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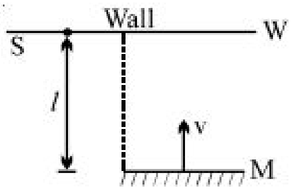
PHYSICS - RAY OPTICS

PHYSICS

1. A flat mirror M is arranged parallel to a wall W at a distance l from it. The light produced by a point source S kept on the wall is reflected by the mirror and produces a light spot on the wall. The mirror moves with velocity v towards the wall.



(A) The spot of light will move with the speed v on the wall.
(B) The spot of light will not move on the wall.
(C) The size of the light spot on the wall remains the same.
(D) Both (B) and (C)

2. Choose the correct statement (s) related to the motion of object and its image in the case of mirrors

(A) Object and its image always move along normal $w.r.t.$ mirror in opposite directions
(B) Only in the case of convex mirror, it may happen that the object and its image move in the same direction
(C) Only in the case of concave mirror, it may happen that the object and its image move in the same direction
(D) Only in case of plane mirrors, object and its image move in opposite directions

3. A small source of light is $4m$ below the surface of a liquid of refractive index $5/3$. In order to cut off all the light coming out of liquid surface, minimum diameter of the disc placed on the surface of liquid is ....m

(A) 3
(B) 4
(C) 6
(D) ∞

4. A telescope has an objective lens of focal length $200\,cm$ and an eye piece with focal length $2\,cm$. If this telescope is used to see a 50 meter tall building at a distance of $2\,km$, what is the height of the image of the building formed by the objective lens......cm

(A) 5
(B) 10
(C) 1
(D) 2

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

(A) the angle between the mirror is 60^o
(B) the number of images formed by this system will be 5, if an object is placed symmetrically between the mirrors.
(C) the no. of images will be 5 if an object is kept unsymmetrically between the mirrors.
(D) All of the above

6. Two stars situated at distances of 1 and 10 light years respectively from the earth appear to possess the same brightness. The ratio of their real brightness is

(A) $1:10$
(B) $10:1$
(C) $1:100$
(D) $100:1$

7. A lens having focal length and aperture of diameter d forms an image f of intensity I. Aperture of diameter $\frac{d}{2}$ in central region of lens is covered by a black paper. Focal length of lens and intensity of image now will be respectively

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

8. An achromatic convergent doublet of two lens in contact has a power of $+2\,D$. The convex lens is 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) $5:3$

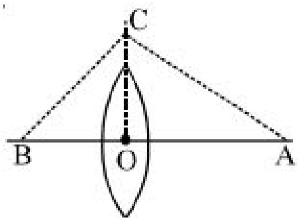
9. Two plane mirrors are inclined at an angle of 72^0. The number of images of a point object placed between them will be

(A) 2
(B) 3
(C) 4
(D) 5

10. The focal lengths of the objective and eye lenses of a telescope are respectively $200\,cm$ and $5\,cm$. The maximum magnifying power of the telescope will be

(A) -40
(B) -48
(C) -60
(D) -100

11. If an object is placed at $A(OA > f)$; Where f is the focal length of the lens the image is found to be formed at $B.A$ perpendicular is erected at o and C is chosen on it such that the angle $\angle BCA$ is a right angle. Then the value of f will be



(A) AB/OC^2
(B) $(AC)(BC)/OC$
(C) OC^2/AB
(D) $(OC)(AB)/AC+BC$

12. A lamp is hanging along the axis of a circular table of radius r. At what height should the lamp be placed above the table, so that the illuminance at the edge of the table is $\frac{1}{8}$ of that at its center

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

13. A biconvex lens has a radius of curvature of magnitude $20\ cm$. Which one of the following options describe best the image formed of an object of height $2\ cm$ placed $30\ cm$ from the lens?
(A) Virtual, upright, height $= 1cm$
(B) Virtual, upright, height $= 0.5cm$
(C) Real, inverted, height $= 4cm$
(D) Real, inverted, height $= 1cm$

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

15. Spherical aberration in a lens
(A) Is minimum when most of the deviation is at the first surface
(B) Is minimum when most of the deviation is at the second surface
(C) Is minimum when the total deviation is equally distributed over the two surface
(D) Does not depend on the above consideration

16. A point object is placed at a distance of $10\,cm$ and its real image is formed at a distance of $20\,cm$ from a concave mirror. If the object is moved by $0.1cm$ towards the mirror, the image will shift by about
(A) $0.4cm$ away from the mirror
(B) $0.4cm$ towards the mirror
(C) $0.8cm$ away from the mirror
(D) $0.8cm$ towards the mirror

17. A concave mirror of focal length $100\,cm$ is used to obtain the image of the sun which subtends an angle of $30°$. The diameter of the image of the sun will be.....cm
(A) 1.74
(B) 0.87
(C) 0.435
(D) 100

18. A vessel of depth $2\mathrm{h}$ is half filled with a liquid of refractive index $2\sqrt{2}$ and the upper half with another liquid of refractive index $\sqrt{2}$. The liquids are immiscible. The apparent depth of the inner surface of the bottom of vessel will be
(A) $\frac{\mathrm{h}}{\sqrt{2}}$
(B) $\frac{3}{4}\mathrm{h}\sqrt{2}$
(C) $\frac{\mathrm{h}}{2(\sqrt{2}+1)}$
(D) $\frac{\mathrm{h}}{3\sqrt{2}}$

19. An object has image thrice of its original size when kept at $8cm$ and $16cm$ from a convex lens. Focal length of the lens is
(A) $8cm$
(B) $16cm$
(C) Between $8cm$ and $16cm$
(D) Less than $8cm$

20. The focal length of a convex lens is $10cm$ and its refractive index is 1.5. If the radius of curvature of one surface is $7.5cm$, the radius of curvature of the second surface will be......cm
(A) 7.5
(B) 15
(C) 75
(D) 5

21. A converging lens forms an image of an object on a screen. The image is real and twice the size of the object. If the positions of the screen and the object are interchanged, leaving the lens in the original position, the new image size on the screen is
(A) twice the object size
(B) same as the object size
(C) half the object size
(D) can't say as it depends on the focal length of the lens.

