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Date : 28.03.2025
Time : 03:53:06
Marks : 259

TEST ID: 42
PHYSICS

OPTICS

Single Correct Answer Type

1. A ray of light travelling through glass of refractive index $\sqrt{2}$ is incident on glass-air boundary at an angle of incidence 45°. If refractive index of air is 1 , then the angle of refraction will be
   a) 45° b) 30°
   c) 60° d) 90^0

2. An object is placed 40 cm from a concave mirror of focal length 20 cm. The image formed is
   a) real, inverted and same in size
   b) real, inverted and smaller in size
   c) virtual, erect and larger in size
   d) virtual, erect and smaller in size

3. An optical fiber essentially consists of thin transparent flexible core of material of refractive index 'μ_1' surrounded by flexible cover called cladding with refractive index 'μ_2'. Then
   a) The difference $\mu -$ μ_1 should be equal to one
   b) μ_2 is slightly greater than μ_1
   c) μ_2 is lightly greater than μ_1
   d) μ_2 is slightly less than μ_1

4. A ray of light from denser medium strikes a rarer medium at an angle of incidence 'i'. The reflected and refracted rays made an angle of 90^0 with each other. The angle of reflection and refraction are r and r′. The critical angle is
   a) $\sin^{-1}(\tan r')$ b) $\sin^{-1}(\cot r)$
   c) $\tan^{-1}(\sin r)$ d) $\sin^{-1}(\tan i)$

5. Rays from a point source of light situated at height 'h' below the liquid surface having refractive index μ, from a circular patch of light of radius 'r' on the surface. The area of the patch is
   a) $\dfrac{\pi h^2}{\sqrt{(\mu^2-1)}}$ b) $\dfrac{\pi h^2}{(\mu^2-1)}$
   c) $\dfrac{\pi h}{\sqrt{(\mu^2-1)}}$ d) $\dfrac{\pi}{h(\mu^2-1)}$

6. A plane mirror produces a magnification of
   a) -1 b) +1
   c) zero d) between 0 and $+\infty$

7. A prism having refractive index $\sqrt{2}$ and refractive angle 30^0 has one of the refracting surfaces silvered. The beam of light incident on the other refracting surface will retrace its path, if angle of incidence is
   $\left[\sin\frac{\pi}{6} = 0.5\right]$
   a) $\sin^{-1}\left(\frac{3}{4}\right)$ b) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$
   c) $\sin^{-1}\left(\frac{1}{2}\right)$ d) $\sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$

8. A bubble in a glass slab (refractive index 1.5) when viewed from one side appears at 5 cm and at 2 cm from other side then thickness of the slab is
   a) 3.75 cm b) 10.5 cm
   c) 2.5 cm d) 3 cm

9. The critical angle for a ray of light from glass to air is 'θ' and refractive index of glass w.r.t. air is 'n'. If a ray of light is incident from air to glass at angle 'θ' then corresponding angle of refraction is
   a) $\sin^{-1}\left(\frac{1}{n}\right)$ b) $\sin^{-1}\left(\frac{1}{n^2}\right)$
   c) $\cos^{-1}\left(\frac{1}{n}\right)$ d) $\cos^{-1}\left(\frac{1}{n^2}\right)$

10. A small bulb is placed at the bottom of a tank containing water to a depth of 80 cm. What is the area of the surface of water through which light from the bulb can emerge out? Refractive index of water is 1.33.(Consider the bulb to be a point source)
    a) 4.6 m^2 b) 3.2 m
    c) 5.6 m^2 d) 2.6 m^2

11. A ray of light travels from air to water to glass and again from glass to air. Refractive index of water w.r.t. air is 'X', glass w.r.t. water is 'Y' and air w.r.t. glass is 'Z'. Which of the following is correct?
    a) $YZ = X$ b) $XYZ = 1$

c) $XY = Z$ d) $XZ = Y$

12. The critical angle for light going from medium A into medium B is θ. The speed of light in the medium A is V_A. What is the speed of light in the medium B?
a) $V_A \sin\theta$ b) $V_A \tan\theta$
c) $\frac{V_A}{\tan\theta}$ d) $\frac{V_A}{\sin\theta}$

13. A ray of light travelling in a transparent medium falls on a surface separating the medium from air at an angle of incidence of 45^0. The ray undergoes total internal reflection. if n is the refractive index of the medium with respect to air, select the possible value of n from the following.
a) 1.2 b) 4/3
c) 1.4 d) 1.5

14. The minimum distance between an object and its real image formed by a convex lens of focal length 'f' is
a) 2.5f b) 1.5f
c) 2f d) 4f

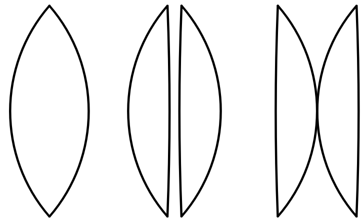
15. An air bubble is seen in a glass slab with refractive index 1.5. When viewed from one surface with normal incidence, it is 5 cm deep and when viewed from the opposite surface, it is 3 cm deep. The thickness of the slab is
a) 16 cm b) 14 cm
c) 10 cm d) 12 cm

16. For the same angle of incidence, the angle of refraction in four media A, B, C and D are $25^0, 30^0, 35^0$ and 40^0 respectively. The speed of light is least in medium
a) D b) C
c) B d) A

17. Object is placed 15 cm from a concave mirror of focal length 10 cm, then the nature of image formed will be
a) magnified and inverted b) magnified and erect
c) small in size and inverted d) small in size and erect

18. There are convex lenses L_1, L_2, L_3 and L_4 of focal length 2, 4, 6 and 8 cm respectively. Two of these lenses form a telescope of length 10 cm and magnifying power 4. The objective and eye lenses are respectively
a) L_1, L_4 b) $L_1 L_2$
c) L_4, L_1 d) L_2, L_3

19. Two similar plano-convex lenses are combined together in three different ways as shown in the adjoining figure. the ratio of the focal lengths in three cases will be



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

20. A plano- convex lens is made of flint glass. its focal length is
a) inversely proportional to the wavelength of light b) longer for red than for blue
c) longer for blue than for red d) the same for all colours

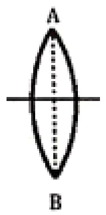
21. A monochromatic beam of light passing through water (refractive index 4/3) has wavelength 5400Å. When it is refracted in glass (refractive index 3/2), its wavelength will be
a) 4800Å b) 4000Å
c) 3200Å d) 6400Å

22. A glass convex lens is of refractive index 1.55 with both faces of same radius of curvature. What will be the radius of curvature if focal length is to be 20 cm?
a) 18 cm b) 21 cm
c) 20 cm d) 22 cm

23. A ray of light through air is incident on a denser medium at an angle 'i'. It is partly reflected and partly refracted. Both these rays are perpendicular to each other. The refractive index of the denser medium 'n' is equal to
a) cos i b) sin i
c) cosec i d) tan i

24. A thin prism in air produces the angle of minimum deviation 'δ'. If the prism is immersed in water, the angle of minimum deviation for the same ray is
[Refractive index of glass prism = 1.5, Refractive index of water is $\frac{4}{3}$]
a) $\frac{\delta}{3}$ b) δ
c) $\frac{\delta}{2}$ d) $\frac{\delta}{4}$

25. The figure shows equi-convex lens of focal length 'f'. If the lens is cut along AB, the focal length of each half will be



a) 4F b) 2f
c) f d) 3f

26. The refractive angle of a glass prism is 30^0. A ray is incident on one of the faces perpendicular to it. The angle of deviation δ between the incident ray and that leaves the prism is
(Refractive index of glass = 1.5)($\sin 30^0 = 0.5, \sin(48.6^0) = 0.75$)
a) $(12.6)^0$ b) $(18.6)^0$
c) 16^0 d) 17^0

27. μ_1 and μ_2 are the refractive index of two mediums and v_1 and v_2 are the velocity of light in these two mediums, respectively. Then, the relation connecting these quantities is
a) $v_1 = v_2$ b) $\mu_2 v_1 = \mu_1 v_2$
c) $\mu_1^2 v_1 = \mu_2^2 v_2$ d) $\mu_1 v_1 = \mu_2 v_2$

28. The angle of minimum deviation produced by a thin prism in air is 'δ_1'. What will be the minimum deviation 'δ_2' if prism is immersed in water?
$\left[{}_a\mu_g = \frac{3}{2} \text{and } {}_a\mu_w = \frac{4}{3}\right]$
a) $\delta_2 = \frac{\delta_1}{4}$ b) $\delta_2 = \frac{\delta_1}{2}$
c) $\delta_2 = 2\delta_1$ d) $\delta_2 = 4\delta_1$

29. The refractive index of diamond, glass and water w.r.t. air are 2.42, 1.5 and 1.33 respectively. Let V_d, V_g and V_w are velocities of light in diamond, glass and water respectively. Then which one of the following relations in correct?
a) $V_d > V_g > V_w$ b) $V_d < V_g > V_w$
c) $V_d < V_g < V_w$ d) $V_d > V_g > V_w$

30. A plano convex lens fits exactly into a plano-concave lens with plane surfaces parallel to each other. The radius of curvature of the curved surface of the lenses is 'R'. If the lenses are made of different materials of refractive indices 'μ_1' and 'μ_2' respectively, then the focal length of the combination is
a) $\frac{R}{(\mu_1 - \mu_2)}$ b) $\frac{R}{2(\mu_1 - \mu_2)}$
c) $\frac{2R}{(\mu_1 - \mu_2)}$ d) $\frac{R}{2(\mu_1 - \mu_2)}$

31. For concave mirror, if the object is just beyond the focal length, the image formed is
a) Real inverted and magnified b) Real, inverted and diminished
c) Real, erect and magnified d) Real, erect and diminished

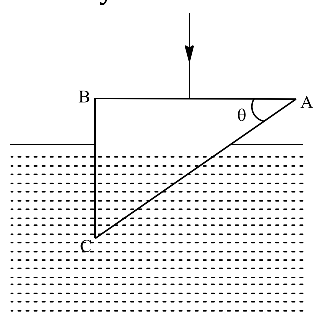
32. A man is 180 cm tall and his eyes are 10 cm below the top of his head . In order to see this entire height right from top to head, he uses a plane mirror kept at a distance of 1 m from him . The minimum length of the plane mirror is
a) 180 cm b) 90 cm
c) 85 cm d) 170 cm

33. A convex lens of focal length 40 cm is in contact with a concave lens of focal length 25 cm. The power of combination is
a) -1.5 D b) -6.5 D
c) +6.5 D d) +1.5 D

34. A ray of light is incident at an angle i on one face of a thin angled prism. The ray emerges normally from the other face. Refractive index of the glass prism is n and angle of prism is A. The value of i is
a) An b) A^2n
c) An^2 d) $\frac{1}{An}$

35. A vessel of depth '2d' cm is half filled with a liquid of refractive index 'μ_1' and upper half with liquid of refractive index 'μ_2', the apparent depth as seen normally is
a) $d\left[\frac{1}{\mu_1} + \frac{1}{\mu_2}\right]$ b) $\frac{2d}{\mu_1 \mu_2}$
c) $d\left[\frac{\mu_1 \mu_2}{\mu_1 + \mu_2}\right]$ d) $2d\left[\frac{1}{\mu_1} + \frac{1}{\mu_2}\right]$

36. A glass prism ABC (refractive index 1.5), immersed in water (refractive index 4/3). A ray of light is incident normally on face AB. If it is totally reflected at face AC, then

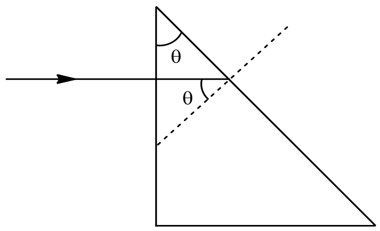


a) $\sin\theta \geq \frac{8}{9}$ b) $\sin\theta \geq \frac{2}{3}$
c) $\sin\theta = \frac{\sqrt{3}}{2}$ d) $\frac{2}{3} < \sin\theta < \frac{8}{9}$

37. A convex lens of refractive index $\frac{3}{2}$ has a power of 2.5. If it is placed in a liquid of refractive index 2, the new power of the lens is (D – dioptre)

a) -125D b) -2.5D
c) 2.5D d) 1.25D

38. Parallel beam containing light of $\lambda = 400$ nm and 500 nm is incident on a prism as shown in figure. The refractive index μ of the prism is given by the relation, $\mu(\lambda) = 1.20 + \frac{0.8\times10^{-14}}{\lambda^2}$



Which of the following statement is correct?

a) Light of $\lambda = 400$ nm undergoes.
b) Light of $\lambda = 500$ nm undergoes total internal reflection.
c) Neither of the two wavelengths undergoes total internal reflection.
d) Both wavelengths undergoes total internal reflection

39. An equi-convex lens made of glass has refractive index 1.5. If radius of each surface is changed from 5cm to 6 cm then power

a) Decrease approximately by 5.5D
b) Increase approximately by 3.33D
c) Remains unchanged
d) Decreases approximately by 3.33D

40. In a optical fiber, the refractive index of the core is 1.5 and that of cladding is 1.42. The critical angle for core – cladding interface of the optical fiber is

a) $\sin^{-1}\left(\frac{0.02}{1.5}\right)$ b) $\sin^{-1}\left(\frac{1.5}{1.42}\right)$
c) $\sin^{-1}\left(\frac{1.42}{1.5}\right)$ d) $\sin^{-1}\left(\frac{0.08}{1.42}\right)$

41. An object is located on a wall, its image of equal size is to be obtained on a parallel wall with the help of a convex lens. The lens is placed at a distance 'd' in front of the second wall. The required focal length of the lens is

a) Less than $\frac{d}{4}$
b) More than $\frac{d}{4}$ but less than $\frac{d}{2}$
c) Only $\frac{d}{4}$
d) Only $\frac{d}{2}$

42. A ray of light travels from air to water to glass and again from glass to air. Refractive index of water with respect to air is 'x', glass with respect to water is 'y' and air with respect to glass is 'z'. Which one of the following is correct?

a) $xz = y$ b) $xyz = 1$
c) $xy = z$ d) $yz = x$

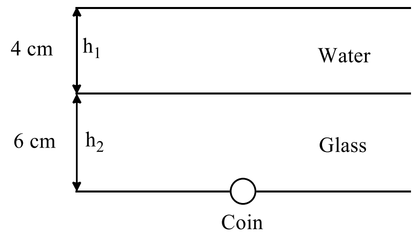
43. A convex lens of focal length 'F' produces a real image 'n' times the size of the object. The image distance is

a) $F(n+1)$ b) $\frac{F}{(n-1)}$
c) $\frac{F}{(n+1)}$ d) $F(n-1)$

44. The intermediate image formed by an objective lens of a compound microscope is

a) Virtual and diminished
b) Real and diminished
c) Virtual and magnified
d) Real and magnified

45. A 4 cm thick layer of water covers a 6 cm thick glass slab. A coin is placed at the bottom of the slab and is being observed from the air side along the normal to the surface. Find the apparent position of the coin from



a) 7.0 cm b) 8.0 cm
c) 10 cm d) 5 cm

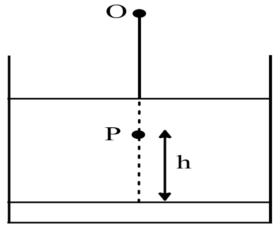
46. A plane mirror reflects a pencil of light to form a real image, then the pencil of light incident on the mirror is

a) parallel b) convergent
c) divergent d) None of these

47. In a thin prism of glass (refractive index 1.5), which of the following relations between the angle of minimum deviations δ_m and angle of prism r will be correct?

a) $\delta_m = r$ b) $\delta_m = 1.5\ r$
c) $\delta_m = 2\ r$ d) $\delta_m = r/2$

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



a) $2\mu h$ b) $\frac{2h}{\mu}$

c) $\frac{2h}{\mu-1}$ d) $h\left(1+\frac{1}{\mu}\right)$

49. An equilateral prism deviates a ray through 45^0 for the two angles of incidence differing by 20^0 . The angle of incidence is

a) 62.5^0 b) 42.5^0

c) Both are correct d) Both are wrong

50. Which one of the following is NOT the correct formula for refractive index of glass w.r.t. air $({}_a\mu_g)$ (i = angle of incidence, r = angle of refraction)

a) ${}_a\mu_g = \frac{\lambda_{air}}{\lambda_{glass}}$ b) ${}_a\mu_g = \frac{\sin i}{\sin r}$

c) ${}_a\mu_g = \frac{V_{glass}}{V_{air}}$ d) ${}_a\mu_g = \frac{\lambda_{glass}}{\lambda_{air}}$

51. A ray of light is incident at an angle 'I' on one face of thin prism. The ray emerges normally from the other face. Refractive index of the glass prism is 'n' and angle of prism is 'A'. The value of 'I' is

a) An b) An^2

c) $\frac{A}{n}$ d) $\frac{A}{n^2}$

52. The magnifying power of a refracting type of astronomical telescope is 'm'. If focal length of eyepiece is doubled then the magnifying power will become

a) m b) 2m

c) $\frac{m}{2}$ d) $\frac{m}{4}$

53. A ray of light passing through a prism of refraction angle 60^0 has to deviate by at least 30^0 . Then refractive index of prism should be

a) $\le \sqrt{2}$ b) $\ge \sqrt{2}$

c) $\ge \sqrt{3}$ d) $\le \sqrt{3}$

54. For a normal eye, the least distance of distinct vision is

a) 0.25 m b) 0.50 m

c) 25 m d) infinite

55. The refractive index of the material of crystal is 1.68 and that of oil is 1.2 when a ray of light passes from oil to glass, its velocity will change by a factor

a) $\frac{2}{3}$ b) $\frac{3}{4}$

c) $\frac{5}{6}$ d) $\frac{5}{7}$

56. If ${}_i\mu_j$ represents refractive index when a light ray goes from medium i to medium j, then the produce ${}_2\mu_1 \times {}_3\mu_2 \times {}_4\mu_3$ is equal to

a) $\frac{1}{{}_1\mu_4}$ b) ${}_3\mu_1$

c) $\frac{1}{{}_3\mu_2}$ d) ${}_4\mu_2$

57. Time taken by sunlight to penetrate 2 mm through a glass slab is of the order Refractive index of glass = 1.5, velocity of light in air= 3×10^8 m/s

a) 10^{-19} s b) 10^5 s

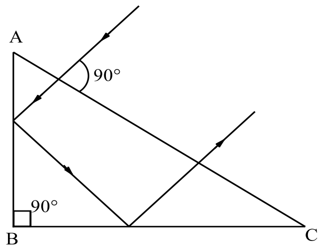
c) 10^{-11} s d) 10^{-10} s

58. In a lake, a fish rising vertically to the Surface of water uniformly at the rate of 3 m/s, observes a bird diving vertically towards the water at the rate of 9 m/s. The actual velocity of the dive of the bird is (Take, refractive index of water = 4/3)

a) 3.6 m/s b) 4.5 m/s

c) 6.0 m/s d) 12.0 m/s

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



a) 4/3 b) $\sqrt{2}$

c) 1.5 d) $\sqrt{3}$

60. A concave mirror of focal length f (in air) is immersed in water (μ = 4/3). The focal length of the mirror in water will be

a) f b) $\frac{4}{3}f$

c) $\frac{3}{4}f$ d) $\frac{7}{3}f$

61. Distance of an object from a concave lens of focal length 20 cm is 40 cm. Then ,linear magnification of the image

a) =1 b) >1

c) <1 d) zero

62. A monochromatic ray of light travels through glass slab and water column. The number of waves in glass slab of thickness 4 cm is the

same as in water column of height 5 cm. If refractive index of glass is 5/3, then refractive index of water is

a) 1.63 b) 1.4
c) 1.3 d) 1.5

63. Light travels from an optically denser medium 'A' into the optically rarer medium 'B' with speeds $1.8 \times 10^8 \frac{m}{s}$ and 2.7×10^8 m/s respectively. Then critical angle between them is (μ_1 and μ_2 are the refractive indices of media A and B respectively.)

a) $\tan^{-1}\left(\frac{2}{3}\right)$ b) $\sin^{-1}\left(\frac{3}{4}\right)$
c) $\sin^{-1}\left(\frac{2}{3}\right)$ d) $\tan^{-1}(3/4)$

64. A ray of light is incident on a medium of refractive index 'μ' at an angle of incidence 'i'. After refraction the angle of deviation is 'δ'. Then $\frac{1}{\mu}$ is

a) $\sin\delta - \cos\delta \tan i$ b) $\cos\delta - \sin\delta \tan i$
c) $\cos\delta - \sin\delta \cot i$ d) $\sin\delta - \cos\delta \cot i$

65. An under water swimmer is at a depth of 12 m below the surface of water. A bird is at a height of 18 m from the surface of water, directly above his eyes. For the swimmer, the bird appears to be at a distance from the surface of water equal to
(Take, refractive index of water = 4/3)

a) 24 m b) 12 m
c) 18 m d) 9 m

66. A convex lens forms an image of an object placed 20 cm away from it at a distance of 20 cm on the other side of the lens. If the object is moved 5 cm towards the lens, the image will move

a) 5 cm towards the lens b) 10 cm towards the lens
c) 10 cm away from the lens d) 8 cm away from the lens

67. Light falls on a plane reflection surface. For what angle of incidence is the reflected ray normal to the incident ray?

