dfrac{f}{2}$ (B) $\dfrac{2f}{3}$

(C) f (D) $\dfrac{3f}{2}$

298. An astronomical telescope has an angular magnification of magnitude 5 for distant objects. The separation between the objective and the eyepiece is 36 cm and the final image is formed at infinity. The focal length f_0 of the objective and f_e of the eyepiece are
(A) $f_0 = 45$ cm and $f_e = -9$ cm
(B) $f_0 = 50$ cm and $f_e = 10$ cm
(C) $f_0 = 7.2$ cm and $f_e = 5$ cm
(D) $f_0 = 30$ cm and $f_e = 6$ cm

299. A plano convex lens of radius of curvature R fits exactly into a plano concave lens such that their plane surfaces are parallel to each other. If the lenses are made of different materials of refractive indices μ_1 and μ_2, then focal length of the combination is given by

(A) $\dfrac{R}{2-(\mu_1+\mu_2)}$ (B) $\dfrac{R}{2(\mu_1-\mu_2)}$

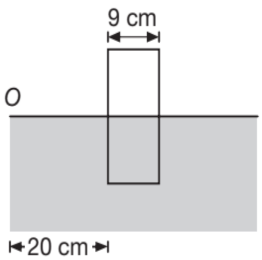
(C) $\dfrac{2R}{\mu_2-\mu_1}$ (D) $\dfrac{R}{\mu_1-\mu_2}$

300. A compound microscope has an objective of focal length 2.0 cm and an eye piece of focal length 6.25 cm separated by 15 cm. If the final image is formed at the least distance of distinct vision (25 cm), the distance of the object from the objective is
(A) 1.5 cm (B) 2.5 cm
(C) 3.0 cm (D) 4.0 cm

301. In PROBLEM 300, the magnifying power of the microscope is

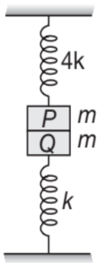
(A) 10
(B) 15
(C) 20
(D) 30

302. A point object is placed at a distance of 20 cm from a glass slab $\left(\mu_g = \frac{3}{2}\right)$ half immersed in water $\left(\mu_w = \frac{4}{3}\right)$ as shown in figure. The distance between two images when seen from the other side of the slab is



(A) 1 cm
(B) 2 cm
(C) 4 cm
(D) 6 cm

303. In the figure shown, blocks P and Q are in contact but do not stick to each other. The lower face of P behaves as a plane mirror. The springs are in their natural lengths.



The system is released from rest. The distance between Q and its image, when Q is at the lowest point for the first time is

(A) $\frac{2mg}{K}$
(B) $\frac{4mg}{K}$
(C) $\frac{3mg}{K}$
(D) 0

304. A compound microscope has a magnification of 30. The focal length of the eye-piece is 5 cm. If the final image is formed at the least distance of distinct vision (25 cm), the magnification produced by the objective is

(A) 5
(B) 7.5
(C) 10
(D) 15

305. The least distance of distinct vision is 25 cm. The focal length of a convex lens is 5 cm . It can act as a simple microscope of magnifying power

(A) 4
(B) 5
(C) 6
(D) None of these

306. An astronomical telescope has an eye piece of focal length 5 cm. If the angular magnification of normal adjustment is 10, the distance between the objective and the eye piece is

(A) 45 cm
(B) 50 cm
(C) 55 cm
(D) 110 cm

307. The focal lengths of the objective and the eyepiece of an astronomical telescope are 100 cm and 20 cm respectively. Its magnifying power in normal adjustment is

(A) 5
(B) 2
(C) 25
(D) 4

308. Two convex lenses of focal lengths 0.3 m and 5 cm are used to make a telescope. The distance kept between them is equal to

(A) 0.35 m
(B) 5.3 cm
(C) 5.3 m
(D) 0.15 m

309. To have larger magnification by a telescope

(A) the objective should be of large focal length and the eyepiece should be of small focal length
(B) both the objective and the eyepiece should be of large focal lengths
(C) both the objective and the eyepiece should be of small focal lengths
(D) the objective should be of small focal length and the eyepiece should be of large focal length

310. The angle of incidence for an equilateral prism is 60°. The refractive index of prism so that the ray inside the prism is parallel to the base of the prism is

(A) $\frac{9}{8}$
(B) $\sqrt{2}$
(C) $\frac{4}{3}$
(D) $\sqrt{3}$

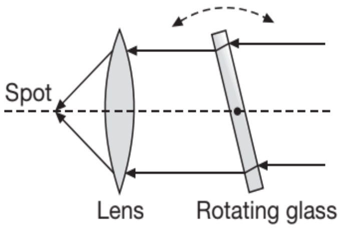
311. Four convergent lenses have focal lengths 100 cm, 10 cm, 4 cm and 0.3 cm. For a telescope with maximum possible magnification, we choose the lenses of focal lengths

(A) 100 cm, 0.3 cm
(B) 10 cm, 0.3 cm
(C) 10 cm, 4 cm
(D) 100 cm, 4 cm

312. The angular magnification of a telescope which contains an objective of focal length f_1 and eyepiece of focal length f_2 is

(A) $\frac{f_2}{f_1}$
(B) $\frac{f_1 + f_2}{f_2}$
(C) $\frac{f_1}{f_2}$
(D) $\frac{f_1 f_2}{f_1 + f_2}$

313. A slab of high quality flat glass, with parallel faces, is placed in the path of a parallel light beam before it is focussed to a spot by a lens. The glass is rotated slightly back and forth from the dotted centre about an axis coming out of the page, as shown in the diagram. According to ray optics the effect on the focussed spot is



(A) There is no movement of the spot.
(B) The spot moves towards then away from the lens.
(C) The spot moves up and down parallel to the lens.
(D) The spot moves along a line making an angle (neither zero nor $90°$) with axis of lens.

314. An achromatic combination is to be made using a convex and a concave lens. The two lenses should have
(A) their power equal.
(B) their refractive indices equal.
(C) their dispersive powers equal.
(D) the product of their powers and dispersive powers equal.

315. For a thin equiconvex lens, the optics axis coincides with the x-axis and the optical centre coincides with the origin. The co-ordinates of a point object and its image are $(-40, 1)$ cm and $(50, -2)$ cm respectively. Lens is located at
(A) $x = 0$ (B) $x = -10$ cm
(C) $x = +20$ cm (D) $x = -30$ cm

316. The near point of a person is 50 cm and the far point is 1.5 m. The spectacles required for reading purpose and for seeing distant objects are respectively
(A) $+2$ D, $-\left(\frac{2}{3}\right)$ D (B) $+\left(\frac{2}{3}\right)$ D, -2 D
(C) -2 D, $+\left(\frac{2}{3}\right)$ D (D) $-\left(\frac{2}{3}\right)$ D, $+2$ D

317. Astigmatism for a human eye can be removed by using
(A) concave lens (B) convex lens
(C) cylindrical lens (D) prismatic lens

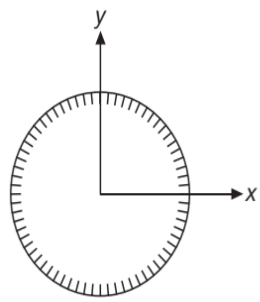
318. A hollow convex lens of glass behaves like a
(A) plane mirror (B) concave lens
(C) convex lens (D) glass plate

319. The far point of a myopic eye is 250 cm. The correcting lens should be a
(A) diverging lens of focal length 250 cm.
(B) converging lens of focal length 250 cm.
(C) diverging lens of focal length 125 cm.
(D) converging lens of focal length 125 cm.

320. A parallel beam of light passes parallel to the principal axis and falls on one face of a thin convex lens of focal length f and after two internal reflections from the second face forms a real image. The distance of image from lens if the refractive index of material of lens is 1.5
(A) $\frac{f}{7}$ (B) $\frac{f}{2}$
(C) $7f$ (D) $\frac{f}{6}$

321. A person cannot see clearly beyond 50 cm. The power of the lens required to correct his vision is
(A) -0.5 D (B) $+0.5$ D
(C) -2 D (D) $+2$ D

322. A ray travelling in negative x-direction is directed towards positive y-direction after being reflected from a surface at point P. The reflecting surface is represented by the equation $x^2 + y^2 = a^2$. Then co-ordinates of point P are



(A) $(a, 0)$ (B) $(0.6a, 0.8a)$
(C) $(0.8a, 0.6a)$ (D) $\left(\frac{a}{\sqrt{2}}, \frac{a}{\sqrt{2}}\right)$

323. A person cannot see clearly objects at a distance less than 100 cm,. The power of the spectacles required to see clearly objects at 25 cm is
(A) $+1$ D (B) $+3$ D
(C) $+4$ D (D) $+2$ D

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

(A) 8 cm (B) 5 cm

(C) 11 cm (D) $\sqrt{96}$ cm

325. A person can see clearly objects lying between 25 cm and 2 m from his eye. His vision can be corrected by using spectacles of power

(A) +0.25 D (B) +0.5 D

(C) –0.25 D (D) –0.5 D

MULTIPLE CORRECT CHOICE TYPE QUESTIONS

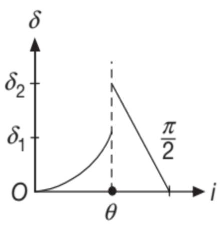
This section contains Multiple Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct.

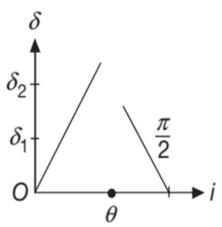
1. The x-y plane is the boundary between two transparent media. Medium 1 with $z \ge 0$ has a refractive index $\sqrt{2}$ and medium 2 with $z < 0$ has a refractive index $\sqrt{3}$. A ray of light in medium 1 given by the vector $\vec{A} = 6\sqrt{3}\hat{i} + 8\sqrt{3}\hat{j} - 10\hat{k}$ is incident on the plane of separation. The refracted ray makes angle r with $+z$ axis and incident ray makes an angle i with $-z$ axis. Then,

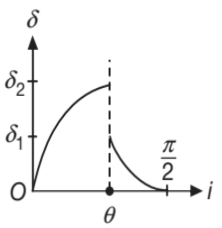
(A) $i = 120°$ (B) $i = 60°$

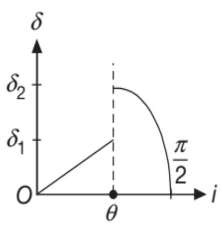
(C) $r = 45°$ (D) $r = 135°$

2. 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. The curve that best represents the plot of deviation δ (along y-axis) with angle of incidence i (along x-axis) is

(A)


(B)


(C)


(D)


3. In PROBLEM 2,

(A) $\theta = \sin^{-1}\left(\frac{1}{\mu}\right)$ (B) $\theta = \frac{\pi}{2} - \sin^{-1}\left(\frac{1}{\mu}\right)$

(C) $\frac{\delta_2}{\delta_1} = \mu$ (D) $\frac{\delta_2}{\delta_1} = 2$

4. A ray of light from a denser medium strikes a rarer medium at angle of incidence i. The reflected and the refracted rays make an angle of 90° with each other. The angles of reflection and refraction are r and r' respectively. The critical angle is

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

(C) $\sin^{-1}(\tan r')$ (D) $\tan^{-1}(\sin i)$

5. A single converging lens is used as a simple microscope. In the position of maximum magnification. Select the correct statement(s).

(A) the object is placed at the focus of the lens.

(B) the object is placed between the lens and its focus.

(C) the image is formed at infinity.

(D) the object and the image subtend the same angle at the eye.

6. A light of wavelength 6000 Å in air enters a medium of refractive index 1.5. Inside the medium, its frequency is ν and its wavelength is λ.

(A) $\nu = 5 \times 10^{14}$ Hz (B) $\nu = 7.5 \times 10^{14}$ Hz

(C) $\lambda = 4000$ Å (D) $\lambda = 9000$ Å

7. If a converging beam of light is incident on a concave mirror, the reflected light

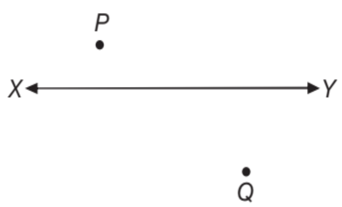
(A) may form a real image

(B) must form a real image

(C) may form a virtual image

(D) may be a parallel beam

8. Two points P and Q lie on either side of an axis XY as shown. It is desired to produce an image of P at Q using a spherical mirror, with XY as the optic axis. The mirror must be



(A) converging
(B) diverging
(C) positioned to the left of P
(D) positioned to the right of Q

9. An object and a screen are fixed at a distance d apart. When a lens of focal length f is moved between the object and the screen, sharp images of the object are formed on the screen for two positions of the lens. The magnifications produced at these two positions are M_1 and M_2.

(A) $d > 2f$
(B) $d > 4f$
(C) $M_1 M_2 = 1$
(D) $|M_1| - |M_2| = \frac{d}{f}$

10. Resolving power of an electron microscope is R_e and that of optical microscope is R_0.

(A) $R_e > R_0$
(B) $R_e < R_0$
(C) $R_e = R_0$
(D) Data Insufficient

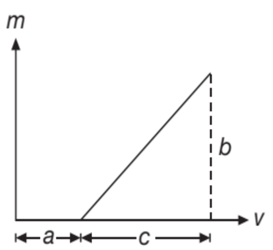
11. In PROBLEM 10, the correct argument for the correct selected option is that

(A) electrons have greater wavelength than visible light.
(B) electrons have lesser wavelength than visible light.
(C) resolving power is inversely proportional to the wavelength of the wave used for detecting an object by the microscope.
(D) resolving power is inversely proportional to the square of the wavelength of the wave used for detecting an object by the microscope.

12. The distance between two point objects P and Q is 32 cm. A convex lens of focal length 15 cm is placed between them so that the images of both the objects are formed at the same place. The distance of P from the lens could be

(A) 20 cm
(B) 18 cm
(C) 16 cm
(D) 12 cm

13. The graph shows the variation of magnification m produced by a convex lens with the image distance v. The focal length of the lens is



(A) $\frac{b}{c}$
(B) $\frac{c}{b}$
(C) a
(D) $\frac{ab}{c}$

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

(A) $f = \frac{x}{m_1 - m_2}$
(B) $m_1 m_2 = 1$
(C) $f = \frac{D^2 - x^2}{4D}$
(D) $D \geq 4f$

15. A parallel beam of white light falls on a combination of a concave and a convex lens, both of same material. Their focal lengths are 15 cm and 30 cm respectively for the mean wavelength in white light. On the other side of the lens system, one sees

(A) a coloured pattern with violet at the outer edge.
(B) a coloured pattern with red at the outer edge.
(C) white light again.
(D) that it is unable for the lens to converge the rays at a point.

16. Consider a ray of light going from A to B. Let the ray traverse, in going from A to B, distances $s_1, s_2, s_3, \ldots\ldots\ldots\ldots s_m$ in media of indices $n_1, n_2, n_3, \ldots\ldots\ldots n_m$ respectively.

(A) Total time of flight $t = \frac{1}{c}\sum_{i=1}^{m} n_i s_i$
(B) Total time of flight $t = \frac{1}{c}\sum_{i=1}^{m} s_i$
(C) Optical path length is (O.P.L.) = $\sum_{i=1}^{m} n_i s_i$
(D) For inhomogeneous media the O.P.L. = $\int_A^B n(s)\,ds$ and the ray travels along 'Stationary Pathways'.

17. A point object is placed at 30 cm from a convex glass lens $\left(\mu_g = \frac{3}{2}\right)$ of focal length 20 cm. For the final image of object to be formed at infinity, which of the following is/are correct?

(A) A concave lens of focal length 60 cm is placed in contact with the convex lens

(B) A convex lens of focal length 60 cm is placed at a distance of 30 cm from the convex lens.

(C) The entire convex lens system is immersed in a liquid of refractive index $\frac{4}{3}$

(D) The entire convex lens system is immersed in a liquid of refractive index $\frac{9}{8}$

18. For a mirror, the linear magnification is $+2$. The conclusion(s) that can be drawn from this information is/are

(A) The mirror is concave

(B) The mirror can be convex or concave but it cannot be plane

(C) The object lies between pole and focus

(D) The object lies beyond focus

19. A ray of light has speed v_0 frequency f_0 and wavelength λ_0 in vacuum. When this ray of light enters in a medium of refractive index μ, corresponding values are v, f and λ. Then

(A) $f = \frac{f_0}{\mu}$ (B) $\lambda = \frac{\lambda_0}{\mu}$

(C) $v = \frac{v_0}{\mu}$ (D) $f = f_0$

20. For which of the pairs of u and f for curved mirror(s), the image formed is smaller in size.

(A) $u = -45$ cm, $f = -10$ cm

(B) $u = -10$ cm, $f = 20$ cm

(C) $u = -60$ cm, $f = 30$ cm

(D) $u = -20$ cm, $f = -30$ cm

21. A diverging lens of focal length f_1 is placed in front of and coaxially with a concave mirror of focal length f_2. Their separation is d. A parallel beam of light incident on the lens returns as a parallel beam from the arrangement. Select the correct statement(s).

(A) The beam diameters of the incident and reflected beams must be the same.

(B) $d = 2|f_2| - |f_1|$

(C) $d = |f_2| - |f_1|$

(D) If the entire arrangement is immersed in water, the conditions will remain unaltered.

22. An astronomical telescope and a Galilean telescope use identical objective lenses. They have the same magnification, when both are in normal adjustment. The eyepiece of the astronomical telescope has a focal length f. Select the correct statement(s).

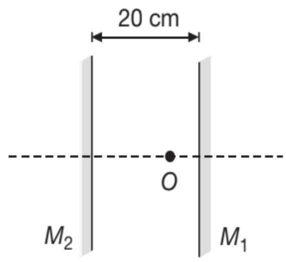
(A) The tube lengths of the two telescopes differ by f.

(B) The tube lengths of the two telescopes differ by $2f$.

(C) The Galilean telescope has shorter tube length.

(D) The Galilean telescope has longer tube length.

23. Two plane mirrors M_1 and M_2 are placed parallel to each other 20 cm apart. A luminous point object 'O' is placed between them at 5 cm from M_1 as shown.



(A) The distances (in cm) of three nearest images from mirror M_1 are 5, 35 and 45 respectively.

(B) The distances (in cm) of three nearest images from mirror M_2 are 5, 35 and 45 respectively.

(C) The distances (in cm) of three nearest images from mirror M_1 are 15, 25 and 55 respectively.

(D) The distances (in cm) of three nearest images from mirror M_2 are 15, 25 and 55 respectively.

24. In the case of hypermetropia

(A) the image of a near object is formed behind the retina.

(B) the image of a distant object is formed in front of the retina.

(C) a concave lens should be used for correction.

(D) a convex lens should be used for correction.

25. Which of the following produce a virtual image longer in size than the object?

(A) Concave lens

(B) Convex lens

(C) Concave mirror

(D) Convex mirror

26. A concave mirror has focal length 15 cm. Where should an object be placed in front of the mirror so that the image formed is three times the size of the object?

(A) 7.5 cm (B) 10 cm

(C) 17.5 cm (D) 20 cm

27. A concave mirror of focal length f forms an image 2 times the size of object. The object distance from the mirror is

(A) $\frac{f}{4}$ (B) $\frac{4f}{3}$

(C) $\frac{3f}{2}$ (D) $\frac{f}{2}$

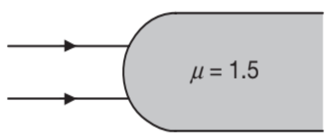
28. A point object P moves towards a convex mirror with a constant speed V, along its optic axis. The speed of the image
(A) is always less than V.
(B) may be less than, equal to or greater than V, depending on the position of P.
(C) increases as P comes closer to the mirror.
(D) decrease as P comes closer to the mirror.

29. A bird flies down vertically towards a water surface. To a fish inside the water, vertically below the bird, the bird will appear to
(A) be closer than its actual distance.
(B) be farther away than its actual distance.
(C) move slower than its actual speed.
(D) move faster than its actual speed.

30. There are three optical media 1, 2 and 3 with their refractive indices $\mu_1 > \mu_2 > \mu_3$. Select the correct statement(s)
(A) When a ray of light travels from 3 to 1 no TIR will take place.
(B) Critical angle between 1 and 2 is less than the critical angle between 1 and 3.
(C) Critical angle between 1 and 2 is more than the critical angle between 1 and 3.
(D) Chances of TIR are more when ray of light travels from 1 to 3 as compare to the case when it travel from 1 to 2.

31. An equilateral prism has a refractive index $\sqrt{2}$. Select the correct alternative(s).
(A) Minimum deviation from this prism can be $30°$
(B) Minimum deviation from this prism can be $45°$
(C) At angle of incidence $45°$, deviation is minimum
(D) At angle of incidence $60°$, deviation is minimum

32. Parallel rays of light are falling on a convex spherical surface of radius of curvature $R = 20$ cm and refractive index $\mu = 1.5$ as shown. After refraction from the spherical surface, the parallel rays



(A) appear to meet after extending the refracted rays backwards.
(B) actually meet at some point.
(C) meet (or appear to meet) at a distance of 60 cm from the spherical surface.
(D) meet (or appear to meet) at a distance of 30 cm from the spherical surface.