22. When a glass prism of refracting angle 60^o is immersed in a liquid its angle of minimum deviation is 30^o. The critical angle of glass with respect to the liquid medium is......^{o}
(A) 42
(B) 45
(C) 50
(D) 52

23. To determine refractive index of glass slab using a travelling microscope, minimum number of readings required are
(A) 2
(B) 4
(C) 3
(D) 5

24. A spherical surface of radius of curvature R separates air (refractive index 1.0) from glass (refractive index 1.5). The centre of curvature is in the glass. A point object P placed in air is found to have a real image Q in the glass. The lime PQ cuts the surface at the point O, and $PO = OQ$. The distance PO is equal to :
(A) $5\,R$
(B) $3\,R$
(C) $2\,R$
(D) $1.5\,R$

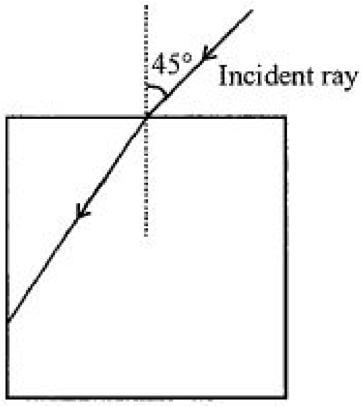
25. An astronomical telescope has an angular magnification of magnitude 5 for distant objects. The separation between the objective and the eye piece is $36cm$ and the final image is formed at infinity. The focal length f_o of the objective and the focal length f_e of the eye piece are
(A) $f_o = 45\,cm$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

26. An initially parallel cylindrical beam travels in a medium of refractive index $\mu(I) = \mu_0 + \mu_2 I$ where μ_0 and μ_2 are positive constants and I is the intensity of the light beam. The intensity of the beam is decreasing with increasing radius.
As the beam enters the medium , it will
(A) travel as a cylindrical beam
(B) diverge
(C) converge
(D) diverge near the axis and converge near the periphery

27. The objective lens of a compound microscope produces magnification of 10. In order to get an overall magnification of 100 when image is formed at $25\,cm$ from the eye, the focal length of the eye lens should be
(A) $4\,cm$
(B) $10\,cm$
(C) $\frac{25}{9}$cm
(D) $9cm$

28. For a prism of apex angle 45^o, it is found that the angle of emergence is 45^o for grazing incidence. Calculate the refractive index of the prism.
(A) $(2)^{1/2}$
(B) $(3)^{1/2}$
(C) 2
(D) $(5)^{1/2}$

29. A light ray falls on a square glass slab as shown in the diagram. The index of refraction of the glass, if total internal reflection is to occur at the vertical face, is equal to



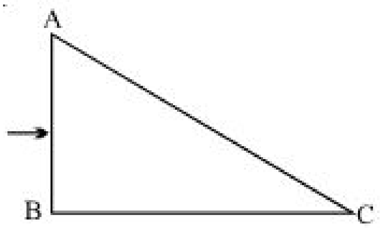
(A) $\frac{(\sqrt{2}\ +1)}{2}$
(B) $\sqrt{\frac{5}{2}}$
(C) $\frac{3}{2}$
(D) $\sqrt{\frac{3}{2}}$

30. A convex lens produces a real image m times the size of the object. What will be the distance of the object from the lens

(A) $\left(\frac{m+1}{m}\right) f$ (B) $(m-1)f$

(C) $\left(\frac{m-1}{m}\right) f$ (D) $\frac{m+1}{f}$

31. A ray of light is incident normally on a prism of refractive index 1.5, as shown. The prism is immersed in a liquid of refractive index $'\mu'$. The largest value of the angle ACB, so that the ray is totally reflected at the face AC, is 30^o. Then the value of μ must be :



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

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

32. A spherical surface of radius of curvature $10\,cm$ separates two media X and Y of refractive indices $3/2$ and $4/3$ respectively. Centre of the spherical surface lies in denser medium. An object is placed in medium X. For image to be real, the object distance must be

(A) greater than $90\,cm$ (B) less than $90\,cm.$

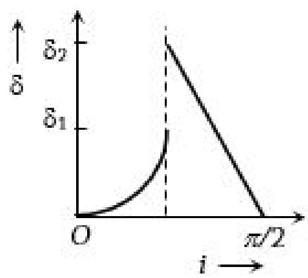
(C) greater than $80\,cm$ (D) less than $80\,cm.$

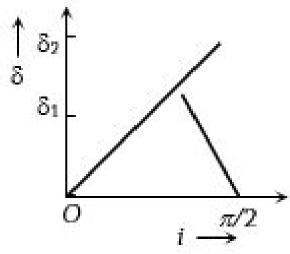
33. An electric bulb illuminates a plane surface. The intensity of illumination on the surface at a point $2m$ away from the bulb is $5 \times 10^{-4}\ phot\ (lumen/cm^2)$. The line joining the bulb to the point makes an angle of 60^o with the normal to the surface. The intensity of the bulb in candela is

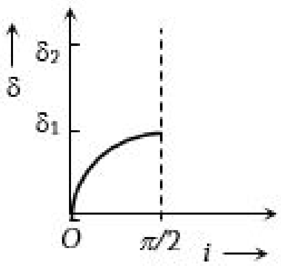
(A) $40\sqrt{3}$ (B) 40

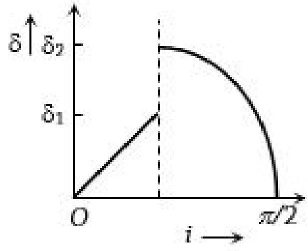
(C) 20 (D) 40×10^{-4}

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

(A) 

(B) 

(C) 

(D) 

35. 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 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) $2d\left(\frac{1}{\mu_1\mu_2}\right)$

36. A combination of two thin lenses with focal lengths f_1 and f_2 respectively forms an image of distant object at distance $60cm$ when lenses are in contact. The position of this image shifts by $30cm$ towards the combination when two lenses are separated by $10cm$. The corresponding values of f_1 and f_2 are

(A) $30\ cm, -60cm$ (B) $20cm,\ -30cm$

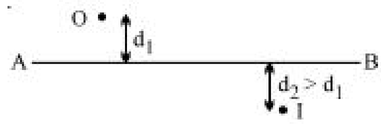
(C) $15cm,\ -20cm$ (D) $12\ cm,\ -15cm$

37. An object is placed infront of a convex mirror at a distance of $50\,cm$. A plane mirror is introduced covering the lower half of the convex mirror. If the distance between the object and plane mirror is $30\,cm$, it is found that there is no parallax between the images formed by two mirrors. Radius of curvature of mirror will be......cm

(A) 12.5 (B) 25

(C) $\frac{50}{3}$ (D) 18

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



(A) concave & placed towards right I (B) concave & placed towards left of I

(C) convex and placed towards right of I (D) convex & placed towards left of I.