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

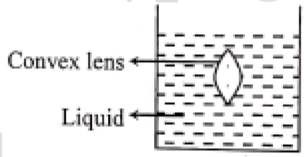
68. Regarding compound microscope consider the following statements.
(P) Aperture of the objective lens is smaller than the eye-lens.
(Q) Objective produces real, inverted and magnified image which is intermediate image.
(R) The final image is virtual, magnified and erect with respect to the original object.

a) Only (P) and (Q) are correct b) Only (P) and (R) are correct
c) Only (P) is correct d) Only (Q) and (R) are correct

69. The refractive indices of glass and water with respect to air are 3/2 and 4/3, respectively. The refractive index of glass with respect to water will be

a) 8/9 b) 9/8
c) 7/6 d) None of these

70. Inside a vessel filled with liquid a converging lens is placed as shown in figure. The lens has focal length 15 cm when in air and has refractive index $\frac{3}{2}$. If the liquid has refractive index $\frac{9}{5}$, the focal length of lens in liquid is



a) 15 cm b) −60 cm
c) 90 cm d) −45 cm

71. The sun appears orange red at sunrise and sunset. This is because of

a) Scattering of light b) Reflection of light
c) Refraction of light d) Total internal reflection

72. When a biconvex lens of glass having refractive index μ_g is dipped in a liquid of refractive index μ_m. It acts as a plane sheet of glass. This implies that the liquid must have refractive index

a) Equal to that of glass b) Greater than that of glass
c) Less than that of glass d) Equal to one

73. A double convex lens made of glass (refractive index n = 1.5) has both radii of curvature of magnitude 20 cm. Incident light rays parallel to the axis of the lens will converge at a distance L such that

a) L = 20 cm b) L = 10 cm
c) L = 40 cm d) $L = \frac{20}{3}$ cm

74. A glass convex lens is of refractive index 1.55 with both faces of same radius of curvature. What is the radius of curvature required if focal length is to be 20 cm?

a) 20 cm b) 22 cm

c) 18 cm
d) 21 cm

75. A ray of light is incident at an angle 'i' on one face of prism of small angle 'A' and emerges normally from the other surface. 'μ' is the refractive index of the material of the prism. The angle of incidence is

a) $\frac{A}{\mu}$
b) $A\mu$
c) $\frac{A\mu}{2}$
d) $\frac{A}{2\mu}$

76. A convex lens is dipped in a liquid whose refractive index is same as that of lens material, Then its focal length will

a) Become zero
b) Become infinite
c) Remain same
d) Decrease

77. A compound microscope produces a magnification of 24. The focal length of the eyepiece is 5 cm. The final image is formed at the least distance of distinct vision. The magnification produced by the object is

a) 5
b) 4
c) 7
d) 6

78. An eye specialist prescribes spectacles having a combination of a convex lens of focal length 40 cm in contact with a concave lens of focal length 25 cm. The power of this lens combination will be

a) +1.5 D
b) -1.5 D
c) +6.67 D
d) -6.67 D

79. For occurring total internal reflection, which one of the following is correct statement? (i = angle of incidence, i_c = critical angle)

a) Ray travels from denser medium to rarer medium and $i < i_c$
b) Ray travels from denser medium to rarer medium and $i > i_c$
c) Ray travels from rarer medium to denser medium and $i > i_c$
d) Ray travels from rarer medium to denser medium and $i < i_c$

80. A thin lens of glass of refractive index 1.5 has focal length 24 cm in air. It is now immersed in a liquid of refractive index $\frac{9}{8}$. Its new focal length is

a) 36 cm
b) 72 cm
c) 18 cm
d) 54 cm

81. A ray of light is incident at an angle of 60^0 on one face of a prism of angle 30^0 , The ray emerging out of the prism makes an angle of 30^0 with the incident ray . The emergent ray is

a) normal to the face through which it emerges
b) inclined at 30^0 to the face through which it emerges
c) inclined at 60^0 to the face through which it emerges
d) None of the above

82. The wavelength of light in two liquids × and y is 3500 A and 7000 A respectively , then the critical angle of × relative to y will be

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

83. A double convex lens made of glass has both radii of curvature of magnitude 20 cm. Incident light rays parallel to the axis of the lens will coverage to a point at a distance 'L' from the common pole P. The value of L is

a) 20 cm
b) 10 cm
c) $\frac{20}{3}$ cm
d) 40 cm

84. When a planer mirror is placed horizontally on ground at a distance of 60 m from the base of a tower, then the top of the tower and its image in the mirror subtend an angle of 90^0 at the corner of the mirror nearer to the base of tower. The height of the tower is

a) 30 m
b) 60 m
c) 90 m
d) 120 m

85. A circular beam of light (diameter = d) falls on a plane surface of a liquid. The angle of incidence is 45° and refractive index of the liquid is μ. The diameter of the refracted beam is

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

86. We combined a convex lens of focal length f_1 and their combined focal length was F . The combination of these lenses will behave like a concave lens, if

a) $f_1 > f_2$
b) $f_1 < f_2$
c) $f_1 = f_2$
d) $f_1 \leq f_2$

87. A glass convex lens (μ_g=1.5) has a length of 8 cm when placed in air. What would be the focal length of the lens when it is immersed in water (μ_w=1.33)?

a) 32 cm
b) 16 cm
c) 4 cm
d) 2 cm

88. The XZ-plane separates two media A and B with refractive indices μ_1 and μ_2, respectively. A ray of light travels from A and B. Its

directions in the two media are given by the unit vectors $\mathbf{r}_A = a\hat{\mathbf{i}} + b\hat{\mathbf{j}}$ and $\mathbf{r}_B = \alpha\hat{\mathbf{i}} + \beta\hat{\mathbf{j}}$ respectively, where $\hat{\mathbf{i}}$ and $\hat{\mathbf{j}}$ are unit vectors in the x and y-directions. Then,

a) $\mu_1 a = \mu_2 \alpha$ b) $\mu_1 \alpha = \mu_2 a$
c) $\mu_1 b = \mu_2 \beta$ d) None of these

89. A ray of light travelling in a medium of refractive index μ, is incident at an angle i on a composite transparent plate consisting of three plates of refractive indices μ_1, μ_2 and μ_3. The ray emerges from the composite plate into a medium of refractive index μ_4, at angle x. Then,

a) $\sin x = \sin i$ b) $\sin x = \frac{\mu}{\mu_4} \sin i$
c) $\sin x = \frac{\mu_4}{\mu} \sin i$ d) $\sin x = \frac{\mu_1}{\mu_2}\frac{\mu_3}{\mu_2}\frac{\mu}{\mu_4} \sin i$

90. A glass cube of length 24 cm has a small air bubble trapped inside. When viewed normally from one face it is 10 cm below the surface. When viewed normally from the opposite face, its apparent distance is 6 cm. The refractive index of glass is

a) 1.50 b) 1.40
c) 1.45 d) 1.55

91. The critical angle for light travelling from medium P to medium Q is ‘θ’. The speed of light in medium P is ‘v’. Then the speed of light in medium Q is

a) $v.\cos\theta$ b) $v(1-\cos\theta)$
c) $\frac{v}{\cos\theta}$ d) $\frac{v}{\sin\theta}$

92. A thin prism ‘P’ of angle 4^0 made up of glass of refractive index 1.48 is combined with another prism ‘Q’ made up of glass of refractive index 1.64 to produce dispersion without deviation. The angle of prism ‘Q’ is

a) 6^0 b) 5^0
c) 4^0 d) 3^0

93. Refractive index of a medium is ‘n’. The incidence angle is twice that of refracting angle. The angle of incidence is

a) $\sin^{-1}\left(\frac{n}{2}\right)$ b) $\cos^{-1}(2/n)$
c) $2\cos^{-1}\left(\frac{n}{2}\right)$ d) $\cos^{-1}\left(\frac{n}{2}\right)$

94. A ray of light passes through equilateral prism such that the angle of incidence is equal to angle of emergence and each of these angles is equal to $(3/4)^{th}$ the angle of prism. The angle of deviation is

a) 35^0 b) 20^0
c) 40^0 d) 30^0

95. For a light ray to undergo total internal reflection, light must travel from
(i = angle of incidence, i_c = critical angle)

a) Denser to rarer medium and $i < i_c$ b) Rarer to denser medium and $i > i_c$
c) Rarer to denser medium and $i < i_c$ d) Denser to rarer medium and $i > i_c$

96. The magnifying power of a telescope is high if its objective and eyepiece have respectively

a) Small and large focal length b) Large focal lengths
c) Large and small focal length d) Small focal lengths

97. A concave mirror of focal length ‘f_1’ is placed at a distance ‘d’ from a convex lens of focal length ‘f_2’. A parallel beam of light coming from infinity parallel to principal axis falls on the convex lens and then after refraction falls on the concave mirror. If it is to retrace the path, the distance ‘d’ should be

a) $2f_1 - f_2$ b) $f_1 + f_2$
c) $-f_1 + f_2$ d) $2f_1 - f_2$

98. The angle of minimum deviation for a prism of refractive index 1.5 is equal to the angle of the prism. The angle of prism is (Take, $\cos t 41^0 = 0.75$)

a) 21^0 b) 42^0
c) 60^0 d) 82^0

99. A ray of light is incident at an angle ‘i’ on one face of prism of small angle ‘A’ and emerges normally from the other surface. ‘μ’ is the refractive index of the material of the prism. The angle of incidence is

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

100. Two thin lenses, one of focal length +60 cm and the other of focal length -20 cm are put in contact. The combined focal length is

a) +15 cm b) -15 cm
c) +30 cm d) -30 cm

101. The critical angle of a prism is 30°. The velocity of light in the medium is

a) 1.5×10^8 m/s b) 3×10^8 m/s
c) 4.5×10^8 m/s d) None of these

102. A thin concave lens is in contact with a thin convex lens. The ratio of the magnitude of the reciprocal of focal length of concave lens and

that of convex lens is $\frac{2}{3}$. The focal length of the combined lens is 30 cm. Focal length of the concave lens is

a) -15 cm b) -21 cm
c) -30 cm d) -75 cm

103. The equi-convex lens has a focal length f. If the lens is cut along the line perpendicular to the principal axis and passing through the pole, What will be the focal length of any half part?

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

104. A ray of light travels from air to water to glass and again from glass to air. Refractive index of water with respect to air is 'x', glass with respect to water is 'y' and air with respect to glass is 'z'. Which of the following is correct?

a) $xyz = 1$ b) $yz = x$
c) $xz = y$ d) $xy = z$

105. A ray of light is incident at an angle 'i' on one face of a thin angled prism. The ray emerges normally from the other face. Refractive index of the glass prism is 'n' and angle of prism is 'A'. The value of 'i' is

a) An b) An^2
c) A^2n d) $\frac{1}{An}$

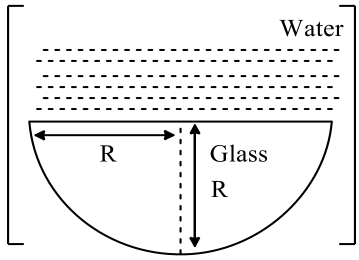
106. A simple microscope is used to see the object first in blue light and then in red light. Due to the change from blue to red light, what is the effect on its magnifying power?

a) Magnifying power increases b) Magnifying power decreases
c) Magnifying power is independent of color of light d) Magnifying power remains constant

107. A convex lens of focal length T is used to form an image whose size is one fourth that of size of the object. Then the object distance is

a) 2f b) 5f
c) 4f d) 3f

108. A ray of light travelling in glass $\left(\mu = \frac{3}{2}\right)$ is incident on a horizontal glass-air surface at the critical angle θ_c If thin layer of water $\left(\mu = \frac{4}{3}\right)$ is now poured on the glass-air surface, the angle at which the ray emerges into air at the water-air surface is



a) 60^0 b) 45^0
c) 90^0 d) 180^0

109. An achromatic convergent doublet of two lenses in contact has a power of +2 d. The convex lens has power +5 D. What is the ratio of the dispersive powers of the convergent and divergent lenses?

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

110. The magnifying power of a refracting type of astronomical telescope is 'm'. If focal length of eyepiece is doubled then the magnifying power will become

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

111. When a ray of light is incident normally on one refracting surface of an equilateral prism of refractive index 1.5, the emerging ray $\left[\sin^{-1}\left(\frac{1}{1.5}\right) = 41.8^0\right]$

a) Undergoes total internal reflection at second refracting surface b) Just grazes the second refracting surface
c) Is deviated by 30^0 d) Is deviated by 20^0

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

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

113. A ray of light is incident at 60^0 on one face of a prism of angle 30^0 and the emergent ray makes 30^0 with the incident ray. The refractive index of the prism is

a) 1.732 b) 1.414
c) 1.5 d) 1.33

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

a) 45^0 b) 39^0

c) 20^0 d) 30^0

115. Sun subtends an angle of 0.5^0 at the centre of curvature of a concave mirror of radius of curvature 15 m. The diameter of the image of the sun formed by the mirror is

a) 8.55 cm b) 7.55 cm
c) 4.55 cm d) 6.55 cm

116. A ray of light is incident on a plane mirror at an angle of 30°. The deviation produced in the ray is

a) 30° b) 60°
c) 90° d) 120°

117. For a ray of light, the critical angle is minimum when it travels from

a) Glass to air b) Water to glass
c) Air to glass d) Glass to water

118. A glass slab has refractive index 'μ' with respect to air and the critical angle for a ray of light in going from glass to glass to air is 'θ'. If a ray of light is incident from air on the glass with angle of incidence 'θ', then the corresponding angle of refraction is

a) $\sin^{-1}\left(\frac{1}{\sqrt{\mu}}\right)$ b) $\sin^{-1}\left(\frac{1}{\mu}\right)$
c) $\sin^{-1}\left(\frac{1}{\mu^2}\right)$ d) 90^0

119. White light consists of wavelengths from 480 nm to 672 nm. What will be the wavelength range when white light is passed through glass of refractive index 1.6?

a) 420 nm – 672 nm b) 300 nm – 480 nm
c) 300 nm – 420 nm d) 300 nm – 672 nm

120. The refractive index of a prism for a monochromatic wave is $\sqrt{2}$ and its refracting angle is 60^0. For minimum deviation, the angle of incidence will be

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

121. Magnifying power of a simple microscope is (when final image is formed at $D = 25$ cm from eye)

a) $\frac{D}{f}$ b) $1 + \frac{D}{f}$
c) $1 + \frac{f}{D}$ d) $1 - \frac{f}{D}$

122. Which one of the following is not associated with the total internal reflection?

a) The mirage formation b) Optical fibre communication
c) The glittering of diamond d) Dispersion of light

123. The light takes in travelling a distance of 500 m in water. Given that μ for water is 4/3 and the velocity of light in vacuum is 3×10^{10} cms^{-1}. Calculate equivalent optical path.

a) 566.64 m b) 666.64 m
c) 586.45 m d) 576.64 m

124. Which one of the following statements is NOT the property of light?

a) Light has finite speed b) Light involves transportation of energy
c) Light can travel through vacuum d) Light requires material medium for propagation

125. A convex lens of refractive index 3/2 has a power of 2.5 if it is placed in a liquid of refractive index 2, the new pow of the lens is

a) 2.5 D b) -2.5 D
c) 1.25 D d) -1.25 D

126. An object is located on a wall, its image of equal size is to be obtained on a parallel wall with the help of a convex lens. The lens is placed at a distance 'd' in front of the second wall. The required focal length of the lens is

a) Less than $\frac{d}{4}$ b) More than $\frac{d}{4}$ but less than $\frac{d}{2}$
c) Only $\frac{d}{4}$ d) Only $\frac{d}{2}$

127. In a compound microscope, let 'u_0' and 'v_0' be the object distance and image distance respectively. The objective of focal length 'f_0' magnifies a tiny object into a real, inverted image. The linear magnification of the objective is

a) $\frac{u_0 f_0}{f_0 + u_0}$ b) $\frac{f_0}{f_0 + u_0}$
c) $\frac{u_0}{u_0 f_0 + 1}$ d) $\frac{f_0 + u_0}{u_0 f_0}$

128. The refractive index of glass is 1.5 and that of water is 1.33. The critical angle for a ray of light going from glass to water is

a) $\sin^{-1}\left(\frac{4}{7}\right)$ b) $\sin^{-1}\left(\frac{5}{8}\right)$
c) $\sin^{-1}\left(\frac{8}{9}\right)$ d) $\sin^{-1}\left(\frac{2}{3}\right)$

129. When final image is formed at D.D.V. from eye, the magnifying power of a simple microscope is ($f =$ focal length of the lens)

a) $1 + \frac{f}{D}$ b) $\frac{D}{f}$

c) $1 + \frac{D}{f}$ d) $1 - \frac{D}{f}$

130. The minimum distance between an object and its real image formed by a convex lens is
a) 1.5 f b) 2 f
c) 2.5 f d) 4 f

131. A convex lens of focal length ‘F’ produces a real image ‘n’ times the size of the object. The image distance is
a) $F(n+1)$ b) $F(n-1)$
c) $\frac{F}{(N+1)}$ d) $\frac{F}{(n-1)}$

132. For convex mirrors, whatever may be the position of the object, the image formed is always on the
a) Same side, virtual, erect, magnified b) Opposite side, real erect, magnified
c) Opposite side, virtual, erect diminished d) Same side, real, erect, diminished

133. A light wave has a frequency of 4×10^{14} Hz and a wavelength of 5×10^{-7} m in a medium. The refractive index of the medium is
a) 1.5 b) 1.33
c) 1.25 d) 1.75

134. A thin hollow prism of refracting angle 3^0, filled with water gives a deviation of 1^0. The refractive index of water is
a) 1.59 b) 1.33
c) 1.46 d) 1.51

135. The critical angle for a ray of light from glass to air is ‘θ’ and refractive index of glass with respect to air is ‘n’. If a ray of light is incident from air to glass at an angle ‘θ’, then corresponding angle of refraction is
a) $\sin^{-1}\left(\frac{1}{n}\right)$ b) $\cos^{-1}\left(\frac{1}{n}\right)$
c) $\sin^{-1}\left(\frac{1}{n^2}\right)$ d) $\cos^{-1}\left(\frac{1}{n^2}\right)$

136. A glass slab of thickness 4 cm contains the same number of waves as in ‘x’ cm of water column when both are traversed by the same monochromatic light. If the refractive indices of glass and water for that light are $\frac{5}{3}$ and $\frac{4}{3}$ respectively, the value of x will be
a) $\frac{9}{20}$ cm b) $\frac{20}{9}$ cm
c) 5 cm d) $\frac{5}{4}$ cm

137. 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

138. For convex mirrors, whatever may be the position of the object, the image formed is always on the
a) Same side, real, erect and diminished b) Opposite side, virtual, inverted and diminished
c) Same side, virtual, inverted and diminished d) Opposite side, virtual, erect and diminished

139. When a ray of light is incident at an angle of 30^0 on an equilateral glass prism, it suffers minimum deviation. The angle between the emergent ray and the second refracting surface of prism is
a) 60^0 b) 45^0
c) 30^0 d) 0^0

140. The focal length of objective and eye lens of a microscope are 4 cm and 8 cm , respectively. if the least distance of distinct vision is 24 cm and object distance is 4.5 cm from the objective lens, then the magnifying power of the microscope will be
a) 18 b) 32
c) 64 d) 20

141. When the same monochromatic ray of light travels through glass slab and through water, the number of waves in glass slab of thickness 6 cm is same as in water column of height 7 cm .if refractive index of glass is 1.5, then refractive index of water is
a) 1.258 b) 1.269
c) 1.286 d) 1.310

142. The speed of light in two media M_1 and M_2 are $1.5 \times 10^8 \frac{m}{s}$ and $2 \times 10^8 \frac{m}{s}$ respectively. If the light undergoes total internal reflection, the critical angle between the two media is
a) $\sin^{-1}\left(\frac{3}{4}\right)$ b) $\sin^{-1}\left(\frac{2}{3}\right)$
c) $\sin^{-1}\left(\frac{4}{3}\right)$ d) $\sin^{-1}\left(\frac{3}{2}\right)$

143. When a ray of light falls on a given plate at an angle of incidence $60^0$the reflected and refracted rays are found to be normal to each other, The refractive index of the material of the plate is
a) $\frac{\sqrt{3}}{2}$ b) 1.5

c) 1.732 d) 2

144. A ray of light strikes a horizontal plane mirror at an angle of 45^0. A second plane mirror is attached at an angle θ with it. If ray after reflection from second mirror runs parallel to the first mirror, then θ is

a) 45^0 b) 60^0
c) $67.^{50}$ d) 135^0

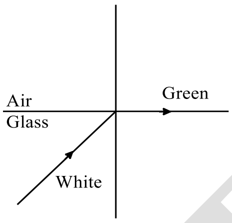
145. A vessel of depth 2d cm is half filled with a liquid of refractive index μ_1 and the upper half with a liquid of refractive index μ_2. The apparent depth of the vessel seen perpendicularly from about is

a) $d\left(\frac{\mu_1\mu_2}{\mu_1+\mu_2}\right)$ b) $d\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}\right)$
c) $2d\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}\right)$ d) $2d\left(\frac{1}{\mu_1\mu_2}\right)$

146. The magnifying power of an refracting type of astronomical telescope is 'm'. If focal length of the eyepiece is doubled, the magnifying power will become