33. The focal length of a lens in air and refractive index are f and μ respectively. The focal length changes to f_1 when the lens is immersed in a liquid of refractive index $\frac{\mu}{2}$ and it becomes f_2 when the lens is immersed in a liquid of refractive index 2μ. Then

(A) $f_1 = -\frac{2(\mu-1)}{f}$ (B) $f_2 = -\frac{2(\mu-1)}{f}$

(C) $f_1 = \frac{\mu-1}{f}$ (D) $f_2 = \frac{\mu-1}{f}$

34. Two thin lenses, when in contact, produce a combination of power $+10$ dioptre. When they are 0.25 m apart, the power is reduced to $+6$ dioptre. The respective powers of the lenses in dioptre, are
(A) 1 and 9 (B) 2 and 8
(C) 4 and 6 (D) 5 each

35. A solid, transparent sphere has a small, opaque dot at its centre. When observed from outside, the apparent position of the dot will be
(A) independent of the refractive index of the sphere.
(B) closer to the eye than its actual position.
(C) farther away from the eye than its actual position.
(D) the same as its actual position.

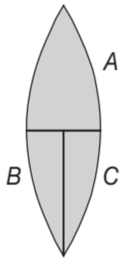
36. For a concave mirror
(A) virtual image is always larger in size
(B) real image is always smaller in size
(C) real image is always larger in size
(D) real image may be smaller or larger in size

37. During refraction, ray of light passes undeviated, then
(A) medium on both sides is same
(B) angle of incidence is $90°$
(C) angle of incidence is $0°$
(D) medium on other side is rarer

38. A convex lens made of glass $\left(\mu_g = \frac{3}{2}\right)$ has focal length f in air. The image of an object placed in front of it is real, inverted and magnified. Now the whole arrangement is immersed in water $\left(\mu_w = \frac{4}{3}\right)$ without changing the distance between object and lens, then
(A) the new focal length becomes $4f$
(B) the new focal length becomes $\frac{f}{4}$

(C) the new image formed will be virtual and magnified.
(D) the new image formed will be real and diminished.

39. A thin, symmetric double-convex lens of power P is cut into three parts A, B and C as shown. The power of



(A) A is P
(B) A is $2P$
(C) B is $\frac{P}{2}$
(D) B is $\frac{P}{4}$

40. A watch glass having uniform thickness and having average radius of curvature of its two surfaces much larger than its thickness is placed in the path of a beam of parallel light. The beam will
(A) be completely unaffected.
(B) converge slightly.
(C) diverge slightly.
(D) converge or diverge slightly depending on whether the beam is incident from the concave or the convex side.

41. A converging lens of focal length f_1 is placed in front of and coaxially with a convex mirror of focal length f_2. Their separation is d. A parallel beam of light incident on the lens returns as a parallel beam from the arrangement. Select the correct statement(s).
(A) The beam diameters of the incident and reflected beams must be the same.
(B) $d = f_1 - 2|f_2|$
(C) $d = f_1 - |f_2|$
(D) If the entire arrangement is immersed in water, the conditions will remain unaltered.

42. Check the wrong statement(s)
(A) A concave mirror can give a virtual image.
(B) A concave mirror can give a diminished virtual image.
(C) A convex mirror can give a real image.
(D) A convex mirror can give a diminished virtual image.

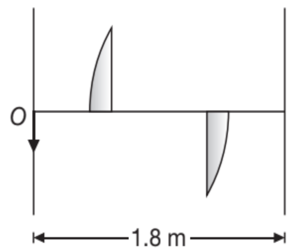
43. When lights of different colours move through water, they must have different
(A) wavelengths
(B) frequencies
(C) velocities
(D) amplitudes

44. A thin concavo-convex lens has two surfaces of radii of curvature R and $2R$. The material of the lens has a refractive index μ. When kept in air, the focal length of the lens
(A) will depend on the direction from which light is incident on it.
(B) will be the same, irrespective of the direction from which light is incident on it.
(C) will be equal to $\frac{2R}{\mu - 1}$.
(D) will be equal to $\frac{R}{\mu - 1}$.

45. A convex mirror is used to form an image of a real object. The image
(A) always lies between the pole and the focus.
(B) is diminished in size.
(C) is erect.
(D) is real.

46. A ray of light is incident on a prism of refracting angle A. C is the critical angle for the material of the prism with respect to the surrounding material (say air/vacuum).
(A) An emergent ray will be there for all values of C.
(B) An emergent ray will be there only for $A < 2C$.
(C) A ray incident at an angle i can pass through the prism if $\sin i > \frac{\sin(A - C)}{\sin C}$ for $C < A < 2C$.
(D) None of above is correct.

47. A thin plane-convex lens of focal length f is split into two equal halves. One of the halves is shifted along the optical axis as shown. The separation between object and image planes is 1.8 m and the magnification of image formed by one of the half lens is 2. The separation between two halves is d.



(A) $f = 0.4\text{ m}$
(B) $f = 0.6\text{ m}$
(C) $d = 0.6\text{ m}$
(D) $d = 0.4\text{ m}$

48. A point source of light is placed at a distance h below the surface of a large and deep lake. If f is the fraction of light energy that escapes directly from water surface and μ is refractive index of water then,

(A) f varies as a function of h

(B) f is independent of value of h

(C) $f = \frac{1}{2\sqrt{\mu^2 - 1}}$

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

49. An object is placed at a distance $2f$ from the pole of a curved mirror of focal length f.

(A) The linear magnification is 1 for both types of curved mirror.

(B) The linear magnification is 1 for a concave mirror.

(C) The linear magnification is $\frac{1}{3}$ for a convex mirror.

(D) Data Insufficient.

50. If a convergent beam of light passes through a diverging lens, the result

(A) may be a convergent beam.

(B) may be a divergent beam.

(C) may be a parallel beam.

(D) must be a parallel beam.

REASONING BASED QUESTIONS

This section contains Reasoning type questions, each having four choices (A), (B), (C) and (D) out of which ONLY ONE is correct. Each question contains STATEMENT 1 and STATEMENT 2. You have to mark your answer as

Bubble (A) If both statements are TRUE and STATEMENT 2 is the correct explanation of STATEMENT 1.

Bubble (B) If both statements are TRUE but STATEMENT 2 is not the correct explanation of STATEMENT 1.

Bubble (C) If STATEMENT 1 is TRUE and STATEMENT 2 is FALSE.

Bubble (D) If STATEMENT 1 is FALSE but STATEMENT 2 is TRUE.

1. **Statement-1:** A parallel beam of light traveling in air can be displaced laterally by a parallel transparent slab by distance more than the thickness of the plate.
Statement-2: The lateral displacement of light traveling in air increases with rise in value of refractive index of slab.

2. **Statement-1:** Even in absolutely clear water, a diver cannot see very clearly.
Statement-2: Velocity of light is reduced in water.

3. **Statement-1:** Spherical aberration of a lens can be reduced by blocking the central portion or peripheral portion of the lens.
Statement-2: Spherical aberration arises on account of inability of the lens to focus central and peripheral rays at the same point.

4. **Statement-1:** For total internal reflection, angle of incident in denser medium must be greater than critical angle for the pair of media in contact.

Statement-2: $\mu = \frac{1}{\sin C}$, where the symbols have their standard meaning.

5. **Statement-1:** The images formed due to total internal reflections are much brighter than those formed by mirrors or lenses.
Statement-2: There is no loss of intensity in total internal reflection.

6. **Statement-1:** A bird in air is diving vertically with speed v_0 over a tank filled with water and having flat silvered bottom serving as plane mirror, it observes velocity of its image in silvered bottom of tank as $2v_0$ upward relative to itself .
Statement-2: Bird and its image in bottom mirror are always equidistant from bottom mirror.

7. **Statement-1:** We cannot produce a real image by plane or convex mirrors under any circumstances.
Statement-2: The focal length of a convex mirror is always taken as positive.

8. **Statement-1:** If a light ray is incident on any one of the two mirrors inclined at $90°$ with each other, then finally the emergent ray is antiparallel with incident ray.
Statement-2: Finally, the reflected and initially incident rays are in same phase when successively reflected from two perpendicularly inclined mirrors.

9. **Statement-1:** 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.
Statement-2: Laws of reflection are strictly valid for plane surfaces, but not for large spherical surfaces.

10. **Statement-1:** The focal length of the mirror is f and distance of the object from the focus is u, the magnification of the mirror is $\frac{f}{u}$.
Statement-2: Magnification $= \frac{\text{size of image}}{\text{size of object}}$.

11. **Statement-1:** Although the surfaces of the lens used in goggles are curved, it does not have any power.
Statement-2: In case of goggles, the lenses are concavo-convex and both the surface of lens have equal radii of curvature.

12. **Statement-1:** A convex lens behaves as a concave lens when placed in a medium of refractive index greater than the refractive index of its material.
Statement-2: Light in that case will travel through the convex lens from denser to rarer medium. It will bend away from normal, i.e., the convex lens would diverge the rays and behave as concave.

13. **Statement-1:** The minimum distance between an object and its real image formed by a convex lens is $2f$.
Statement-2: The distance between an object and its real image is minimum when its magnification is one.

14. **Statement-1:** The lens formula $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ indicates that focal length of a lens depends on distances of object and image from the lens.
Statement-2: The formula does indicate but when u is changed v also changes, so that f of a particle lens remains constant.

15. **Statement-1:** For observing traffic at our back, we prefer to use a convex mirror.
Statement-2: A convex mirror has a much larger field of view than a plane mirror or a concave mirror.

16. **Statement-1:** When a ray of light enters glass from air, its frequency decreases.
Statement-2: The velocity of light in glass is less than that in air.

17. **Statement-1:** A ray incident along normal to the mirror retraces its path.
Statement-2: In reflection, angle of incidence is always equal to angle of reflection.

18. **Statement-1:** A concave mirror of focal length in air is used in a medium of refractive index 2. Then the focal length of mirror in medium becomes double.
Statement-2: The radius of curvature of a mirror is double of the focal length.

19. **Statement-1:** Light from an object falls on a concave mirror forming a real image of the object. If both the object and mirror are immersed in water, there is no change in position of the image.
Statement-2: The formation of image by reflection does not depend on surrounding medium, so there is no change in position of image.

20. **Statement-1:** A convex lens can be convergent in one medium and divergent in other medium.
Statement-2: In denser medium, convex lens is convergent and in rarer medium, convex lens is divergent.

21. **Statement-1:** For a prism of refracting angle $60°$ and refractive index $\sqrt{2}$ minimum deviation is $30°$.
Statement-2: At minimum deviation, $r_1 = r_2 = \frac{A}{2} = 30°$.

22. **Statement-1:** There exist two angles of incidence for the same magnitude of deviation (except minimum deviation) by a prism kept in air.
Statement-2: For a prism kept in air, a ray is incident on first surface and emerges out of second surface (of prism) along the previous emergent ray, then this ray emerges out of first surface along the previous incident ray. This principle is called the Principle of Reversibility of Light.

23. **Statement-1:** A plane convex lens is silvered from plane surface. It can act as a diverging mirror.
Statement-2: Focal length of concave mirror is independent of medium.

24. **Statement-1:** Maximum distance of image formed by convex mirror from pole of mirror equals $'f'$ for all the objects (real/virtual).
Statement-2: Convex mirrors forms virtual images for objects placed in front of mirror.

25. **Statement-1:** We cannot produce a real image by plane or convex mirror under any circumstances.
Statement-2: Reflection Law is valid for plane mirror as well as convex mirror.

26. **Statement-1:** There is no dispersion of light refracted through a rectangular glass slab.
Statement-2: Dispersion of light is the phenomenon of splitting of a beam of white light into its constituent colours.

27. **Statement-1:** Convex mirror always form a virtual image.
Statement-2: Focal length of a mirror is half of the radius of curvature.

28. **Statement-1:** A fish inside a pond will see a person standing outside taller than he is actually.
Statement-2: Light rays from person converges into eyes of fish on entering water from air.

29. **Statement-1:** Optical fibre has thin glass core coated by glass of small refractive index and is used to send light signals.
Statement-2: All the rays of light entering the fibre are totally reflected even at very small angles of incidence.

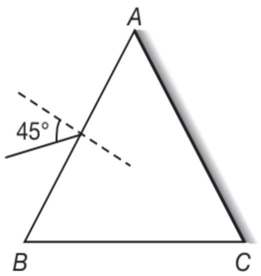
30. **Statement-1:** The mirror used in search light are parabolic and not concave spherical.
Statement-2: In a concave spherical mirror the image formed is always virtual.

LINKED COMPREHENSION TYPE QUESTIONS

This section contains Linked Comprehension Type Questions or Paragraph based Questions. Each set consists of a Paragraph followed by questions. Each question has four choices (A), (B), (C) and (D), out of which only one is correct. (For the sake of competitiveness there may be a few questions that may have more than one correct options)

Comprehension I

A ray of light is incident at $45°$ on the face AB of an equilateral prism ABC which has the face AC silvered. Based on the information provided answer the following questions.



1. The refractive index μ of the material of the prism so that when the ray falls on face BC (after reflecting from AC) it makes an angle $60°$ with it is

(A) $\sqrt{3}$ (B) $\sqrt{2}$
(C) 2 (D) 1.5

2. The total deviation, when the ray of light finally emerges from BC is

(A) $120°$ (B) $180°$
(C) $150°$ (D) $90°$

Comprehension 2

A convex lens of focal length 20 cm and a concave lens of focal length 10 cm are placed 20 cm apart. In between them an object is placed at distance x from the convex lens.
Based on the information provided answer the following questions.

3. The value of x (in cm) so that images formed by both the lenses coincide is

(A) $20(\sqrt{3}-1)$ (B) $\frac{20\sqrt{3}-1}{\sqrt{3}}$
(C) $\frac{20}{\sqrt{3}}$ (D) $10(\sqrt{3}-1)$

4. The linear magnification produced by convex lens and concave lens individually is

(A) $(\sqrt{3}+1)$ and $\frac{1}{\sqrt{3}}$
(B) $\sqrt{3}$ and $\frac{1}{\sqrt{3}}$
(C) $(\sqrt{3}+1)$ and $(\sqrt{3}-1)$
(D) $\sqrt{3}$ and $(2\sqrt{3}-3)$

Comprehension 3

A telescope is an optical instrument used to increase the visual angle of distant objects such as stars, planets etc. An astronomical telescope consists of two converging lenses. The one facing the object is called objective and the lens close to the eye is called an eyepiece. It can be adjusted by displacing relative to the objective. The angular magnification is defined as the ratio of focal length of objective and eyepiece. One can see the image with unstrained eye if it forms at infinity. An astronomical telescope has an objective of focal length 50 cm and a magnification of 20. Based on above information, answer the following questions.

5. Focal length of the eyepiece is
(A) 2.5 cm
(B) 5 cm
(C) 7.5 cm
(D) None of these

6. To view remote object by an unstrained normal eye, separation between two lenses will be
(A) 55 cm (B) 57.5 cm
(C) 60 cm (D) 52.5 cm

7. If object is at a distance 600 m from the telescope to see the image with unstrained eye separation between two lenses should be (in cm)
(A) 46.65 (B) 47.65
(C) 49.96 (D) 49.65

Comprehension 4

Speed of light in a medium of refractive index n is given by $\frac{c}{n}$ where c is speed of light in vacuum refractive index of a medium depends on wavelength (λ). As wavelength increases refractive index decreases. It is also given

$$\lambda_{\text{red}} > \lambda_{\text{orange}} > \lambda_{\text{yellow}}$$

Based on above information, answer the following questions.

8. In glass
(A) orange light travels faster than yellow light
(B) yellow light travels faster than orange light
(C) yellow light travels faster than red light
(D) orange light travels faster than red light

9. The quantity that remains unchanged if light enters from water to glass is
(A) Wavelength and colour
(B) Refractive index and frequency
(C) Frequency and velocity
(D) Colour and frequency

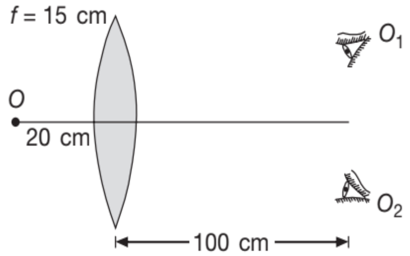
10. The phenomenon that happens because of variation of wavelength is
(A) Aberration
(B) Dispersion
(C) Total internal reflection
(D) Bending of light

11. Which of the following statement is true?
(A) Time taken (t) by yellow light to travel distance x_0 in refractive index n can be $t \le \frac{nx_0}{c_0}$
(B) Time taken (t) by yellow light to travel distance x_0 in refractive index n can be $t \ge \frac{nx_0}{c}$
(C) Since wavelength of yellow light increases in refractive index n its frequency must decreases.
(D) None of the above

12. Which of the following statement is false?
(A) Light is a electromagnetic wave
(B) Speed of light of each colour is same in vacuum
(C) Time to cover distance x_0 in a medium is same for each colour
(D) As frequency of light increases then refractive index of glass increases

Comprehension 5

The figure shows a convex lens of focal length 15 cm. A point object is placed on the principle axis of lens at a distance 20 cm from it as shown. On the other side of the lens two observer eyes O_1 and O_2 are situated at a distance 100 cm from the lens at some distance above and below the principle axis.



Now half position of lens below principle axis is painted black. Based on above information, answer the following questions.

13. In initial setup (before painting the lens) which of the following statement is correct.
(A) Observer O_1 will see a real image at 60 cm from the lens but observer O_2 will not be able to see it
(B) Observer O_2 will see a real image at 60 cm from the lens but observer O_1 will not be able to see it
(C) Both the observers will see a real image at 60 cm from lens irrespective the positions of O_1 and O_2
(D) Both the observers may or may not be able to see the image at 60 cm from lens depending on the positions of O_1 and O_2

14. After painting the lens, which of the following observer will not be able to see the image of object, if before this activity both were seeing the image

(A) O_1 (B) O_2

(C) Both O_1 and O_2 (D) Neither O_1 nor O_2

15. After painting the lens, for which observer the intensity of image will be reduced to half?

(A) For O_1

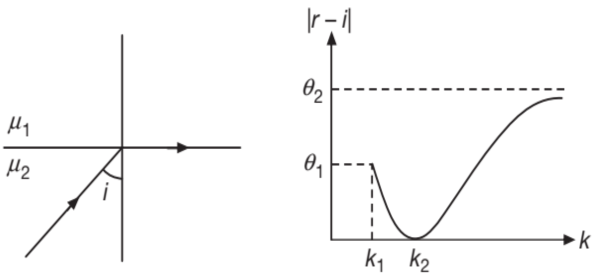
(B) For O_2

(C) Both for O_1 and O_2

(D) Neither for O_1 nor for O_2

Comprehension 6

The figure shows a ray incident at an angle $i = \frac{\pi}{3}$. If the plot drawn shows the variation of $|r - i|$ versus $\frac{\mu_1}{\mu_2} = k$, where r is the angle of refraction, then based on above information, answer the following questions.



16. The value of k_1 is

(A) $\frac{2}{\sqrt{3}}$ (B) 1

(C) $\frac{1}{\sqrt{3}}$ (D) $\frac{\sqrt{3}}{2}$

17. The value of θ_1 is

(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{2}$

(C) $\frac{\pi}{6}$ (D) ZERO

18. The value of k_2 is

(A) 1 (B) 2

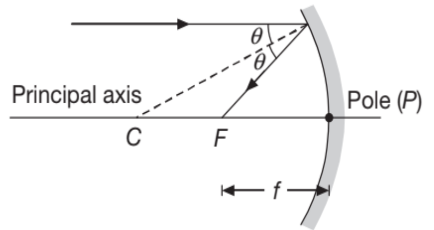
(C) $\frac{1}{2}$ (D) None of these

Comprehension 7

Spherical aberration in spherical mirrors is a defect which is due to dependence of focal length f on angle of incidence θ as shown in figure is given by

$$f = R - \frac{R}{2}\sec\theta$$

where R is radius of curvature of mirror and θ is the angle of incidence. The rays which are closed to principal axis are called paraxial rays and the rays far away from principal axis are called marginal rays. As a result of above dependence different rays are brought to focus at different points and the image of a point object is not a point.



Based on above information, answer the following questions.

19. If f_p and f_m represent the focal length of paraxial and marginal rays respectively, then correct relationship is

(A) $f_p = f_m$ (B) $f_p > f_m$

(C) $f_p < f_m$ (D) None of these

20. If angle of incidence is $60°$, then focal length of this marginal ray is

(A) R (B) $\frac{R}{2}$

(C) $2R$ (D) 0

21. The total deviation suffered by the ray falling on mirror at an angle of incidence equal to $60°$ is

(A) $60°$

(B) $90°$

(C) $30°$

(D) Cannot be determined

Comprehension 8

The XY plane is the boundary between two transparent media. Medium-I with $z \geq 0$ has a refractive index $\sqrt{2}$ and medium-II with $z \leq 0$ has a refractive index $\sqrt{3}$. A ray of light in medium-I given by $\vec{A} = 6\sqrt{3}\hat{i} + 8\sqrt{3}\hat{j} - 10\hat{k}$ is incident on the plane of separation. Based on the above facts, answer the following questions.