39. A ray of light from a denser medium strike a rarer medium. The angle of reflection is r and that of refraction is r'. The reflected and refracted rays make an angle of 90^o with each other. The critical angle will be :

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

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

40. The focal lengths of the objective and eye-lens of a microscope are $1\,cm$ and $5\,cm$ respectively. If the magnifying power for the relaxed eye is 45, then the length of the tube is.......cm

(A) 30 (B) 25

(C) 15 (D) 12

41. A tiny air bubble in a glass slab $(\mu = 1.5)$ appears from one side to be $6\,cm$ from the glass surface and from other side, $4\,cm$. The thickness of the glass slab is......cm

(A) 10 (B) 6.67

(C) 15 (D) None of these

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

(A) 30 (B) 60

(C) 45 (D) $\sin^{-1}\sqrt{1.5}$

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

(A) 10 (B) 15

(C) 2.5 (D) 5

44. The focal length of lens of refractive index 1.5 in air is $30cm$. When it is immersed in a liquid of refractive index $\frac{4}{3}$, then its focal length in liquid will be......cm

(A) 30 (B) 60

(C) 120 (D) 240

45. We wish to see inside an atom. Assuming the atom to have a diameter of $100\ pm$, this means that one must be able to resolved a width of say $10\ p.m.$ If an electron microscope is used, the minimum electron energy required is about.......KeV

(A) 1.5 (B) 15
(C) 150 (D) 1.5

46. The separation between the screen and a concave mirror is $2r$. An isotropic point source of light is placed exactly midway between the mirror and the point source. Mirror has a radius of curvature r and reflects 100% of the incident light. Then the ratio of illuminances on the screen with and without the mirror is

(A) $10:1$ (B) $2:1$
(C) $10:9$ (D) $9:1$

47. There is an equiconvex glass lens with radius of each face as R and ${}_a\mu_g = 3/2$ and ${}_a\mu_w = 4/3$. If there is water in object space and air in image space, then the focal length is

(A) $2R$ (B) R
(C) $3\dfrac{R}{2}$ (D) R^2

48. The magnifying power of an astronomical telescope is 8 and the distance between the two lenses is $54\,cm$. The focal length of eye lens and objective lens will be respectively

(A) $6\,cm$ and $48\,cm$ (B) $48\,cm$ and $6\,cm$
(C) $8\,cm$ and $64\,cm$ (D) $64\,cm$ and $8\,cm$

49. A simple telescope, consisting of an objective of focal length $60\,cm$ and a single eye lens of focal length $5\,cm$ is focussed on a distant object is such a way that parallel rays comes out from the eye lens. If the object subtends an angle 2^o at the objective, the angular width of the image........^{o}

(A) 10 (B) 24
(C) 50 (D) $1/6$

50. In a parallel beam of white light is incident on a converging lens, the colour which is brought to focus nearest to the lens is

(A) Violet (B) Red
(C) The mean colour (D) All the colours together

51. Assertion: A double convex lens $(\mu = 1.5)$ has focal length $10\,cm$. When the lens is immersed in water $(\mu = 4/3)$ its focal length becomes $40\,cm$

Reason: $\dfrac{1}{f} = \dfrac{\mu_1 - \mu_m}{\mu_m}\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$

(A) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(B) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(C) If the Assertion is correct but Reason is incorrect.
(D) If both the Assertion and Reason are incorrect.

52. Material A has critical angle i_A, and material B has critical angle $i_B (i_B > i_A)$. Then which of the following is true

(i) Light can be totally internally reflected when it passes from B to A

(ii) Light can be totally internally reflected when it passes from A to B

(iii) Critical angle for total internal reflection is $i_B - i_A$

(iv) Critical angle between A and B is $\sin^{-1}\left(\dfrac{\sin i_A}{\sin i_B}\right)$

(A) (i) and (iii) (B) (i) and (iv)
(C) (ii) and (iii) (D) (ii) and (iv)

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

(A) $(2f, 2f)$ (B) $(f/2, f/2)$
(C) (f, f) (D) $(4f, 4f)$

54. A man can see only between $75\,cm$ and $100\,cm$. The power of lens to correct the near point will be

(A) $+\dfrac{8}{3}D$ (B) $+3\,D$
(C) $-3\,D$ (D) $-\dfrac{8}{3}D$

55. A concave mirror is used to form image of the Sun on a white screen. If the lower half of the mirror were covered with an opaque card, the effect on the image on the screen would be

(A) negligible (B) to make the image less bright than before
(C) to make the upper half of the image disappear (D) to make the lower half of the image disappear

56. It is desired to photograph the image of an object placed at a distance of $3m$ from the plane mirror. The camera which is at a distance of $4.5m$ from the mirror should be focussed for a distance of......m

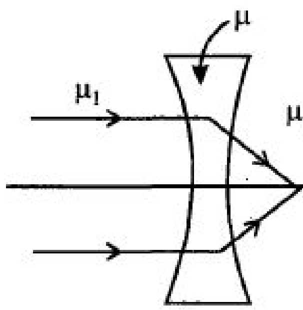
(A) 3 (B) 4.5
(C) 6 (D) 7.5

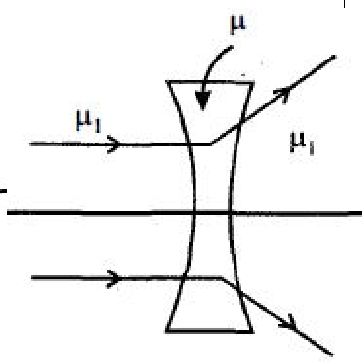
57. Each quarter of a vessel of depth H is filled with liquids of the refractive indices n_1, n_2, n_3 and n_4 from the bottom respectively. The apparent depth of the vessel when looked normally is

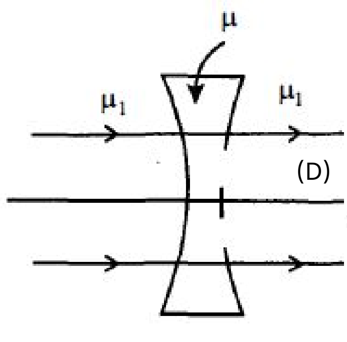
(A) $\dfrac{H(n_1 + n_2 + n_3 + n_4)}{4}$ (B) $\dfrac{H\left(\dfrac{1}{n_1} + \dfrac{1}{n_2} + \dfrac{1}{n_3} + \dfrac{1}{n_4}\right)}{4}$