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

147. 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

148. A convex lens of focal length 'f_1' and concave lens of focal length 'f_2' are combined to have effective focal length 'F'. This combination of lenses will behave like a concave lens, if

a) $f_1 > f_2$ b) $f_1 \le f_2$
c) $f_1 = f_2$ d) $f_1 < f_2$

149. The critical angle for light going from medium x to medium y is θ .The speed of light in medium x is V_x. The speed of light in medium y is

a) $\frac{V_x}{\tan\theta}$ b) $V_x \sin\theta$
c) $V_x \tan\theta$ d) $\frac{V_x}{\sin\theta}$

150. Two identical equi-convex glass lenses ($\mu =$ 1.5) each of focal length 'f' are kept in contact. The space between the two lenses is filled with water $\left(\mu = \frac{4}{3}\right)$. The focal length of the combination is

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

151. If the focal length of objective and eye lens are 1.2 cm and 3 cm respectively and the object is put 1.25 cm away form the objective lens and the final image is formed at infinity. The magnifying power of the microscope is

a) 150 b) 200
c) 250 d) 400

152. The refraction of light ray takes place from air to water, water to glass and again glass to air. The ray emerges parallel to incident ray. (n_a, n_w, n_g represent refractive index of air, water and glass respectively). The correct relation is

a) ${}_wn_g = \frac{{}_an_w}{{}_an_g}$ b) ${}_wn_g = {}_an_w = {}_wn_g$
c) ${}_an_w = \frac{{}_wn_g}{{}_an_g}$ d) ${}_wn_g = \frac{{}_an_g}{{}_an_w}$

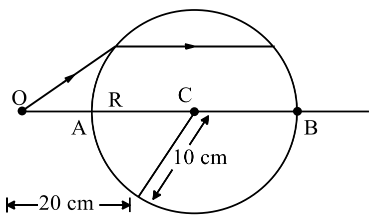
153. One surface of a lens is convex and the other is concave. If the radii of curvature are $r_1$andr_2 respectively, the lens will be convex, if

a) $r_1 > r_2$ b) $r_1 = r_2$
c) $r_1 < r_2$ d) $r_1 = 1/r_2$

154. A compound microscope has two lenses. The magnifying power of one is 5 and the combined magnifying power is 100. The magnifying power of the other lens is

a) 10 b) 20
c) 50 d) 25

155. Find the position of image from given diagram.



a) -15 cm b) -20 cm
c) -30 cm d) -25 cm

156. In order to obtain a real image of magnification 2 using converging lens of focal length 20 cm, Where should an object be placed

a) 50 cm b) 30 cm
c) -50 cm d) -30 cm

157. A rectangular glass slab ABCD of refractive

index μ_1, is immersed in water of refractive index $\mu_2 (\mu_1 > \mu_2)$. A ray of light is incident at the surface AB of the slab as shown in figure. 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) $\sin^{-1}\left[\left(\frac{\mu_1}{\mu_2}\right)\cos\left(\sin^{-}\right.\right.$
b) $\sin^{-1}\left(\frac{\alpha_2}{\alpha_1}\right)$
c) $\sin^{-1}\left[\alpha_1 \cdot \cos\left(\sin^{-1}\frac{1}{\alpha_2}\right)\right]$
d) $\left[\sin^{-1}\frac{\alpha_1}{\alpha_2}\right]$

158. Which one of the following statements is NOT the property of light?
a) Light has finite speed
b) Light involves transportation of energy
c) Light can travel through vacuum
d) Light requires material medium for propagation

159. When light is refracted into a medium from vacuum,
a) its wavelength and frequency both increase
b) its wavelength increases but frequency remains unchanged
c) its wavelength decreases but frequency remains unchanged
d) its wavelength and frequency both decrease

160. Focal length of a convex lens will be minimum for
a) Violet light
b) Red light
c) Yellow light
d) Blue light

161. The critical angle is θ for a light going from medium P to medium Q. I speed of light in medium P is V_P then speed of light in medium Q is
a) $\frac{\sin\theta}{V_P}$
b) $\frac{V_P}{\sin\theta}$
c) $V_P \sin\theta$
d) $V_P \tan\theta$

162. The size of the real image produced by a convex lens of focal length F is m times the size of the object. The image distance from the lens is
a) $F(m-1)$
b) $F(m+1)$
c) $\frac{(m-1)}{F}$
d) $\frac{F}{(m-1)}$

163. A monochromatic ray of light travels through glass slab and water column. The number of waves in glass slab of thickness 4 cm is the same as in water column of height 5 cm. If refractive index of glass is $\frac{5}{3}$ then refractive index of water is
a) 1.33
b) 1.30
c) 1.25
d) 1.10

164. The radii of curvature of the two surfaces of a lens are 20 cm and 30 cm ; and the refractive index of the material of the lens is 1.5 if the lens is concave-convex, then the focal length of the lens is
a) 24 cm
b) 10 cm
c) 15 cm
d) 120 cm

165. If a ray of light in a denser medium strikes a rarer medium at an angle of incidence i, the angles of reflection and refraction are respectively, r and r′. If the reflected and refraction rays are at right angles to each other, the critical angle for the given pair of media is
a) $\sin^{-1}(\tan r)$
b) $\sin^{-1}(\tan r)$
c) $\tan^{-1}(\sin i)$
d) $\cot^{-1}(\tan i)$

166. A thin prism P_1 with angle 4^0 and made from glass of refractive index 1.54 is combined with another thin prism P_2 made from glass of refractive index 1.72 to produce dispersion without deviation. The angel of prism for P_2 is
a) 5.33^0
b) 3^0
c) 2.6^0
d) 4^0

167. To get three images of a single object the two plane mirrors should be inclined at
a) 30^0
b) 150^0
c) 90^0
d) 60^0

168. To a bird in air, a fish in water appears to be at 30 cm from the surface. If refractive index of water with respect to air is 4/3, the real distance of bird from the surface is
a) 30 cm
b) 50 cm
c) 40 cm
d) 60 cm

169. A ray of light passes through equilateral prism such that the angle of incident is equal to angle of emergence and each of these angles is equal to $\left(\frac{3}{4}\right)^{th}$ the angle of prism. The angle of deviation is
a) 20^0
b) 35^0
c) 40^0
d) 30^0

170. Absolute refractive indices of glass and water are $\frac{3}{2}$ and $\frac{4}{3}$. The ratio of velocities of light in glass and water will be
a) 4 : 3
b) 9 : 8

c) 8 : 9 d) 3 : 4

171. A convex lens 'A' of focal length 20 cm and a concave lens 'B' of focal length 5 cm are kept along the same axis with the distance 'd' between them. If a parallel beam of light falling on A leaves B as a parallel beam, then the magnitude of distance d (in cm) is
a) 15 b) 25
c) 30 d) 36

172. The length of the compound microscope is 14 cm .The magnifying power for relaxed eye is 25. If the focal length of eye lens is 5 cm, then the object distance for objective lens will be
a) 2.4 cm b) 2.1 cm
c) 1.5 cm d) 1.8 cm

173. Wavelength of light in vacuum is 5890Å, then its wavelength in glass ($\mu = 1.5$) will be
a) 9372Å b) 7932Å
c) 7548Å d) 3927Å

174. A convex lens of focal length $\frac{1}{3}$m forms a real, inverted image twice in size of the object. The distance of the object from the lens is
a) 0.5 m b) 0.166 m
c) 0.33 m d) 1 m

175. When light rays are incident on a prism at an angle of 45^0 , the minimum deviation is obtained. if refractive index of the material of prism is $\sqrt{2}$, then the angle of prism will be
a) 30^0 b) 75^0
c) 90^0 d) 60^0

176. An object is placed at a distance U from a simple microscope of focal length f. The angular magnification obtained depends
a) on f but not on U b) on U but not on f
c) on f as well as U d) Neither on f nor on U

177. In compound microscope, the focal length and aperture of the objective used is respectively
a) large and large b) large and small
c) short and large d) short and small

178. A glass slab has a critical angle of 30^0 When placed in air . what will be the critical angle when it is placed in liquid of refractive index 6/5?
a) 45^0 b) 37^0
c) 53^0 d) 60^0

179. A compound microscope has an objective and eyepiece as thin lenses of focal length 1 cm and 5 cm, respectively. The distance between the objective and the eyepiece is 20 cm. The distance at which the object must be placed in front of the objective, if the final image is located at 25 cm from the eyepiece, is numerically
a) (95/6) cm b) 5 cm
c) (95/89) cm d) (25/6) cm

180. An equi-convex lens has radius of curvature 'R', The refractive index of the material of the lens when numerical value of 'R' and focal length 'f' are same is
a) 1.25 b) 1.75
c) 2 d) 1.5

181. Two thin lenses have a combined power of +9 D. When they are separated by distance of 20 cm, then their equivalent power becomes $+\frac{27}{5}$ D. Their individual power (in diopter) are
a) 1, 8 b) 2, 7
c) 3, 6 d) 4, 5

182. Light travels in two media A and B with speeds 1.8×10^8 ms^{-1} and 2.4×10^8 ms^{-1}, respectively.Then, the critical angle between them is
a) $\sin^{-1}\left(\frac{2}{3}\right)$ b) $\tan^{-1}\left(\frac{3}{4}\right)$
c) $\tan^{-1}\left(\frac{2}{3}\right)$ d) $\sin^{-1}\left(\frac{3}{4}\right)$

183. A plano-convex lens is made of glass of refractive index 1.5 The radius of curvature of its convex surface is R. its focal length is
a) R/2 b) R
c) 2 R d) 1.5 R

184. A diver at a depth of 12 m in water $\left(\mu = \frac{4}{3}\right)$ sees the sky at a cone of semivertical angle
a) $\sin^{-1}\left(\frac{4}{3}\right)$ b) $\tan^{-1}\left(\frac{4}{3}\right)$
c) $\sin^{-1}\left(\frac{3}{4}\right)$ d) 90°

185. In the case of spherical mirrors, the images formed on the side of the object and images formed on the opposite side are respectively
a) Virtual and real b) Virtual and virtual
c) Real and real d) Real and virtual

186. A plano-convex lens fits exactly into a plano-concave lens. Their plane surfaces are parallel to each other. If the lenses are made of different materials of refractive indices μ_1 and μ_2 and R is the radius of curvature of the curved surface of the lenses, then focal length of the combination is
a) $\frac{R}{2(\mu_1 + \mu_2)}$ b) $\frac{R}{2(\mu_1 - \mu_2)}$

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

187. An object is clearly seen through an astronomical telescope of length 50 cm. The focal lengths of its objective and eyepiece respectively, can be

a) 45 cm and 5 cm b) -45 cm and -5 cm

c) 45 cm and -5 cm d) 5 cm and 45 cm

188. The refractive index of material of glass is $\sqrt{3}$. If the angle of minimum deviation is equal to the angle of prism, the angle of prism is $\left(\cos 30^0 = \frac{\sqrt{3}}{2} = \sin 60^0, \sin 30^0 = \frac{1}{2} = \cos 60^0\right)$

a) 60^0 b) 50^0

c) 30^0 d) 45^0

189. Rainbow is the phenomenon due to

a) Combined effect of reflection, refraction and dispersion of light b) Reflection only

c) Refraction only d) Dispersion only

190. A ray of light is incident on one face of an equilateral glass prism having refractive index $\sqrt{2}$. It produces the emergent ray which just grazes along the adjacent face. The value of angle of incidence is $\left(\sin 45^0 = \cos 45^0 = \frac{1}{\sqrt{2}}\right)$

a) $\sin^{-1}\left(\frac{1}{\sqrt{2}}\sin 15^0\right)$ b) $\sin^{-1}\left(\sqrt{2}\sin 30^0\right)$

c) $\sin^{-1}\left(\frac{1}{\sqrt{2}}\sin 45^0\right)$ d) $\sin^{-1}\left(\sqrt{2}\sin 15^0\right)$

191. To get three images of a single object, one should have two plane mirrors at an angle of

a) 30^0 b) 60^0

c) 90^0 d) 150^0

192. When light of wavelength λ is incident on an equilateral prism kept in its minimum deviation position, it is found that the angle of deviation equals the angle of the prism itself. The refractive index of the material of the prism for the wavelength λ, is

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

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

193. The focal length of concave lens is 30 cm. To form the image one-fifth of the size of object, object must be kept in front of the lens on its axis at a distance.

a) 180 cm b) 120 cm

c) 60 cm d) 90 cm

194. The optical path of a monochromatic light is same whether , if it goes through 4.0 cm of glass or 4.5 cm of water . if the refractive index of glass is 1.53, then the refractive index of the water is

a) 1.30 b) 1.36

c) 1.42 d) 1.46

195. Two thin lenses of focal lengths 20 cm and 25 cm are placed in contact. The effective power of the combination is

a) 9D b) 2D

c) 3D d) 7D

196. A ray of light travels from a denser medium to a rarer medium. The reflected and the refracted rays are perpendicular to each other. If 'r' and 'r_1' are the angle of reflection and refraction respectively and 'C' is the critical angle, then the angle of incidence is

a) $\cot^{-1}(\sin C)$ b) $\tan^{-1}(\sin C)$

c) $\sin^{-1}(\tan C)$ d) $\cos^{-1}(\tan C)$

197. A convex lens of focal length 'f' is placed in contact with a concave lens of the same focal length. The equivalent focal length of the combination is

a) Zero b) Infinity

c) f d) $\frac{f}{2}$

198. Which of the following is correct for the image formed by a plane mirror?

a) Always real b) Always virtual

c) Virtual and laterally inverted d) Real and laterally inverted

199. The real image which is exactly equal to the size of an object is to be obtained on a screen with the help of a convex lens of focal length 15 cm. For this, what must be the distance between the object and screen?

a) 15 cm b) 30 cm

c) 45 cm d) 60 cm

200. For a prism, 'A' is the angle of prism, 'δ' is the angle of deviation, μ is the refractive index of the material of a prism, the refractivity of the material of a prism is

a) $(\mu - 1)$ b) μ

c) $(1 - \mu)$ d) $(\mu + 1)$

201. A double convex lens of refractive index 1.5 designed to reduce spherical aberration has ratio of radius of curvatures $R_1 : R_2 = 1 : 6$. If a point object is kept 36 cm in front of this lens,

it produces its real image at 18 cm. The value of R_1 and R_2 respectively will be

a) 10 cm, 60 cm b) 5 cm, 30 cm
c) 7 cm, 42 cm d) 15 cm, 90 cm

202. A convex lens produces 4 times magnified erect image. If the focal length of the lens is 20 cm, magnitude of image distance is

a) 25 cm b) 45 cm
c) 60 cm d) 15 cm

203. How much water should be filled in a container of height 21 cm, so that it appears half filled to the observer when viewed from the top of the container? (Take, $\mu = 4/3$)

a) 8 cm b) 10.5 cm
c) 12 cm d) 14 cm

204. A biconvex lens ($R_1 = R_2 = 20$ cm) has focal length equal to focal length of concave mirror. The radius of curvature of concave mirror is R. I. of glass lens = 1.5.

a) −20 cm b) 40 cm
c) 20 cm d) −40 cm

205. An object is immersed in a fluid of refractive index 'μ'. In order that the object becomes invisible when observed from outside, it should

a) Behave as a perfect reflector
b) Have refractive index equal to one
c) Absorb all light falling on it
d) Have refractive index same as surrounding fluid, that is 'μ'

206. The critical angle is maximum when light travels from $\left(a^{\mu}w = \frac{4}{3}, a^{\mu}g = \frac{3}{2}\right)$

a) Air to water b) Glass to water
c) Glass to air d) Water to air

207. The radii of curvature of both the surfaces of a convex lens of focal length 'f' and focal power 'P' are equal. One of the surfaces is made plane by grinding. The new focal length and focal power of the lens is respectively

a) $\frac{1}{2}, 2$ b) $2f, \frac{P}{2}$
c) $\sqrt{\frac{2}{f}}, \sqrt{\frac{P}{2}}$ d) $\frac{2f}{3}, \frac{2}{3}P$

208. A symmetric double convex lens is cut in two equal parts by a plane perpendicular to the principal axis. If the power of the original lens is 4D, then the power of a cut lens will be

a) 2D b) 3D
c) 4D d) 5D

209. To obtain a magnified image at distance of distinct vision (DDV) using a simple microscope, the object should be placed

a) Slightly beyond the principal focus
b) At the principal focus
c) Between the principal focus and optical centre of the lens
d) At the distance of distinct vision

210. When a ray of light is refracted from one medium to another, then the wavelength changes from 6000 Å to 4000 Å. The critical angle for the interface will be

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

211. The refractive index of glass is 1.5 and that of water is 1.33. The critical angle for a ray of light going from glass to water is

a) $\sin^{-1}(9/8)$ b) $\sin^{-1}\left(\frac{8}{5}\right)$
c) $\sin^{-1}\left(\frac{5}{8}\right)$ d) $\sin^{-1}\left(\frac{8}{9}\right)$

212. If μ_j represents refractive index when a light ray 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) ${}_4\mu_2$

213. A ray of light is incident at an angle of incidence 'i' on one surface of a thin prism of small angle 'A'. The ray 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) $\frac{A}{2\mu}$ b) $\frac{A}{\mu}$
c) μA d) $\frac{\mu A}{2}$

214. The angle made by incident ray of light with the reflecting surface is called

a) glancing angle b) angle of incidence
c) angle of deviation d) angle of refraction

215. A light of wavelength 'λ_1' and velocity C_1 travels from the first medium of refractive index 'μ_1' into the second medium of refractive index 'μ_2'. The wavelength and velocity of light in the second medium is 'λ_2' and C_2 respectively. The refractive index of second medium with respect to first medium is given

by

a) $\frac{\mu_2}{\mu_1}$ b) $\frac{\lambda_2}{\lambda_1}$

c) $\frac{\mu_1}{\mu_2}$ d) $\frac{C_2}{C_1}$

216. A ray of light makes an angle of 10^0 with the horizontal above it and strikes a plane mirror which is inclined at an angle θ to the horizontal. The angle θ for which the reflected ray becomes vertical is

a) 50^0 b) 80^0

c) 100^0 d) 40^0

217. When lens of refractive index 'μ_1' is placed in liquid of refractive index 'μ_2', the lens looks to be disappeared only if

a) $\mu_1 = \mu_2$ b) $\mu_1 = \frac{2\mu_2}{3}$

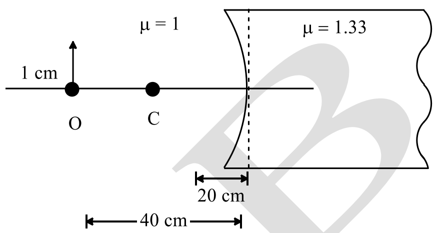
c) $\mu_1 = \frac{3\mu_2}{2}$ d) $2\mu_1 = \mu_2$

218. A ray of light is incident at an angle I on one face of prism of small angle A and emerges normally from the other surface if μ is the refractive index of the material of the prism, the angle of incidence is

a) $\frac{A}{2\mu}$ b) A μ

c) $\frac{A}{\mu}$ d) $\frac{A\mu}{2}$

219. For a optical arrangement shown in the figure, find the position and nature of image.



a) 32 cm, inverted b) 0.6 cm, erect

c) 6 cm, inverted d) 0.5 cm erect

220. A ray of light is incident normally on a glass slab of thickness 5 cm and refractive index 1.6. The time taken to travel by a ray from source to surface of slab is same as to travel through glass slab. The distance of source from the surface is

a) 4 cm b) 8 cm

c) 12 cm d) 16 cm

221. Let 'μ_1' and 'μ_2' be the refractive indices of two media. 'v_1' and 'v_2' are the velocities of light in the media respectively. Which of the following relations is TRUE?

a) $\mu_2^2 v_1 = \mu_1^2 v_2$ b) $\mu_1 v_1 = \mu_2 v_2$

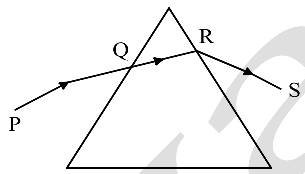
c) $\mu_2 v_1 = \mu_1 v_2$ d) $\mu_1 v_1^2 = \mu_2 v_2^2$

222. A lens of refractive index 'μ' has focal length 'f'. When the lens is immersed in a liquid of refractive index μ_0, its focal length become 'f_0'. Then

a) $f_0 = \frac{(\mu - \mu_0)}{\mu_0 f(\mu - 1)}$ b) $f_0 = \frac{\mu(\mu_0 - 1)}{(\mu_0 - \mu)}$

c) $f_0 = \frac{\mu_0(\mu - 1)f}{(\mu - \mu_0)}$ d) $f_0 = \frac{(\mu_0 - \mu)}{\mu(\mu_0 - \mu)}$

223. 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

224. A ray of light travels from air to water to glass and again from glass to air. Refractive index of water w.r.t. air is 'X', glass w.r.t. water is 'Y' and air w.r.t. glass is 'Z'. Which one of the following is correct?