22. The vector representing the incident ray has a magnitude of

(A) 5 units (B) 10 units
(C) 15 units (D) 20 units

23. The angle of incidence is
(A) 30° (B) 45°
(C) 60° (D) 90°

24. The angle of refraction is
(A) 30° (B) 45°
(C) 60° (D) 90°

25. The refracted ray is represented by the vector given by
(A) $6\sqrt{3}i - 8\sqrt{3}\hat{j} + 10\sqrt{3}\hat{k}$
(B) $8\sqrt{3}\hat{j}$
(C) $-10\sqrt{3}\hat{k}$
(D) $6\sqrt{3}\hat{i} + 8\sqrt{3}\hat{j} - 10\sqrt{3}\hat{k}$

26. The vector representing the refracted ray has a magnitude of
(A) $\sqrt{6}$ units (B) 10 units
(C) $10\sqrt{6}$ units (D) $20\sqrt{6}$ units

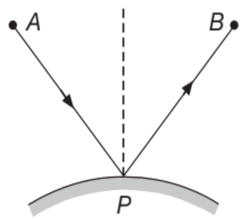
27. The unit vector along refracted ray is
(A) $\frac{3}{5\sqrt{2}}\hat{i} + \frac{4}{5\sqrt{2}}\hat{j} - \frac{1}{\sqrt{2}}\hat{k}$
(B) $3\hat{i} + 4\hat{j} - 5\hat{k}$
(C) $\frac{3}{5\sqrt{2}}\hat{i} - \frac{4}{5\sqrt{2}}\hat{j} + \frac{1}{\sqrt{2}}\hat{k}$
(D) $2\hat{i} - 3\hat{k}$

Comprehension 9

The lens governing the behaviour of the rays namely rectilinear propagation, laws of reflection and refraction can be summarised in one fundamental law known as Fermat's Principle. According to this principle a ray of light travels from one point to another such that the time taken is at a stationary value (maximum or minimum). If c is the velocity of light in a vacuum, the velocity in a medium of refractive index n is $\frac{c}{n}$, hence time taken to travel a distance l is $\frac{nl}{c}$. If the light passes through a number of media, the total time taken is $\left(\frac{1}{c}\right)\sum nl$ or $\frac{1}{c}\int ndl$ if refractive index varies continuously. Now, $\sum nl$ is the total optical path, so that Fermat's Principle states then the path of a ray is such that the optical path in at a stationary value. This principle is obviously in agreement with the fact that the ray are straight lines in a homogeneous isotropic medium. It is found that it also agrees with the classical laws of reflection and refraction. Based on above information, answer the following questions.

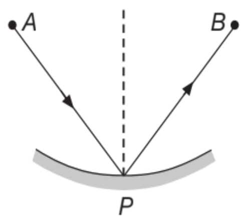
28. If refractive index of a slab varies as $m = 1 + x^2$ where x is measured from one end, then optical path length of a slab of thickness 1 m is
(A) $\frac{4}{3}$ m (B) $\frac{3}{4}$ m
(C) 1 m (D) None of these

29. The optical path length followed by ray from point A to B, given that laws of reflection are obeyed as shown in figure is



(A) Maximum (B) Minimum
(C) Constant (D) None of these

30. The optical path length followed by ray from point A to B, given that laws of reflection are obeyed as shown in figure is



(A) Maximum (B) Minimum
(C) Constant (D) None of these

Comprehension 10

Consider an equiconvex lens of radius R, made of a material of refractive index μ. Its focal length is f_1 when any one face is silvered. Now consider another plano-convex lens of radius R, made of same material having focal length, f_2 when no face is silvered, f_3 when plane face is silvered and f_4 when curved surface is silvered. Based on above information, answer the following questions.

31. f_1 equals

(A) $\frac{R}{(2\mu-1)}$ (B) $\frac{2R}{(2\mu-1)}$

(C) $\frac{R}{2(2\mu-1)}$ (D) $\frac{2R}{2(2\mu+1)}$

32. f_2 equals

(A) R (B) $\frac{R}{2\mu-1}$

(C) $\frac{R}{\mu-1}$ (D) $\frac{R}{\mu+1}$

33. f_3 equals

(A) $\frac{R}{2\mu}$ (B) $\frac{R}{2(\mu-1)}$

(C) $\frac{2R}{\mu}$ (D) $2R\mu$

34. f_4 equals

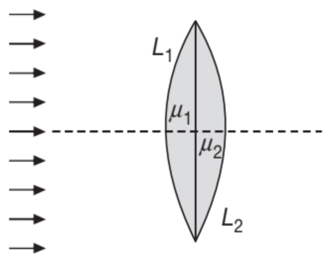
(A) $\frac{R}{\mu}$ (B) $\frac{2R}{\mu}$

(C) $2R\mu$ (D) $\frac{R}{2\mu}$

Comprehension 11

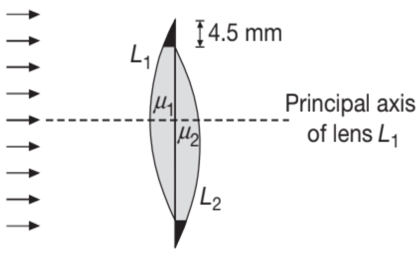
SITUATION-I

Two identical plano-convex lenses L_1 and L_2 having radii of curvature $R = 20$ cm and refractive indices $\mu_1 = 1.4$ and $\mu_2 = 1.5$ are placed as shown in the figure.



SITUATION-II

Now, the second plano-convex lens is shifted vertically downward by a small distance of 4.5 mm and the extended parts of L_1 and L_2 are blackened as shown in figure.



Based on above information, answer the following questions.

35. In SITUATION-I, the position of the image of the parallel beam of light relative to the common principal axis is

(A) $\frac{100}{9}$ cm (B) $\frac{100}{3}$ cm

(C) $\frac{200}{3}$ cm (D) $\frac{200}{9}$ cm

36. In SITUATION-II, the new position of the image of the parallel beam is

(A) $\frac{200}{9}$ cm in front of the lens 2 mm below the principal axis of L_1.

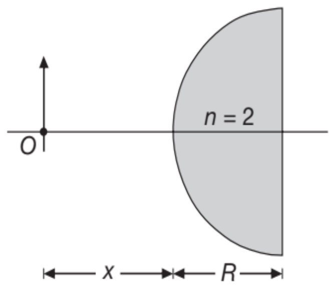
(B) $\frac{100}{9}$ cm behind the lens 2 mm below the principal axis of L_1.

(C) $\frac{200}{9}$ cm behind the lens 2.5 mm below the principal axis of L_1.

(D) $\frac{200}{9}$ cm in front of the lens 2.5 mm below the principal axis of L_1.

Comprehension 12

A small object O is placed in air at the principal axis at a distance x from the pole of the curved surface of a transparent hemisphere having refractive index 2 and radius R as shown. Based on above information, answer the following questions.



37. The value of x, for which the final image of the object at O will be virtual is

(A) $2R$ (B) $3R$

(C) $\frac{R}{3}$ (D) $1.5R$

38. The nature of final image of the object when $x = 2R$ is

(A) Erect and magnified

(B) Inverted and magnified

(C) Erect and same size
(D) Inverted and same size

39. It is observed that for $x = R$, a ray starting from O strikes the spherical surface at grazing incidence. The angle with the normal at which the ray emerges from the plane surface is

(A) 90° (B) 0°
(C) 30° (D) 60°

Comprehension 13

The refractive indices of the crown glass for blue and red lights are 1.51 and 1.49 respectively and those of the flint glass are 1.77 and 1.73 respectively. An isosceles prism of angle 6° is made of crown glass. A beam of white light is incident at a small angle on this prism. The other flint glass isosceles prism is combined with the crown glass prism such that there is no deviation of the incident light. Based on the above facts, answer the following questions.

40. The refractive index of crown glass for yellow colour is
(A) 1.51 (B) 1.49
(C) 1.50 (D) 1.59

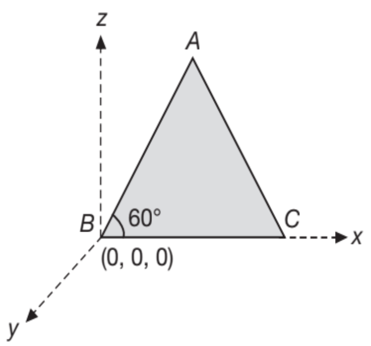
41. The refractive index of flint glass for yellow colour is
(A) 1.70 (B) 1.72
(C) 1.73 (D) 1.75

42. The refracting angle of flint glass prism is
(A) +2° (B) +4°
(C) −2° (D) −4°

43. The net dispersion produced by the combined system is
(A) 0.02° (B) −0.02°
(C) +0.04° (D) −0.04°

Comprehension 14

An equilateral prism ABC is placed in air with its base side BC lying horizontally along x-axis as shown in figure. A ray of light represented by equation $\sqrt{3}z + x = 10$ is incident at a point P on the face AB of prism. Based on above information, answer the following questions.



44. The value of μ for which the ray grazes the face AC is

(A) $\frac{3}{2}$ (B) $\frac{4}{3}$
(C) $\frac{2}{\sqrt{3}}$ (D) $\frac{\sqrt{5}}{2}$

45. The direction of the finally refracted ray for $\mu = \frac{3}{2}$ is

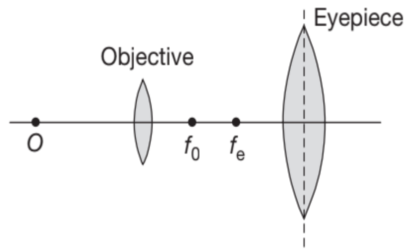
(A) parallel to x-axis
(B) parallel to z-axis
(C) parallel to y-axis
(D) parallel to face AB

46. The equation of ray emerging out of prism, if the bottom BC is silvered is

(A) $z + \sqrt{3}x = 10$ (B) $\sqrt{3}z + x = 10$
(C) $z + \sqrt{3}x = 20$ (D) $x + z = 10\sqrt{3}$

Comprehension 15

The schematic diagram of a compound microscope is shown in the adjacent figure. Its main components are two convex lenses: one acts as the main magnifying lens and is referred to as the objective, and another lens called the eyepiece. The two lenses act independently of each other when bending light rays.



f_0 = focal point of objective

f_e = focal point of eyepiece

Light from the object (O) first passes through the objective and enlarged, inverted first image is formed. The eyepiece then magnifies this image. Usually the magnification of the eyepiece is fixed (either × 10 or × 15) and three rotating objective lenses are used : × 10, × 40 and × 60. Angular magnification is defined as the angle subtended by the final image at the eye to the angle subtended by the object placed at least distance of distinct vision $(\approx 25 \text{ cm})$ when viewed by the naked eye. Based on above information, answer the following questions.

47. The type of image that would have to be produced by the objective is

(A) Either virtual or real
(B) Virtual
(C) Real
(D) It depends on the focal length of the lens.

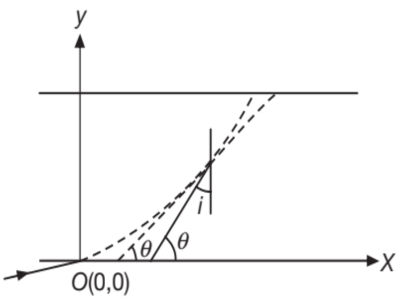
48. Where would the first image have to be produced by the objective relative to the eyepiece such that a second, enlarged image would be generated on the same side of the eyepiece as the first image? Assume that the first image distance is d_i from the eyepiece.

(A) $d_i < f_e$ (B) $d_i = f_e$
(C) $f_e < d_i < 2f_e$ (D) $d_i > 2f_e$

49. Two compound microscopes A and B were compared. Both had objectives and eyepieces with the same magnification but A gave an overall magnification that was greater than that of B. Which of the following is a possible explanation?
(A) The distance between object and eyepiece in A is greater than the corresponding distance in B.
(B) The distance between object and eyepiece in A is less than the corresponding distance in B.
(C) The eyepiece and objective positions were reversed in A.
(D) The eyepiece and objective positions were reversed in B.

Comprehension 16

A ray of light travelling in air is incident at grazing angle on a long rectangular slab of a transparent medium of thickness $t = 1.0$ m. The point of incidence O is the origin $(0, 0)$. The medium has a variable index of refraction $\mu(y)$ given by $\mu(y) = \left[Ky^{3/2} + 1\right]^{1/2}$ where $K = 1.0(m)^{-3/2}$. The refractive index of air is 1.0.



Based on the above facts, answer the following questions.

50. The relation between the slope of the trajectory of the ray at the point $B(x, y)$ in the medium and the angle of incidence (i) at that point is given by

(A) $\tan\theta = \sin i$ (B) $\tan\theta = 2\sin i$
(C) $\tan\theta = \cot i$ (D) $\tan\theta = 2\cot i$

51. The equation for the trajectory $y(x)$ of the ray in the medium is

(A) $y = \frac{x^2}{16}$ (B) $y = \frac{x^3}{16}$
(C) $y = \frac{x^4}{16}$ (D) $y = \frac{x^4}{256}$

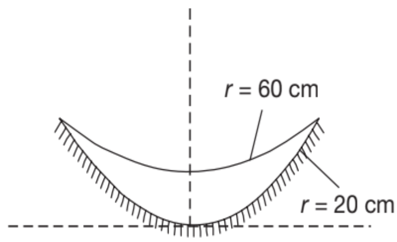
52. The co-ordinates (x, y) of the point where the ray intersects the upper surface of the slab-air boundary are

(A) $(1, 1)$ m (B) $(2, 1)$ m
(C) $(3, 1)$ m (D) $(4, 1)$ m

53. The ray finally emerges
(A) parallel to the incident ray
(B) perpendicular to the incident ray
(C) at an angle of $30°$ to the incident ray
(D) at an angle of $45°$ to the incident ray

Comprehension 17

The convex surface of a thin concavo–convex lens of glass of refractive index 1.5 has a radius of curvature of 20 cm. The concave surface has a radius of curvature of 60 cm. The convex side is silvered and placed on a horizontal surface as shown in the figure.



Based on above information, answer the following questions.

54. The focal length of the combination has the magnitude
(A) 1.5 cm (B) 15 cm
(C) 7.5 cm (D) 8.6 cm

55. The combination behaves like
(A) a convex mirror
(B) a concave mirror
(C) a convex lens
(D) a concave lens

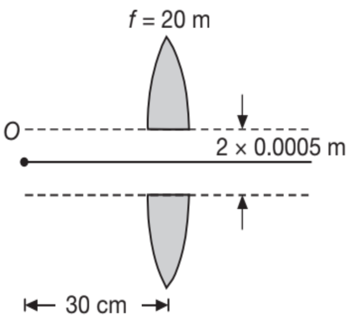
56. A small object is placed on the principal axis of the combination, at a distance of 30 cm in front of the mirror. The magnification of the image is

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

(C) 5 (D) $-\frac{1}{4}$

Comprehension 18

A point object O is placed at a distance of 0.3 m from a convex lens (focal length 0.2 m) cut into two halves each of which is displaced by 0.0005 m as shown in the figure.



Based on above information, answer the following questions.

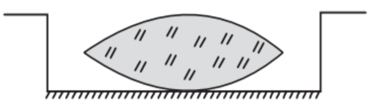
57. The position at which the image is formed is
(A) 30 cm, right of lens (B) 40 cm, left of lens
(C) 60 cm, right of lens (D) 70 cm, left of lens

58. The total number of images generated by the arrangement is/are
(A) 1 (B) 2
(C) 4 (D) 6

59. The spacing between the images so formed is
(A) 0.1 cm (B) 0.3 cm
(C) 0.5 cm (D) 1 cm

Comprehension 19

A thin biconvex lens of refractive index $\frac{3}{2}$ is placed on a horizontal plane mirror as shown in figure.



The space between the lens and the mirror is then filled with water of refractive index $\frac{4}{3}$. It is found that when a point object is placed 15 cm 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 25 cm from the lens. Based on the above facts, answer the following questions.

60. The radius of curvature of both the surfaces of the convex lens is R, then the focal length of the convex lens is
(A) R (B) $\frac{R}{2}$

(C) $\frac{R}{4}$ (D) $\frac{R}{8}$

61. When the space between the lens and mirror is filled with water, the focal length of water concave lens is
(A) R (B) $2R$
(C) $3R$ (D) $4R$

62. The radius of curvature R of each surface of convex lens is
(A) 2 cm (B) 5 cm
(C) 10 cm (D) 15 cm

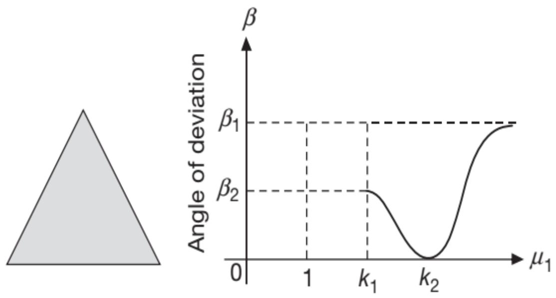
63. The focal length of the liquid concave lens is
(A) $\frac{20}{3}$ cm (B) $\frac{40}{3}$ cm

(C) $\frac{50}{3}$ cm (D) $\frac{70}{3}$ cm

64. The refractive index of the liquid is
(A) 1.1 (B) 1.2
(C) 1.4 (D) 1.6

Comprehension 20

The diagram shows an equilateral prism. The medium on one side of the prism has refractive index μ_1. The refractive index of the prism is $\mu = \frac{4}{\sqrt{3}}$. The diagram shows variation of magnitude of angle of deviation with respect to μ_1. Consider the light ray to be incident normally on the first face.



Based on above information, answer the following questions.

65. Value of k_2 is

(A) $\frac{6}{\sqrt{3}}$ (B) $\frac{4}{\sqrt{3}}$

(C) $\frac{\sqrt{3}}{2}$ (D) $\frac{8}{\sqrt{3}}$

66. Value of k_1 is

(A) $\frac{4}{3}$ (B) $\frac{5}{3}$

(C) $\frac{8}{3}$ (D) $\frac{10}{3}$

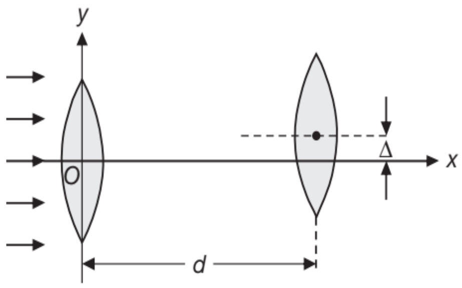
67. Value of $\beta_1 - \beta_2$ is

(A) 20° (B) 30°

(C) 60° (D) 90°

Comprehension 21

Two thin convex lenses of focal lengths f_1 and f_2 are separated by a horizontal distance $d(d < f_1 \text{ and } d < f_2)$ and their centers are displaced by a vertical separation as shown in the figure. Take the origin of coordinates O at the center of first lens. For a parallel beam of light coming from the left, as shown in figure.



Based on above information, answer the following questions.

68. The x-coordinate of the focal point of this lens system is

(A) $\frac{d(f_1 - d) + f_1 f_2}{f_1 + f_2 - d}$ (B) $\frac{f_1 f_2}{f_1 + f_2 - d}$

(C) $\frac{d(f_1 - d)}{f_1 + f_2 - d}$ (D) $\frac{2d(f_1 + d) - f_1 f_2}{f_1 + f_2 - d}$

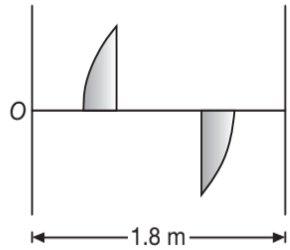
69. The y-coordinate of the focal point of this lens system is

(A) $\frac{(f_1 + d)\Delta}{(f_1 + f_2 - d)}$ (B) $\frac{2(f_1 + d)}{(f_1 + f_2 - d)}$

(C) $\frac{2(f_1 - d)\Delta}{(f_1 + f_2 + d)}$ (D) $\frac{(f_1 - d)\Delta}{(f_1 + f_2 - d)}$

Comprehension 22

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



Based on above information, answer the following questions.

70. The focal length of the lens used is

(A) 0.4 m (B) 0.6 m

(C) 1 m (D) 2 m

71. The separation between the two halves of the thin plano-convex lens is

(A) 0.2 m (B) 0.4 m

(C) 0.6 m (D) 0.8 m

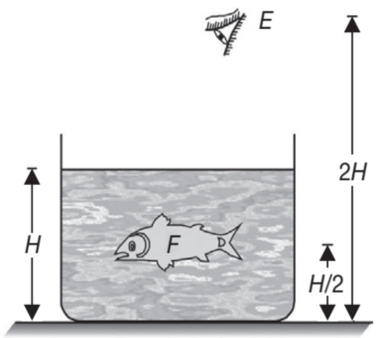
72. The magnification for the second half lens is

(A) 0.5 (B) –0.5

(C) 0.4 (D) –2

Comprehension 23

Consider a beaker filled with water (of refractive index μ) to a height H. A fish F is at a height $\frac{H}{2}$ from the transparent base of the beaker which lies on a surface that happens to be a mirror. An observer whose eye E is at a height $2H$ from the base of beaker is also there. Based on above information, answer the following questions.