(C) $\dfrac{(n_1 + n_2 + n_3 + n_4)}{4H}$ (D) $\dfrac{H\left(\dfrac{1}{n_1} + \dfrac{1}{n_2} + \dfrac{1}{n_3} + \dfrac{1}{n_4}\right)}{2}$

58. The refractive index of the material of a concave lens is μ. It is immersed in a medium of refractive index μ_1 . A parallel beam of light is incident on the lens. The path of the emergent rays when $\mu_1 > \mu$ is

(A)


(B)


(C)


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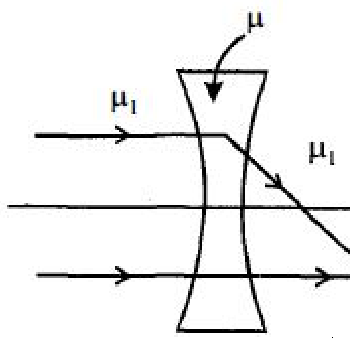
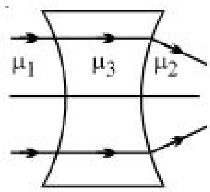
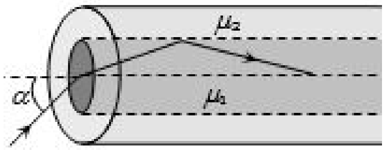


59. From the figure shown establish a relation between, μ_1, μ_2, μ_3.



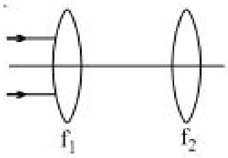
(A) $\mu_1 < \mu_2 < \mu_3$ (B) $\mu_3 < \mu_2; \mu_3 = \mu_1$
(C) $\mu_3 > \mu_2; \mu_3 = \mu_1$ (D) None of these

60. An optical fibre consists of core of μ_1 surrounded by a cladding of μ_2 < μ_1. A beam of light enters from air at an angle α with axis of fibre. The highest α for which ray can be travelled through fibre is



(A) $\cos^{-1}\sqrt{\mu_2^2 - \mu_1^2}$ (B) $\sin^{-1}\sqrt{\mu_1^2 - \mu_2^2}$
(C) $\tan^{-1}\sqrt{\mu_1^2 - \mu_2^2}$ (D) $\sec^{-1}\sqrt{\mu_1^2 - \mu_2^2}$

61. Parallel beam of light is incident on a system of two convex lenses of focal lengths $f_1 = 20\,cm$ and $f_2 = 10\,cm$. What should be the distance between the two lenses so that rays after refraction from both the lenses pass undeviated :........cm



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

62. If an observer is walking away from the plane mirror with $6m/sec.$ Then the velocity of the image with respect to observer will be........m/sec

(A) 6 (B) -6
(C) 12 (D) 3

63. A convex lens of focal length $40cm$ is in contact with a concave lens of focal length $25cm$. The power of combination is

(A) $-1.5D$ (B) $-6.5D$
(C) $+6.5D$ (D) $+6.67D$

64. A parallel beam of white light falls on a convex lens. Images of blue, yellow and red light are formed on other side of the lens at a distance of $0.20m, 0.205m$ and $0.214m$ respectively. The dispersive power of the material of the lens will be

(A) $619/1000$ (B) $9/200$
(C) $14/205$ (D) $5/214$

65. If the refractive indices of crown glass for red, yellow and violet colours are $1.5140, 1.5170$ and 1.5318 respectively and for flint glass these are $1.6434, 1.6499$ and 1.6852 respectively, then the dispersive powers for crown and flint glass are respectively

(A) 0.034 and 0.064 (B) 0.064 and 0.034
(C) 1.00 and 0.064 (D) 0.034 and 1.0

66. An object is placed in front of a thin convex lens of focal length $30\,cm$ and a plane mirror is placed $15\,cm$ behind the lens. If the final image of the object coincides with the object, the distance of the object from the lens is.....cm

(A) 60 (B) 30
(C) 15 (D) 25

67. The light ray is incidence at angle of 60^o on a prism of angle 45^o . When the light ray falls on the other surface at 90^o , the refractive index of the material of prism μ and the angle of deviation δ are given by

(A) $\mu = \sqrt{2}\,,\, \delta = 30^o$ (B) $\mu = 1.5\,,\, \delta = 15^o$
(C) $\mu = \dfrac{\sqrt{3}}{2}, \delta = 30^o$ (D) $\mu = \sqrt{\dfrac{3}{2}}, \delta = 15^o$

68. To prepare a print the time taken is $5\,sec$ due to lamp of $60\,watt$ at $0.25\,m$ distance. If the distance is increased to $40\,cm$ then what is the time taken to prepare the similar print......sec

(A) 3.1 (B) 1
(C) 12.8 (D) 16

69. Two plane mirrors are inclined at 70^o. Aray incident on one mirror at angle θ after reflection falls on the second mirror and is reflected from there parallel to the first mirror, θ is ......^{o}

(A) 50 (B) 45
(C) 30 (D) 55

70. A Galileo telescope has an objective of focal length $100\,cm$ and magnifying power 50. The distance between the two lenses in normal adjustment will be......cm

(A) 96 (B) 98
(C) 102 (D) 104

71. A plano-convex lens is made of refractive index of 1.6. The radius of curvature of the curved surface is $60cm.$ The focal length of the lens is.....cm

(A) 400 (B) 200
(C) 100 (D) 50

72. A telescope has an objective of focal length $50cm$ and an eye piece of focal length $5cm.$ The least distance of distinct vision is $25cm.$ The telescope is focussed for distinct vision on a scale $200cm$ away. The separation between the objective and the eye-piece is.......cm

(A) 75 (B) 60
(C) 71 (D) 74

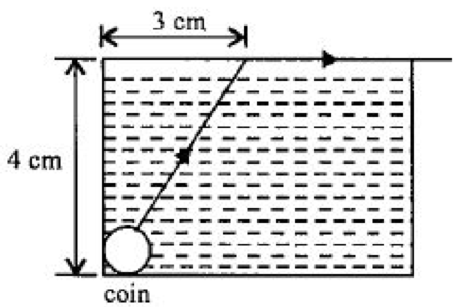
73. A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is $\dfrac{4}{3}$ and the fish is $12\,cm$ below the surface, the radius of this circle in cm is

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

74. The power (in diopters) of an equiconvex lens with radii of curvature of $10\,cm$ and refractive index of 1.6 is :

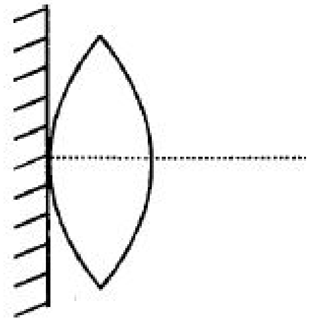
(A) -12 (B) $+12$
(C) $+1.2$ (D) -1.2

75. A small coin is resting on the bottom of a beaker filled with liquid. A ray of light from the coin travels upto the surface of the liquid and moves along its surface. How fast is the light travelling in the liquid?