a) YZ = X b) XYZ = 1

c) XY = Z d) XZ = Y

225. Focal length of a convex lens will be maximum for

a) Blue light b) Yellow light

c) Violet light d) Red light

226. In vacuum, light takes time 't' to travel a distance 'd' and it takes time 'T' to travel a distance '5d' in a denser medium. The critical angle of the given pair of media is

a) $\sin^{-1}\left(\frac{t}{T}\right)$ b) $\sin^{-1}\left(\frac{3t}{T}\right)$

c) $\sin^{-1}\left(\frac{2t}{T}\right)$ d) $\sin^{-1}\left(\frac{5t}{T}\right)$

227. Two thin lenses of focal lengths f_1 and f_2 are in contact and co-axial. Ti.e combination is equivalent to a single lens of power

a) $f_1 + f_2$ b) $\frac{f_1 f_2}{f_1 + f_2}$

c) $\frac{1}{2}(f_1 + f_2)$ d) $\frac{f_1 + f_2}{f_1 f_2}$

228. The angle of minimum deviation produced by a thin glass prism in air is 'δ'. If that prism is immersed in water, the angle of minimum deviation will be (${}_a\mu_g$ = refractive index of

glass w.r.t. air, ${}_a\mu_w$ = refractive index of water w.r.t. air)

a) $\delta\left[\frac{({}_a\mu_g - {}_a\mu_w)}{{}_a\mu_w({}_a\mu_g + 1)}\right]$
b) $\delta\left[\frac{({}_a\mu_g - {}_a\mu_w)}{{}_a\mu_w({}_a\mu_g - 1)}\right]$
c) $\delta\left[\frac{({}_a\mu_w - {}_a\mu_g)}{{}_a\mu_w({}_a\mu_g - 1)}\right]$
d) $\delta\left[\frac{({}_a\mu_w - {}_a\mu_g)}{{}_a\mu_w \times {}_a\mu_g}\right]$

229. For convex mirrors, whatever may be the position of the object, the image formed is always on the

a) Opposite side, virtual, erect, diminished
b) Opposite side, real, erect, magnified
c) Same side, virtual, erect, diminished
d) Same side, real, inverted, magnified

230. The size of the image formed by a convex lens of focal length 'f', is half the size of the object. The distance of the object from the lens is

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

231. What is the magnifying power of a simple microscope of focal length 5 cm, if the image is formed at the distance of distinct vision?

a) 4
b) 6
c) 5
d) 7

232. When a ray is refracted from one medium to another, then the wavelength changes from 6000Å to 4000Å. 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) $\cos^{-1}\left(\frac{2}{\sqrt{3}}\right)$

233. When a light ray is incident on a prism at an angle of 45^0, the minimum deviation is obtained. If refractive index of material of prism is $\sqrt{2}$, then angle of prism will be

$\sin\frac{\pi}{4} = \frac{1}{\sqrt{2}}, \sin 30^0 = \cos 60^0 = \frac{1}{2}$

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

234. A glass prism A deviates red and blue rays through 10^0 and 12^0 respectively. A second prism B deviates them through 8^0 and 10^0 respectively. The ratio of their dispersive powers is

a) $\frac{7}{9}$
b) $\frac{2}{9}$
c) $\frac{2}{11}$
d) $\frac{9}{11}$

235. A plano-convex lens of curvature of 30 cm and refractive index 1.5 produces a real image of an object kept 90 cm from it. What is the magnification?

a) 4
b) 0.5
c) 1.5
d) 2

236. A convex lens of focal length f is placed in contact with a concave lens of the same length .The equivalent focal length of the combination is

a) f
b) infinity
c) $\frac{f}{2}$
d) zero

237. A particle executes linear S.H.M. along the principal axis of convex lens of focal length 8 cm. The mean position of oscillation is at 14 cm from the lens with amplitude 1 cm. The amplitude of oscillating image of the particle in nearly.

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

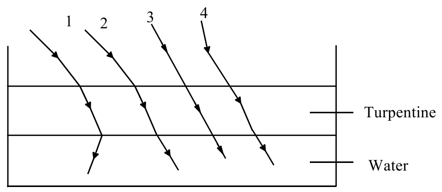
238. A convex lens of focal length 1.0 m and a concave lens of focal length 0.25 m are 0.75 m apart. A parallel beam of light is incident in the convex lens, the beam emerging after refraction from both lenses is

a) parallel to principal axis
b) convergent
c) divergent
d) None of these

239. For an angle of incidence θ on an equilateral prism of refractive index $\sqrt{3}$, the say refracted is parallel to the base inside the prism . The value of θ is

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

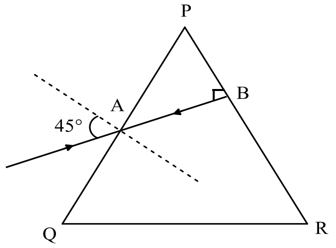
240. The optical density of turpentine is higher than that of water while its mass-density is lower. Figure shows a layer of turpentine floating over water in a container. For which one of the four rays incident on turpentine in figure, the path shown is correct?



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

241. The face PR of a prism PQR of angle 30^0 is silvered. A ray is incident on face PQ at an angle of 45^0 as shown in figure. The refracted ray undergoes reflection on face PR and

retraces its path. The refractive index of the prism is



a) $\sqrt{2}$ b) $3/\sqrt{2}$
c) 1.5 d) 1.33

242. The brilliance of diamonds is due to
a) Dispersion of light b) Polarization of light
c) Refraction of light d) Total internal reflection of light

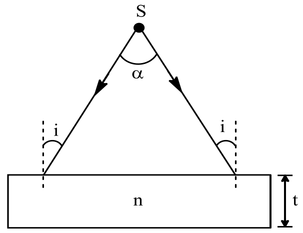
243. The refractive index of glass is 3/2 and that of water is 4/3. The critical angle for a ray of light going from glass to water is
a) $\sin^{-1}\left(\frac{4}{7}\right)$ b) $\sin^{-1}\left(\frac{2}{3}\right)$
c) $\sin^{-1}\left(\frac{5}{8}\right)$ d) $\sin^{-1}\left(\frac{8}{9}\right)$

244. Refractive index of the medium is μ and wavelength is λ, then which of the following proportionality relation is correct?
a) $\mu \propto \lambda^2$ b) $\mu \propto \frac{1}{\lambda}$
c) $\mu \propto \lambda$ d) $\mu \propto \frac{1}{\lambda^2}$

245. A prism having refractive index 1.414 and refracting angle 30^0 has one of the refracting surfaces silvered. A beam of light incident on the other refracting surface will retrace its path, if the angle of incidence is
a) 0^0 b) 30^0
c) 60^0 d) 45^0

246. Which one of the following statements is NOT the property of light?
a) Light requires material medium for propagation b) Light has finite speed
c) Light can travel through vacuum d) Light involves transportation of energy

247. A diverging beam of light from a point source S having divergence angle ∝, falls symmetrically on a glass slab as shown in figure . 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) ∝
c) $\sin^{-1}\frac{1}{n}$ d) $2\sin^{-1}\left(\frac{1}{n}\right)$

248. 'Circle of least confusion' refers to which one of the following defects occurring in images formed by mirrors or lenses?
a) Distortion b) Coma
c) Astigmatism d) Spherical aberration

249. Dispersive power depends upon
a) the angle of prism b) material of prism
c) deviation produced by prism d) height of the prism

250. The radius of curvature of the curved surface of a plano-convex lens is 20 cm. If the refractive index of the material of the lens be 1.5,it will
a) act as a convex lens only for the objects that lie on its curved side b) act as a concave lens for the objects that lie on its curved side
c) act as a convex lens irrespective of the side on which the object lies d) act as a concave lens lens irrespective of side on which the object lies

251. An equi-convex lens has radius of curvature R. The refractive index of the material of the lens when numerical value of R and focal length F are same is
a) 1.75 b) 2
c) 1.25 d) 1.5

252. Two beams of red and violet colours made to pass separately through a prism ($A = 60^0$). In the minimum deviation position, the angle of refraction inside the prism will be
a) greater for red colour b) equal but not 30^0 for both the colours
c) greater for violet colour d) 30^0 for both the colours

253. A ray incident at a point as an angle of incidence of 60^0 enters a glass sphere of refractive index $n = \sqrt{3}$ and is reflected and refracted further at the surface of the sphere. The angle between the reflected and refracted rays at this surface is
a) 50^0 b) 60^0

c) 90^0 d) 40^0

254. The magnifying power of simple microscope is inversely proportional to its focal length (f) and it is maximum when image is formed at D = Distance of distinct vision (DDV)

a) A distance less than DDV
b) Infinity
c) DDV
d) A distance greater than DDV

255. A convex lens A of focal length 20 cm and a concave lens B of focal length 56 cm are kept along the same axis with the distance d between them. If a parallel beam of light falling on A leaves B as a parallel beam ,then distance d (in cm), will be

a) 25
b) 36
c) 30
d) 50

256. A light travels through water in the beaker. The height of water column is 'h'. Refractive index of water is 'μ_w'. If c is velocity of light in air, the time taken by light to travel through water will be

a) $\frac{h}{\mu_w c}$
b) $\frac{hc}{\mu_w}$
c) $h\mu_w c$
d) $\frac{\mu_w h}{c}$

257. Glass has refractive index μ with respect to air and the critical angle for a ray of light going from glass to air is θ . if a ray of light is incident from air on the glass with angle of incidence θ , Corresponding angle of refraction is

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

258. Three immiscible transparent liquids with refractive indices 3/2, 4/3 and 6/5 are arranged one on top of another. The depths of the liquids are 3 cm, 4 cm and 6 cm, respectively. The apparent depth of the vessel is

a) 10 cm
b) 9 cm
c) 8 cm
d) 7 cm

259. A thin prism is first placed in air and then surrounded by water. The ratio of deviations produced by it in two cases is (air and water) (Refractive index $a^{\mu}g = \frac{3}{2}, a^{\mu}w = \frac{4}{3}$)

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

N.B.Navale

Date : 28.03.2025
Time : 03:53:06
Marks : 259

TEST ID: 42
PHYSICS

OPTICS

: ANSWER KEY :

1)	d	2)	a	3)	d	4)	b	133)	a	134)	b	135)	c	136)	c
5)	b	6)	b	7)	d	8)	b	137)	c	138)	d	139)	a	140)	b
9)	b	10)	d	11)	b	12)	d	141)	c	142)	a	143)	c	144)	c
13)	c	14)	d	15)	d	16)	d	145)	b	146)	c	147)	a	148)	a
17)	a	18)	c	19)	b	20)	d	149)	d	150)	b	151)	b	152)	d
21)	a	22)	d	23)	d	24)	d	153)	c	154)	b	155)	c	156)	d
25)	b	26)	b	27)	d	28)	a	157)	a	158)	d	159)	c	160)	a
29)	c	30)	a	31)	a	32)	b	161)	b	162)	b	163)	a	164)	d
33)	a	34)	a	35)	a	36)	a	165)	b	166)	b	167)	c	168)	c
37)	a	38)	a	39)	d	40)	c	169)	d	170)	c	171)	a	172)	d
41)	d	42)	b	43)	a	44)	d	173)	d	174)	a	175)	d	176)	a
45)	a	46)	b	47)	a	48)	b	177)	b	178)	b	179)	c	180)	d
49)	c	50)	a	51)	a	52)	c	181)	c	182)	d	183)	c	184)	c
53)	b	54)	a	55)	d	56)	a	185)	d	186)	c	187)	a	188)	a
57)	c	58)	b	59)	b	60)	a	189)	a	190)	d	191)	c	192)	a
61)	c	62)	c	63)	c	64)	c	193)	b	194)	b	195)	a	196)	b
65)	a	66)	c	67)	b	68)	a	197)	b	198)	b	199)	b	200)	a
69)	b	70)	d	71)	a	72)	a	201)	c	202)	c	203)	d	204)	d
73)	a	74)	b	75)	b	76)	b	205)	d	206)	b	207)	b	208)	a
77)	b	78)	b	79)	b	80)	a	209)	c	210)	a	211)	d	212)	c
81)	a	82)	c	83)	a	84)	b	213)	c	214)	a	215)	a	216)	d
85)	c	86)	a	87)	a	88)	a	217)	a	218)	b	219)	b	220)	b
89)	b	90)	a	91)	d	92)	d	221)	b	222)	c	223)	b	224)	b
93)	c	94)	d	95)	d	96)	c	225)	d	226)	d	227)	d	228)	b
97)	a	98)	d	99)	a	100)	d	229)	a	230)	c	231)	b	232)	c
101)	a	102)	a	103)	b	104)	a	233)	d	234)	d	235)	d	236)	b
105)	a	106)	b	107)	b	108)	c	237)	d	238)	a	239)	c	240)	b
109)	b	110)	c	111)	a	112)	d	241)	a	242)	d	243)	d	244)	b
113)	a	114)	d	115)	d	116)	d	245)	d	246)	a	247)	b	248)	d
117)	a	118)	c	119)	c	120)	b	249)	b	250)	c	251)	d	252)	d
121)	b	122)	d	123)	b	124)	d	253)	c	254)	c	255)	b	256)	d
125)	d	126)	d	127)	b	128)	c	257)	b	258)	a	259)	c		
129)	c	130)	d	131)	a	132)	c								

N.B.Navale

Date : 28.03.2025 **TEST ID: 42**
Time : 03:53:06 **PHYSICS**
Marks : 259

OPTICS

: HINTS AND SOLUTIONS :

Single Correct Answer Type

1 **(d)**

From Snell's law,

$\mu_i \sin i = \mu_r \sin r$

Where, refractive index of glass is μ_i, angle of incidence is i, refractive index of air is μ_r and angle of refraction is r.

Here, $\mu_i = \sqrt{2}, i = 45°$ and $\mu_r = 1$

$\Rightarrow (\sqrt{2}) \sin 45° = (1) \sin r$

$(\sqrt{2})\left(\frac{1}{\sqrt{2}}\right) = \sin r$

$\Rightarrow \sin r = 1 = \sin 90°$

$r = 90°$

2 **(a)**

Image formed is real, inverted and same in size because object is at the centre of curvature of the mirror.

3 **(d)**

An optical fiber essentially consists of thin transparent flexible core of material of refractive index 'μ_1' surrounded by flexible cover called cladding with refractive index 'μ_2'. Then μ_2 is slightly less than μ_1. This is necessary for total internal reflection to take place.

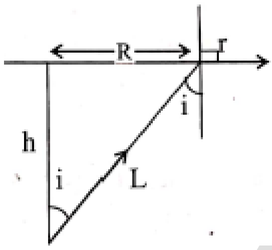
4 **(b)**

If reflected and refracted rays are perpendicular thentan $i = \mu$

Also $\mu = \frac{1}{\sin C}$ or $\sin C = \frac{1}{\mu} = \frac{1}{\tan i} = \cot i$

$\therefore C = \sin^{-1}(\cot i) = \sin^{-1}(\cot r) \quad [\because i = r]$

5 **(b)**



$\sin i = \frac{R}{L} = \frac{R}{\sqrt{R^2 + h^2}}$

Also $\sin i = \frac{1}{\mu}$

$\therefore \frac{1}{\mu} = \frac{R}{\sqrt{R^2 + h^2}}$

$\Longrightarrow \therefore \frac{1}{\mu^2} = \frac{R^2}{R^2 + h^2}$

$\therefore \mu^2 R^2 = R^2 + h^2$

$\therefore R^2(\mu^2 - 1) = h^2$

$\therefore R^2 = \frac{h^2}{\mu^2 - 1}$

Area $= \pi R^2 = \pi \frac{h^2}{(\mu^2 - 1)}$

6 **(b)**

Size of image formed by a plane mirror is same as that of the object. Hence , its magnification will be 1.

7 **(d)**

$A = f_1 + f_2$ but $r_2 = 0$ since is incident normally on the second surface.

$\therefore r_1 = A = 30^0$

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

$\therefore \sqrt{2} = \frac{\sin i}{\sin 30^0}$

$\therefore \sin i = \sqrt{2} \sin 30^0 = \sqrt{2} \times \frac{1}{2} = \frac{1}{\sqrt{2}}$

$\therefore i = \sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$

8 **(b)**

$$\text{Refractive index} = \frac{\text{Real depth}}{\text{Apparent depth}}$$

Let the real distance of the bubble from one side be x and the other side be y. Then the thickness of the glass slab is $(x + y)$

$$\frac{x}{5} = 1.5$$

$$\therefore x = 7.5 \text{ cm}$$

$$\frac{y}{2} = 1.5$$

$$\therefore y = 3 \text{ cm}$$

$$\therefore x + y = 7.5 + 3 = 10.5 \text{ cm}$$

9 **(b)**

If θ is the critical angle, then

$$n = \frac{1}{\sin\theta}$$

If θ is the angle of incidence is air and r is the angle of refraction then

$$\frac{\sin\theta}{\sin r} = n = \frac{1}{\sin\theta}$$

$$\therefore \sin r = \sin^2\theta = \frac{1}{n^2}$$

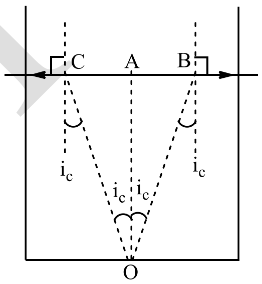
$$\therefore r = \sin^{-1}\left(\frac{1}{n^2}\right)$$

10 **(d)**

Let the bulb is placed at point O,

AB = AC = r

If the light falls at an angle of incidence equal to critical angle i_c, then only a circular area is formed because if angle of incidence is less than the critical angle, it will refract into air and when angle of incidence is greater refract into air and when angle of incidence is greater than critical angle , then it will be reflected back in water.



The source of light is 80 cm below the surface of water,

i.e. AO=80 cm,$\mu_w = 1.33$

Using the formula for critical angle,$\sin i_c = \frac{1}{\mu_w}$

$$\sin i_c = \frac{1}{1.33} = 0.75$$

$$\Rightarrow i_c = 48.6^0$$

In Δ OAB, $\tan i_c = \frac{AB}{AO}$

$$\Rightarrow \tan i_c = \frac{r}{l} \Rightarrow r = l\tan i_c = 80 \tan 48.6$$

$\Rightarrow$ r=80× 1.1345=90.7 cm

Area of circular surface of water through which light will emerge,

$$A = \pi^2$$

$$A = 3.14 \times (90.7)^2 = 25865.36 \text{ cm}^2$$

$$A = 2.6 \text{ m}^2$$

11 **(b)**

$$X = \frac{\vartheta_a}{\vartheta_w}, Y = \frac{\vartheta_w}{\vartheta_g}; Z = \frac{\vartheta_g}{\vartheta_a}$$

$$\therefore XYZ = 1$$

12 **(d)**

$${}_B\mu_A = \frac{v_B}{v_A} = \frac{1}{\sin\theta}$$

13 **(c)**

We have, $\sin i > \sin\theta_C$

$$\therefore \sin 45^0 > \frac{1}{n} \text{ or } \frac{1}{\sqrt{2}} > \frac{1}{n}$$

$$\therefore n > \sqrt{2} \text{ or } n > 1.414$$

14 **(d)**

In a convex lens when the object is at 2f its image is formed at 2f on the other side. The distance between the object and image is 4f, which is minimum.

If the object distance is reduced, then object is between 2f and f and image is between 2f and infinity. Thus the distance between object and image will be greater. Similarly when the object is between 2f and infinity, image is between 2f and f.

15 **(d)**

If x is the real depth from one side, then

$\frac{x}{5} = 1.5$

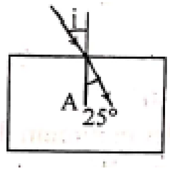
$\therefore x = 1.5 \times 5 = 7.5$ cm

If y is the real depth from the other side, then

$\frac{y}{3} = 1.5$

$\therefore y = 1.5 \times 3 = 4.5$ cm

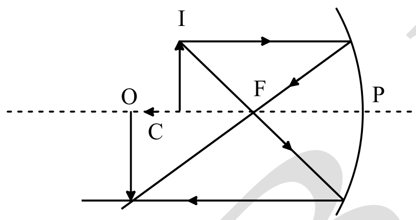
16 **(d)**



$r_A = 25^0, r_B = 30^0, r_C = 35^0, r_D = 40^0$

Since angle of refraction is lowest in medium A, means bending of light is highest. So the speed of light will be least in medium A.

17 **(a)**
When object is placed between centre of curvature and focus (i.e.f<u<2f), then image will be beyond the centre of curvature real, inverted and large in size.



18 **(c)**
$f_0 + f_e = 10$

$\frac{f_0}{f_e} = 4$

$\therefore f_0 = 4f_e$

$5f_e = 10$

$\therefore f_e = 2 - f_0 = 8$

So, L_4 and L_1 were used

19 **(b)**
In each case, there is a combination of two plano-convex lenses placed close to each other. Focal length of combination $\frac{1}{F} = \frac{1}{f} + \frac{1}{f}$ is same in all cases, so ration of focal length in three cases is 1: 1 : 1.

20 **(d)**
Focal length of lens is independent of wavelength.