73. The distance from itself at which the fish will see the image of the eye by direct observation is

(A) $H\left(\mu + \frac{1}{2}\right)$ (B) $\frac{H}{2}\left(1 + \frac{\mu}{2}\right)$

(C) $H\left(\frac{\mu}{2} + 1\right)$ (D) $\frac{H}{2}\left(\mu + \frac{1}{2}\right)$

74. The distance from itself at which the fish sees the image of eye by viewing in the mirror is

(A) $H\left(\mu+\frac{1}{2}\right)$ (B) $H\left(\mu+\frac{3}{2}\right)$

(C) $2H\left(\mu+\frac{1}{2}\right)$ (D) $2H\left(\mu+\frac{3}{2}\right)$

75. The distance from itself at which the eye sees the image of the fish by directly observing the fish is

(A) $2H\left(1+\frac{1}{2\mu}\right)$ (B) $2H\left(\frac{1}{2}+\frac{1}{\mu}\right)$

(C) $H\left(1+\frac{1}{2\mu}\right)$ (D) $H\left(\frac{1}{2}+\frac{1}{\mu}\right)$

76. The distance from itself at which the eye sees the image of the fish by viewing in the mirror is

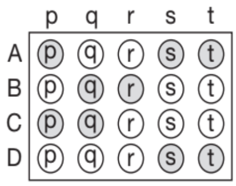
(A) $2\left(H+\frac{3}{2\mu}\right)$ (B) $H+\frac{3}{2\mu}$

(C) $H\left(\frac{1}{2}+\frac{3}{\mu}\right)$ (D) $H\left(1+\frac{3}{2\mu}\right)$

MATRIX MATCH/COLUMN MATCH TYPE QUESTIONS

Each question in this section contains statements given in two columns, which have to be matched. The statements in **COLUMN-I** are labelled A, B, C and D, while the statements in **COLUMN-II** are labelled p, q, r, s (and t). Any given statement in **COLUMN-I** can have correct matching with **ONE OR MORE** statement(s) in **COLUMN-II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following examples:

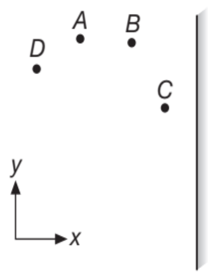
If the correct matches are A → (p, s, t); B → (q, r); C → (p, q); and D → (s, t); then the correct darkening of bubbles will look like the following:



1. For a real object, match the magnification situations in **COLUMN-I**, with their respective matches in **COLUMN-II**.

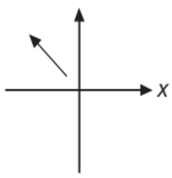
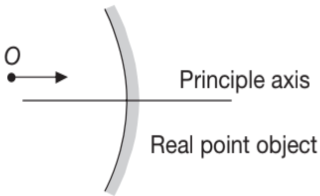
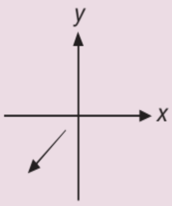
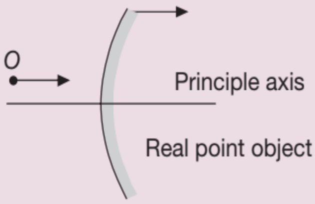
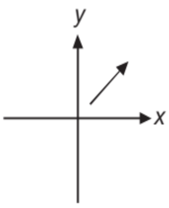
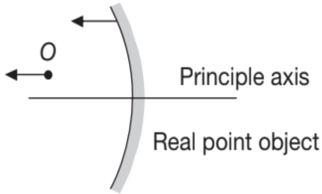
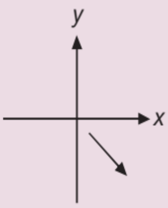
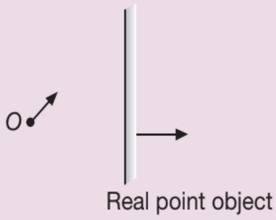
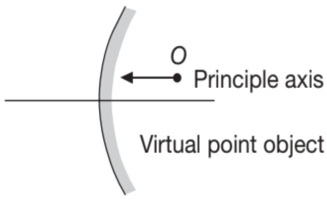
COLUMN-I	COLUMN-II
(A) $m<0$	(p) Plane mirror
(B) $m>0$	(q) Convex mirror
(C) $\lvert m\rvert<1$	(r) Concave mirror
(D) $\lvert m\rvert\geq 1$	(s) Convex lens
	(t) Concave lens

2. Four particles are moving with different velocities in front of stationary plane mirror that lies in the y-z plane. At $t=0$, velocity of A is $\vec{v}_A=\hat{i}$, velocity of B is $\vec{v}_B=-\hat{i}+3\hat{j}$, velocity of C is $\vec{v}_C=5\hat{i}+6\hat{j}$, velocity of D is $\vec{v}_D=3\hat{i}-\hat{j}$. The acceleration of particle A is $\vec{a}_A=2\hat{i}+\hat{j}$ and acceleration of particle C is $\vec{a}_C=2\hat{i}+\hat{j}$, whereas the particle B and D move with uniform velocity. Assume no collision to take place till $t=2$ s, all quantities to be in SI units, the relative velocity of image of object A with respect to object A to be denoted by $\vec{v}_{A'A}$. If velocity of images relative to corresponding objects are given in **COLUMN-I** and their values at $t=2$ s are given in **COLUMN-II**, then match the quantities in **COLUMN-I** with the corresponding values in **COLUMN-II**.

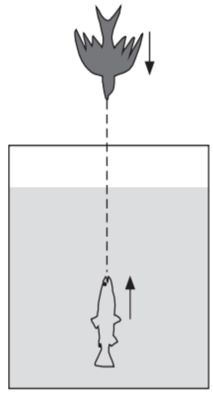


COLUMN-I	COLUMN-II
(A) $\vec{v}_{A'A}$	(p) $2\hat{i}$
(B) $\vec{v}_{B'B}$	(q) $-6\hat{i}$
(C) $\vec{v}_{C'C}$	(r) $-12\hat{i}+4\hat{j}$
(D) $\vec{v}_{D'D}$	(s) $-10\hat{i}$
	(t) Perpendicular to the plane of mirror

3. The **COLUMN-I** shows some probable directions of velocity of images formed due to system shown in **COLUMN-II**. Match the quantities of **COLUMN-I** with the respective possibilities shown in **COLUMN-II.**

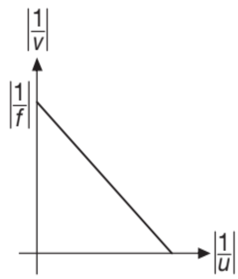
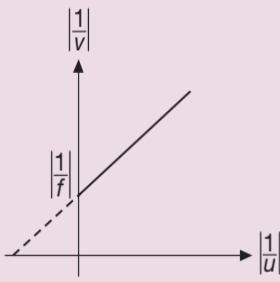
COLUMN-I	COLUMN-II
(A) 	(p) 
(B) 	(q) 
(C) 	(r) 
(D) 	(s) 
	(t) 

4. A bird in air is diving vertically over a tank with a speed of $6\ cms^{-1}$. The base of the tank is silvered. A fish in the tank is rising upward along the same line with a speed of $8\ cms^{-1}$. Taking $\mu_{water} = \frac{4}{3}$, match the quantities in **COLUMN-I** with their respective values in **COLUMN-II**.



COLUMN-I	COLUMN-II
(A) Speed of the image of fish, in cms^{-1} as seen by the bird directly	(p) 16
(B) Speed of the image of fish, in cms^{-1} formed after reflection from the mirror as seen by the bird	(q) 0
(C) Speed of image of bird, in cms^{-1} relative to the fish looking upwards	(r) 12
(D) Speed of image of bird, in cms^{-1} relative to the fish looking downwards in the mirror	(s) 8

5. Match the descriptions in **COLUMN-I** with corresponding plot(s) in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) In convex mirror, when object is real and image is virtual	(p) 
(B) In convex mirror, when object is virtual and image is real.	(q) 

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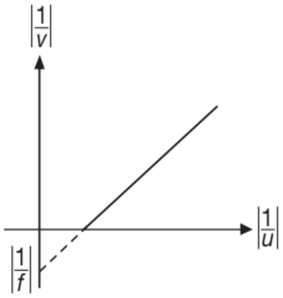
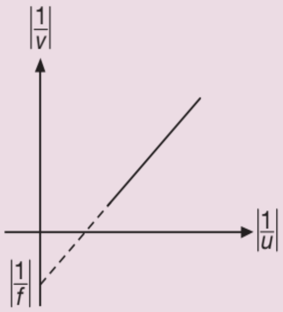
COLUMN-I	COLUMN-II
(C) In concave mirror, when object is real and image is virtual.	(r) 
(D) In concave mirror, when object is real or virtual and image is real.	(s) 

6. If (μ_1, λ_1, v_1) and (μ_2, λ_2, v_2) are the refractive indices, wavelengths and speeds of two light waves respectively, then match the entries of **COLUMN-I** with the entries of **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) $\mu_1 > \mu_2$	(p) $v_1 < v_2$
(B) $\mu_1 < \mu_2$	(q) $v_1 > v_2$
(C) $\mu_1 \neq \mu_2$	(r) $\lambda_1 = \lambda_2$
(D) $\mu_1 = \mu_2$	(s) $\lambda_1 < \lambda_2$

7. Match the descriptions in **COLUMN-I** to corresponding details in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) In refraction from a rarer to a denser medium.	(p) Speed of wave does not change.
(B) In refraction.	(q) Wavelength must be decreased.
(C) In reflection from a denser medium.	(r) Frequency does not change.
(D) In reflection.	(s) The reflected ray suffers an additional path change of $\frac{\lambda}{2}$.

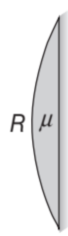
8. Light rays are incident on devices which may cause either reflection or refraction or both. The nature of the incident light and the devices are described in **COLUMN–I**. Some possible results of this on the rays are given in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) A ray of white light passes from an optically denser medium to an optically rarer medium.	(p) Divergent beam
(B) A parallel beam of monochromatic light passes symmetrically through a glass lens.	(q) Total internal reflection
(C) A ray of white light is incident at an angle on a thick glass sheet.	(r) Lateral shift
(D) A ray of white light is incident on one face of an equivalent glass prism.	(s) Dispersion

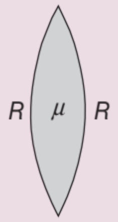
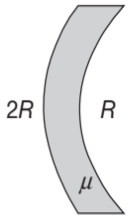
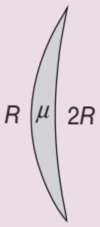
9. For a real object, match the descriptions in **COLUMN-I** to the corresponding details in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Convex mirror	(p) Virtual image
(B) Concave mirror	(q) Real image
(C) Convex lens	(r) Enlarged image
(D) Concave lens	(s) Diminished image

10. Match the details of **COLUMN-I** with the respective name and nature described in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) 	(p) Converging

(Continued)

COLUMN-I	COLUMN-II
(B) 	(q) Concavo-convex
(C) 	(r) Convexo-concave
(D) 	(s) Diverging

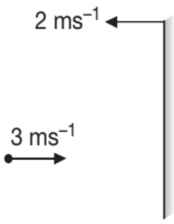
11. Match the following

COLUMN-I	COLUMN-II
(A) Concave mirror, virtual object	(p) Real image
(B) Convex mirror, virtual object	(q) Virtual image
(C) Convex lens, real object	(r) Magnified image
(D) Concave lens, real object	(s) Diminished image

12. For a concave mirror of focal length 20 cm, match the object distances in **COLUMN-I** to the corresponding details of images formed in **COLUMN-II.**

COLUMN-I	COLUMN-II
(A) 10 cm	(p) Magnified, inverted and real
(B) 30 cm	(q) Equal size, inverted and real
(C) 40 cm	(r) Smaller, inverted and real
(D) 50 cm	(s) Magnified, erect and virtual

13. A point object is placed in front of a plane mirror as shown and moving with velocity $3\ ms^{-1}$ towards mirror. Mirror is moving with speed $2\ ms^{-1}$ towards object, then

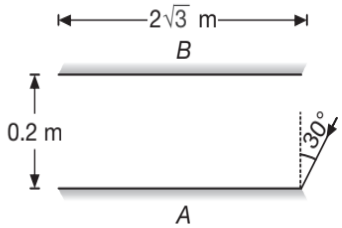


COLUMN-I	COLUMN-II
(A) Speed of image w.r.t. ground	(p) $10\ ms^{-1}$
(B) Speed of image w.r.t. mirror	(q) $5\ ms^{-1}$
(C) Speed of image w.r.t. object	(r) $14\ ms^{-1}$
(D) Speed of mirror w.r.t. object	(s) $7\ ms^{-1}$

INTEGER/NUMERICAL ANSWER TYPE QUESTIONS

In this section, the answer to each question is a numerical value obtained after doing series of calculations based on the data given in the question(s).

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



2. Where should an object be placed, in cm, in front of a concave mirror of focal length 30 cm so the image size is 5 times the object size?

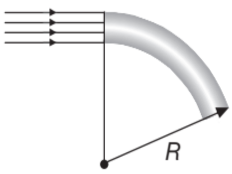
3. A rod of length 20 cm is placed along the optical axis of a concave mirror of focal length 30 cm. One end of the rod is at the centre of curvature and the other end lies between F and C. Find the magnitude of the linear magnification of the rod

4. A point source of light S is placed on the major optical axis of concave mirror at a distance of 60 cm. At what distance, in cm, from the concave mirror should a flat mirror be placed for the rays to converge again at the point S having been reflected from the concave mirror and then from the flat one? Will the position of the point where the rays meet change if they are first reflected from the flat mirror? The radius of the concave mirror is 80 cm.

5. A concave mirror forms on a screen a real image of thrice the linear dimensions of the object. Object and screen are moved until the image is twice the size of the object. If the shift of the object is 6 cm, find the shift of the screen and the focal length of the mirror (both in cm).

6. A fish is rising up vertically inside a pond with velocity $4\ \text{cms}^{-1}$ and notices a bird, which is diving vertically downward and its velocity appears to be $16\ \text{cms}^{-1}$ (to the fish). What is the actual velocity of the diving bird, in cms^{-1}, if refractive index of water is $4/3$.

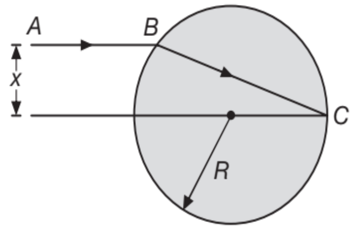
7. A portion of a straight glass rod of diameter 4 cm and refractive index 1.5 is bent into an arc of radius R cm and a parallel beam of light is incident on it as shown in figure. Find the smallest R, in cm, which permits all the light to pass around the arc.



8. A man of height 2 m is standing on level road where because of temperature variation the refractive index of air is varying as $\mu = \sqrt{1+ay}$, where y is height from road. If $a = 2\times10^{-6}\ \text{m}^{-1}$. Then find the maximum distance, in km, till which he can see on the road.

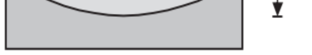
9. A ray of light falls on a glass sphere of refractive index $\sqrt{3}$ such that the directions of the incident ray and emergent ray when produced meet the surface at the same point on the surface. Draw the ray diagram and find the value of angle of incidence, in degree.

10. A spherical ball of transparent material has index of refraction μ. A narrow beam of light AB is aimed as shown. What must the index of refraction be in order that the light is focussed at the point C on the opposite end of the diameter from where the light entered? Given that $x \ll R$.

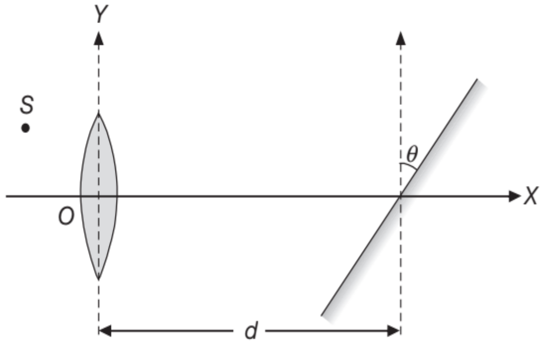


11. The perpendicular faces of a right isosceles prism are coated with silver. The rays incident at an arbitrary angle on the hypotenuse face emerge from the prism after suffering a deviation of x degree. Find x.

12. 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 radius of curvature 8 cm and is silvered to make it concave mirror as shown in the figure. When an object is placed at a distance of 10 cm directly above the centre of the sphere its final image coincides with it. Find h (as shown in figure), the height of the liquid surface in the beaker, in cm, from the apex of the bottom. Consider the paraxial rays only. The refractive index of the sphere is $\dfrac{3}{2}$ and that of the liquid is $\dfrac{4}{3}$.



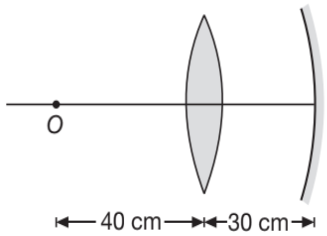
13. A thin converging lens of focal length $f = 1.5$ m is placed along y-axis such that its optical centre coincides with the origin. A small light source S is placed at $(-2, 0.1)$ m. A plane mirror inclined at an angle θ, (where $\tan\theta = 0.3$) is placed as shown in figure, such that y co-ordinate of final image is 0.3 m. Find the distance d, in metre. Also find the x co-ordinate of final image, in metre.



14. An object is placed 12 cm to the left of a diverging lens of focal length -6 cm. A converging lens with a focal length of 12 cm is placed at a distance d to the right of the diverging lens. Find the distance d, in cm, that corresponds to a final image at infinity.

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

16. The figure shows an arrangement of an equiconvex lens of focal length 20 cm and a concave mirror of radius of curvature 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 the object. Find the distance d, in cm. Also draw the ray diagram.



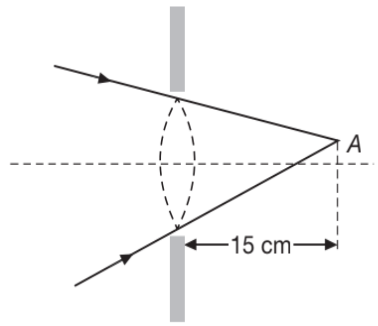
17. A converging beam of rays is incident on a diverging lens. After passing through the lens the rays intersect at a point 15 cm from the lens. If the lens is removed, the point where the rays meet, move 5 cm closer to the mounting that holds the lens. Find the focal length of the lens, in cm.

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

19. The height of a candle flame is 5 cm. A lens produces an image of this flame 15 cm high on a screen. Without touching the lens, the candle is moved over a distance of $\ell = 1.5$ cm away from the lens and a sharp image of the flame 10 cm high is obtained again after shifting the screen. Calculate the focal length of the lens, in cm.

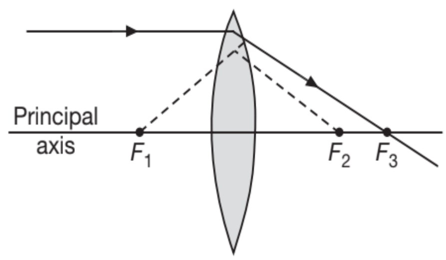
20. The focal length of a convex lens in air is 10 cm. Find its focal length, in cm, in water. Given that $\mu_g = \frac{3}{2}$ and $\mu_w = \frac{4}{3}$.

21. A converging beam of rays passes through a round aperture in a screen as shown in figure. The apex of the beam A is at a distance of 15 cm from the screen. How will the distance from the focus of the rays to the screen change, in cm, if a convergent lens is inserted in the aperture with a focal length of 30 cm? Plot the path of the rays after the lens is fitted.



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

23. An intense beam parallel to the principal axis is incident on a convex lens. Multiple extra images F_1, F_2, … are formed due to feeble internal reflections, called flare spots as shown in the figure. The rardii of curvature of the lens are 30 cm and 60 cm and the refractive index is 1.5. Find the position of the first flare spot, in cm.



24. A parallel beam of rays is incident on a convergent lens with a focal length of 40 cm. Where should a divergent lens with a focal length of 15 cm be placed

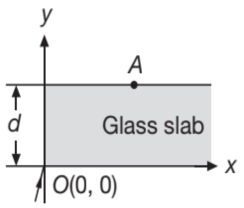
for the beam of rays to remain parallel after passing through the two lenses. Give your answer in cm.

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

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

27. A long rectangular slab of transparent medium of thickness d is placed on a table with length parallel to x-axis and width parallel to the y-axis as shown.