(A) $2.4 \times\ 10^8 m/s$ (B) $3.0 \times\ 10^8 m/s$
(C) $1.2 \times\ 10^8 m/s$ (D) $1.8 \times\ 10^8 m/s$

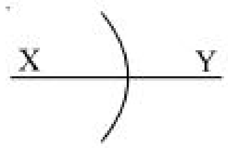
76. A thin convex lens of focal length $'f'$ is put on a plane mirror as shown in the figure. When an object is kept at a distance $'a'$ from the lens - mirror combination, its image is formed at a distance $\frac{a}{3}$ in front of the combination. The value of $'a'$ is



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

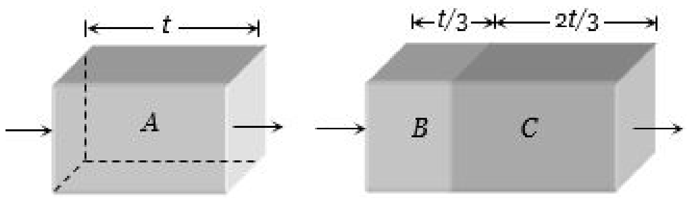
77. A person is in a room whose ceiling and two adjacent walls are mirrors. How many images are formed
(A) 5 (B) 6
(C) 7 (D) 8

78. A concave spherical surface of radius of curvature $10cm$ separates two medium x & y of refractive index $4/3$ & $3/2$ respectively. If the object is placed along principal axis in medium X then



(A) image is always real
(B) image is real if the object distance is greater than $90cm$
(C) image is always virtual
(D) image is virtual if the object distance is less than $90cm$

79. Two transparent slabs have the same thickness as shown. One is made of material A of refractive index 1.5. The other is made of two materials B and C with thickness in the ratio $1 : 2$. The refractive index of C is 1.6. If a monochromatic parallel beam passing through the slabs has the same number of waves inside both, the refractive index of B is



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

80. Diameter of a plano-convex lens is $6\,cm$ and thickness at the centre is $3\,mm$. If the speed of light in the material of the lens is $2 \times 10^8 m/sec$, the focal length of the lens is.......cm
(A) 15 (B) 20
(C) 30 (D) 10

81. An object $2.5\,cm$ high is placed at a distance of $10\,cm$ from a concave mirror of radius of curvature $30\,cm$ The size of the image is........cm
(A) 9.2 (B) 10.5
(C) 5.6 (D) 7.5

82. A short sighted person can see distinctly only those objects which lie between $10\,cm$ and $100\,cm$ from him. The power of the spectacle lens required to see a distant object is
(A) $+0.5\,D$ (B) $-1.0\,D$
(C) $-10\,D$ (D) $+4.0\,D$

83. A ray of light is incident upon an air/water interface (it passes from air into water) at an angle of 45^o. Which of the following quantities change as the light enters the water?

(I) wavelength (II) frequency
(III) speed of propagation (IV) direction of propagation

(A) I, III only (B) III, IV only
(C) I, II, IV only (D) I, III, IV only

84. A thin prism of angle 5^o is placed at a distance of $10\,cm$ from object. What is the distance of the image from object? (Given μ of prism $= 1.5$)
(A) $\frac{\pi}{8}cm$ (B) $\frac{\pi}{12}cm$
(C) $\frac{5\pi}{36}cm$ (D) $\frac{\pi}{7}cm$

85. A concave lens and a convex lens have same focal length of $20cm$ and both put in contact this combination is used to view an object $5cm$ long kept at $20cm$ from the lens combination. As compared to object the image will be
(A) Magnified and inverted (B) Reduced and erect
(C) Of the same size and erect (D) Of the same size and inverted

86. A convex lens (of focal length $20\,cm$) and a concave mirror, having their principal axes along the same lines, are kept $80\,cm$ apart from each other. The concave mirror is to the right of the convex lens. When an object is kept at a distance of $30\,cm$ to the left of the convex lens, its image remains at the same position even if the concave mirror is removed. The maximum distance of the object for which this concave mirror, by itself would produce a virtual image would be.....cm
(A) 20 (B) 10
(C) 30 (D) 40

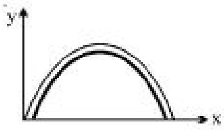
87. A thin rod of length $f/3$ lies along the axis of a concave mirror of focal length f. One end of its magnified image touches an end of the rod. The length of the image is
(A) f (B) $\frac{1}{2}f$
(C) $2f$ (D) $\frac{1}{4}f$

88. A movie projector forms an image $3.5m$ long of an object $35mm$. Supposing there is negligible absorption of light by aperture then illuminance on slide and screen will be in the ratio of
(A) $100 : 1$ (B) $10^4 : 1$
(C) $1 : 100$ (D) $1 : 100^4$

89. If a convex lens of focal length $80cm$ and a concave lens of focal length $50cm$ are combined together, what will be their resulting power
(A) $+6.5D$ (B) $-6.5D$
(C) $+7.5D$ (D) $-0.75D$

90. The distance of the moon from earth is $3.8 \times 10^5 km$. The eye is most sensitive to light of wavelength 5500. The separation of two points on the moon that can be resolved by a $500\ cm$ telescope will be......m
(A) 51 (B) 60
(C) 70 (D) All the above

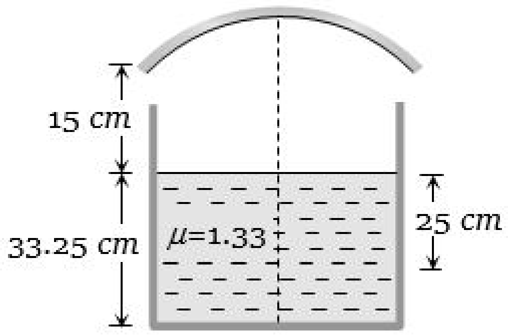
91. A reflecting surface is represented by the equation $Y = \frac{2L}{\pi}\sin\left(\frac{\pi x}{L}\right)$, $0 \le x \le L$. A ray travelling horizontally becomes vertical after reflection. The coordinates of the point (s) where this ray is incident is ?