21 **(a)**
$\mu_w = \frac{4}{3}, \mu_g = \frac{3}{2}$

$\therefore {}_w\mu_g = \frac{9}{8}$

${}_w\mu_g = \frac{\lambda_w}{\lambda_g}$

$\therefore \lambda_g = \frac{\lambda_w}{{}_w\mu_g} = \frac{5400 \times 8}{9} = 4800$ Å

22 **(d)**
$\mu = 1.5$

$R_1 = R_2$

$f = 20$ cm $= 0.2$m

$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{0.2} = 0.55 \times \frac{2}{R}$

$\therefore R = 0.55 \times 2 \times 0.2 = 0.22$ m $= 22$ cm

23 **(d)**
According to Snell's law

Reflected and refracted rays are perpendicular. If r' is the angle of reflection and r is the angle of refraction then $r + r' = 90^0$

$\therefore r + i = 90$

$\Rightarrow \therefore r = 90 - i$

$\therefore \sin r = \sin(90 - i) = \cos i$

$\therefore n = \frac{\sin i}{\cos i} = \tan i$

24 **(d)**
$\mu_g = 1.5, \mu_w = \frac{4}{3}$

$\therefore {}_w\mu_g = \frac{1.5 \times 3}{4} = \frac{9}{8}$

$\delta = A(\mu_g - 1),$

$$\delta' = A\left({}_{w}\mu_g - 1\right)$$

$$\frac{\delta'}{\delta} = \frac{{}_{w}\mu_g - 1}{\mu_g - 1} = \frac{\left(\frac{9}{8} - 1\right)}{(1.5 - 1)}$$

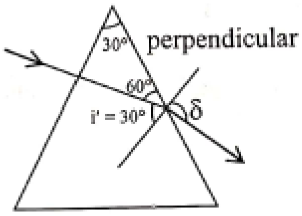
$$= \frac{1}{8 \times 0.5} = \frac{1}{4}$$

$$\therefore \delta' = \frac{\delta}{4}$$

26 **(b)**

$A = 30^0, i = 0^0$

Angle of incidence i' on the second surface of the prism in equal to 30^0



$$\frac{\sin e}{\sin 30^0} = 1.5$$

$$\sin e = 1.5 \times \sin 30^0$$

$$= 1.5 \times 0.5 = 0.75$$

$$\therefore e = 48.6^0$$

We have for a prism: $i + e = A + \delta$

$$\therefore \delta = i + e - A = 0 + 48.6 - 30 = 18.6^0$$

27 **(d)**

According to given sitution, $\mu_1 = \frac{c}{v_1}$

and $\mu_2 = \frac{c}{v_2}$

From Eqs. (i) and (ii), we have,

$$\frac{\mu_1}{\mu_2} = \frac{\frac{c}{v_1}}{\frac{c}{v_2}}$$

$$\frac{\mu_1}{\mu_2} = \frac{v_2}{v_1} \Rightarrow \mu_1 v_1 = \mu_2 v_2$$

28 **(a)**

$\delta_1 = A(\mu - 1), \delta_2 = A(\mu' - 1)$

$$\mu' = \frac{{}_{a}\mu_g}{{}_{a}\mu_w} = \frac{\frac{3}{2}}{\frac{4}{3}} = \frac{9}{8}$$

$$\frac{\delta_2}{\delta_1} = \frac{\mu' - 1}{\mu' - 1} = \frac{\frac{9}{8} - 1}{\frac{3}{2} - 1} = \frac{\frac{1}{8}}{\frac{1}{2}} = \frac{1}{4}$$

$$\therefore \delta_2 = \frac{\delta_1}{4}$$

29 **(c)**

$$\mu_d = \frac{V_a}{V_d}$$

$$\therefore V_d = \frac{V_a}{\mu_d}$$

similarly $V_g = \frac{V_a}{\mu_d}$ and $V_w = \frac{V_a}{\mu_w}$

Velocities are inversely proportional to the refractive indices.

$\therefore V_d < V_g < V_w$

30 **(a)**

$$\frac{1}{f_1} = (\mu_1 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{\mu_1 - 1}{R}$$

$$\frac{1}{f_2} = (\mu_2 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{\mu_2 - 1}{-R}$$

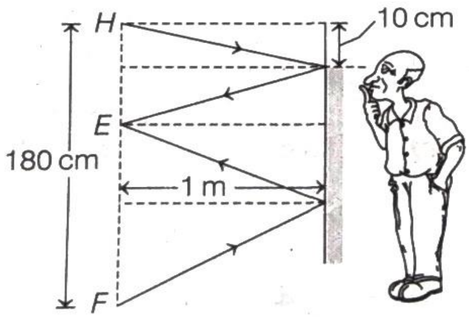
$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{\mu_1 - 1}{R} - \frac{\mu_2 - 1}{R}$$

$$= \frac{1}{R}[\mu_1 - 1 - \mu_2 + 1]$$

$$= \frac{\mu_1 - \mu_2}{R}$$

32 **(b)**

According to ray diagram shown in figure



Length of mirror $= \frac{1}{2}\ (10 + 170) = 90$ cm

33 **(a)**

Focal length of the combination, $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$

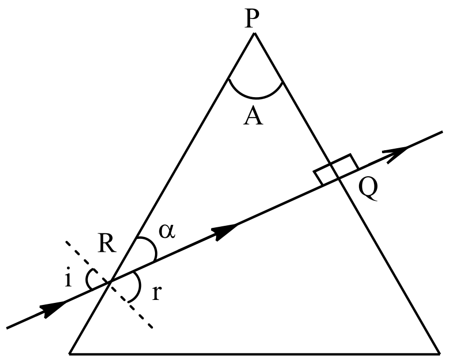
$\Rightarrow \frac{1}{F} = \frac{1}{(+40)} + \frac{1}{(-25)}$

$\Rightarrow F = -\frac{200}{3}$ cm

As, power, $P = \frac{100}{F} = \frac{100}{(-\frac{200}{3})} = -1.5$ D

34 **(a)**

Consider the figure shown below



In ΔPQR, $\alpha = 180^\circ - 90^\circ - A$

$\Rightarrow \alpha = 90^\circ - A$

Also, $r + \alpha = 90^\circ$

$\Rightarrow r = 90^\circ - \alpha = 90^\circ - 90^\circ + A$

or $r = A$

Using Snell's law, $\mu_1 \sin i = \mu_2 \sin r$

$1 \times \sin i = n \sin A$(given, $\mu_2 = n$ for glass prism)

$\Rightarrow \sin i = n \sin A$

For small angle, $\sin i \simeq i$ and $\sin A \simeq A$

$\therefore i = nA$

35 **(a)**

Net apparent depth is the sum of individual apparent depth due to each layer.

$$d\left[\frac{1}{\mu_1} + \frac{1}{\mu_2}\right]$$

36 **(a)**

For total internal reflection at AC face,

$$\sin i \geq \frac{\mu_w}{\mu_g}$$

$$\sin \theta \geq \frac{4}{3 \times 1.5}$$

$$\sin \theta \geq \frac{8}{9}$$

37 **(a)**

$$\frac{1}{f} = P = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

When placed in liquid the power is given by

$$P' = (\mu' - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

where $\mu' = \frac{\mu}{\mu_l} = \frac{3}{2 \times 2} = \frac{3}{4}$

$$\frac{P'}{P} = \frac{\mu' - 1}{\mu - 1} = \frac{\frac{3}{4} - 1}{\frac{3}{2} - 1} = \frac{-\frac{1}{4}}{\frac{1}{2}} = -\frac{1}{2}$$

$$\therefore P' = -\frac{1}{2} \times P = -\frac{1}{2} \times 2.5 = -1.25 \text{ D}$$

38 **(a)**

We have, $\mu_1 = 1.20 + \frac{0.8 \times 10^{-14}}{(400 \times 10^{-9})^2}$

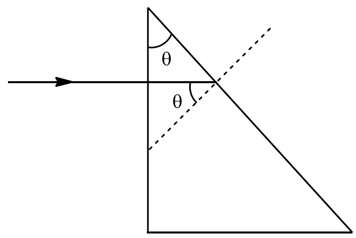
or $\mu_1 = 1.20 + \frac{0.8 \times 10^{-14}}{400 \times 400 \times 10^{-18}}$

or $\mu_1 = 1.20 + \frac{0.8}{16}$ or $\mu_1 = 1.20 + 0.05$

or $\mu_1 = 1.25$

$\because \sin i_c = \frac{1}{1.25} = 0.8 \Rightarrow i_c = 53.13^\circ$

Again, $\mu_2 = 1.20 + \frac{0.8 \times 10^{-14}}{(500 \times 10^{-9})^2}$



or $\mu_2 = 1.20 + \frac{0.8}{25}$

or $\mu_2 = 1.20 + 0.32$

or $\mu_2 = 1.232$

$\because \sin i_c = \frac{1}{1.232} = 0.81$

$\Rightarrow i_c = \sin^{-1} 0.81 = 54.26^\circ$

Now, $\sin \theta = 0.8$ or $\theta = 53.13^\circ$

This angle is clearly greater than critical angle corresponding to wavelength 400 nm. So, light of 400 nm wavelength undergoes total internal reflection.

39 **(d)**
Power of an equi-convex lens of radius R and refractive index μ is given by

$$p = \frac{1}{f} = (\mu - 1)\left(\frac{1}{R} + \frac{1}{R}\right)$$

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

For $\mu = 1.5$ and $R = 5$ cm

$$P_1 = (1.5 - 1).\frac{2}{0.05} = \frac{0.5 \times 2}{0.05} = 20\text{ D}$$

For $R = 6$ cm

$$P_2 = (1.5 - 1)\frac{2}{0.06} = \frac{0.5 \times 2}{0.06} = 16.66\text{D}$$

$$P_1 - P_2 = 20 - 16.66 = 3.33\text{D}$$

40 **(c)**
Refractive index of the core w.r.t. the cladding is

$$\therefore \frac{1}{\sin C} = \frac{1.5}{1.42}$$

$$\therefore \sin C = \frac{1.42}{1.5}$$

$$\Rightarrow C = \sin^{-1}\left(\frac{1.42}{1.5}\right)$$

41 **(d)**
Size of the image is equal to the size of the object. Hence image distance will be equal to object distance. Also if object distance $u = 2f$, Image distance will be 2f.

$$\therefore u = v = d = 2f$$

$$\therefore u + v = 2d = 4f$$

$$\therefore f = \frac{d}{2}$$

42 **(b)**
$$X = \frac{V_a}{V_w}, Y = \frac{V_w}{V_g}, Z = \frac{V_g}{V_a}$$

$$\therefore XYZ = 1$$

43 **(a)**
$$\frac{v}{u} = (-n)$$

$$\therefore \frac{1}{F} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{v}{F} = 1 - \frac{v}{u} = 1 + n$$

$$\therefore v = F(1 + n)$$

44 **(d)**
The intermediate image formed by an objective lens of a compound microscope is real and magnified.

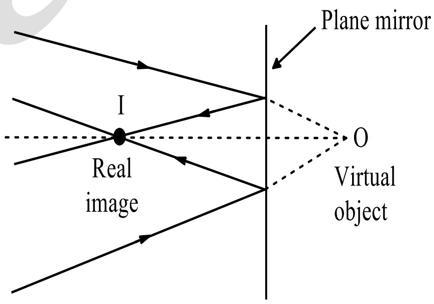
45 **(a)**
Using equation, the total apparent shift is

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

$$\text{or } s = 4\left(1 - \frac{1}{\frac{4}{3}}\right) + 6\left(1 - \frac{1}{\frac{3}{2}}\right) = 3.0\text{ cm}$$

Thus, $h = h_1 + h_2 - s = 4 + 6 - 3 = 7.0$ cm

46 **(b)**
When convergent beam incident on a pane mirror, then mirror forms real image, for a virtual object.



47 **(a)**
Angle of minimum deviation in prism,

$$\delta_m = (\mu - 1)A = (\mu - 1)(2r) \qquad (\because r = \frac{A}{2})$$

$$=(1.5-1)(2r)=0.5\times 2r=r$$

48 **(b)**
Note that image formation by a mirror does not depend on the medium. As, P is at a height h above the mirror, image of P will be at a depth h below the mirror. if d is depth of liquid in the tank, apparent depth of P,

$$x_1 = \frac{d - h}{\mu}$$

∴ Apparent distance between P and its image

$= x_2 - x_1 = \frac{d+h}{\mu} - \frac{d-h}{\mu} = \frac{2h}{\mu}$

49 **(c)**

We have, $\delta = i_1 + i_2 - A$

$45° = (i_1 + i_2) - 60°$

$\therefore\ i_1 + i_2 = 105°$

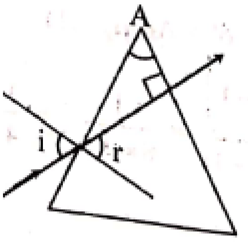
and $i_1 - i_2 = 20°$

On solving Eqs. (i) and (ii), we get $i_1 = 62.5°$ and $i_2 = 42.5°$

50 **(a)**

$_a\mu_g = \frac{c}{v} = \frac{\lambda_a v}{\lambda_g v} = \frac{\lambda_a}{\lambda_g}$

51 **(a)**



From the figure $A = r$

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

(Angles are small)

$\therefore i = An$

52 **(c)**

Magnifying power

$m = \frac{f_0}{f_e}$

If f_e is doubled, the magnifying power will become $m/2$

53 **(b)**

Given, $A = 60°$ and $\delta_m = 30°$

$\therefore$ Refractive index of prism, $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}}$

$= \frac{\sin 45°}{\sin 30°} = \sqrt{2}$

Hence, μ shou:ld be greater than equal to $\sqrt{2}$ for $\delta_m \geq 30°$.

54 **(a)**

For normal eye, the least distance of distinct vision is equal to 25 cm i.e. 0.25 m.

55 **(d)**

We know that, refractive index of crystal w.r.t. oil,

$\mu_{co} = \frac{\mu_0}{\mu_0} = \frac{\text{speed of light in oil}}{\text{speed of light in crystal}}$

where, 11_c = absolute refractive index of crystal w.r.t. vacuum

and u_0 = absolute refractive index of oil w.r.t. vacuum.

$H_{co} = \frac{1.68}{12} = \frac{7}{5} = \frac{\text{speed in oil}}{\text{speed in crystal}}$

Fractional change in velocity,
when light travel from oil to crystal

$= \frac{\text{speed in crystal}}{\text{speed in oil}} = \frac{5}{7}$

56 **(a)**

$_2\mu_1 \times {}_3\mu_2 \times {}_4\mu_3 = \frac{V_1}{V_2} \times \frac{V_2}{V_3} \times \frac{V_3}{V_4} = {}_1\mu_4$

57 **(c)**

$d = 2\text{ mm} = 2 \times 10^{-3}\text{ m}$

$\mu = 1.5 = \frac{c}{v}$

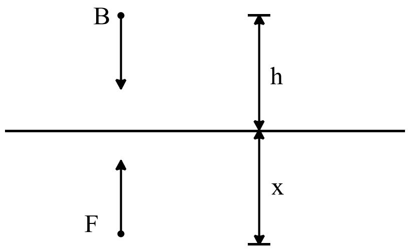
$\therefore v = \frac{c}{\mu} = \frac{3 \times 10^8}{1.5} = 2 \times 10^8\text{ m/s}$

$\therefore v = \frac{d}{t}$

$\therefore t = \frac{d}{v} = \frac{2 \times 10^{-3}}{2 \times 10^8} = 10^{-11}\text{ s}$

58 **(b)**

Fish is observer and bird is object.



Apparent distance between F and B at some instant will be

$y=(x+\mu h)$

$$\left(-\frac{dy}{dt}\right)=\left(-\frac{dx}{dt}\right)+(\mu)\left(-\frac{dh}{dt}\right)$$

$$9=3+\frac{4}{3}\left(-\frac{dh}{dt}\right)$$

$$-\frac{dh}{dt}=4.5\ m/s$$

59 **(b)**
Angle i at both focus will be 45°.
For TIR to take place,

$$i>\theta_C \text{ or } \sin i>\sin\theta_C$$

$$\therefore\ \frac{1}{\sqrt{2}}>\frac{1}{\mu} \text{ or } \mu>\sqrt{2}$$

60 **(a)**
On immersing a mirror in water, focal length of the mirror remains unchanged as medium does not affect the focal length of a mirror.

61 **(c)**
From a concave lens, image is always smaller in size Thus, m<1

62 **(c)**

$$t_g=4\text{ cm}$$

$$t_w=5\text{ cm}$$

$$\mu_g t_g=\mu_w t_w$$

$$\mu_w=\frac{\mu_g t_g}{t_w}$$

$$=\frac{\frac{5}{3}\times 4}{5}$$

$$=\frac{20}{15}=\frac{4}{5}=1.33$$

63 **(c)**

$$\frac{\mu_A}{\mu_B}={}_B\mu_A=\frac{V_B}{V_A}=\frac{2.7\times10^8}{1.8\times10^8}=\frac{3}{2}$$

$${}_B\mu_A=\frac{1}{\sin C}$$

$$\therefore\frac{3}{2}=\frac{1}{\sin C}$$

$$\therefore \sin C=\frac{2}{3}$$

$$\text{or } C=\sin^{-1}\frac{2}{3}$$

64 **(c)**

$$\mu=\frac{\sin i}{\sin r}=\frac{\sin i}{\sin(i-\delta)}$$

$$\frac{1}{\mu}=\frac{\sin(1-\delta)}{\sin i}=\frac{\sin i\cos\delta-\cos i\sin\delta}{\sin i}$$

$$=\cos\delta-\sin\delta\cot i$$

65 **(a)**
Distance from the surface of water,

$$h=\mu h=\frac{4}{3}\times 18=24\text{ m}$$

66 **(c)**
When an object is placed at 2f from a convex lens, its image is formed at 2f on the other side.

$$\therefore 2f=20\text{ cm}$$

$$\Longrightarrow\therefore f=10\text{ cm}$$

When the object is moved 5 cm towards the lens its distance from the lens becomes 15 cm.

$$\therefore u=-15\text{ cm}, f=10\text{ cm}$$

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

$$\text{or}\frac{1}{v}=\frac{1}{f}+\frac{1}{u}$$

$$=\frac{1}{10}+\frac{1}{-15}$$

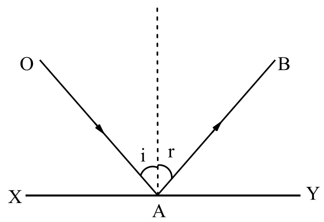
$$\Longrightarrow=\frac{1}{10}-\frac{1}{15}$$

$$=\frac{1}{30}$$

$$\Longrightarrow\therefore v=30\text{ cm}$$

Hence image moves 10 cm away from the lens.

67 **(b)**



Here, XY is a plane reflecting surface, OA and AB are the incident and reflected rays,

i = angle of incidence

and r = angle of reflection.

As, $AB \perp OA$

$\therefore I + r = 90^0$

Also, according to laws of reflection,

$r = i$

$\therefore i + I = 90^0$

$\Rightarrow 2i = 90^0$

$\Rightarrow I = \frac{90^0}{2} = 45^0$

69 **(b)**
Refractive index of glass with respect to water,

$$_w\mu_g = \frac{_a\mu_g}{_a\mu_w} = \frac{3/2}{4/3} = \frac{9}{8}$$

70 **(d)**
Focal length in air is given by

$$\frac{1}{f} = (n_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \ldots (1)$$

Focal length in liquid is given by

$$\frac{1}{f'} = (n' - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \ldots (2)$$

where $n' = \frac{n_g}{n_f} = \frac{3}{2} \times \frac{5}{9} = \frac{5}{6}$

Dividing Eq. (1) and (2),

$$\frac{f'}{f} = \frac{n_g - 1}{n' - 1} = \frac{\frac{3}{2} - 1}{\frac{5}{6} - 1} = \frac{\frac{1}{2}}{\frac{-1}{6}} = -3$$

$\therefore f' = -3f$

$= -3 \times 15 = -45$ cm

72 **(a)**
It acts as a plane sheet of glass then its focal power is zero. For biconvex lens,

$$\text{Focal power} = \frac{1}{f} = \left(\frac{\mu_g}{\mu_m} - 1\right)\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = 0$$

$$\therefore \frac{\mu_g}{\mu_m} - 1 = 0$$

$\therefore \mu_g = \mu_m$

73 **(a)**
Here, n= 1.5, as per sign convention followed

$R_1 = +20$ cm and $R_2 = -20$ cm

$\therefore \frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$= (1.5 - 1)\left[\frac{1}{(+20)} - \frac{1}{(-20)}\right]$$

$$0.5 \times \frac{2}{20} = \frac{1}{20}$$

$\Rightarrow f = +20$ cm

Incident rays travelling parallel to the axis of lens will converge at its second principal focus, hence L=+ 20 cm

74 **(b)**

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = (n-1)\left(\frac{1}{R} - \frac{1}{-R}\right)$$

$$\frac{1}{20} = (1.55 - 1)\left(\frac{2}{R}\right)$$

$$\therefore \frac{1}{20} = 0.55 \times \frac{2}{R}$$

$\therefore R = 20 \times 0.55 \times 2 = 22$ cm

75 **(b)**
For small angled prism $\delta_m = (\mu - 1)A$

$= \mu A - A$

Again $i + e = A + \delta_m$

Here $e = 0$

$\therefore i = A + \delta_m = A + \mu A - A = \mu A$

76 **(b)**
Focal length of a lens is given by

$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

If $\mu_2 - \mu_1$ then $\frac{1}{f} = 0$ or $f = \infty$

77 **(b)**
Angular magnification by a compound microscope

is given by

$M = m_0 M_e$

Where m_0 = magnification by objective and M_e = angular magnification by eyepiece

$$M_e = 1 + \frac{D}{f_e} = 1 + \frac{25}{2} = 1 + 5 = 6$$

$\Longrightarrow M = 24$

$$\therefore m_0 = \frac{M}{M_e} = \frac{24}{6} = 4$$

78 **(b)**
$\therefore$ Power of the lens$=\frac{1}{\text{Focal length}}$

Focal length of combination of convex and concave lenses is given by $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$

Where, f_1 and f_2 be the focal lengths of convex and concave lenses, respectively.