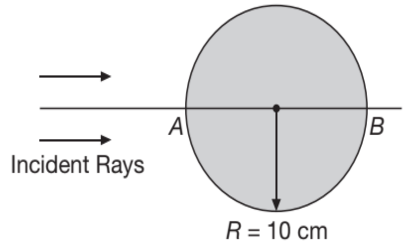
A ray of light is grazing along y-axis and hits the interphase separating the two media at origin. The refractive index μ of the medium varies with x as $\mu = \sqrt{1 + e^{\frac{x}{d}}}$. The refractive index of the air is 1.



(a) The x-coordinate of the point A, where the ray intersects the upper surface of the slab-air boundary is $x = d\log_e(\alpha)$. Find α.

(b) The refractive index of the medium at A is $\sqrt{\beta}$. Find β.

28. A parallel paraxial beam of light is incident on a glass sphere of radius 10 cm along its diameter AB from one side as shown. If all the rays after refraction converge at the point B then calculate the refractive index of the glass sphere.



29. An object of height 4 cm is kept to the left of and on the axis of a converging lens of focal length 10 cm at a distance of 15 cm from the lens. A plane mirror is placed inclined at 45° to the lens axis, 10 cm to the right of the lens. Find the position and size of the image (in cm) formed by the lens and mirror combination. Trace the path of the rays forming the image.

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

31. The focal lengths of the objective and the eye-piece of an astronomical telescope are 0.25 m and 0.025 m, respectively. The telescope is focussed on an object 5 m from the objective, the final image being formed 0.25 m from the eye of the observer. Calculate the tube length (in centimetre) of the telescope to the nearest integer and $10M$, where M is the magnifying power of the telescope.

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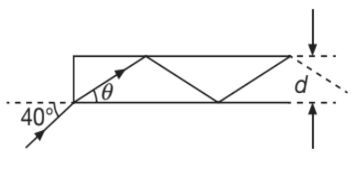
1. **[Online April 2019]**
In figure, the optical fiber is $l = 2$ m long and has a diameter of $d = 20\ \mu$m. If a ray of light is incident on one end of the fiber at angle $\theta_1 = 40°$, the number of reflections it makes before emerging from the other end is close to (refractive index of fiber is 1.31 and $\sin 40° = 0.64$)



(A) 66000 (B) 55000
(C) 45000 (D) 57000

2. **[Online April 2019]**
An upright object is placed at a distance of 40 cm in front of a convergent lens of focal length 20 cm. A convergent mirror of focal length 10 cm is placed at a distance of 60 cm on the other side of the lens. The position and size of the final image will be
(A) 20 cm from the convergent mirror, twice the size of the object
(B) 20 cm from the convergent mirror, same size as the object
(C) 40 cm from the convergent lens, same as the size of the object
(D) 40 cm from the convergent mirror, twice the size as the object

3. **[Online April 2019]**
Calculate the limit of resolution of a telescope objective having a diameter of 200 cm, if it has to detect light of wavelength 500 nm coming from a star.
(A) 457.5×10^{-9} radian (B) 305×10^{-9} radian
(C) 152.5×10^{-9} radian (D) 610×10^{-9} radian

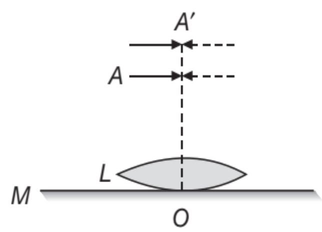
4. **[Online April 2019]**
A convex lens (of focal length 20 cm) and a concave mirror, having their principal axes along the same lines, are kept 80 cm apart from each other. The concave mirror is to the right of the convex lens. When an object is kept at a distance of 30 cm to the left of the convex lens, its image remains at the same position even if the concave mirror is removed. The maximum distance of the object for which this concave mirror, by itself, produces a virtual image would be
(A) 30 cm (B) 25 cm
(C) 20 cm (D) 10 cm

5. **[Online April 2019]**
A concave mirror for face viewing has focal length of 0.4 m. The distance at which you hold the mirror from your face in order to see your image upright with a magnification of 5 is
(A) 0.32 m (B) 0.24 m
(C) 1.60 m (D) 0.16 m

6. **[Online April 2019]**
A convex lens of focal length 20 cm produces images of the same magnification 2 when an object is kept at two distances x_1 and x_2 $(x_1 > x_2)$ from the lens. The ratio of x_1 and x_2 is
(A) 3:1 (B) 2:1
(C) 4:3 (D) 5:3

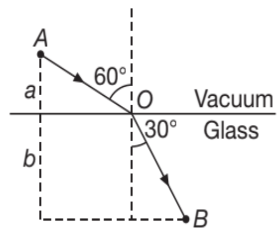
7. **[Online April 2019]**
Diameter of the objective lens of a telescope is 250 cm. For light of wavelength 600 nm. Coming from a distant object, the limit of resolution of the telescope is close to
(A) 1.5×10^{-7} rad (B) 3.0×10^{-7} rad
(C) 2.0×10^{-7} rad (D) 4.5×10^{-7} rad

8. **[Online April 2019]**
A thin convex lens L (refractive index $=1.5$) is placed on a plane mirror M. When a pin is placed at A, such that $OA = 18$ cm, its real inverted image is formed at A itself, as shown in figure. When a liquid of refractive index μ_ℓ is put between the lens and the mirror, the pin has to be moved to A', such that $OA' = 27$ cm, to get its inverted real image at A' itself. The value of μ_ℓ will be



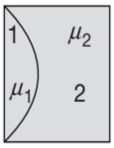
(A) $\sqrt{2}$ (B) $\frac{4}{3}$
(C) $\sqrt{3}$ (D) $\frac{3}{2}$

9. **[Online April 2019]**
A ray of light AO in vacuum is incident on a glass slab at angle 60° and refracted at angle 30° along OB as shown in the figure. The optical path length of light ray from A to B is



(A) $\frac{2\sqrt{3}}{a}+2b$ (B) $2a+\frac{2b}{\sqrt{3}}$
(C) $2a+\frac{2b}{3}$ (D) $2a+2b$

10. **[Online April 2019]**
One plano-convex and one plano-concave lens of same radius of curvature R but of different materials are joined side by side as shown in the figure. If the refractive index of the material of 1 is μ_1 and that of 2 is μ_2, then the focal length of the combination is

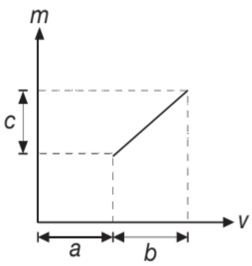


(A) $\dfrac{R}{2(\mu_1-\mu_2)}$ (B) $\dfrac{R}{2-(\mu_1-\mu_2)}$

(C) $\dfrac{R}{\mu_1-\mu_2}$ (D) $\dfrac{2R}{\mu_1-\mu_2}$

11. [Online April 2019]

The graph shows how the magnification m produced by a thin lens varies with image distance v. What is the focal length of the lens used?



(A) $\dfrac{b^2}{ac}$ (B) $\dfrac{b^2c}{a}$

(C) $\dfrac{a}{c}$ (D) $\dfrac{b}{c}$

12. [Online April 2019]

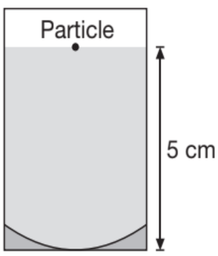
The value of numerical aperture of the objective lens of a microscope is 1.25. If light of wavelength 5000 Å is used, the minimum separation between two points, to be seen as distinct, will be

(A) $0.24\ \mu$m (B) $0.38\ \mu$m

(C) $0.48\ \mu$m (D) $0.12\ \mu$m

13. [Online April 2019]

A concave mirror has radius of curvature of 40 cm. It is at the bottom of a glass that has water filled up to 5 cm (see figure). If a small particle is floating on the surface of water, its image as seen, from directly above the glass, is at a distance d from the surface of water. The value of d is close to: (Refractive index of water = 1.33)

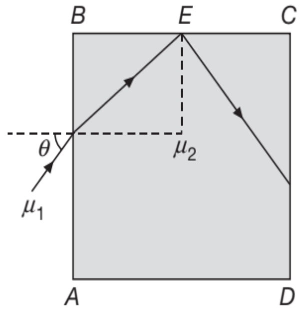


(A) 11.7 cm (B) 6.7 cm

(C) 13.4 cm (D) 8.8 cm

14. [Online April 2019]

A transparent cube of side d, made of a material of refractive index μ_2, is immersed in a liquid of refractive index $\mu_1 (\mu_1 < \mu_2)$. A ray is incident on the face AB at an angle θ (shown in the figure). Total internal reflection takes place at point E on the face BC.



Then θ must satisfy

(A) $\theta < \sin^{-1}\left(\dfrac{\mu_1}{\mu_2}\right)$ (B) $\theta < \sin^{-1}\left(\sqrt{\dfrac{\mu_2^2}{\mu_1^2}-1}\right)$

(C) $\theta > \sin^{-1}\left(\dfrac{\mu_1}{\mu_2}\right)$ (D) $\theta > \sin^{-1}\left(\sqrt{\dfrac{\mu_2^2}{\mu_1^2}-1}\right)$

15. [Online January 2019]

A convex lens is put 10 cm from a light source and it makes a sharp image on a screen, kept 10 cm from the lens. Now a glass block (refractive index 1.5) of 1.5 cm thickness is placed in contact with the light source. To get the sharp image again, the screen is shifted by a distance d. Then d is

(A) 1.1 cm away from the lens

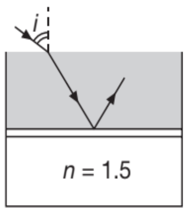
(B) 0.55 cm towards the lens

(C) 0

(D) 0.55 cm away from the lens

16. [Online January 2019]

Consider a tank made of glass (refractive index 1.5) with a thick bottom. It is filled with a liquid of refractive index μ. A student finds that, irrespective of what the incident angle i (see figure) is for a beam of light entering the liquid, the light reflected from the liquid glass interface is never completely polarized. For this to happen, the minimum value of μ is



(A) $\frac{4}{3}$ (B) $\sqrt{\frac{5}{3}}$

(C) $\frac{3}{\sqrt{5}}$ (D) $\frac{5}{\sqrt{3}}$

17. [Online January 2019]

Two plane mirrors are inclined to each other such that a ray of light incident on the first mirror (M_1) and parallel to the second mirror (M_2) is finally reflected from the second mirror (M_2) parallel to the first mirror (M_1). The angle between the two mirrors will be

(A) 75° (B) 45°

(C) 90° (D) 60°

18. [Online January 2019]

A plano convex lens of refractive index μ_1 and focal length f_1 is kept in contact with another plano concave lens of refractive index μ_2 and focal length f_2. If the radius of curvature of their spherical faces is R each and $f_1 = 2f_2$, then μ_1 and μ_2 are related as

(A) $2\mu_1 - \mu_2 = 1$ (B) $3\mu_2 - 2\mu_1 = 1$

(C) $2\mu_2 - \mu_1 = 1$ (D) $\mu_1 + \mu_2 = 3$

19. [Online January 2019]

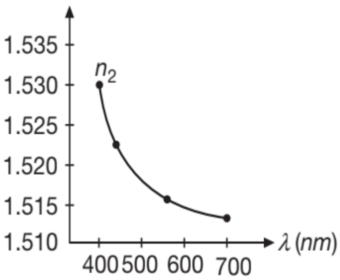
The eye can be regarded as a single refracting surface. The radius of curvature of this surface is equal to that of cornea (7.8 mm). This surface separates two media of refractive indices 1 and 1.34, Calculate the distance from the refracting surface at which a parallel beam of light will come to focus.

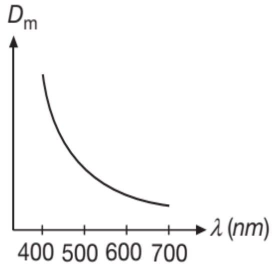
(A) 4.0 cm (B) 1 cm

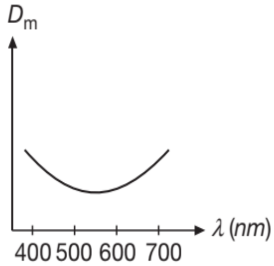
(C) 3.1 cm (D) 2 cm

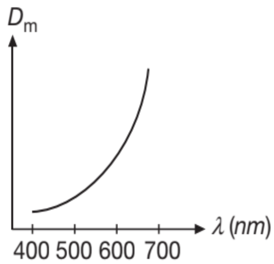
20. [Online January 2019]

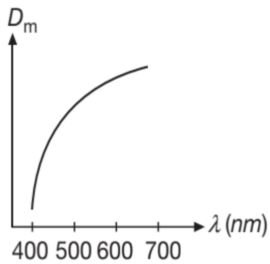
The variation of refractive index of a crown glass thin prism with wavelength of the incident light is shown. Which of the following graphs is the correct one, if D_m is the angle of minimum deviation?



(A)


(B)


(C)


(D)


21. [Online January 2019]

An object is at a distance of 20 m from a convex lens of focal length 0.3 m. The lens forms an image of the object. If the object moves away from the lens at a speed of 5 ms^{-1}, the speed and direction of the image will be

(A) $0.92\times10^{-3} \text{ ms}^{-1}$ away from the lens

(B) $2.26\times10^{-3} \text{ ms}^{-1}$ away from the lens

(C) $1.16\times10^{-3} \text{ ms}^{-1}$ towards the lens

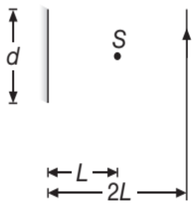
(D) $3.22\times10^{-3} \text{ ms}^{-1}$ towards the lens

22. [Online January 2019]

A monochromatic light is incident at a certain angle on an equilateral triangular prism and suffers minimum deviation. If the refractive index of the material of the prism is $\sqrt{3}$, then the angle of incidence is

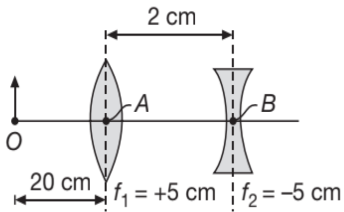
(A) 90°　　(B) 30°
(C) 45°　　(D) 60°

23. [Online January 2019]
A point source of light, S is placed at a distance L in front of the centre of plane mirror of width d which is hanging vertically on a wall. A man walks in front of the mirror along a line parallel to the mirror, at a distance $2L$ as shown below. The distance over which the man can see the image of the light source in the mirror is



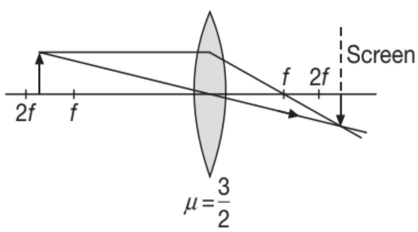
(A) $\frac{d}{2}$　　(B) $3d$
(C) $2d$　　(D) d

24. [Online January 2019]
What is the position and nature of image formed by lens combination shown in figure? (f_1, f_2 are focal lengths)



(A) $\frac{20}{3}$ cm from point B at right; real
(B) 70 cm from point B at right; real
(C) 40 cm from point B at right; real
(D) 70 cm from point B at left; virtual

25. [Online January 2019]
Formation of real image using a biconvex lens is shown below



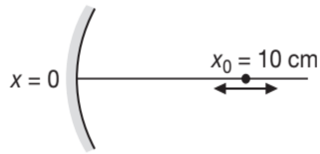
If the whole set up is immersed in water $\mu = \frac{4}{3}$ without disturbing the object and the screen positions, what will one observe on the screen?

(A) Erect real image　　(B) No change
(C) Image disappears　　(D) Magnified image

26. [Online January 2019]
A plano-convex lens (focal length f_2, refractive index μ_2, radius of curvature R) fits exactly into a plano-concave lens (focal length f_1, refractive index μ_1, radius of curvature R). Their plane surfaces are parallel to each other. Then, the focal length of the combination will be

(A) $f_1 - f_2$　　(B) $\frac{R}{\mu_2 - \mu_1}$
(C) $\frac{2f_1f_2}{f_1 + f_2}$　　(D) $f_1 + f_2$

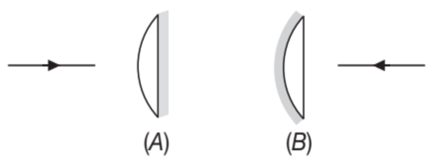
27. [Online 2018]
A particle is oscillating on the x-axis with an amplitude 2 cm about the point $x_0 = 10$ cm, with a frequency ω. A concave mirror of focal length 5 cm is placed at the origin (see figure). Identify the correct statements.



(1) The image executes periodic motion.
(2) The image executes non-periodic motion.
(3) The turning points of the image are asymmetric w.r.t. the image of the point at $x = 10$ cm.
(4) The distance between the turning points of the oscillation of the image is $\frac{100}{21}$ cm

(A) 2, 4　　(B) 2, 3
(C) 1, 3, 4　　(D) 1, 4

28. [Online 2018]
A planoconvex lens becomes an optical system of 28 cm focal length when its plane surface is silvered and illuminated from left to right as shown in figure (A). If the same lens is instead silvered on the curved surface and illuminated from other side as shown in figure (B), it acts like an optical system of focal length 10 cm. The refractive index of the material of lens is



(A) 1.75　　(B) 1.51
(C) 1.55　　(D) 1.50

29. [Online 2018]
A convergent doublet of separated lenses, corrected for spherical aberration, has resultant focal length of 10 cm. The separation between the two lenses is 2 cm. The focal lengths of the component lenses are

(A) 18 cm, 20 cm (B) 12 cm, 14 cm
(C) 16 cm, 18 cm (D) 10 cm, 12 cm

30. [Online 2018]
A ray of light is incident at an angle of $60°$ on one face of a prism of angle $30°$. The emergent ray of light makes an angle of $30°$ with incident ray. The angle made by the emergent ray with second face of prism will be

(A) $0°$ (B) $45°$
(C) $90°$ (D) 30

31. [2017]
A diverging lens with magnitude of focal length 25 cm 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

(A) real and at a distance of 40 cm from convergent lens.
(B) virtual and at a distance of 40 cm from convergent lens.
(C) real and at a distance of 40 cm from the divergent lens.
(D) real and at a distance of 6 cm from the convergent lens.

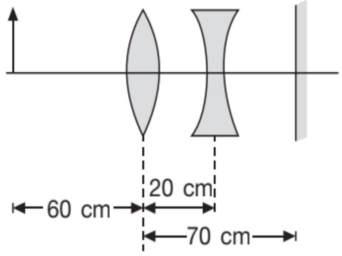
32. [Online 2017]
Let the refractive index of a denser medium with respect to a rarer medium be n_{12} and its critical angle θ_C. At an angle of incidence A when light is travelling from denser medium to rarer medium, a part of the light is reflected and the rest is refracted and the angle between reflected and refracted rays is $90°$. Angle A is given by

(A) $\dfrac{1}{\tan^{-1}(\sin\theta_C)}$ (B) $\dfrac{1}{\cos^{-1}(\sin\theta_C)}$
(C) $\tan^{-1}(\sin\theta_C)$ (D) $\cos^{-1}(\sin\theta_C)$

33. [2016]
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

(A) 10 times taller (B) 10 times nearer
(C) 20 times taller (D) 20 times nearer

34. [Online 2016]
A convex lens, of focal length 30 cm, a concave lens of focal length 120 cm, and a plane mirror are arranged as shown. For an object kept at a distance of 60 cm from the convex lens, the final image formed by the combination is a real image at a distance of

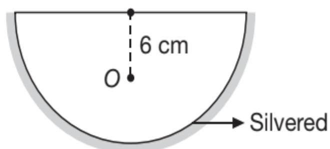


(A) 60 cm from the convex lens
(B) 60 cm from the concave lens
(C) 70 cm form the convex lens
(D) 70 cm from the concave lens

35. [Online 2016]
To determine refractive index of glass slab using a travelling microscope, minimum number of readings required are

(A) Two (B) Four
(C) Three (D) Five

36. [Online 2016]
A hemispherical glass body of radius 10 cm and refractive index 1.5 is silvered on its curved surface. A small air bubble is 6 cm below the flat surface inside it along the axis. The position of the image of the air bubble made by the mirror is seen



(A) 14 cm below flat surface
(B) 20 cm below flat surface
(C) 16 cm below flat surface
(D) 30 cm below flat surface

37. [Online 2016]
Two stars are 10 light years away from the earth. They are seen through a telescope of objective diameter 30 cm. The wavelength of light is 600 nm. To see the stars just resolved by the telescope, the minimum distance between them should be (1 light year $= 9.46\times10^{15}$ m) of the order of

(A) 10^8 km (B) 10^{10} km
(C) 10^{11} km (D) 10^6 km

38. [2015]

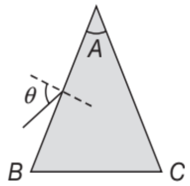
Assuming human pupil to have a radius of 0.25 cm and a comfortable viewing distance of 25 cm, the minimum separation between two objects that human eye can resolve at 500 nm wavelength is

(A) $100\ \mu$m (B) $300\ \mu$m

(C) $1\ \mu$m (D) $30\ \mu$m

39. [2015]

Monochromatic light is incident on a glass prism of angle A. If the refractive index of the material of the prism is μ, a ray, incident at an angle θ, on the face AB would get transmitted through the face AC of the prism provided



(A) $\theta > \cos^{-1}\left(\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right)$

(B) $\theta < \cos^{-1}\left(\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right)$

(C) $\theta > \sin^{-1}\left(\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right)$

(D) $\theta < \sin^{-1}\left(\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right)$

40. [Online 2015]

You are asked to design a shaving mirror assuming that a person keeps it 10 cm from his face and views the magnified image of the face at the closest comfortable distance of 25 cm. The radius of curvature of the mirror would then be

(A) 30 cm (B) 24 cm

(C) 60 cm (D) -24 cm

41. [Online 2015]

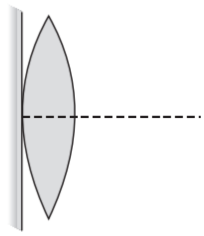
A telescope has an objective lens of focal length 150 cm and an eyepiece of focal length 5 cm. If a 50 m tall tower at a distance of 1 km is observed through this telescope in normal setting, the angle formed by the image of the tower is θ, then θ is close to

(A) $1°$ (B) $15°$

(C) $30°$ (D) $60°$

42. [Online 2015]

A thin convex lens of focal length f is put on a plane mirror as shown in the figure. When an object is kept at a distance a from the lens-mirror combination, its image is formed at a distance $\frac{a}{3}$ in front of the combination. The value of a is



(A) f (B) $2f$

(C) $3f$ (D) $\frac{3}{2}f$

43. [2014]

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 lengths is

(A) f_1 and f_2 both becomes negative

(B) $f_1 = f_2 < f$

(C) $f_1 > f$ and f_2 becomes negative

(D) $f_2 > f$ and f_1 becomes negative

44. [2014]

A green light is incident from the water to the air-water interface at the critical angle (θ). Select the correct statement.