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

(C) $\left(\frac{2L}{3}, \frac{\sqrt{3}\,L}{\pi}\right)$ (D) Both (B) and (C)

92. A container is filled with water $(\mu = 1.33)$ upto a height of $33.25\ cm$. A concave mirror is placed $15\ cm$ above the water level and the image of an object placed at the bottom is formed $25\ cm$ below the water level. The focal length of the mirror is



(A) 10 (B) 15

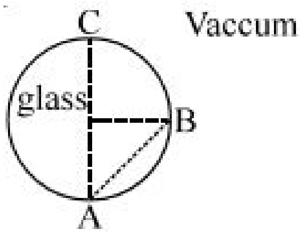
(C) 20 (D) 25

93. The diameter of moon is $3.5 \times 10^3 km$ and its distance from the earth is $3.8 \times 10^5 km.$ If it is seen through a telescope whose focal length for objective and eye lens are $4\ m$ and $10\ cm$ respectively, then the angle subtended by the moon on the eye will be approximately.......^{o}

(A) 15 (B) 20

(C) 30 (D) 35

94. It is found that electromagnetic signals sent inside glass sphere from A towards B reach point C. The speed of electromagnetic signals in glass cannot be:



(A) $1.0 \times 10^8 m/s$ (B) $2.4 \times 10^8 m/s$

(C) $2 \times 10^7 m/s$ (D) $4 \times 10^7 m/s$

95. Light is incident from a medium into air at two possible angles of incidence $(A)\,20^o$ and $(B)\,40^o$. In the medium light travels $3.0\,cm$ in $0.2\,ns$. The ray will

(A) suffer total internal reflection in both cases (A) and (B)

(B) suffer total internal reflection in case (B) only

(C) have partial reflection and partial transmission in case (B)

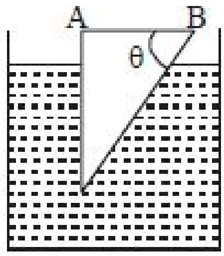
(D) have 100% transmission in case (A)

96. A boy is trying to start a fire by focusing sunlight on a piece of paper using an equiconvex lens of focal length $10\ cm.$ The diameter of the sun is $1.39 \times 10^9\ m$ and its mean distance from the earth is $1.5 \times 10^{11}\ m.$ What is the diameter of the sun's image on the paper?

(A) $6.5 \times\ 10^{-5} m$ (B) $12.4 \times\ 10^{-4} m$

(C) $9.2 \times\ 10^{-4} m$ (D) $6.5 \times\ 10^{-4} m$

97. A glass prism of refractive index 1.5 is immersed in water (refractive index $4/3$). A light beam incident normally on the face AB is totally reflected to reach on the face BC if



(A) $\sin\,\theta \geqslant \frac{8}{9}$ (B) $\frac{2}{3} <\ \sin\,\theta < \frac{8}{9}$

(C) $\sin\,\theta \leqslant \frac{2}{3}$ (D) None of these

98. How much water should be filled in a container $21cm$ in height, so that it appears half filled when viewed from the top of the container......cm (given that ${}_a\mu_\omega = 4/3$)

(A) 8 (B) 10.5

(C) 12 (D) None of the above

99. A ray of light is incident at an angle of 75^o into a medium having refractive index μ . The reflected and the refracted rays are found to suffer equal deviations in opposite direction μ equals

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

(C) $\frac{2\sqrt{2}}{\sqrt{3}\ +1}$ (D) None of these

100. A thin convex lens made from crown glass $\left(\mu = \frac{3}{2}\right)$ has focal length f. When it is measured in two different liquids having refractive indices $\frac{3}{2}$ and $\frac{3}{2}$ it has the focal lengths f_1 and f_2 respectively. The correct relation between the focal lengths is:

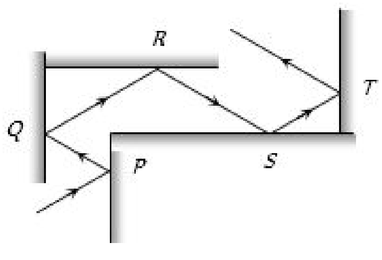
(A) $f_1 > f$ and f_2 becomes negative

(B) $f_2 > f$ and f_1 becomes negative

(C) f_1 and f_2 both becomes negative

(D) $f_1 = f_2 < f$

101. Following figure shows the multiple reflections of a light ray along a glass corridor where the walls are either parallel or perpendicular to one another. If the angle of incidence at point P is 30^o , what are the angles of reflection of the light ray at points Q, R, S and T respectively



(A) $30^o\ ,30^o\ ,30^o\ ,30^o$ (B) $30^o\ ,60^o\ ,30^o\ ,60^o$

(C) $30^o\ ,60^o\ ,60^o\ ,30^o$ (D) $60^o\ ,60^o\ ,60^o\ ,60^o$

102. The refracting angle of prism is A and refractive index of material of prism is $\cot\frac{A}{2}$. The angle of minimum deviation is

(A) $180° - 3A$ (B) $180° + 2A$

(C) $90° - A$ (D) $180° - 2A$

103. A screen is placed $90\,cm$ from a object. The image of an object on the screen is formed by a convex lens at two different locations separated by $20\,cm.$ if the size of the image formed at the positions are $6\,cm$ and $3\,cm$, then the highest of the object is.....cm

(A) 4.2 (B) 4.5

(C) 5 (D) none of these

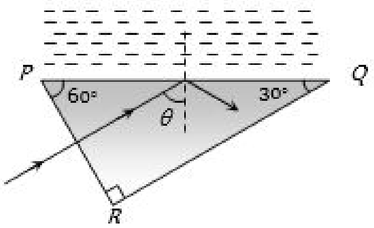
104. A prism of refracting angle 60^o is made with a material of refractive index μ. For a certain wavelength of light, the angle of minimum deviation is 30^o. For this, wavelength the value of refractive index of the material is