Now, $\frac{1}{F} = \frac{1}{0.4} + \frac{1}{(-0.25)}$

$\Rightarrow \frac{1}{F} = 1.5$

Power, P = -1.5 D $\left(\therefore P = \frac{1}{F}\right)$

79 **(b)**
For occurring total internal reflection, ray travels from denser medium to rarer medium and $i > i_c$.

80 **(a)**

$$\frac{f_1}{24} = \frac{1.5}{\frac{1.5}{\frac{9}{8}} - 1} = \frac{0.5}{\frac{1.5}{1.16} - 1} = \frac{0.5 \times 1.16}{0.34}$$

$$f_1 = 24 \times \frac{1}{2} \times \frac{1.16}{0.34} = \frac{12 \times 1.16}{0.34} = 40.94 \text{ cm}$$

81 **(a)**
Deviation of any in prism is given by

$\delta = i + e - A$

So, $e = \delta + A - I = 30 + 30^0 - 60^0 = 0^0$

So, emergent ray will be perpendicular to face or emergent ray will make an angle of 90^0 with the face through which it emerges.

82 **(c)**

Critical angle, $\sin C = \frac{n_2}{n_1} = \frac{\lambda_1}{\lambda_2}$

$\Rightarrow \sin C = \frac{3500}{7000} = \frac{1}{2}$

$\therefore C = 30^0$

83 **(a)**
Rays will converge to the focal point of the lens. Hence L = F.

$\mu = 1.5, R = 20 \text{ cm}, f = ?$

$R_1 = 20 \text{ cm}, R_2 = -20 \text{ cm}$

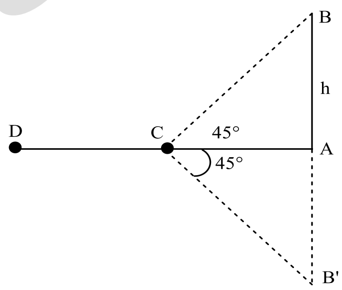
$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{20} - \frac{1}{-20}\right)$$

$$= 0.5 \times \frac{2}{20} = \frac{1}{20}$$

f = 20 cm

84 **(b)**
Given, AC=60 m and $<BCB = 90^0$



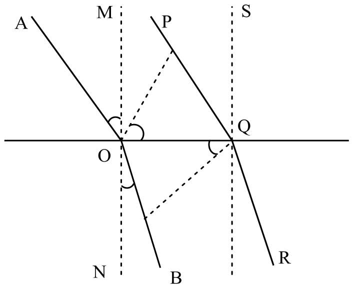
From the figure,

$$\therefore \text{Angle}, < BCA = \frac{< BCB}{2} = 45^0$$

We have, $\tan 45^0 = \frac{h}{AC}$

$\Rightarrow$ AC=h and AB=AC=60 m

85 **(c)**
From the figure, $AB = \frac{d}{\cos i} = \frac{d}{\cos r}$



$\therefore\ d' = \frac{\cos r}{\cos i} d = \sqrt{2} \cos r \cdot d$ ...(i)

Further, $\sin r = \frac{\sin i}{\mu} = \frac{1}{\sqrt{2}\mu}$

Hence, $\cos r = \sqrt{1 - \frac{1}{2\mu^2}} = \frac{\sqrt{2\mu^2 - 1}}{\sqrt{2}\mu}$

Substituting in Eq. (i), we get

$$d' = \frac{\sqrt{2\mu^2 - 1}}{\mu} \cdot d$$

86 **(a)**
For combination of one convex and one concave lens,

$$\frac{1}{F} = \frac{1}{f_1} - \frac{1}{f_2} \Rightarrow F = \frac{f_1 f_2}{f_2 - f_1}$$

if $f_1 > f_2$, then F will be negative.

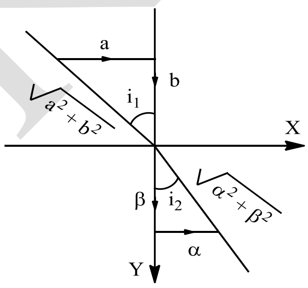
87 **(a)**

$$\frac{f_w}{f_a} = \frac{({}_a\mu_g - 1)}{({}_w\mu_g - 1)}$$

$$\Rightarrow \frac{f_w}{f_a} = \frac{(1.5 - 1)}{\left(\frac{1.5}{1.33} - 1\right)} = \frac{0.5}{0.17} \times 1.33$$

$$\Rightarrow\ f_w = \frac{50}{17} \times f_a = \frac{50}{17} \times 8 \times 1.33 \simeq 32 \text{ cm}$$

88 **(a)**
From the Snell's law $\mu_1 \sin i_1 = \mu_2 \sin i_2$



$\therefore \frac{\mu_1}{\sqrt{a^2+b^2}} = \frac{\mu_2 \propto}{\sqrt{\propto^2+\beta^2}}$

$\left(\therefore \sin\theta \frac{\text{height}}{\text{hypotenuse}}\right)$

$\left(\begin{matrix}\therefore = ai + bj \text{ and} \\ r_{B=\propto+\beta j \text{ are unit vectors}}\end{matrix}\right)$

$\sqrt{a^2 + b^2} = \sqrt{\propto^2 + \beta^2} = 1$

$\therefore \mu_1 a = \mu_2 \propto$

89 **(b)**
From Snell's law, $\mu \sin I$ = constant

$\mu_4 \sin x = \mu \sin i$

$\therefore \sin x = \frac{\mu}{\mu_4} \sin i$

90 **(a)**
Let x be the real depth when the apparent depth is 10 cm.

$\therefore \mu = \frac{x}{10}$

Let y be the real depth when the apparent depth is 6 cm.

$\therefore \mu = \frac{y}{6}$

$\therefore \frac{x}{10} = \frac{y}{6}$

$\therefore x = \frac{5}{3} y$

Also $x + y = 24$

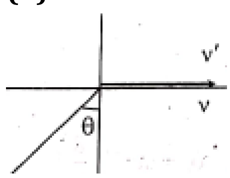
$\therefore \frac{5}{3} y + y = 24$

$\therefore \frac{8}{3} y = 24$

$\therefore y = 9$ cm

$\mu = \frac{y}{6} = \frac{9}{6} = 1.5$

91 **(d)**



$\mu = \frac{v'}{v}$

$\therefore \frac{1}{\mu} = \frac{v}{v'}$

$$\sin\theta = \left(\frac{1}{\mu}\right) = \frac{v}{v'}$$

$$\therefore v' = \frac{v}{\sin\theta}$$

92 **(d)**

For no deviation, $A_1(\mu_1 - 1) = A_2(\mu_2 - 1)$

$$\therefore 4(1.48 - 1) = A_2(1.64 - 1)$$

$$\therefore 4 \times 0.48 = A_2 \times 0.64$$

$$\therefore A_2 = \frac{4 \times 0.48}{0.64} = 4 \times \frac{3}{4} = 3^0$$

93 **(c)**

$$n = \frac{\sin i}{\sin r} = \frac{\sin 2r}{\sin r} = \frac{2 \sin r \cos r}{\sin r}$$

$$= 2\cos r$$

$$\therefore \cos r = \frac{n}{2} \text{ or } r = \cos^{-1}\frac{n}{2}$$

$$i = 2r = 2\cos^{-1}\frac{n}{2}$$

94 **(d)**

$$i = e = \frac{3A}{4}$$

$$i + e = A + \delta$$

$$\delta = i + e - A = 2i - A$$

$$= \frac{3A}{2} - A = \frac{A}{2} = 30^0$$

95 **(d)**

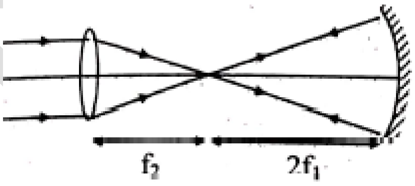
For a light ray to undergo total internal reflection, light must travel from denser to rarer medium and $i > i_c$

96 **(c)**

Magnifying power of a telescope

$$= \frac{f_0}{f_e}$$

97 **(a)**



The convex lens will form image at its focus, i.e. at a distance f_2 from it. If this image falls on the centre of curvature of the concave mirror, the rays falling on it will be normal to the mirror and retrace their path.

Hence, $d = 2f_1 + f_2$

98 **(d)**

Refractive index of prism, $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

Substituting $A = \delta_m$ and $\mu = 1.5$,

$$1.5 = \frac{\sin A}{\sin\left(\frac{A}{2}\right)}$$

$$\frac{1.5}{2} = \cos\frac{A}{2}$$

$$0.75 = \cos\frac{A}{2}$$

We get $A = 82°$.

99 **(a)**

$$\mu = \frac{\sin i}{\sin r} = \frac{i}{r_1}$$

If angles are small

$A = r_1 + r_2 = r_1$

Since $r_2 = 0$ since the ray emerges normally.

$$\therefore \mu = \frac{i}{A} \text{ or } i = \mu A$$

100 **(d)**

Focal length of the combination,

$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{60} + \frac{1}{(-20)} \Rightarrow F = -30$ cm

101 **(a)**

We have, $\sin\theta_c = \frac{1}{\mu}$

$$\therefore \mu = \frac{1}{\sin 30^0} = 2$$

The velocity of light, $V = \frac{C}{\mu} = \frac{3.0 \times 10^8}{2}$

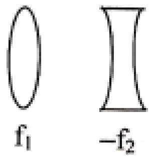
$= 1.5 \times 10^8$ m/s

102 **(a)**

$$\frac{f_1}{f_2} = \frac{2}{3}$$

$$f_1 = \frac{2}{3} f_2$$

$$\frac{1}{f} = \frac{1}{f_1} - \frac{1}{f_2} = \frac{f_2 - f_1}{f_1 f_2} = \frac{1}{30}$$



$$f_1 f_2 = 30(f_2 - f_1) = 30\left(f_2 - \frac{2}{3}f_2\right) = 30 \times \frac{1}{3}f_2$$
$$= 10f_2$$

$\therefore f_1 = 10$

$\therefore f_2 = \frac{3}{2}f_1 = \frac{3}{2} \times 10 = 15$ cm

For concave lens focal length is negative.

103 **(b)**

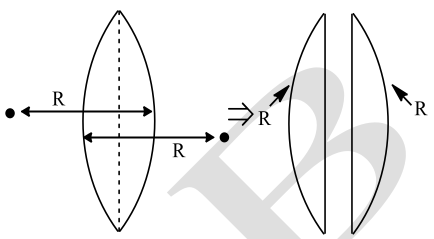
The lens maker's formula is given as — = $(\mu_{med} - 1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

Where, f=focal length of lens, $R_1 =$ radius of first curved part and $R_2 =$ radius of second curved part.

As, for equi-convex lens,$R_1 = R_2 = R$(say)

So, $\frac{1}{f} = (\mu_{real} - 1)\frac{2}{R}$ ... (i)

Now ,if lens is cut along the line perpendicular to the principal axis as shown in the figure



The new cut part of the lens has $R_1 = R$ and $R_2 = \infty$ Again by using the lens maker's formula, focal length of the new part of the lens,

$$\frac{1}{f'} = (\mu_{real} - 1)\left[\frac{1}{R} - \left(-\frac{1}{\infty}\right)\right]$$

$$\Rightarrow \frac{1}{f} = (\mu_{real} - 1)\left[\frac{1}{R}\right]$$

So, from Eqs. (i) and (ii), we get $f' = 2f$

104 **(a)**

${}_aX^w{}_wY^g{}_gZ^a = 1$

$\therefore XYZ = 1$

105 **(a)**

For a prism $A = r_1 + r_2$

Here $r_2 = 0$

$\therefore A = r_1$

Refractive index $n = \frac{\sin i}{\sin r_1} = \frac{i}{r_1} = \frac{i}{A}$

$\therefore i = An$

106 **(b)**

The magnifying power of the simple microscope is given by

$$\frac{M}{P}. = 1 + \frac{D}{f}$$

The focal length of red light is greater than that of blue light. Hence the magnifying power decreases.

107 **(b)**

Magnification,

$m = -\frac{1}{4}$

(Since the image is real and inverted, it is taken as negative)

$\therefore m = \frac{v}{u}$

$= -\frac{1}{4}$

$\therefore v = -\frac{u}{4}$

We have,

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$-\frac{4}{u} - \frac{1}{u} = \frac{1}{f}$

$-\frac{5}{u} = \frac{1}{f}$

$\therefore u = -5f$

108 **(c)**

We have, $\mu_g \sin\theta_c = \mu_1 \sin 90°$

or $\mu_g \sin\theta_c = 1$

When water is poured,

$\mu_w \sin r = \mu_s \sin \theta_c$

or $\mu_w \sin r = 1$

Again, $\mu_a \sin \theta = \mu_w \sin r$

or $\mu_a \sin \theta = 1$

or $\sin \theta = 1$

or $\theta = 90^\circ$

109 **(b)**
The condition for achromatism is

$\omega_1 P_1 + \omega_2 P_2 = 0$

$\omega_1 P_1 = -\omega_2 P_2$

$\Rightarrow \frac{\omega_1}{\omega_2} = -\frac{P_2}{P_1}$

Now, $P_1 + P_2 = 2D$

or $5 + P_2 = 2$ or $P_2 = -3D$

$\therefore \frac{\omega_1}{\omega_2} = -\frac{-3}{5} = \frac{3}{5}$(in magnitude)

110 **(c)**
Magnifying power $m = \frac{f_0}{f_e}$

If f_e is doubled, the magnifying power will become $m/2$

111 **(a)**
If C is the critical angle then

$\sin C = \frac{1}{1.5}$

$\therefore C = \sin^{-1}\left(\frac{1}{1.5}\right) = 41.8^0$

For a prism $A = r_1 + r_2$

For normal incidence $i = 0$

$\therefore r_1 = 0$

$\therefore r_2 = A = 60^0$

r_2 is the angle of incidence on the second surface of the prism.

Since $r_2 > C$, the ray will undergo total internal reflection at the second surface.

112 **(d)**
Under minimum deviation I = e = 30^0, So angle between emergent ray and second refracting surface is 90^0-30^0=60^0.

113 **(a)**
As, $A + \delta = i + e \Rightarrow 30^\circ + 30^\circ = 60^\circ + e$

Angle of emergence, $e = 60^\circ - 60^\circ = 0$

$r_1 = A = 30^\circ$

$\therefore$ Refractive index, $\mu = \frac{\sin i}{\sin r} = \frac{\sin 60^\circ}{\sin 30^\circ} = \sqrt{3} = 1.732$

114 **(d)**
Given, $I = e = \frac{3}{4} A = \frac{3}{4} \times 60^0 = 45^0$

In the position of minimum deviation, $2i = A + \delta_m$

or $\delta_m = 2i - A = 2 \times 45^0 - 60^0 = 30^0$

115 **(d)**
We have, $\theta = \frac{1}{2} \times \frac{\pi}{180}$ rad

As, $\frac{\text{diameter of image}}{\text{focal length}} = \theta$

or diameter of image$= \frac{1}{2} \times \frac{\pi}{180} \times \frac{15}{2} \times 100$ cm = 6.55 cm

116 **(d)**
Deviation by a plane mirror,

$\delta = 180^0 - 2\,\theta = 180^0 - 60^0 = 120^0$

118 **(c)**
In the first case θ is the critical angle

Hence

$\sin \theta = \frac{1}{\mu}$

In the second case $\frac{\sin \theta}{\sin r} = \mu$

$\therefore \sin r = \frac{\sin \theta}{\mu}$

$\therefore \sin r = \frac{1}{\mu^2}$

$\therefore r = \sin^{-1}\left(\frac{1}{\mu^2}\right)$

119 **(c)**

If wavelength in air are 480 nm and 672 nm, then wavelengths in a medium of refractive index 1.6 will be

$\dfrac{480}{1.6} = 300$ nm and

$\dfrac{672}{1.6} = 420$ nm

120 **(b)**

Refractive index, $\mu = \frac{\sin i}{\sin A/2}$

$\Rightarrow \sqrt{2} = \frac{\sin i}{\sin(\frac{60^0}{2})}$ or $\sqrt{2} \times \sin 30^0 = \sin i$

or $\sqrt{2} \times \frac{1}{2} = \sin i \Rightarrow \sin i = \frac{1}{\sqrt{2}} = \sin 45^0 \Rightarrow i = 45^0$

121 **(b)**

When final image is formed at D = 25 cm from eye.in this situation, v= -D from lens formula, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$,

We have $\frac{1}{-D} - \frac{1}{(-u)} = \frac{1}{f}$

i.e. $\frac{D}{u} = 1 + \frac{D}{f}$

So, magnifying power $= \frac{D}{u} = \left(1 + \frac{D}{f}\right)$

123 **(b)**

We know that,

$$\mu = \frac{\text{velocity of light in vacuum}}{\text{velocity of light in water}}$$

$$\frac{4}{3} = \frac{3 \times 10^{10}}{\text{velocity of light in water}}$$

Velocity of light in water $= 2.25 \times 10^{10} \text{cms}^{-1}$

Time taken $= \frac{500 \times 100}{2.25 \times 10^{10}} = 2.22 \times 10^{-6}$ s

Equivalent optical path = μ × Distance travelled in water

$= \dfrac{4}{3} \times 500 = 666.64$ m

124 **(d)**

Theory question

125 **(d)**

We have, P= (μ - 1) $\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$2.5 = \left(\frac{3}{2} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

P=$\left(\frac{3/2}{2} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

∴ P=-1.25 D

126 **(d)**

Size of the image is equal to the size of the object. Hence image distance will be equal to object distance. Also if object distance u = 2f, Image distance will be 2f.

$\therefore u = v = d = 2f$

$\therefore u + v = 2d = 4f$

$\therefore f = \dfrac{d}{2}$

127 **(b)**

Magnification by objective is given by

$$m = \frac{v_0}{u_0}$$

For objective lens we have

$$\therefore \frac{1}{v_0} - \frac{1}{u_0} = \frac{1}{f_0}$$

Multiplying by u_0 we get

$$\frac{u_0}{v_0} - 1 = \frac{u_0}{f}$$

$$\therefore \frac{u_0}{v_0} = 1 + \frac{u_0}{f_0} = \frac{f_0 + u_0}{f_0}$$

$$\therefore \frac{v_0}{u_0} = \frac{f_0}{f_0 + u_0}$$

128 **(c)**

$$\mu_g = 1.5 = \frac{3}{2}$$

$$\mu_w = 1.33 = \frac{4}{3}$$

$$\therefore {}_w\mu_g = \frac{\mu_g}{\mu_w} = \frac{3}{2} \times \frac{3}{4} = \frac{9}{8}$$

$$\sin C = \frac{1}{{}_w\mu_g} = \frac{8}{9}$$

$\therefore C = \sin^{-1}\left(\frac{8}{9}\right)$

129 **(c)**
When final image is formed at D. D. V. from eye, the magnifying power of a simple microscope is $1 + \frac{D}{f}$

130 **(d)**
Minimum distance $= 2f + 2f = 4f$

131 **(a)**
The image is real and hence inverted.

$$\therefore \frac{v}{u} = -n \text{ or } u = -\frac{v}{n}$$

By lens equation,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\therefore \frac{1}{v} + \frac{n}{v} = \frac{1}{f}$$

$$\therefore \frac{1+n}{v} = \frac{1}{f}$$

$$\therefore v = f(1+n)$$

133 **(a)**
Refractive index of the medium,

$$\mu\frac{c}{v} = \frac{c}{n\lambda} = \frac{3 \times 10^8}{4 \times 10^{14} \times 5 \times 10^{-7}} = 1.5$$

134 **(b)**
Angle of deviation of the light ray produced by prism is
i. $A(\mu - 1)$ ... (i)
where, δ = angie of deviation,
A = angle of prism
and μ = refractive index of the prism.
Given, $A = 3°, \delta = 1°$ and $= ?$
Substituting the given values in Eq. (i), we get

$$1 = 3(u - 1)$$

$$\mu = \frac{4}{3} = 1.33$$

Hence, the refractive index of the prism is 1.33.

135 **(c)**
Since θ is critical angle from glass to air, the refractive index of glass is

$$n = \frac{1}{\sin\theta}$$

When ray is incident at an angle θ in air, we have

$$n = \frac{\sin\theta}{\sin r} = \frac{1}{\sin\theta}$$

136 **(c)**

$$\frac{n_g}{n_w} = \frac{5}{3} \times \frac{3}{4} = \frac{5}{4}$$

$$\frac{\lambda_g}{\lambda_w} = \frac{n_g}{n_w} = \frac{5}{4}$$

Since the number of wares is same we have

$$\frac{X}{4} = \frac{5}{4}$$

$$\therefore x = 5 \text{ cm}$$

137 **(c)**
In compound microscope the intermediate image (image formed by objective lens) is real, inverted and magnified.

139 **(a)**
$i = 30^0$

Under minimum deviation condition $i_1 = i_2 = e$

$\therefore e = 30^0$

$\therefore$ emergent ray makes an angle of 60^0 with the surface.