(A) The entire spectrum of visible light will come out of the water at various angles to the normal.

(B) The entire spectrum of visible light will come out of the water at an angle of $90°$ to the normal.

(C) The spectrum of visible light whose frequency is less than that of green light will come out to the air medium

(D) The spectrum of visible light whose frequency is more than that of green light will come out to the air medium.

45. [2013]

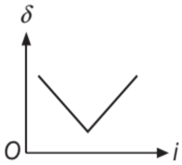
Diameter of a plano-convex lens is 6 cm and thickness at the centre is 3 mm. If speed of light in material of lens is 2×10^8 ms^{-1}, the focal length of the lens is

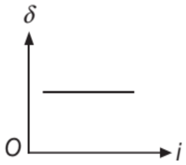
(A) 10 cm (B) 15 cm

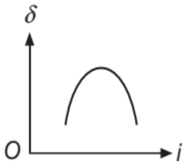
(C) 20 cm (D) 30 cm

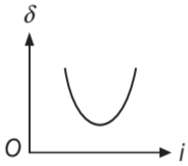
46. **[2013]**

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

(A)


(B)


(C)


(D)


47. **[2012]**

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 be shifted to be in sharp focus on film?

(A) 2.4 m (B) 3.2 m

(C) 5.6 m (D) 7.2 m

48. **[2011]**

Let the x-z plane be the boundary between two transparent media. Medium 1 in $z \geq 0$ has a refractive index of $\sqrt{2}$ and medium 2 with $x < 0$ 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) 30° (B) 45°

(C) 60° (D) 75°

49. **[2011]**

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 ms^{-1}. The speed of the image of the second car as seen in the mirror of the first one is

(A) $\frac{1}{10}$ ms^{-1} (B) $\frac{1}{15}$ ms^{-1}

(C) 10 ms^{-1} (D) 15 ms^{-1}

Directions: *Questions number 50-52 are based on the following paragraph.*

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.

50. **[2010]**

The initial shape of the wavefront of the beam is

(A) planar

(B) convex

(C) concave

(D) convex near the axis and concave near the periphery

51. **[2010]**

The speed of light in the medium is

(A) maximum on the axis of the beam

(B) minimum on the axis of the beam

(C) the same everywhere in the beam

(D) directly proportional to the intensity I

52. **[2010]**

As the beam enters the medium, it will

(A) travel as a cylindrical beam

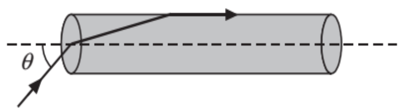
(B) diverge

(C) converge

(D) diverge near the axis and converge near the periphery

53. **[2009]**

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

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

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

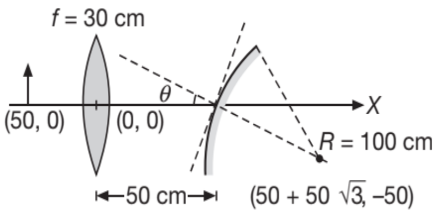
ARCHIVE: JEE ADVANCED

Single Correct Choice Type Problems

(In this section each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct)

1. [JEE (Advanced) 2016]

A small 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 $\theta = 30°$ to the axis of the lens, as shown in the figure.



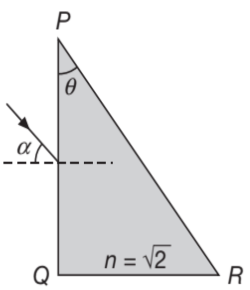
If the origin of the coordinate system is taken to be at the centre of the lens, the coordinates (in cm) of the point (x, y) at which the image is formed are

(A) $(25, 25\sqrt{3})$ (B) $\left(\frac{125}{3}, \frac{25}{\sqrt{3}}\right)$

(C) $(50-25\sqrt{3}, 25)$ (D) $(0, 0)$

2. [JEE (Advanced) 2016]

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

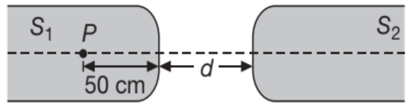


(A) 15° (B) 22.5°

(C) 30° (D) 45°

3. [JEE (Advanced) 2015]

Two identical 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

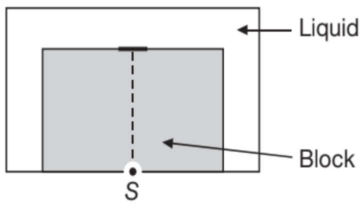


(A) 60 cm (B) 70 cm

(C) 80 cm (D) 90 cm

4. [JEE (Advanced) 2014]

A point source S is placed at the bottom of a transparent block of height 10 mm and refractive index 2.72. It is immersed in a lower refractive index liquid as shown in the figure. It is found that the light emerging from the block to the liquid forms a circular bright spot of diameter 11.54 mm on the top of the block. The refractive index of the liquid is



(A) 1.21 (B) 1.30
(C) 1.36 (D) 1.42

5. [JEE (Advanced) 2013]

A ray of light ravelling in the direction $\frac{1}{2}(\hat{i}+\sqrt{3}\hat{j})$ is incident on a plane mirror. After reflection, it travels along the direction $\frac{1}{2}(\hat{i}-\sqrt{3}\hat{j})$. The angle of incidence is

(A) 30° (B) 45°

(C) 60° (D) 75°

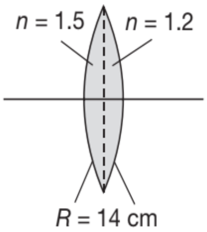
6. [JEE (Advanced) 2013]

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 cured surface of the lens is

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

7. [IIT-JEE 2012]

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 the object distance of 40 cm, the image distance will be



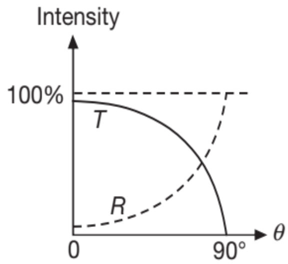
(A) –280 cm (B) 40 cm

(C) 21.5 cm (D) 13.3 cm

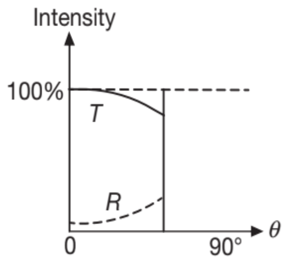
8. [IIT-JEE 2010]

A light ray travelling in glass medium is incident on glass-air interference at an angle of incidence θ. The reflected (R) and transmitted (T) intensities, both as function of θ, are plotted. The correct sketch is

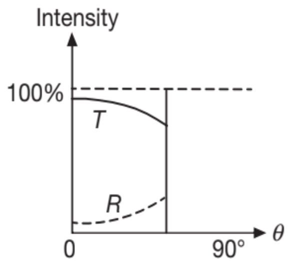
(A)



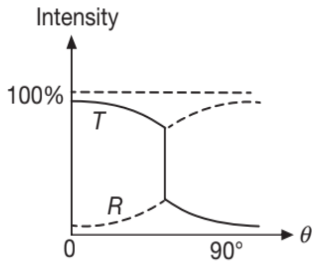
(B)



(C)



(D)



9. [IIT-JEE 2010]

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

(A) virtual and at a distance of 16 cm from the mirror

(B) real and at a distance of 16 cm from the mirror

(C) virtual and at a distance of 20 cm from the mirror

(D) real and at a distance of 20 cm from the mirror

10. [IIT-JEE 2009]

A ball is dropped from a height of 20 m above the surface of water in a lake. The refractive index of water is $\left(\frac{4}{3}\right)$. 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

(A) 9 ms^{-1} (B) 12 ms^{-1}

(C) 16 ms^{-1} (D) 21.33 ms^{-1}

11. [IIT-JEE 2008]

Two beams of red and violet colours are made to pass separately through a prism (angle of the prism is 60°). In the position of minimum deviation, the angle of refraction will be

(A) 30° for both the colours

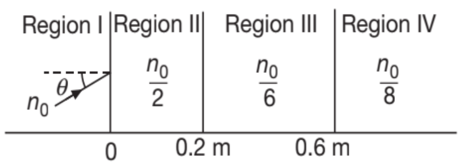
(B) greater for the violet colour

(C) greater for the red colour

(D) equal but not 30° for both colours

12. [IIT-JEE 2008]

A light beam is travelling from Region I to Region IV (Refer Figure). The refractive index in Regions I, II, III and IV are n_0, $\frac{n_0}{2}$, $\frac{n_0}{6}$ and $\frac{n_0}{8}$, respectively. The angle of incidence θ for which the beam just misses entering Region IV is



(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. [IIT-JEE 2007]

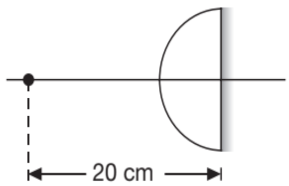
A ray of light travelling in water is incident on its surface open to air. The angle of incidence is θ, which is less than the critical angle. Then there will be

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

14. [IIT-JEE 2007]
In an experiment to determine the focal length (f) of a concave mirror by the u-v method, a student places the object pin A on the principal axis at a distance x from the pole P. The student looks at the pin and its inverted image from a distance keeping his/her eye in line with PA. When the student shifts his/her eye towards left, the image appears to the right of the object pin. Then

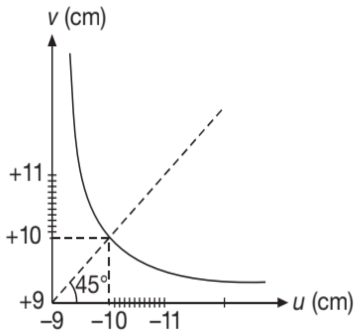
(A) $x < f$ (B) $f < x < 2f$
(C) $x = 2f$ (D) $x > 2f$

15. [IIT-JEE 2006]
A point object is placed at distance of 20 cm from a thin planoconvex lens of focal length 15 cm. The plane surface of the lens is now silvered. The image created by the system is at



(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

16. [IIT-JEE 2006]
The graph between object distance u and image distance v for a lens is given below. The focal length of the lens is



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

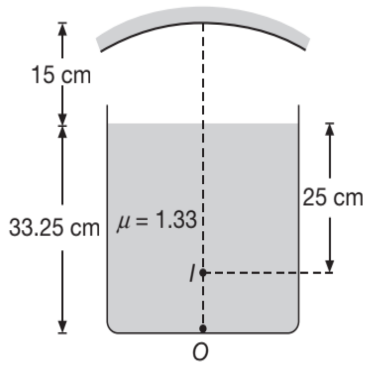
17. [IIT-JEE 2006]
A biconvex lens of focal length f forms a circular image of radius r of sun in focal plane. Then which option is correct?

(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 $\frac{\pi r^2}{2}$
(D) If f is doubled, intensity will increase

18. [IIT-JEE 2005]
A convex lens is in contact with concave lens. The magnitude of the ratio of their focal length is $\frac{2}{3}$. Their equivalent focal length is 30 cm. What are their individual focal lengths?

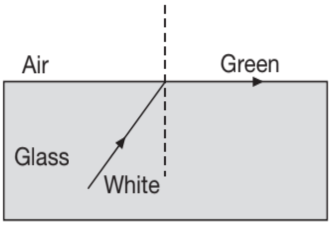
(A) −75 , 50 (B) −10 , 15
(C) 75, 50 (D) −15 , 10

19. [IIT-JEE 2005]
A container is filled with water $(\mu = 1.33)$ upto a height of 33.25 cm. A concave mirror is placed 15 cm above the water level and the image of an object placed at the bottom is formed 25 cm below the water level. The focal length of the mirror is



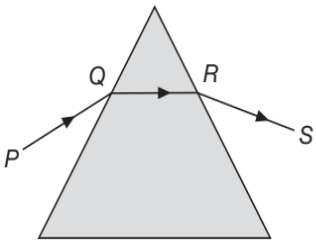
(A) 10 cm (B) 15 cm
(C) 20 cm (D) 25 cm

20. [IIT-JEE 2004]
White light is incident on the interface of glass and air as shown in the figure. If green light is just totally internally reflected then the emerging ray in air contains



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

21. [IIT-JEE 2004]
A ray of light is incident on an equilateral glass prism placed on a horizontal table. For minimum deviation which of the following is true?



(A) PQ is horizontal
(B) QR is horizontal
(C) RS is horizontal
(D) Either PQ or RS is horizontal

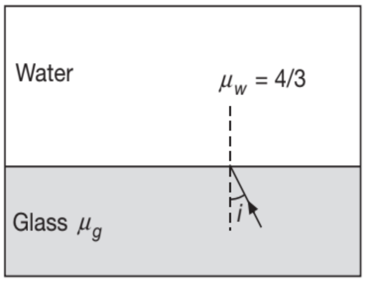
22. [IIT-JEE 2004]
A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of the virtual image from the surface of the sphere is

(A) 2 cm (B) 4 cm
(C) 6 cm (D) 12 cm

23. [IIT-JEE 2003]
The size of the image of an object, which is at infinity, as formed by a convex lens of focal length 30 cm is 2 cm. If a concave lens of focal length 20 cm is placed between the convex lens and the image at a distance of 26 cm from the convex lens, calculate the new size of the image

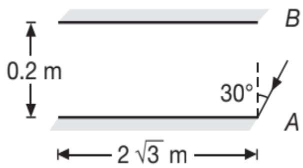
(A) 1.25 cm (B) 2.5 cm
(C) 1.05 cm (D) 2 cm

24. [IIT-JEE 2003]
A ray of light is incident at the glass-water interface at an angle i, it emerges finally parallel to the surface of water, then the value of μ_g would be



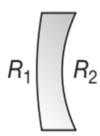
(A) $\left(\frac{4}{3}\right)\sin i$ (B) $\frac{1}{\sin i}$
(C) $\frac{4}{3}$ (D) 1

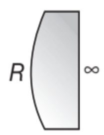
25. [IIT-JEE 2002]
Two plane mirrors A and B are alligned parallel to each other, as shown in figure. A light ray is incident at an angle of $30°$ at a point just inside one end of A. The plane of incidence coincides with the plane of figure. The maximum number of times the ray undergoes reflections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



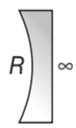
(A) 28 (B) 30
(C) 32 (D) 34

26. [IIT-JEE 2002]
Which one of the following spherical lenses does not exhibit dispersion? The radii of curvature of the surfaces of the lenses are as given in the diagrams

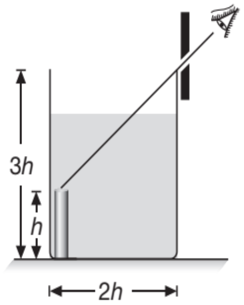
(A) 

(B) 

(C) 

(D) 

27. [IIT-JEE 2002]
An observer can see through a pin hole, the top of a thin rod of height h, placed as shown in figure. The beaker's height is $3h$ and its radius is h. When the beaker is filled with a liquid upto a height $2h$, he can see the lower end of the rod. Then the refractive index of liquid must be

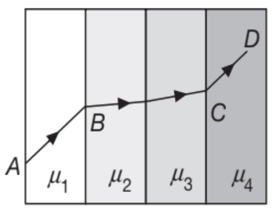


(A) $\frac{5}{2}$ (B) $\sqrt{\frac{5}{2}}$

(C) $\sqrt{\frac{3}{2}}$ (D) $\frac{3}{2}$

28. [IIT-JEE 2001]

A ray of light passes through four transparent media with refractive indices μ_1, μ_2, μ_3 and μ_4 as shown in figure. The surface of all media are parallel. If the emergent ray CD is parallel to the incident ray AB, we must have

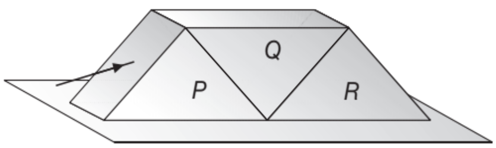


(A) $\mu_1 = \mu_2$ (B) $\mu_2 = \mu_3$

(C) $\mu_3 = \mu_4$ (D) $\mu_4 = \mu_1$

29. [IIT-JEE 2001]

A given ray of light suffers minimum deviation in an equilateral prism P. Additional prisms Q and R of identical shape and of same material as P are now added as shown in figure. The ray will now suffer



(A) greater deviation.
(B) no deviation.
(C) same deviation as before.
(D) total internal reflection.

30. [IIT-JEE 2000]

In a compound microscope, the intermediate image is

(A) virtual, erect and magnified
(B) real, erect and magnified
(C) real, inverted and magnified
(D) virtual, erect and reduced

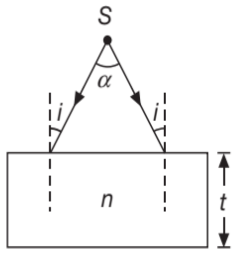
31. [IIT-JEE 2000]

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

(A) air and placed in air.
(B) air and immersed in L_1.
(C) L_1 and immersed in L_2.
(D) L_2 and immersed in L_1.

32. [IIT-JEE 2000]

A diverging beam of light from a point source S having divergence angle α falls symmetrically on a glass slab as shown. The angles of incidence of the two extreme rays are equal. If the thickness of the glass slab is t and the refractive index n, then the divergence angle of the emergent beam is

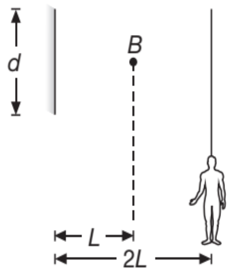


(A) zero (B) α

(C) $\sin^{-1}\left(\frac{1}{n}\right)$ (D) $2\sin^{-1}\left(\frac{1}{n}\right)$

33. [IIT-JEE 2000]

A point source of light B is placed at a distance L in front of the centre 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. The greatest distance over which he can see the image of the light source in the mirror is

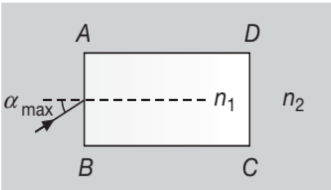


(A) $\frac{d}{2}$ (B) d

(C) $2d$ (D) $3d$

34. [IIT-JEE 2000]

A rectangular glass slab *ABCD* of refractive index n_1, is immersed in water of 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 only from the other surface *CD* is given by



(A) $\sin^{-1}\left\{\frac{n_1}{n_2}\cos\left(\sin^{-1}\left(\frac{n_2}{n_1}\right)\right)\right\}$

(B) $\sin^{-1}\left\{n_1\cos\left(\sin^{-1}\left(\frac{1}{n_2}\right)\right)\right\}$

(C) $\sin^{-1}\left(\frac{n_1}{n_2}\right)$

(D) $\sin^{-1}\left(\frac{n_2}{n_1}\right)$

35. [IIT-JEE 1999]

A concave lens of glass, refractive index 1.5, has both surfaces of same radius of curvature R. On immersion in a medium of refractive index 1.75, it will behave as a

(A) convergent lens of focal length $3.5R$.

(B) convergent lens of focal length $3.0R$.

(C) divergent lens of focal length $3.5R$.

(D) divergent lens of focal length $3.0R$.

36. [IIT-JEE 1998]

A real image of a distant object is formed by a plano-convex lens on its principal axis. Spherical aberration

(A) is absent.

(B) is smaller if the curved surface of the lens faces the object.

(C) is smaller if the plane surface of the lens faces the object.

(D) is the same whichever side of the lens faces the object.