(A) 1.231 (B) 1.82
(C) 1.503 (D) 1.414

105. If two lenses of $+5$ diopters are mounted at some distance apart, the equivalent power will always be negative if the distance is

(A) Greater than $40cm$ (B) Equal to $40cm$
(C) Equal to $10cm$ (D) Less than $10cm$

106. PQR is a right angled prism with other angles as 60^o and 30^o. Refractive index of prism is 1.5. PQ has a thin layer of liquid. Light falls normally on the face PR. For total internal reflection, maximum refractive index of liquid is



(A) 1.4 (B) 1.3
(C) 1.2 (D) 1.6

107. The sun makes 0.5^o angle on earth surface. Its image is made by convex lens of $50cm$ focal length. The diameter of the image will be......mm

(A) 5 (B) 4.36
(C) 7 (D) None of these

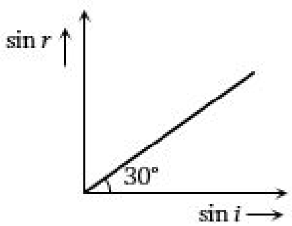
108. One face of a rectangular glass plate $6\,cm$ thick is silvered. An object held $8\,cm$ in front of the first face, forms an image $12\,cm$ behind the silvered face. The refractive index of the glass is

(A) 0.4 (B) 0.8
(C) 1.2 (D) 1.6

109. 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

110. A medium shows relation between i and r as shown. If speed of light in the medium is nc then value of n is



(A) 1.5 (B) 2
(C) 2^{-1} (D) $3^{-1/2}$

111. A curved surface of radius R separates two medium of refractive indices μ_1 and μ_2 as shown in figures A and B Identify the correct statement (s) related to the formation of images of a real object O placed at x from the pole of the concave surface, as shown in figure B

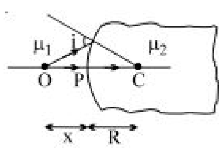


Fig. A

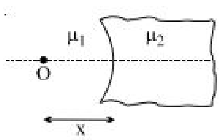


Fig. B

(A) If $\mu_2 > \mu_1$, then virtual image is formed for any value of x

(B) If $\mu_2 < \mu_1$, then virtual image is formed if $x < \dfrac{\mu_1 R}{\mu_1 - \mu_2}$

(C) If $\mu_2 < \mu_1$, then real image is formed for any value of x

(D) Both (A) and (B)

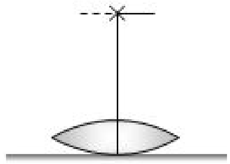
112. A prism $(\mu = 1.5)$ has the refracting angle of 30^o . The deviation of a monochromatic ray incident normally on its one surface will be $(sin48^o\ 36' = 0.75)$

(A) $18^o\ 36'$ (B) $20^o\ 30'$
(C) 18^o (D) $22^o\ 1'$

113. In a compound microscope the focal length of objective lens is $1.2\,cm$ and focal length of eye piece is $3.0\,cm$. When object is kept at $1.25\,cm$ in front of objective, final image is formed at infinity. Magnifying power of the compound microscope should be

(A) 200 (B) 100
(C) 400 (D) 150

114. A lens when placed on a plane mirror then object needle and its image coincide at $15\,cm$. The focal length of the lens is......cm



(A) 15 (B) 30
(C) 20 (D) ∞

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

(A) 80 (B) 40
(C) 20 (D) 162

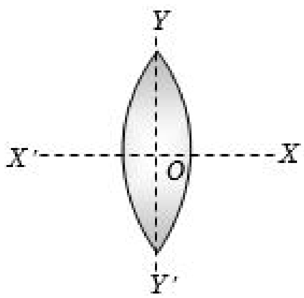
116. The magnifying power of a telescope with tube 60 cm is 5. What is the focal length of its eye piece?......cm

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

117. An achromatic convergent lens of focal length $20\,cms$ is made of two lenses (in contact) of materials having dispersive powers in the ratio of $1:2$ and having focal lengths f_1 and f_2. Which of the following is true ?

(A) $f_1 = 10\,cms,\ f_2 = -20\,cms,$ (B) $f_1 = 20\,cms,\ f_2 = 10\,cms,$
(C) $f_1 = -10\,cms,\ f_2 = -20\,cms,$ (D) $f_1 = 20\,cms,\ f_2 = -20\,cms,$

118. An equiconvex lens is cut into two halves along $(i) XOX'$ and $(ii) YOY'$ as shown in the figure. Let f, f', f" be the focal lengths of the complete lens, of each half in case (i), and of each half in case (ii), respectively Choose the correct statement from the following



(A) $f' = 2f,\ f'' = f$ (B) $f' = f,\ f'' = f$
(C) $f' = 2f,\ f'' = 2f$ (D) $f' = f,\ f'' = 2f$

119. Let the refractive index of a denser medium with respect to a rarer medium be n_{12} and its critical angle be θ_C. At an angle of incidence A when light is travelling from denser medium to rarer medium, a part of the light is reflected and the rest is refracted and the angle between reflected and refracted rays is 90^o. Angle A is given by

(A) $\frac{1}{\cos^{-1}(\sin\theta_C)}$ (B) $\frac{1}{\tan^{-1}(\sin\theta_C)}$

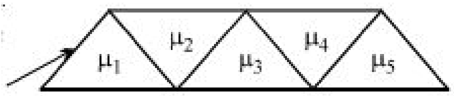
(C) $\cos^{-1}(\sin\theta_C)$ (D) $\tan^{-1}(\sin\theta_C)$

120. The refracting angle of prism is 60^o and the index of refraction is $\sqrt{7/3}$ relative to surrounding. The limiting angle of incidence of a ray that the will be transmitted through the prism is ......^{o}

(A) 30 (B) 45

(C) 15 (D) 50

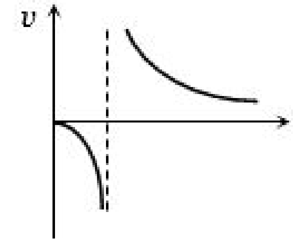
121. The diagram shows five isosceles right angled prisms.Alight ray incident at 90^o at the first face emerges at same angle with the normal from the last face. Which of the following relations will hold regarding the refractive indices?