140 **(b)**
For objective lens, $\frac{1}{f_0} = \frac{1}{V_0} - \frac{1}{u_0}$ or $\frac{1}{4} = \frac{1}{V_0} - \frac{1}{(-4.5)}$

$\Rightarrow |V_0| = 36$ cm

$\therefore$ Magnifying power, $|M| = \frac{V_0}{u_0}\left(1 + \frac{D}{f_e}\right) = \frac{36}{4.5}\left(1 + \frac{24}{8}\right) = 32$

141 **(c)**
As we know,

number of waves in glass slab=number of waves in water colum

$\therefore \mu_g \cdot h_g = \mu_w \cdot h_w$
where, μ_g = refractive index of glass,
μ_w = refractive index of water column,
h_g = thickness of slab.

and h_w = height of water column.
Given, $\mu_g = 1.5, h_g = 6\text{ cm}, h_w = 7\text{ cm}$

$$\Rightarrow \mu_w = \frac{\mu_g \cdot h_g}{h_w} = \frac{1.5 \times 6}{7}$$

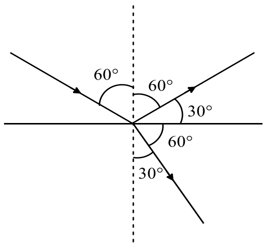
$$\therefore \mu_w = \frac{9}{7} = 1.286$$

142 **(a)**
Refractive index of M_1 with respect to M_2 will be

$$2^{\mu_1} = \frac{2 \times 10^8}{1.5 \times 10^8} = \frac{4}{3}$$

$$\therefore \frac{1}{\sin C} = \frac{4}{3} \text{or} \sin C = \frac{3}{4}$$

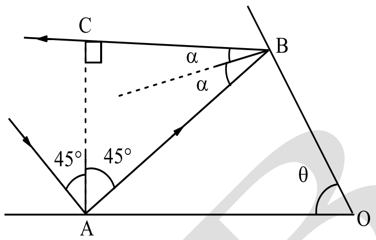
143 **(c)**



Refractive index of the material,

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin 60^0}{\sin 60^0} = \sqrt{3} = 1.732$$

144 **(c)**
From the figure in ΔABC, $45^0 + 90^0 + 2 \propto = 180^0$



$\Rightarrow$ or $\propto = 22.5^0$

$< OBA = 90^0 - \propto = 67.5$

InΔ AB, $\theta + 45^0 + 67.5 = 180^0 \Rightarrow \theta = 67.5^0$

145 **(b)**
apparent depth, $h = \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2} + \frac{d}{\mu_1} + \frac{d}{\mu_2} =$
$d\left(\frac{1}{\mu_1} + \frac{1}{\mu_2}\right)$

146 **(c)**
The magnifying power

$$m = \frac{f_0}{f_e}$$

If f_e is doubled, the magnifying power becomes half.

147 **(a)**
Critical angle, $\sin C = \frac{1}{\mu} \Rightarrow C = \sin^{-1}\left(\frac{1}{\mu}\right)$

As μ decreases with increase in λ , yellow, orange, red have higher wavelength than green, So μ will be less for these rays, and So critical angle for these rays will be high, hence if green is just total internally reflected, then yellow, orange and red rays will emerge out.

148 **(a)**
Power of a tens $P = \frac{1}{f}$

For two lenses in contact

$$P = P_1 + P_2 = \frac{1}{f_1} + \frac{1}{f_2}$$

For convex lens power is positive and for concave lens power is negative.

$\therefore$ P will be negative if $P_2 > P_1$ or $f_2 < f_1$ or $f_1 > f_2$

149 **(d)**
The critical angle is that angle on incidence in the denser medium for which the angle of refraction in rarer medium is 90^0 , i.e.

$$\frac{\sin \theta}{\sin 90°} = \frac{\mu_y}{\mu_x} \Rightarrow \sin \theta = \frac{\mu_y}{\mu_x}$$

where, μ = refractive index of medium.

Also, $\mu = \frac{\text{speed of light in vacuum}}{\text{speed of light in medium}} = \frac{c}{v}$

From Eqs. (i) and (ii), we get

$$\sin \theta = \frac{c}{v_y} \times \frac{v_x}{c} = \frac{v_x}{v_y}$$

$$\Rightarrow v_y = \frac{v_x}{\sin \theta}$$

Thus, the speed of light in medium y is $\frac{v_x}{\sin \theta}$.

150 **(b)**
For glass lenses:

$$\frac{1}{f} = (\mu_g - 1)\left(\frac{1}{R} + \frac{1}{R}\right)$$

$$\Rightarrow= (1.5 - 1)\frac{2}{R} = \frac{1}{R}$$

$\therefore f = R$

A concave water lens is formed between the two lenses. For water lens

$$\frac{1}{f_w} = (\mu_w - 1)\left(-\frac{1}{R} - \frac{1}{R}\right) = -\left(\frac{4}{3} - 1\right) \times \frac{2}{R}$$

$$= -\frac{2}{3R}$$

$$\therefore \frac{1}{f_w} = -\frac{2}{3R} = -\frac{2}{3f}$$

Hence three lenses are in contacts their equivalent focal length is given by

$$\frac{1}{f'} = \frac{1}{f} + \frac{1}{f} + \frac{1}{f_w} = \frac{1}{f} + \frac{1}{f} - \frac{2}{3f}$$

$$\Longrightarrow = \frac{4}{3f}$$

$$\Longrightarrow f' = \frac{3f}{4}$$

151 **(b)**

When final image is formed at infinity, then magnifying

power, $M_\infty = -\frac{V_o}{u_o} \times \frac{D}{f_e}$

From $\frac{1}{f_0} = \frac{1}{V_0} - \frac{1}{u_0}$

$$\Rightarrow \frac{1}{+1.2} = \frac{1}{v_0} - \frac{1}{(-1.25)}$$

$\Rightarrow v_0 = 30$ cm

$$\therefore |M_\infty| = \frac{30}{1.25} \times \frac{25}{3} = 200$$

152 **(d)**

$${}_1n_2 = \frac{n_2}{n_1}$$

$$\therefore {}_wn_g = \frac{{}_an_g}{{}_an_w}$$

153 **(c)**

As, $\frac{1}{f} = (\mu - 1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ (lens maker formula)

For lens to be convex, $\left(\frac{1}{r_1} - \frac{1}{r_2}\right) > 0$

or $\frac{1}{r_1} > \frac{1}{r_2}$ or $r_1 < r_2$

154 **(b)**

Magnifying power, $m = m_1 \times m_2$

$100 = 5 \times m_2$

$\Rightarrow m_2 = 20$

155 **(c)**

Applying $\frac{\mu_2}{V} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$, We have

$\frac{3/2}{v} - \frac{\frac{4}{3}}{(-20)} = \frac{\frac{3}{2} - 4/3}{10}$ or V =-30 cm

156 **(d)**

For real image from converging lens,

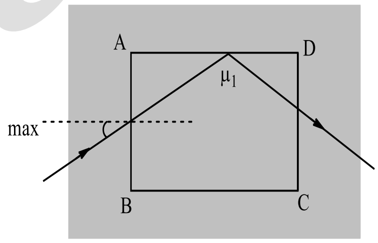
m=-2

$\therefore$ Magnification, m=$\frac{f}{f+u} \Rightarrow 2 = \frac{f}{u+f} = \frac{20}{u+20}$

$\Rightarrow$ u= - 30 cm

157 **(a)**

The ray comes out from CD, means rays after refraction from AB get, total internal reflected at AD



According to Snell's law, $\frac{\mu_1}{\mu_2} = \frac{\sin \alpha_{max}}{\sin r_1}$

$\Rightarrow \alpha_{max} = \sin^{-1}\left[\frac{\mu_1}{\mu_2} \sin r_1\right]$...(i)

Also, $r_1 + r_2 = 90°$

$\Rightarrow r_1 = 90° - r_2 = 90° - C$

$$\Rightarrow r_1 = 90° - \sin^{-1}\left(\frac{1}{2\mu_1}\right)$$

$\Rightarrow r_1 = 90° - \sin^{-1}\left(\frac{\mu_2}{\mu_1}\right)$...(ii)

Then, from Eqs.(i) and (ii), we get

$$\alpha_{max} = \sin^{-1}\left[\left(\frac{\mu_1}{\mu_2}\right) \sin\left(90° - \sin^{-1}\frac{\mu_2}{\mu_1}\right)\right]$$

$$= \sin^{-1}\left[\left(\frac{\mu_1}{\mu_2}\right) \cos\left(\sin^{-1}\frac{\mu_2}{\mu_1}\right)\right]$$

159 **(c)**

When light is refracted into a medium from vacuum, its wavelength decreases but frequency remains unchanged.

161 **(b)**

Light is going from medium P (denser) to medium Q (rarer). Hence refractive index of denser medium.

$$\mu = \frac{1}{\sin\theta} = \frac{V_Q}{V_P}$$

$$\therefore V_Q = \frac{V_P}{\sin\theta}$$

162 **(b)**

For a lens we have

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{F}$$

u is negative, v and F are positive.

$$\frac{1}{v} - \frac{1}{-u} = \frac{1}{F}$$

$$\therefore \frac{1}{v} + \frac{1}{u} = \frac{1}{F}$$

$$\therefore \frac{1}{v} = \frac{1}{F} - \frac{1}{u}$$

Multiplying by v,

$$1 = \frac{v}{F} - \frac{v}{u}$$

$$1 = \frac{v}{F} - m \quad \left[\because \frac{v}{u} = m\right]$$

$$\therefore \frac{v}{F} = 1 + m$$

$$\therefore V = F(1 + m)$$

163 **(a)**

If the number of waves is N, then we wavelength in water is $\frac{5}{N}$ cm and wavelength in glass is $\frac{4}{N}$ cm.

$$\lambda_w = \frac{5}{N}, \lambda_g = \frac{4}{n}$$

$$_w\mu_g = \frac{\lambda_w}{\lambda_g} = \frac{5}{4}$$

$$\therefore \frac{\mu_g}{\mu_w} = \frac{5}{4}$$

$$\therefore \mu_w = \frac{4}{5}\mu_g = \frac{4}{5} \times \frac{5}{3} = \frac{4}{3} = 1.33$$

164 **(d)**

The focal length of the lens,

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{20} - \frac{1}{30}\right)$$

$$\Rightarrow \frac{1}{f} = 0.5\left(\frac{30-20}{600}\right)$$

$$\text{or } \frac{1}{f} = \frac{1}{2} \times \frac{10}{600} = \frac{1}{120}$$

The focal length, $f = 120$ cm

165 **(b)**

We know that, $\frac{1}{\mu} = \frac{\sin i}{\sin r}$

But $r + r = 90^0$ or $r = 90^0 - r$

$\sin r = \sin(90^0 - r) = \cos r$

or $\sin r = \cos i$

$\therefore \frac{1}{\mu} = \frac{\sin i}{\cos i}$ or $\frac{1}{\mu} = \tan i$

or $\sin i_C = \tan i = \tan r$

The critical angle for pair of media,

$i_C = \sin^{-1}(\tan r)$

166 **(b)**

For thin prism the angle of deviation $\delta = A(n - 1)$

$\therefore \delta_1 = \delta_2$ for no deviation

$$\therefore A_1(n_1 - 1) = A_2(n_2 - 1)$$

$$4(1.54 - 1) = A_2(1.72 - 1)$$

$$\therefore 4 \times 0.54 = A_2 \times 0.72$$

$$A_2 = \frac{4 \times 0.54}{0.72} = 3^0$$

167 **(c)**

$$N = \frac{360^0}{\theta} - 1$$

$$\therefore 3 = \frac{360}{\theta} - 1$$

$\therefore \frac{360}{\theta} = 4 \text{ or } \theta = \frac{360}{4} = 90^0$

168 **(c)**

$\mu = \frac{\text{Real depth (R)}}{\text{Apparant depth (A)}}$

$\therefore R = \mu A = \frac{4}{3} \times 30 = 40 \text{ cm}$

169 **(d)**

For a prism we have

$i + e = A + \delta$

Given: $i = e = \frac{3}{4}A, A = 60^0$

$\therefore i = e = 45^0$

$\therefore \delta = i + e - A$

$= 45^0 + 45^0 - 60^0 = 30^0$

170 **(c)**

As,$\mu = \frac{c}{v} \Rightarrow v \propto \frac{1}{\mu}$

$\therefore \frac{V_1}{V_2} = \frac{\mu_2}{\mu_1}$

$\Rightarrow$ Ratio of velocities of light,

$\frac{V_g}{V_g} = \frac{\mu_w}{\mu_g} = \frac{4/3}{3/2} = \frac{8}{9}$

171 **(a)**

$d = f_1 - f_2,$

By using formula,

$\frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2} = \frac{1}{F}$

For emergent beam to be parallel

$P = 0 \text{ and } F = \infty$

$\therefore \frac{1}{20} - \frac{1}{5} + \frac{d}{20 \times 5} = 0$

$\therefore -\frac{3}{20} = -\frac{d}{100}$

$\therefore d = 15 \text{ cm}$

172 **(d)**

As, $L_\infty = v_0 + f_\theta$

$\Rightarrow 14 = v_0 + 5$

$\Rightarrow \ v_0 = 9 \text{ cm}$

Magnifying power of microscope for relaxed eye,

$m = \frac{v_o}{u_o} \cdot \frac{D}{f_e}$

$25 = \frac{9}{u_o} \times \frac{25}{5}$

$\Rightarrow \ 25 = \frac{9}{u_0} \times \frac{25}{5}$

$\text{or } u_0 = \frac{9 \times 25}{5 \times 25} = \frac{9}{5} \text{ cm} = 1.8 \text{ cm}$

173 **(d)**

Given, wavelength in vacuum = 5890 A

In a medium of refractive index $\mu = 1.5$,the wavelength of light decreases to $\frac{\lambda}{\mu} = \frac{5890}{1.5} = 39$ 3927Å

174 **(a)**

As, $m = \frac{f}{f+u} = -2 = \frac{\frac{1}{3}}{\frac{1}{3}+u} \Rightarrow -\frac{2}{3} - 2u = \frac{1}{3}$

$\text{or} - 2u = \frac{1}{3} + \frac{2}{3} = 1$

$\text{or} |u| = \frac{1}{2} m = 0.5 m$

175 **(d)**

Refractive index of prism,

$\mu = \frac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}} \Rightarrow \ I = 45^0 = \frac{A+\delta_m}{2}$

So, $\frac{\sin 45^0}{\sin\left(\frac{A}{2}\right)} = \sqrt{2}$

Thus, $\frac{1}{2} = \sin\frac{A}{2} \Rightarrow A = 60^0$

176 **(a)**

Angular magnification of simple microscope, when final image is formed at infinity, is given of $M = \frac{D}{f}$

Hence, angular magnification obtained depends on f but not on u.

177 **(b)**

Compound microscope, the and aperture of the objective should be large and small, respectively.

178 **(b)**
Refractive index of glass,

$$\mu_g = \frac{1}{\sin 30^0} = 2$$

Now, $\sin\theta_C = \frac{6/5}{2} = \frac{3}{5}$

$\therefore \theta_C = 37^0$

179 **(c)**
For the eyepiece,

$v_e = -25 \text{ cm}, f_e = 5 \text{ cm}$

or $\frac{1}{u_e} = -\frac{1}{25} - \frac{1}{5}$

or $\frac{1}{u_e} = -\frac{-1-5}{25}$

or $u_e = -\frac{25}{6}$

Now, $u_e = L - |u_e| = 20 - \frac{25}{6}$

$= \frac{120-25}{6} \text{ cm} = \frac{95}{6} \text{ cm}$

Now, $\frac{1}{\frac{95}{6}} - \frac{1}{u_0} = \frac{1}{1}$

or $\frac{1}{u_0} = \frac{6}{95} - 1$

or $u_o = -\frac{95}{89}$ cm

$\therefore |u_o| = \frac{95}{89}$ cm

180 **(d)**
$\frac{1}{f} = (\mu - 1)\left(\frac{2}{R}\right)$

$\frac{1}{R} = (\mu - 1)\left(\frac{2}{R}\right)$

$\mu - 1 = \frac{1}{2}$

$\therefore \mu = \frac{3}{2} = 1.5$

181 **(c)**
Given, $P_1 + P_2 = 9$...(i)

We have , $P = P_1 + P_2 - dP_1P_2$

$\Rightarrow \frac{27}{5} = 9 - \frac{20}{100} \times P_1P_2$

$(P_2 - P_1)^2 = (P_1 + P_2)^2 - 4P_1P_2$

$\Rightarrow P_2 - P_1 = 3$...(ii)

On solving Eqs. (i) and (ii), we get $P_1 = 3$ and $P_2 = 6$

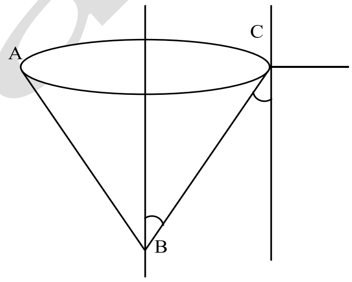
182 **(d)**
We have,

$C = \sin^{-1}\left(\frac{v_1}{v_2}\right) = \sin^{-1}\left(\frac{1.8\times10^8}{2.4\times10^8}\right) = \sin^{-1}\left(\frac{3}{4}\right)$

183 **(c)**
Focal length of plano - convex lens;

$$f = \frac{R}{\mu - 1} = \frac{R}{(1.5-1)} = 2R$$

184 **(c)**
We can represent this diagrammatically as



Thus, we see that, $C = \sin^{-1}\left(\frac{1}{\mu}\right) = \sin^{-1}\left(\frac{3}{4}\right)$

185 **(d)**
Theory question

186 **(c)**
The focal length of combination of two lenses,

$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$

$\therefore \frac{1}{F} = (\mu_1 - 1)\left(\frac{1}{\infty} + \frac{1}{R}\right) + (\mu_2 - 1)\left(\frac{1}{-R} - \frac{1}{\infty}\right)$

$= \frac{\mu_1 - 1}{R} - \frac{\mu_{2-1}}{R}$

$\Rightarrow \frac{1}{F} = \frac{\mu_1 - \mu_2}{R}$ or $F = \frac{R}{\mu_1 - \mu_2}$

187 **(a)**
$l = f_0 + f_e$; f_0 and f_e are positive

Magnifying power $= \frac{f_0}{f_e} > 1$

188 **(a)**

For a prism we have

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$\delta_m = A$ and $\mu = \sqrt{3}$

$$\therefore \sqrt{3} = \frac{\sin A}{\sin\left(\frac{A}{2}\right)} = \frac{2\sin\frac{A}{2}\cos\frac{A}{2}}{\sin\frac{A}{2}}$$

$$\therefore \sqrt{3} = 2\cos\frac{A}{2}$$

$$\therefore \cos\frac{A}{2} = \frac{\sqrt{3}}{2}$$

$$\therefore \frac{A}{2} = 30^0$$

$$\therefore A = 60^0$$

189 **(a)**

Theory question

190 **(d)**

The emergent ray just grazes the second face.

Hence, angle of emergence $e = 90^0$

$$\mu = \frac{\sin e}{\sin r_2} = \frac{\sin 90^0}{\sin r_2}$$

$$\therefore \frac{1}{\sin r_2} = \sqrt{2} \text{ or } \sin r_2 = \frac{1}{\sqrt{2}}$$

$\therefore r_2 = 45^0$;

$A = r_1 + r_2$

$\therefore r_1 = A - r_2 = 60 - 45 = 15^0$

Also, $\frac{\sin i}{\sin r_1} = \mu$

$\therefore \sin i = \mu \sin r_1 = \sqrt{2}\sin 15^0$

$\therefore i = \sin^{-1}\left(\sqrt{2}\sin 15^0\right)$

191 **(c)**

As number of images, $n = 3$

So, no$\frac{360}{\theta} - 1$

$\Rightarrow 3 = \frac{360}{\theta} - 1$

$\therefore \theta = 90^0$

192 **(a)**

Refractive index for prism,

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(\frac{60^\circ+60^\circ}{2}\right)}{\sin\left(\frac{60^\circ}{2}\right)} \; (\because A = \delta_m) = \sqrt{3}$$

193 **(b)**

$f = -30$ cm, $m = \frac{1}{5} = \frac{v}{u}$

$\therefore v = \frac{u}{5}$

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\therefore \frac{5}{u} - \frac{1}{u} = \frac{1}{-30}$

$\therefore \frac{4}{u} = -\frac{1}{30}$

$\therefore u = -30 \times 4 = -120$ cm

194 **(b)**

As optical paths are equal, hence

$n_g x_g = n_w x_w$

$\Rightarrow n_w = n_g \frac{x_g}{x_w}$

Refractive index of the water,

$n_w = 1.53 \times \frac{4.0}{4.5} = 1.36$

195 **(a)**

We have, the effective power given by

$P_{eff} = P_1 + P_2$

Also we know, $P = \frac{1}{f}$

Hence, $P_{eff} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{0.20} + \frac{1}{0.25} = 5 + 4 = 9D$

196 **(b)**

Since reflected and refracted rays are perpendicular to each other.