37. [IIT-JEE 1998]

A concave mirror is placed on a horizontal table, with its axis directed vertically upwards. Let O be the pole of the mirror and C its centre of curvature. A point object is placed at C. It has a real image, also located at C. If the mirror is now filled with water, the image will be

(A) real and will remain at *C*.

(B) real and located at a point between C and ∞.

(C) virtual and located at a point between C and O.

(D) real and located at a point between C and O.

38. [IIT-JEE 1998]

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 glass. The line PQ cuts the surface at the point O and $PO = OQ$. The distance PO is equal to

(A) $5R$ (B) $3R$

(C) $2R$ (D) $1.5R$

39. [IIT-JEE 1997]

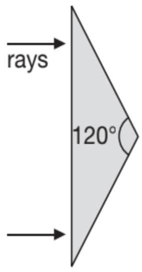
An eye specialist prescribes spectacles having combination of convex lens of focal length 40 cm in contact with a concave lens of focal length 25 cm. The power of this lens combination in diopters is

(A) +1.5 (B) −1.5

(C) +6.67 (D) −6.67

40. [IIT-JEE 1995]

An isosceles prism of angle 120° has a refractive index 1.44. Two parallel of monochromatic light enter the prism parallel to each other in air as shown. The rays emerge from the opposite face



(A) are parallel to each other

(B) are diverging

(C) make an angle $2\left(\sin^{-1}(0.72) - 30°\right)$ with each other

(D) make an angle $2\sin^{-1}(0.72)$ with each other

41. [IIT-JEE 1995]

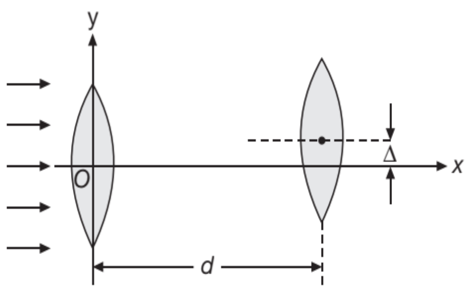
The focal lengths of the objective and the eye piece of a compound microscope are 2.0 cm and 3.0 cm respectively. The distance between the objective and the eye piece is 15.0 cm. The final image formed by the eye piece is at infinity. The two lenses are thin. The distance in cm of the object and the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

(A) 2.4 and 12.0 (B) 2.4 and 15.0
(C) 2.0 and 12.0 (D) 2.0 and 3.0

42. [IIT-JEE 1995]
A diminished image of an object is to be obtained on a screen 1.0 m from it. This can be achieved by appropriate placing
(A) a concave mirror of suitable focal length
(B) a convex mirror of suitable focal length
(C) a convex lens of focal length less than 0.25 m
(D) a convex lens of suitable focal length

43. [IIT-JEE 1994]
Spherical aberration in a thin lens can be reduced by
(A) using a monochromatic light.
(B) using a doublet combination.
(C) using a circular annular mask over the lens.
(D) increasing the size of the lens.

44. [IIT-JEE 1993]
Two thin convex lenses of focal lengths f_1 and f_2 are separated by a horizontal distance d (where, $d < f_1$, $d < f_2$) and their centres are displaced by a vertical separation Δ as shown in the figure



Taking the origin of coordinates, O, at the centre of the first lens, the x and y-coordinates of the focal point of this lens system, for a parallel beam of rays coming from the left, are given by

(A) $x = \dfrac{f_1 f_2}{f_1 + f_2}$, $y = \Delta$

(B) $x = \dfrac{f_1(f_2 + d)}{f_1 + f_2 - d}$, $y = \dfrac{\Delta}{f_1 + f_2}$

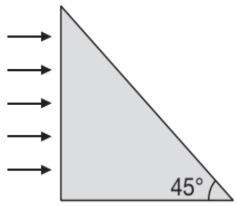
(C) $x = \dfrac{f_1 f_2 + d(f_1 - d)}{f_1 + f_2 - d}$, $y = \dfrac{\Delta(f_1 - d)}{f_1 + f_2 - d}$

(D) $x = \dfrac{f_1 f_2 + d(f_1 - d)}{f_1 + f_2 - d}$, $y = 0$

45. [IIT-JEE 1990]
A thin prism P_1 with angle $4°$ and made from glass of refractive index is 1.54 is combined with another thin prism P_2 made from glass of refractive index 1.72 to produce dispersion without deviation. The angle of the prism P_2 is

(A) $5.33°$ (B) $4°$
(C) $3°$ (D) $2.6°$

46. [IIT-JEE 1989]
A beam of light consisting of red, green and blue colours is incident on a right angled prism. The refractive indices of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. The prism will



(A) separate the red colour from the green and blue colours
(B) separate the blue colour from the red and green colours
(C) separate all the three colours from one another
(D) not separate even partially any colour from the other two colours

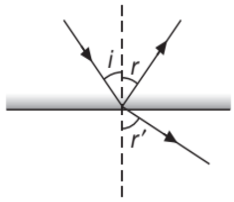
47. [IIT-JEE 1989]
An astronomical telescope has an angular magnification of magnitude 5 for distant objects. The separation between the objective and the eye piece is 36 cm and the final image is formed at infinity. The focal length f_o of the objective and the focal length f_e of the eye piece are
(A) $f_o = 45$ cm and $f_e = -9$ cm
(B) $f_o = 50$ cm and $f_e = 10$ cm
(C) $f_o = 7.2$ cm and $f_e = 5$ cm
(D) $f_o = 30$ cm and $f_e = 6$ cm

48. [IIT-JEE 1988]
A short linear object of length b lies along the axis of a concave mirror or focal length f at a distance u from the pole of the mirror. The size of the image is approximately equal to

(A) $b\left(\dfrac{u-f}{f}\right)^{\frac{1}{2}}$ (B) $b\left(\dfrac{f}{u-f}\right)^{\frac{1}{2}}$

(C) $b\left(\dfrac{u-f}{f}\right)$ (D) $b\left(\dfrac{f}{u-f}\right)^{2}$

49. [IIT-JEE 1983]
A ray of light from a denser medium strikes a rarer medium at an angle of incidence i (shown in figure). The reflected and refracted rays make an angle of $90°$ with each other. The angles of reflection and refraction are r and r'. The critical angle is



(A) $\sin^{-1}(\tan r)$ (B) $\sin^{-1}(\cot i)$

(C) $\sin^{-1}(\tan r')$ (D) $\tan^{-1}(\sin i)$

50. [IIT-JEE 1982]

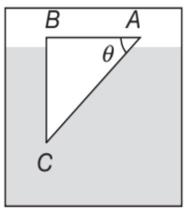
A convex lens of focal length 40 cm is in contact with a concave lens of focal length 25 cm. The power of the combination in dioptre is

(A) –1.5 (B) –6.5

(C) +6.5 (D) +6.67

51. [IIT-JEE 1981]

A glass prism of refractive index 1.5 is immersed in water (refractive index $\frac{4}{3}$). A light beam incident normally on the face AB is totally reflected to reach the face BC, if



(A) $\sin\theta > \frac{8}{9}$ (B) $\sin\theta \le \frac{2}{3}$

(C) $\frac{2}{3} < \sin\theta < \frac{8}{9}$ (D) None of these

52. [IIT-JEE 1980]

When a ray of light enters a glass slab from air

(A) its wavelength decreases.

(B) its wavelength increases.

(C) its frequency increases.

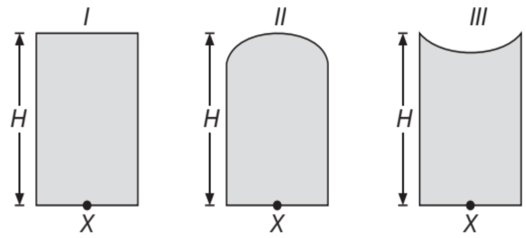
(D) neither its wavelength nor its frequency changes.

Multiple Correct Choice Type Problems

(In this section each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct)

1. [JEE (Advanced) 2019]

Three glass cylinders of equal height $H = 30$ cm and same refractive index $n = 1.5$ are placed on a horizontal surface as shown in figure. Cylinder I has a flat top, cylinder II has a convex top and cylinder III has a concave top. The radii of curvature of the two curved tops are same ($R = 3$ m). If H_1, H_2 and H_3 are the apparent depths of a point X on the bottom of the three cylinders, respectively, the correct statement(s) is/are



(A) $0.8\text{ cm} < (H_2 - H_1) < 0.9\text{ cm}$

(B) $H_2 > H_3$

(C) $H_3 > H_1$

(D) $H_2 > H_1$

2. [JEE (Advanced) 2019]

A thin convex lens is made of two materials with refractive indices n_1 and n_2, as shown in figure. The radius of curvature of the left and right spherical surfaces are equal. f is the focal length of the lens when $n_1 = n_2 = n$. The focal length is $f + \Delta f$ when $n_1 = n$ and $n_2 = n + \Delta n$. Assuming $\Delta n \ll (n-1)$ and $1 < n < 2$, the correct statement(s) is/are

(A) $\left|\frac{\Delta f}{f}\right| < \left|\frac{\Delta n}{n}\right|$

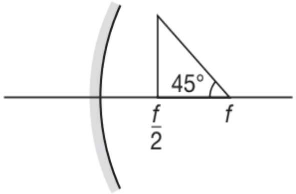
(B) The relation between $\frac{\Delta f}{f}$ and $\frac{\Delta n}{n}$ remains unchanged if both the convex surfaces are replaced by concave surfaces of the same radius of curvature.

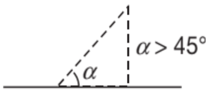
(C) If $\frac{\Delta n}{n} < 0$ then $\frac{\Delta f}{f} > 0$

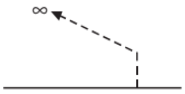
(D) For $n = 1.5$, $\Delta n = 10^{-3}$ and $f = 20$ cm, the value of $|\Delta f|$ will be 0.02 cm (round off to 2nd decimal place)

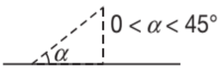
3. [JEE (Advanced) 2017]

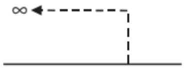
A wire is bent in the shape of a right angled triangle and is placed in front of a concave mirror of focal length f, as shown in the figure. Which of the figures shown in the four options qualitatively represent(s) the shape of the image of the bent wire? (These figures are not to scale).



(A) 

(B) 

(C) 

(D) 

4. [JEE (Advanced) 2017]

For an isosceles prism of angle A and refractive index μ, it is found that the angle of minimum deviation $\delta_m = A$. Which of the following options is/are correct?

(A) For the angle of incidence $i_1 = A$, the ray inside the prism is parallel to the base of the prism

(B) At minimum deviation, the incident angle i_1 and the refracting angle r_1 at the first refracting surface are related by $r_1 = \left(\frac{i_i}{2}\right)$

(C) For this prism, the emergent ray at the second surface will be tangential to the surface when the angle of incidence at the first surface is $i_1 = \sin^{-1}\left[\sin A\sqrt{4\cos^2\left(\frac{A}{2}\right)-1} - \cos A\right]$

(D) For this prism, the refractive index μ and the angle prism A are related as $A = \frac{1}{2}\cos^{-1}\left(\frac{\mu}{2}\right)$

5. [JEE (Advanced) 2016]

A plano-convex lens is made of material of refractive index n. When a small object is placed 30 cm away in front 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 statements(s) is (are) true?

(A) The refractive index of the lens is 2.5

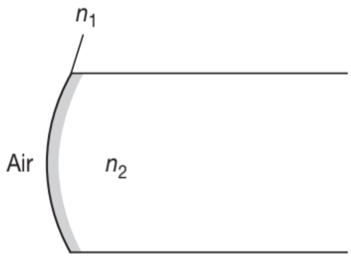
(B) The radius of curvature of the convex surface is 45 cm

(C) The faint image is erect and real

(D) The focal length of the lens is 20 cm

6. [JEE (Advanced) 2014]

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

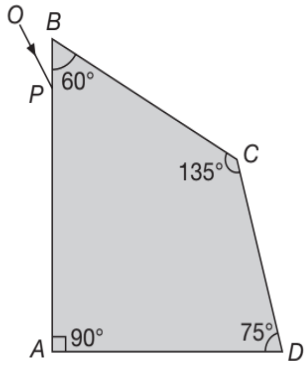


(A) $|f_1| = 3R$ (B) $|f_1| = 2.8R$

(C) $|f_2| = 2R$ (D) $|f_2| = 1.4R$

7. [IIT-JEE 2010]

A ray OP of monochromatic light is incident on the face AB of prism $ABCD$ near vertex B at an incident angle of $60°$ (see figure). If the refractive index of the material of the prism is $\sqrt{3}$, which of the following is (are) correct?



(A) The ray gets totally internally reflected at face CD

(B) The ray comes out through face AD

(C) The angle between the incident ray and the emergent ray is $90°$

(D) The angle between the incident ray and the emergent ray is $120°$

8. [IIT-JEE 2009]

A student performed the experiment of determination of focal length of a concave mirror by u-v method using an optical bench of length $1.5\ \text{m}$. The focal length of the mirror used is $24\ \text{cm}$. The maximum error in the location of the image can be $0.2\ \text{cm}$. 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)

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

9. [IIT-JEE 1986]
A converging lens is used to form an image on a screen. When the upper half of the lens is covered by an opaque screen
(A) half of the image will disappear
(B) complete image will be formed
(C) intensity of the image will increase
(D) intensity of the image will decrease

10. [IIT-JEE 1992]
A planet is observed by an astronomical refracting telescope having an objective of focal length 16 m and an eye piece of focal length 2 cm .
(A) The distance between objective and eye piece is 16.02 m .
(B) The angular magnification of the planet is −800 .
(C) The image of the planet is inverted.
(D) The objective is larger than the eye piece.

11. [IIT-JEE 1996]
Which of the following form(s) the virtual and erect image for all positions of object ?
(A) concave mirror (B) convex lens
(C) convex mirror (D) concave lens

12. [IIT-JEE 1998]
A ray of light travelling in a transparent medium falls on a surface separating the medium from air at an angle of incidence 45°. The ray undergoes total internal reflection. If n is the refractive index of the medium with respect to air, select the possible value(s) of n from the following
(A) 1.3 (B) 1.4
(C) 1.5 (D) 1.6

Reasoning Based Questions

This section contains Reasoning type questions, each having four choices (A), (B), (C) and (D) out of which ONLY ONE is correct. Each question contains STATEMENT 1 and STATEMENT 2. You have to mark your answer as
Bubble (A) If both statements are TRUE and STATEMENT 2 is the correct explanation of STATEMENT 1.
Bubble (B) If both statements are TRUE but STATEMENT 2 is not the correct explanation of STATEMENT 1.
Bubble (C) If STATEMENT 1 is TRUE and STATEMENT 2 is FALSE.
Bubble (D) If STATEMENT 1 is FALSE but STATEMENT 2 is TRUE.

1. [IIT-JEE 2007]
Statement-1: 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.
Statement-2: Laws of reflection are strictly valid for plane surfaces, but not for large spherical surfaces.

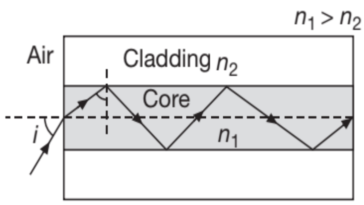
Comprehension Type Questions

Comprehension 1

Light guidance in an optical fibre 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 $\sin i_m$.

1. [JEE (Advanced) 2015]

For two structures namely S_1 with $n_1 = \frac{\sqrt{45}}{4}$ and $n_2 = \frac{3}{2}$, and S_2 with $n_1 = \frac{8}{5}$ and $n_2 = \frac{7}{5}$ and taking the refractive index of water to be $\frac{4}{3}$ and that to air to be 1 , the correct options is/are



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

2. **[JEE (Advanced) 2015]**
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

(A) $\dfrac{NA_1 NA_2}{NA_1 + NA_2}$ (B) $NA_1 + NA_2$

(C) NA_1 (D) NA_2

Comprehension 2

Most materials have the refractive index, $n > 1$. So, when a light ray from air enters a naturally occurring material, then by Snell's law, $\dfrac{\sin\theta_1}{\sin\theta_2} = \dfrac{n_2}{n_1}$, 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, $n = \left(\dfrac{c}{v}\right) = \pm\sqrt{\varepsilon_r \mu_r}$, where c is the speed of electromagnetic waves in vacuum, v its speed in the medium, ε_r and μ_r are the relative permittivity and permeability of the medium respectively.

In normal materials, both ε_r and μ_r are positive, implying positive n for the medium. When both ε_r and μ_r are negative, one most 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 behaviour, 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.

3. **[IIT-JEE 2012]**
Choose the correct statement.

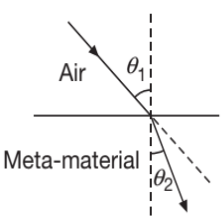
(A) The speed of light in the meta-material is $v = c|n|$

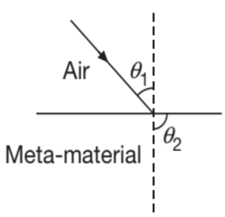
(B) The speed of light in the meta-material is $v = \dfrac{c}{|n|}$

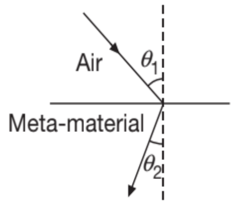
(C) The speed of light in the meta-materials is $v = c$

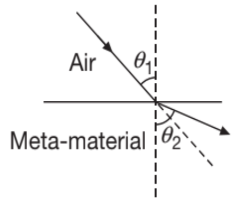
(D) The wavelength of the light in the meta-material (λ_m) is given by $\lambda_m = \lambda_{air}|n|$, where λ_{air}

4. **[IIT-JEE 2012]**
For light incident from air on a meta-material, the appropriate ray diagram is

(A)


(B)


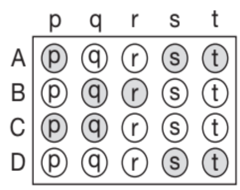
(C)


(D)


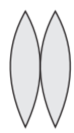
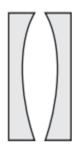
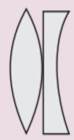
Matrix Match/Column Match Type Questions

Each question in this section contains statements given in two columns, which have to be matched. The statements in **COLUMN-I** are labelled A, B, C and D, while the statements in **COLUMN-II** are labelled p, q, r, s (and t). Any given statement in **COLUMN-I** can have correct matching with **ONE OR MORE** statement(s) in **COLUMN-II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following examples:

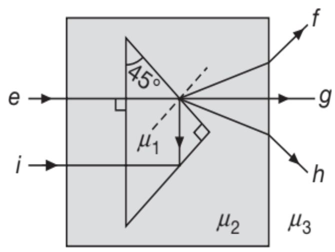
If the correct matches are A → p, s and t; B → q and r; C → p and q; and D → s and t; then the correct darkening of bubbles will look like the following :



1. **[JEE (Advanced) 2014]**
Four combinations of two thin lenses are given in **COLUMN-I.** The radius of curvature of all curved surfaces is r and the refractive index of all the lenses is 1.5. Match lens combinations in **COLUMN-I** with their focal length in **COLUMN-II** and select the correct answer using the codes given below the lists.

COLUMN-I	COLUMN-II
A. 	p. $2r$
B. 	q. $\dfrac{r}{2}$
C. 	r. $-r$
D. 	s. r

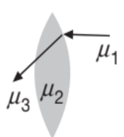
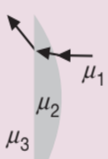
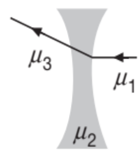
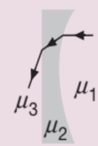
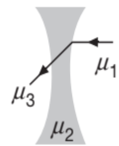
2. [JEE (Advanced) 2013]
A right angled prism of refractive index μ_1 is placed in a rectangular block of refractive index μ_2, which is surrounded by a medium of refractive index μ_3, as shown in the figure. A ray of light e enters the rectangular block at normal incidence. Depending upon the relationships between μ_1, μ_2 and μ_3, it takes one of the four possible paths ef, eg, eh or ei.



Match the paths in **COLUMN-I** with conditions of refractive indices in **COLUMN-II** and select the correct answer using the codes given below the lists.

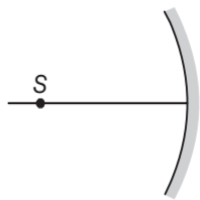
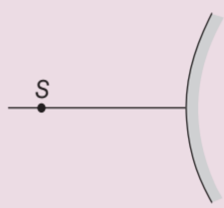
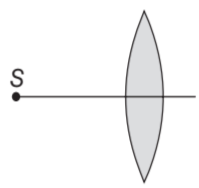
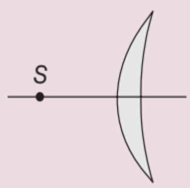
COLUMN-I	COLUMN-II
A. $e \to f$	p. $\mu_1 > \sqrt{2}\mu_2$
B. $e \to g$	q. $\mu_2 > \mu_1$ and $\mu_2 > \mu_3$
C. $e \to h$	r. $\mu_1 = \mu_2$
D. $e \to i$	s. $\mu_2 < \mu_1 < \sqrt{2}\mu_2$ and $\mu_2 > \mu_3$

3. [IIT-JEE 2010]
Two transparent media of refractive indices μ_1 and μ_3 have a solid lens shaped transparent material of refractive index μ_2 between them as shown in figures in **COLUMN-II**. A ray traversing these media is also shown in the figures. In **COLUMN-I** different relationships between μ_1, μ_2 and μ_3 are given. Match them to the ray diagram shown in **COLUMN-II**.