$r + r_1 = 90^0$

$\therefore r_1 = 90^0 - r$

Refractive index of the denser medium

$$\mu = \frac{\sin r_1}{\sin r} = \frac{\sin(90^0 - r)}{\sin r} = \frac{\cos r}{\sin r}$$

$$= \cot r$$

$$\text{Also, } \mu = \frac{1}{\sin C}$$

$$\therefore \frac{1}{\sin C} = \cot r$$

$$\text{or } \sin C = \frac{1}{\cot r} = \tan r = \tan i$$

$$\therefore i = \tan^{-1}(\sin C)$$

197 **(b)**

$$\frac{1}{F} = \frac{1}{f} - \frac{1}{f} = 0$$

$$\therefore F = \infty$$

198 **(b)**

Image formed by a plane mirror is always virtual.

199 **(b)**

Keep the object at a distance 2f from the lens.

201 **(c)**

$$\mu = 1.5, \frac{R_1}{R_2} = \frac{1}{6}, u = -36 \text{ cm}, v = 18 \text{ cm}$$

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$= \frac{1}{18} - \frac{1}{-36}$$

$$= \frac{1}{18} + \frac{1}{36}$$

$$= \frac{1}{12}$$

$$\therefore f = 12 \text{ cm}$$

$$\text{Also, } \frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$= (1.5 - 1)\left(\frac{1}{R_1} + \frac{1}{6R_1}\right)$$

$$\therefore \frac{1}{12} = 0.5 \times \frac{7}{6R_1}$$

$$\therefore R_1 = 7 \text{ cm}$$

$$\therefore R_2 = 6R_1 = 6 \times 7$$

$$= 42 \text{ cm}$$

202 **(c)**

Magnification

$$m = 4 = \frac{v}{u}$$

$$\therefore v = 4u$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{4u} - \frac{1}{u} = \frac{1}{20}$$

$$\frac{1 - 4}{4u} = \frac{1}{20}$$

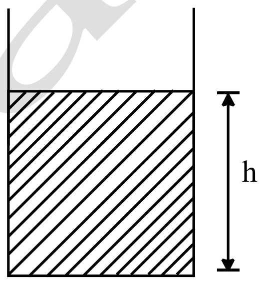
$$\therefore -\frac{3}{4u} = \frac{1}{20}$$

$$\therefore u = -15 \text{ cm}$$

$$v = -60 \text{ cm}$$

203 **(d)**

According to the question, $\frac{h}{2} = \frac{21}{2} = 10.5$ cm



$\therefore$ Height, h=$10.5 \times \frac{4}{3} \Rightarrow h = 14$ cm

204 **(d)**

$$\frac{1}{f} = (n - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$n = 1.5, R_1 = 20 \text{ cm}, R_2 = -20 \text{ cm}$$

$$\therefore f = 20 \text{ cm}$$

For a concave mirror, $R = 2f$ and it is negative.

$$\therefore R = -40 \text{ cm}$$

206 **(b)**

$$\sin c = \frac{1}{\mu}$$

$${}_a\mu_w = \frac{4}{3}, {}_a\mu_g = \frac{3}{2}, {}_w\mu_g = {}_a\mu_g / {}_a\mu_w = \frac{9}{8}$$

Critical angle will be maximum when refractive index of the denser medium w.r.t. the rarer medium is minimum.

${}_{w}\mu_g = \dfrac{9}{8}$ is minimum

207 **(b)**

$$p = \frac{1}{f} = (\mu - 1)\left(\frac{1}{R} + \frac{1}{R}\right) = (\mu - 1)\frac{2}{R}$$

$$p' = \frac{1}{f'} = (\mu - 1)\frac{1}{R}$$

$$\therefore p' = \frac{p}{2} \text{and } f' = 2f$$

208 **(a)**

Biconvex lens is cut perpendicularly to the principal axis, it will become a plano - convex lens.

Focal length of biconvex lens,

$$\frac{1}{f} = (n - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = (n - 1)\frac{2}{R} \ (\because R_1 = R, R_2 = -R)$$

$$\Rightarrow f = \frac{R}{2(n-1)} \ \ldots(i)$$

For plano- convex lens,

$$\frac{1}{f_1} = (n - 1)\left(\frac{1}{R} - \frac{1}{\infty}\right)$$

$$\Rightarrow \ f_1 = \frac{R}{(n - 1)}$$

On comparing Eqs. (i) and (ii), we see the focal length become double.
As power of lens, $P \propto \frac{1}{\text{Focal length}}$

Hence, power will become half.
New power $= \frac{4}{2} = 2D$

210 **(a)**

$$\mu = \frac{v_1}{v_2} = \frac{v\lambda_1}{v\lambda_2} = \frac{6000}{4000} = \frac{3}{2}$$

$$\theta = \sin^{-1}\left(\frac{2}{3}\right)$$

211 **(d)**

$$\frac{3}{2}\sin\theta_c = \sin 90^0 \times \frac{4}{3}$$

$$\sin\theta_c = \frac{\frac{4}{3}}{\frac{3}{2}} = \frac{8}{9}$$

$$\therefore \theta_c = \sin^{-1}\left(\frac{8}{9}\right)$$

212 **(c)**

$${}_2\mu_1 \times {}_3\mu_2 \times {}_4\mu_3 = \frac{\mu_1}{\mu_2} \times \frac{\mu_2}{\mu_3} \times \frac{\mu_3}{\mu_4} = \frac{\mu_1}{\mu_4} = {}_4\mu_1 = \frac{1}{{}_1\mu_4}$$

213 **(c)**

$$\mu = \frac{\sin i}{\sin r} = \frac{i}{r_1}$$

If angles are small.

$A = r_1 + r_2 = r_1$

Since $r_2 = 0$ since the ray emerges normally.

$$\therefore \mu = \frac{i}{A} \text{ or } i = \mu A$$

214 **(a)**

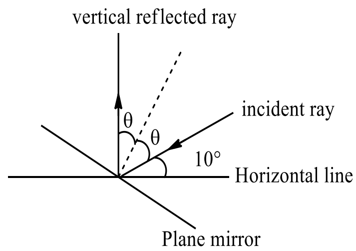
The angle made by incident ray of light with the reflecting surface is called glancing angle, angle

216 **(d)**

From figure, we see that

$\theta + \theta + 10^0 = 90^0$

Vertical reflected ray



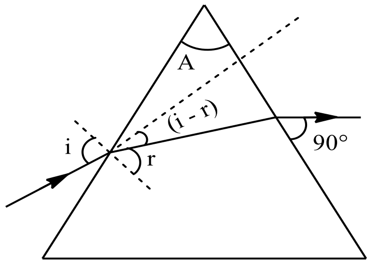
$\Rightarrow 2\theta + 10 = 90$

$\Rightarrow 2\theta = 80$

$\Rightarrow \theta = 40^0$

218 **(b)**

The path followed by ray of light is shown in figure



As, the ray emerges normally from other surface. So angle of emergence is zero. The angle of deviation i.e. between incident and emergent ray is $\delta = (i + e) - A = i - A$ ($\because e = 0$) ... (i)

Also, for minimum deviation, $\delta = (\mu - 1)A$ ...(ii)
From Eqs. (i) and (ii), we get
$i - A = (\mu - 1)A \Rightarrow i = (\mu - 1)A + A = \mu A$

219 **(b)**
According to Cartesian sign convention,

u= -40 cm, R = -20 cm

Given, $\mu_1 = 1$ and $\mu_2 = 1.33$

Applying equation for refraction through spherical surface, we get

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$\frac{1.33}{V} - \frac{1}{(-40)} = \frac{1.33 - 1}{-20}$$

After solving v= -32 cm

Magnification, $m = \frac{h_2}{h_1} = \frac{\mu_1 v}{\mu_2 u}$

$\therefore \frac{h_2}{1} = -\frac{1(32)}{1.33(-40)}$

or $h_2 = 0.6$ cm

The positive sign shows that the image is erect.

220 **(b)**
Time taken by light to cross the glass slab,

$$t = \frac{\text{Distance}}{\text{Speed of light in glass slab}}$$

$$= \frac{5 \times 10^{-2}}{\frac{3}{1.6} \times 10^8} \text{ s} = 2.67 \times 10^{-10} \text{ s}$$

In same time, distance travelled by light in air

$= c \times t = 3 \times 10^8 \times 2.67 \times 10^{-10}$

$= 8.02 \times 10^{-2}$ m ≈ 8 cm

221 **(b)**

$$\mu_1 = \frac{c}{v_1}$$

$$\mu_2 = \frac{c}{v_2}$$

$$\therefore \mu_1 v_1 = \mu_2 v_2$$

222 **(c)**

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{... (i)}$$

$$\frac{1}{f_0} = \left(\frac{\mu}{\mu_0} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{... (ii)}$$

Dividing Eq. (i) by Eq. (ii)

$$\frac{f_0}{f} = \frac{(\mu - 1)}{(\mu/\mu_0 - 1)} = \frac{\mu_0(\mu - 1)}{(\mu - \mu_0)}$$

$$\therefore f_0 = \frac{\mu_0(\mu - 1)f}{(\mu - \mu_0)}$$

223 **(b)**
In minimum deviation position, refracted ray inside an isosceles prism is parallel to the base of the prism. Hence, ray QR should be parallel to the base of prism, i. e. horizontal.

224 **(b)**

$$X = \frac{\vartheta_a}{\vartheta_w}, Y = \frac{\vartheta_w}{\vartheta_g}; Z = \frac{\vartheta_g}{\vartheta_a}$$

$\therefore XYZ = 1$

225 **(d)**

$$\frac{1}{f} = (n - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$n_v > n_r$$

$$\therefore \frac{1}{f_v} > \frac{1}{f_r}$$

$$\therefore f_r > f_v$$

226 **(d)**

$$c = \frac{d}{t}$$

$$v = \frac{5d}{T}$$

$$\mu = \frac{c}{v} = \frac{d}{t} \times \frac{T}{5d} = \frac{T}{5t}$$

$$\theta = \sin^{-1}(1/\mu) = \sin^{-1}\left(\frac{5t}{T}\right)$$

227 **(d)**

Focal length of the combination, $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$

$$\Rightarrow F = \frac{f_1 f_2}{f_1+f_2}$$

Power of lens, $P = \frac{1}{F} = \frac{f_1+f_2}{f_1 f_2}$

228 **(b)**

$\delta = (\mu - 1)$

$$\therefore \delta_{air} = {}_a\mu_g - 1$$

$$\delta_{water} = {}_w\mu_g - 1$$

$$\therefore \frac{\delta_{water}}{\delta_{air}} = \frac{{}_w\mu_g - 1}{{}_a\mu_g - 1}$$

$$= \frac{\frac{{}_a\mu_g}{{}_a\mu_w} - 1}{{}_a\mu_g - 1}$$

$$= \frac{{}_a\mu_g - {}_a\mu_w}{{}_a\mu_w({}_a\mu_g - 1)}$$

230 **(c)**

For a convex lens the diminished image will be real and inverted.

Hence magnification,

$$m = -\frac{1}{2}$$

$$\therefore -\frac{1}{2} = \frac{v}{u} \text{ or } v = -\frac{u}{2}$$

$$\text{we } \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$-\frac{2}{u} - \frac{1}{u} = \frac{1}{f}$$

$$-\frac{3}{u} = \frac{1}{f}$$

$$\therefore u = -3f$$

231 **(b)**

$$M.P. = 1 + \frac{D}{f} = 1 + \frac{25}{5} = 1 + 5 = 6$$

232 **(c)**

$$\text{As}, {}_1\mu_2 = \frac{1}{\sin C} \Rightarrow \frac{\mu_2}{\mu_1} = \frac{\lambda_1}{\lambda_2} = \frac{1}{\sin C}$$

$$\Rightarrow \frac{6000}{4000} = \frac{1}{\sin C} \Rightarrow \text{Critical angle, } C = \sin^{-1}\left(\frac{2}{3}\right)$$

233 **(d)**

$$i = \frac{A + \delta m}{2} = 45^0$$

$$\frac{\sin 45^0}{\frac{\sin A}{2}} = \sqrt{2}$$

$$\therefore \frac{1}{2} = \sin\frac{A}{2} = \sin 30^0$$

$$\therefore \frac{A}{2} = 30^0$$

$$\therefore A = 60^0$$

234 **(d)**

Dispersive power $\omega = \frac{\delta_v - S_R}{\delta_y}, \delta y = \frac{\delta_v + \delta_R}{2}$

For prism: $\omega_A = \frac{12 - 10}{11} = \frac{2}{11}$

For prism B: $\omega_B = \frac{10 - 8}{9} = \frac{2}{9}$

$$\therefore \frac{\omega_A}{\omega_B} = \frac{9}{11}$$

235 **(d)**

We have, $\frac{1}{v} - \frac{1}{(-90)} = \frac{1}{f} \Rightarrow (1.5 - 1)\left(\frac{1}{30}\right) = \frac{1}{60}$

$$\therefore v = 180 \text{ cm}$$

$$\therefore |m| = \left|\frac{v}{u}\right| = \frac{180}{90} = 2.0$$

236 **(b)**

Given focal length of convex lens, f_1=f and focal length of concave lens, f_2 = -f.

The local length of combination, when two lenses are in contact is given by $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ ... (i)

Substituting given value in eq. (i), we get

$$\Rightarrow \frac{1}{f} = \frac{1}{f} - \frac{1}{f} = 0 \Rightarrow f = \infty$$

Hence, the equivalent focal length of the combination is infinity.

237 **(d)**

When particle is at mean position

$u = -14$ cm, $f = 8$ cm

$$\therefore \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} - \frac{1}{-14} - \frac{1}{8}$$

$$\frac{1}{v} = \frac{1}{8} - \frac{1}{14} = \frac{6}{14 \times 8}$$

$$\therefore v = \frac{14 \times 8}{6} = 19 \text{ cm}$$

When the particle is at one extreme position $u = -15$ cm

$$\therefore \frac{1}{v} = -\frac{1}{-15} = \frac{1}{8}$$

$$\therefore \frac{1}{v'} = \frac{1}{8} - \frac{1}{15} = \frac{7}{15 \times 8}$$

$$\therefore v' = \frac{15 \times 8}{7} = 17 \text{ cm}$$

Amplitude of oscillating image is nearly (19 – 17) = 2 cm.

238 **(a)**

Power of combination $= \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$

$$= \frac{1}{1} + \left(\frac{1}{-0.25}\right) - \frac{0.75}{(1)(-0.25)}$$

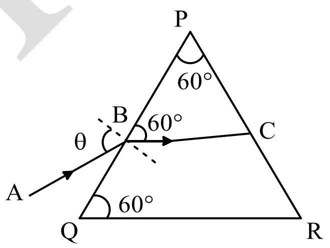
=1-4+3=-3+3=0

Since, power of the system is zero, therefore the incident parallel beam of light will remain parallel after emerging from the system.

239 **(c)**

As from figure $r_1 = 90^0 - 60^0 = 30^0$

$$\therefore \sqrt{3} = \frac{\sin\theta}{\sin 30^0} \Rightarrow \sin\theta = \frac{\sqrt{3}}{2} \Rightarrow \theta = 60^0$$

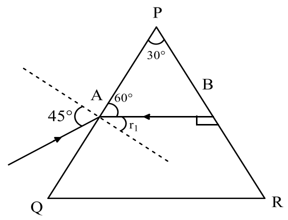


240 **(b)**

Here, light ray goes from (optically) rarer medium air to optically denser medium turpentine, then it bends towards the normal i.e.$r_1 > r_1$, whereas when it goes from to optically denser medium turpentine to rarer medium water, then it bends away from the normal, i.e.$i_2 < r_2$.

Thus, ray-2 path shown is correct.

241 **(a)**



Given, $r_2 = 0, A = 30°$ and $i_1 = 45°$

Here, $r_1 = 90° - 60° = 30°$

$$\therefore \text{Refractive index, } \mu = \frac{\sin i_1}{\sin r_1} = \frac{\sin 45°}{\sin 30°} = \frac{1/\sqrt{2}}{1/2} = \sqrt{2}$$

243 **(d)**

$$\sin C = \frac{1}{{}_2\mu_1}$$

$${}_2\mu_1 = \frac{\mu_1}{\mu_2} = \frac{\frac{3}{2}}{\frac{4}{3}} = \frac{3}{2} \times \frac{3}{4} = \frac{9}{8}$$

$$\sin C = \frac{1}{\frac{9}{8}} = \frac{8}{9}$$

$$\therefore C = \sin^{-1}\frac{8}{9}$$

244 **(b)**

The refractive index of a medium,

$$\mu = \frac{c}{v} = \frac{c}{v\lambda}$$

$$\therefore \mu \propto \frac{1}{\lambda}$$

245 **(d)**

At second surface, there is no refraction, so

$$r_2 = 0$$

$$\therefore\ r_1 = A = 30°$$

From Snell's law, $n = \frac{\sin i_1}{\sin r_1}$

$$\Rightarrow\ n = \frac{\sin i_1}{\sin 30°}$$

$\Rightarrow \ \sin i_1 = \sqrt{2} \times \frac{1}{2} = \frac{1}{\sqrt{2}}$

$\Rightarrow \ \sin i_1 = \frac{1}{\sqrt{2}} \Rightarrow \ i_1 = 45°$

246 **(a)**
Theory question

247 **(b)**
Since, rays after passing through the glass slab just suffer lateral displacement. So, angle between emergent ray is also $\propto$.

249 **(b)**
Dispersive power depends upon the material of prism

250 **(c)**
Here, $\mu = 1.5$

If object lies on place side, $R_1 = \infty, R_2 = -20$ cm

$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$= (1.5 - 1)\left(\frac{1}{\infty} + \frac{1}{20}\right) = \frac{1}{40}$

$\Rightarrow \ f = +40$ cm

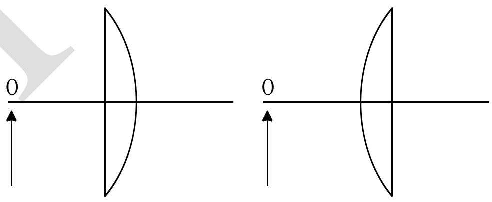
The lens behaves as convex.
If object lies on its curved side, $R_1 = 20$ cm, $R_2 = \infty$

$\frac{1}{f'} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$= (1.5 - 1)\left(\frac{1}{20} - \frac{1}{\infty}\right) = \frac{1}{40}$

$\Rightarrow \ f' = 40$ cm

The lens behaves as convex irrespective of the side on which the object lies.



251 **(d)**
$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Putting $R_1 = R$ and $R_2 = -R$ anf $f = R$

we get $\frac{1}{R} = (\mu - 1) \times \frac{2}{R}$

$\therefore \mu - 1 = \frac{1}{2}$

$\therefore \mu = 1.5$

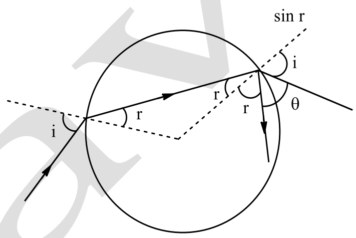
252 **(d)**
Here, angle of prism, $A = 60^0$

For minimum deviation, $A = 2r$

or $r = \frac{A}{2} = \frac{60^0}{2} = 30^0$ for both colours.

253 **(c)**
We have, refractive index,

$\mu = \frac{\sin i}{\sin r} \Rightarrow \sqrt{3} = \frac{\sin 60^0}{\sin r}$



$\sin r = \frac{1}{2}$

Refracted angle, $r = 30^0$

The angle between the reflected and refracted rays,

$\theta = 180^0 - i - r = 90^0$

255 **(b)**
As, power of combination,

$P = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2} = 0$

$\therefore \frac{1}{f_1} + \frac{1}{f_2} = \frac{d}{f_1 f_2}$

$\Rightarrow \frac{1}{20} - \frac{1}{56} = \frac{d}{20(-56)}$

$\Rightarrow \frac{56-20}{20 \times 56} = \frac{d}{-20 \times 56}$

$\therefore |d| = 36$ cm

256 **(d)**
$\text{Velocity} = \frac{\text{distance}}{\text{time}}$

$\therefore$ time $= \dfrac{\text{distance}}{\text{velocity}} = \dfrac{h}{c}\mu_w$

$\therefore \mu_w = \dfrac{c}{v}$

$\therefore v = \dfrac{c}{\mu_w}$

257 **(b)**

Refractive index of glass with respect to air=μ
Critical angle = θ

$\therefore \mu = \frac{1}{\sin\theta}$ .... (i)

When a ray of light incident from air on the glass with angle of incidence θ . if r be the angle of refraction, then by snell's law, $\mu = \frac{\sin\theta}{\sin r}$

$\Rightarrow \sin r = \frac{\sin\theta}{\mu} = \frac{1/\mu}{\mu}$ [from Eq.(i)]

$\Rightarrow \sin r = \frac{1}{\mu_2}$

$\Rightarrow r = \sin^{-1}\left(\frac{1}{\mu^2}\right)$

258 **(a)**

As, $d_{app} = \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2} + \frac{d_3}{\mu_3} = \frac{3}{3/2} + \frac{4}{4/3} + \frac{6}{6/5}$

=2+3+5=10 cm

259 **(c)**

$\delta_1 = A({}_a\mu_g - 1) = A({}_w\mu_g - 1)$

${}_w\mu_g = \dfrac{{}_a\mu_g}{{}_a\mu_w} = \dfrac{\frac{3}{2}}{\frac{4}{3}} = \dfrac{9}{8}$

$\therefore \dfrac{\delta_1}{\delta_2} = \dfrac{\frac{3}{2} - 1}{\frac{9}{8} - 1} = \dfrac{1/2}{1/8} = \dfrac{8}{2} = 4$