COLUMN-I	COLUMN-II
A. $\mu_1 < \mu_2$	p. 
B. $\mu_1 > \mu_2$	q. 
C. $\mu_2 = \mu_3$	r. 
D. $\mu_2 > \mu_3$	s. 
	t. 

(*Continued*)

4. [IIT-JEE 2008]
An optical component and an object S placed along its optic axis are given in **COLUMN-I**. The distance between the object and the component can be varied. The properties of images are given in **COLUMN-II**. Match all the properties of images from **COLUMN-II** with the appropriate components given in **COLUMN-I**.

COLUMN-I	COLUMN-II
(A) 	(p) Real image
(B) 	(q) Virtual image
(C) 	(r) Magnified image
(D) 	(s) Image at infinity

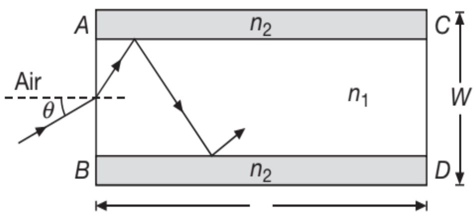
5. **[IIT-JEE 2006]**
Some laws/processes are given in **COLUMN-1.** Match these with the physical phenomena given in **COLUMN-II.**

COLUMN-I	COLUMN-II
A. Intensity of light received by lens	p. radius of aperture (R)
B. Angular magnification	q. dispersion of lens
C. Length of telescope	r. focal length f_0, f_e
D. Sharpness of image	s. spherical aberration

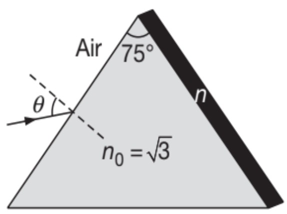
Integer/Numerical Answer Type Questions

In this section, the answer to each question is a numerical value obtained after series of calculations based on the data provided in the question(s).

1. **[JEE (Advanced) 2019]**
A planar structure of length L and width W is made of two different optical media of refractive indices $n_1 = 1.5$ and $n_2 = 1.44$ as shown in figure. If $L \gg W$, a ray entering from end AB will emerge from end CD only if the total internal reflection condition is met inside the structure, For $L = 9.6$ m, if the incident angle θ is varied, the maximum time taken by a ray to exit the plane CD is $t \times 10^{-9}$ s, where t is ______
(Speed of light $c = 3 \times 10^8$ ms^{-1})

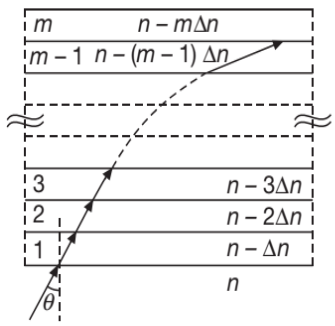


2. **[JEE (Advanced) 2019]**
A monochromatic light is incident from air on a refracting surface of a prism of angle 75° and refractive index $n_0 = \sqrt{3}$. The other refracting surface of the prism is coated by a thin film of material of refractive index n as shown in figure. The light suffers total internal reflection at the coated prism surface for an incidence angle of $\theta \le 60°$. The value of n^2 is ______.

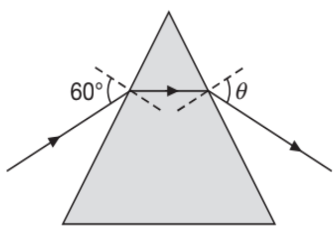


3. **[JEE (Advanced) 2018]**
Sunlight of intensity 1.3 kWm^{-2} is incident normally on a thin convex lens of focal length 20 cm. Ignore the energy loss of light due to the lens and assume that the lens aperture size is much smaller than its focal length. The average intensity of light, kWm^{-2}, at a distance 22 cm from the lens on the other side is ______.

4. **[JEE (Advanced) 2017]**
A monochromatic light is travelling in a medium of refractive index $n = 1.6$. It enters a stack of glass layers from the bottom side at an angle $\theta = 30°$. The interfaces of the glass layers are parallel to each other. The refractive indices of different glass layers are monotonically decreasing as $n_m = n - m\Delta n$, where n_m is the refractive index of the mth slab and $\Delta n = 0.1$ (see the figure). The ray is refracted out parallel to the interface between the $(m-1)$th and mth slabs from the right side of the stack. What is the value of m?

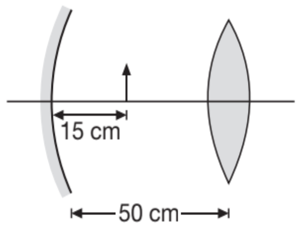


5. **[JEE (Advanced) 2015]**
A monochromatic beam of light is incident at 60° on one face of an equilateral prism of refractive index n and emerges from the opposite face making an angle $\theta(n)$ with the normal (see figure). For $n = \sqrt{3}$ the value of θ is 60° and $\frac{d\theta}{dn} = m$. The value of m is



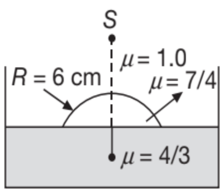
6. **[JEE (Advanced) 2015]**
Consider a concave mirror and a convex lens (refractive index $= 1.5$) of focal length 10 cm each, separated by a distance of 50 cm in air (refractive index $= 1$) as shown in the figure. An object is placed at a distance of 15 cm from the mirror. Its erect image formed by this combination has magnification M_1.

When the set-up is kept in a medium of refractive index $\frac{7}{6}$, the magnification becomes M_2. The magnitude $\left|\frac{M_2}{M_1}\right|$ is



7. [IIT-JEE 2011]

Water (with refractive index $=\frac{4}{3}$) in a tank is 18 cm deep. Oil of refractive index $\frac{7}{4}$ lies on water making a convex surface of radius of curvature $R = 6$ cm as shown. Consider oil to act as a thin lens. An object S is placed 24 cm above water surface. The location of its image is at x cm above the bottom of the tank. Then x is.



8. [IIT-JEE 2010]

Image of an object approaching a convex mirror of radius of curvature 20 m along its optical axis is observed to move from $\frac{25}{3}$m to $\frac{50}{7}$m in 30 s. What is the speed of the object in kmh^{-1}?

9. [IIT-JEE 2010]

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

10. [IIT-JEE 2010]

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

ANSWER KEYS–TEST YOUR CONCEPTS AND PRACTICE EXERCISES

Test Your Concepts-I (Based on Reflection at Plane Surfaces)

1. $30°$
2. 4 cm
3. $\dfrac{u\cos\alpha(\tan\alpha-\tan\theta)}{g}$
4. (a) $60°$
   (b) $240°$ CCW
5. $60°$
6. $100°$ (CW)
7. 20 cm, 60 cm, 80 cm, 100 cm and 140 cm
8. 12
9. $3d$
10. (a) $12\text{ cm}\times 8\text{ cm}$
    (b) $12\text{ cm}\times 4\text{ cm}$
12. $-5(1+\sqrt{3})\hat{i}+5\hat{j}$
13. $\alpha=2\theta$
14. $30°$
15. $50°$

Test Your Concepts-II (Based on Reflection at Curved Surfaces)

1. 5 cm inverted
2. Concave, 6.67 m
4. 7.5 cm, 12.5 cm
5. (a) 8 cm
   (b) 16 cm
   (c) 48 cm
6. 15 cm
7. (a) $\left(\dfrac{2+\cos\omega t}{1+\cos\omega t}\right)f$
   (b) $x=0$
   (c) $m\to\infty$
8. (a) Concave
9. $\left(\dfrac{\sqrt{3}+1}{2}\right)R$ from the convex mirror
11. 10 cm
12. $-\dfrac{3}{2}, -\dfrac{3}{4}$
13. $40\sqrt{2}$ cm, $10\sqrt{2}$ cm

Test Your Concepts-III (Based on General Refraction)

1. 75 cm
2. 7.5 cm
3. $\Delta v=0.55$ cm, $\dfrac{m_2}{m_1}\approx 1.1$
4. $2\times10^8\ \text{ms}^{-1}$, 4000 Å yellow
5. 3.5 cm
6. 6.6 cm
7. 2.88 m
9. 0.7 r
10. $\sin^{-1}\left(\dfrac{L}{R^2}\left(\sqrt{\mu^2R^2-L^2}-\sqrt{R^2-L^2}\right)\right)$
11. 12 cm
12. $y=\dfrac{x^2}{4}$

Test Your Concepts-IV (Based on Total Internal Reflection (TIR))

1. (a) $54.34°$
   (b) Yes
2. (a) 2.81 m
   (b) 0.23 m
3. (b) $\sqrt{2}$
4. (a) $26.8°$
   (b) Yes
5. $\dfrac{h}{\sqrt{\mu^2-1}}$
6. (a) $40.54°$
   (b) $26.6°$
7. $67.3°$
8. $\dfrac{4}{3}$ cm
9. $\sqrt{2}$
10. $OP \ngtr \sqrt{\dfrac{2}{3}}R$

Test Your Concepts-V (Based on Prism)

1. (a) $30°$
   (b) $\sqrt{\dfrac{7}{3}}$

2. (a) 157.2°
   (b) 128.4°
3. $A_{max} = 83.62°$
4. (a) $\sqrt{5}$
   (b) 58.8°
5. (a) 34.2°
   (b) 8.4°
6. $\sin^{-1}(\mu \sin\alpha) - \alpha$
7. $\sqrt{2}$
8. $0°$, $\sqrt{3}$
9. $\delta_V - \delta_R = 4.5°$
10. $22°$, $56°$
11. $0°$
12. 19°
13. 10.1°
14. $\delta_{red} = 30.6°$, $\delta_{violet} = 33.4°$
15. 2, 10

Test Your Concepts-VI (Based on Refraction at Curved Surfaces)

1. 2.5 D
2. Final image is formed at pole of the mirror
3. $x \approx 0.75R$
4. 7.42 cm
5. (a) 80 cm
   (b) $u < 12$ cm
6. Final image is formed at 65 cm from first face on the same side of the object.
7. 3.33 cm, infinity
9. 3.84 mms^{-1}
10. $\dfrac{R(2-\mu)}{2(\mu-1)}$
11. $\dfrac{2d}{3}$
12. $\dfrac{3+\sqrt{5}}{2}$
13. 8.57 cm

Test Your Concepts-VII (Based on Lens Formula)

1. 6 cm from either of the object
2. 12 cm
3. $\dfrac{4}{3}$
4. Concave mirror of focal length 15 cm
5. (a) 90 cm
   (b) 102 cm
6. 12.5 cm in front of the silvered lens
7. 10 cm
8. 2.14 cm
9. 1.37
10. 7.5 cm
11. $\dfrac{4f_1^2}{f_2}$
12. 2 m, 1 m
13. (a) $\dfrac{t}{t-f_1}$
    (b) No Shift
14. 7.5 cm
17. $(m+1)$ times smaller
18. (a) Convex
19. 2.4 cm
20. (a) 1.4
21. Rays will become parallel to the optic axis.
22. $I = \dfrac{3-2\mu_0}{2a}$
23. $\dfrac{R}{2(\mu n + \mu - 1)}$
24. (a) x_1
    (b) $\dfrac{x_1 x_2}{x_1 - x_2}$
    (c) $\dfrac{x_1}{x_1 - x_2}$
25. 0.6 m
26. 1.7
27. $(5f, 2d)$

Test Your Concepts-VIII (Based on Aberrations, Human Eye and Optical Instruments)

1. 20 D to 24 D
2. 0.0325
3. –0.5 D
4. (i) 98 cm × 98 cm (ii) 2401
5. 0.2575 m
6. 9 cm away from objective lens
7. –327.5
8. 0.31852 m , 27.39
9. 55 cm, 2.63 cm, 10

Single Correct Choice Type Questions

1. C	2. C	3. A	4. D	5. B	6. C	7. C	8. D	9. A	10. D
11. C	12. B	13. B	14. A	15. C	16. B	17. B	18. D	19. B	20. D
21. C	22. C	23. C	24. D	25. D	26. D	27. B	28. D	29. A	30. B
31. C	32. D	33. A	34. B	35. C	36. D	37. D	38. C	39. B	40. B
41. C	42. B	43. A	44. B	45. C	46. D	47. C	48. B	49. D	50. C
51. C	52. B	53. A	54. A	55. A	56. A	57. C	58. D	59. D	60. C
61. D	62. B	63. A	64. B	65. A	66. B	67. D	68. A	69. B	70. C
71. D	72. A	73. D	74. C	75. A	76. B	77. C	78. C	79. C	80. A
81. B	82. B	83. C	84. A	85. C	86. C	87. A	88. C	89. C	90. C
91. D	92. A	93. B	94. B	95. B	96. A	97. C	98. C	99. D	100. A
101. C	102. C	103. A	104. D	105. C	106. B	107. B	108. C	109. D	110. C
111. C	112. B	113. B	114. D	115. C	116. C	117. C	118. B	119. D	120. B
121. B	122. A	123. B	124. C	125. C	126. C	127. B	128. D	129. C	130. C
131. C	132. B	133. C	134. B	135. A	136. A	137. A	138. C	139. B	140. D
141. C	142. C	143. D	144. B	145. C	146. A	147. C	148. C	149. A	150. D
151. C	152. C	153. A	154. D	155. C	156. C	157. C	158. A	159. D	160. B
161. D	162. A	163. C	164. C	165. A	166. B	167. C	168. C	169. C	170. D
171. A	172. C	173. D	174. C	175. D	176. B	177. C	178. D	179. D	180. C
181. B	182. C	183. C	184. A	185. C	186. C	187. B	188. B	189. D	190. A
191. C	192. B	193. A	194. A	195. B	196. B	197. D	198. B	199. C	200. C
201. C	202. C	203. C	204. A	205. B	206. A	207. B	208. B	209. A	210. A
211. D	212. B	213. D	214. D	215. A	216. A	217. D	218. D	219. C	220. D
221. C	222. C	223. B	224. D	225. B	226. A	227. B	228. C	229. C	230. C
231. C	232. C	233. C	234. C	235. D	236. B	237. D	238. A	239. B	240. D
241. D	242. A	243. B	244. D	245. A	246. D	247. B	248. B	249. B	250. A
251. B	252. B	253. B	254. B	255. C	256. D	257. D	258. D	259. A	260. B
261. B	262. C	263. A	264. A	265. D	266. C	267. D	268. B	269. D	270. B
271. B	272. C	273. D	274. A	275. D	276. C	277. B	278. C	279. B	280. D
281. A	282. A	283. A	284. B	285. D	286. C	287. A	288. B	289. C	290. D
291. B	292. D	293. D	294. A	295. A	296. C	297. C	298. A	299. D	300. B
301. C	302. B	303. B	304. A	305. C	306. C	307. A	308. A	309. A	310. D
311. A	312. C	313. A	314. D	315. B	316. A	317. C	318. D	319. A	320. A
321. C	322. D	323. B	324. C	325. D					

Multiple Correct Choice Type Questions

1. B, C	2. A	3. A, D	4. A, B	5. B, D
6. A, C	7. A, C, D	8. B, C	9. B, C, D	10. A
11. B, C	12. A, D	13. B, C	14. A, B, CD	15. B, D
16. A, C, D	17. A, D	18. A, C	19. B, C, D	20. A, B, C
21. A, B	22. B, C	23. A, D	24. A, D	25. B, C
26. B, D	27. C, D	28. A, C	29. B, D	30. A, C, D

31. A, C	**32.** B, C	**33.** B	**34.** B	**35.** A, D
36. A, D	**37.** A, C	**38.** A, C	**39.** A, C	**40.** C
41. A, B	**42.** B, C	**43.** A, B, C	**44.** B, C	**45.** A, B, C
46. B, C	**47.** A, C	**48.** B, D	**49.** B, C	**50.** A, B, C

Reasoning Based Questions

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

Linked Comprehension Type Questions

1. B	**2.** C	**3.** B	**4.** D	**5.** A	**6.** D	**7.** C	**8.** A	**9.** D	**10.** B
11. D	**12.** C	**13.** D	**14.** A	**15.** D	**16.** D	**17.** C	**18.** A	**19.** C	**20.** D
21. A	**22.** D	**23.** C	**24.** B	**25.** D	**26.** C	**27.** A	**28.** A	**29.** B	**30.** A
31. C	**32.** C	**33.** B	**34.** D	**35.** D	**36.** C	**37.** C	**38.** D	**39.** C	**40.** C
41. D	**42.** D	**43.** D	**44.** C	**45.** B	**46.** B	**47.** C	**48.** A	**49.** A	**50.** C
51. D	**52.** D	**53.** A	**54.** C	**55.** B	**56.** A	**57.** C	**58.** B	**59.** B	**60.** A
61. C	**62.** C	**63.** C	**64.** D	**65.** B	**66.** C	**67.** B	**68.** A	**69.** D	**70.** A
71. C	**72.** D	**73.** A	**74.** B	**75.** C	**76.** D				

Matrix Match/Column Match Type Questions

1. A → (r, s)	B → (p, q, r, s, t)	C → (q, r, s, t)	D → (p, r, s)
2. A → (s, t)	B → (p, t)	C → (s, t)	D → (q, t)
3. A → (s)	B → (p, q, r)	C → (q, r, s)	D → (t)
4. A → (r)	B → (q)	C → (p)	D → (p)
5. A → (p, q)	B → (r)	C → (s)	D → (p, q)
6. A → (p, s)	B → (q)	C → (p, q, s)	D → (r)
7. A → (q, r)	B → (r)	C → (p, r, s)	D → (p, r)
8. A → (p, q, s)	B → (p, q)	C → (r)	D → (p, q, s)
9. A → (p, s)	B → (p, q, r, s)	C → (p, q, r, s)	D → (p, s)
10. A → (p)	B → (p)	C → (r, s)	D → (q, p)
11. A → (p, s)	B → (p, q, r, s)	C → (p, q, r, s)	D → (q, s)
12. A → (s)	B → (p)	C → (q)	D → (r)
13. A → (s)	B → (q)	C → (p)	D → (q)

Integer/Numerical Answer Type Questions

1. 30.	**2.** 24, 36	**3.** 3	**4.** 90	**5.** 36
6. 9	**7.** 12	**8.** 2	**9.** 60	**10.** 2
11. 180	**12.** 15	**13.** 5, 4	**14.** 8	**15.** 5
16. 30	**17.** 30	**18.** 60	**19.** 9	**20.** 40
21. 5	**22.** 100	**23.** 12	**24.** 25	**25.** 10
26. 45	**27.** (a) 4 (b) 5	**28.** 2	**29.** 30 (Right of lens), 8	**30.** 15
31. 29 cm, 116				

ARCHIVE: JEE MAIN

1. D	2. C	3. B	4. D	5. A	6. A	7. B	8. B	9. D	10. C
11. D	12. A	13. D	14. B	15. D	16. C	17. D	18. A	19. C	20. A
21. C	22. D	23. B	24. B	25. C	26. B	27. C	28. C	29. A	30. C
31. A	32. C	33. D	34. A	35. C	36. B	37. A	38. D	39. C	40. C
41. D	42. B	43. C	44. C	45. D	46. D	47. C	48. B	49. B	50. A
51. B	52. C	53. D							

ARCHIVE: JEE ADVANCED

Single Correct Choice Type Problems

1. A	2. A	3. B	4. C	5. A	6. C	7. B	8. C	9. B	10. C
11. A	12. B	13. C	14. B	15. C	16. B	17. B	18. D	19. C	20. A
21. B	22. C	23. B	24. B	25. B	26. C	27. B	28. D	29. C	30. C
31. D	32. B	33. D	34. A	35. A	36. B	37. D	38. A	39. B	40. C
41. A	42. C	43. C	44. C	45. C	46. A	47. D	48. D	49. A	50. A
51. A	52. A								

Multiple Correct Choice Type Problems

1. B, D	2. B, C, D	3. D	4. A, B, C	5. A, D
6. A, C	7. A, B, C	8. C, D	9. B, D	10. A, B, C, D
11. C, D	12. C, D			

Reasoning Based Questions

1. C

Comprehension Type Questions

1. A	2. D	3. B	4. C

Matrix Match/Column Match Type Questions

1. A → (p)	B → (s)	C → (r)	D → (p)
2. A → (q)	B → (r)	C → (s)	D → (p)
3. A → (p, r)	B → (q, s, t)	C → (p, r, t)	D → (q, s)
4. A → (p, q, r, s)	B → (q)	C → (p, q, r, s)	D → (p, q, r, s)
5. A → (p)	B → (r)	C → (r)	D → (p, q, r)

Integer/Numerical Answer Type Questions

1. 50	2. 1.5	3. 130	4. 8	5. 2
6. 7	7. 2	8. 3	9. 6	10. 6