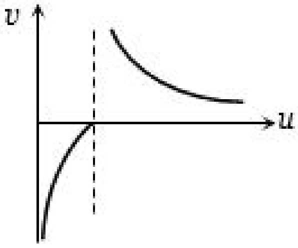


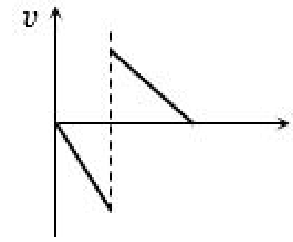
(A) $\mu_1^2+\mu_3^2+\mu_5^2=\mu_2^2+\mu_4^2$ (B) $\mu_1^2+\mu_3^2+\mu_5^2=1+\mu_2^2+\mu_4^2$

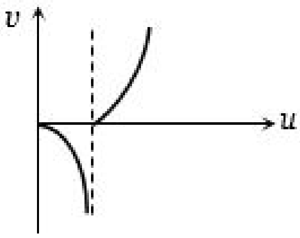
(C) $\mu_1^2+\mu_3^2+\mu_5^2=2+\mu_2^2+\mu_4^2$ (D) none

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

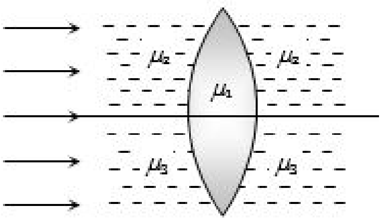
(A)


(B)


(C)


(D)


123. A double convex lens, lens made of a material of refractive index μ_1, is placed inside two liquids or refractive indices μ_2 and μ_3, as shown. $\mu_2>\mu_1>\mu_3$. A wide, parallel beam of light is incident on the lens from the left. The lens will give rise to



(A) A single convergent beam (B) Two different convergent beams

(C) Two different divergent beams (D) A convergent and a divergent beam

124. The diameter of the objective lens of a telescope is $5.0\,m$ and wavelength of light is 6000. The limit of resolution of this telescope will be......sec

(A) 0.03 (B) 3.03

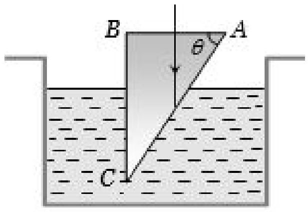
(C) 0.06 (D) 0.15

125. A magnifying glass is to be used at the fixed object distance of 1 inch. If it is to produce an erect image magnified 5 times its focal length should be........$inch$

(A) 0.2 (B) 0.8

(C) 1.25 (D) 5

126. A glass prism $(\mu=1.5)$ is dipped in water $({}_a\mu_w=4/3)$ as shown in figure. A light ray is incident normally on the surface AB. It reaches the surface BC after totally reflected, if



(A) $sin\theta\ \geq 8/9$ (B) $2/3<sin\theta<8/9$

(C) $sin\theta\ \leq 2/3$ (D) It is not possible

127. 1% of light of a source with luminous intensity 50 candela is incident on a circular surface of radius $10\,cm$. The average illuminance of surface is

(A) $100\,lux$ (B) $200\,lux$

(C) $300\,lux$ (D) $400\,lux$

128. A compound microscope has an eye piece of focal length $10\,cm$ and an objective of focal length $4\,cm$. Calculate the magnification, if an object is kept at a distance of $5\,cm$ from the objective so that final image is formed at the least distance vision $(20\,cm)$

(A) 12 (B) 11

(C) 10 (D) 13

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

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

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

130. A convex lens is in contact with concave lens. The magnitude of the ratio of their focal length is $2/3$. Their equivalent focal length is $30cm$. What are their individual focal lengths

(A) $-75,50$ (B) $-10,15$

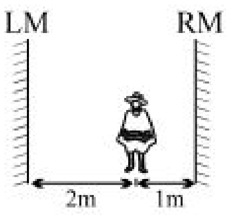
(C) $75,50$ (D) $-15,10$

131. Two thin lenses of focal lengths f_1 and f_2 are in contact. The focal length of this combination is

(A) $\frac{f_1f_2}{f_1-f_2}$ (B) $\frac{f_1f_2}{f_1+f_2}$

(C) $\frac{2f_1f_2}{f_1-f_2}$ (D) $\frac{2f_1f_2}{f_1+f_2}$

132. Two mirrors, labeled LM for left mirror and RM for right mirror in the adjacent figure, are parallel to each other and $3.0\,m$ apart. A person standing $1.0\,m$ from the right mirror (RM) looks into this mirror and sees a series of images. How far from the person is the second closest image seen in the right mirror (RM)?......m



(A) 10 (B) 4

(C) 6 (D) 8

133. A astronomical telescope has objective and eyepiece of focal lengths $40\ cm$ and $4\ cm$ respectively. To view an object $200\ cm$ away from the objective, the lenses must be separated by a distance.....cm

(A) 46 (B) 50
(C) 54 (D) 37.3

134. Two lenses have focal lengths f_1 and f_2 and their dispersive powers are ω_1 and ω_2 respectively. They will together form an achromatic combination if

(A) $\omega_1 f_1 = \omega_2 f_2$ (B) $\omega_1 f_2 + \omega_2 f_1 = 0$
(C) $\omega_1 + f_1 = \omega_2 + f_2$ (D) $\omega_1 - f_1 = \omega_2 - f_2$

135. Two parallel pillars are $11\,km$ away from an observer. The minimum distance between the pillars so that they can be seen separately will be.....m

(A) 3.2 (B) 20.8
(C) 91.5 (D) 183

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

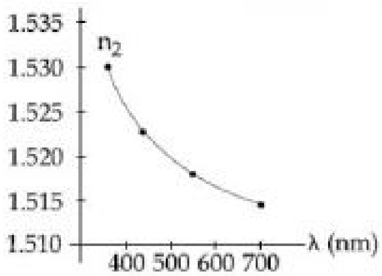
137. The magnifying power of a telescope is 9. When it is adjusted for parallel rays, the distance between the objective and the eye-piece is found to be $20\,cm$. The focal length of the two lenses are

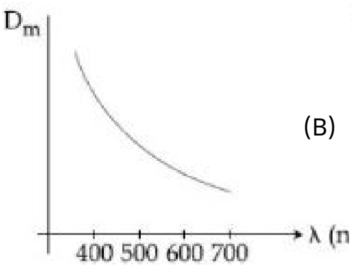
(A) $18\,cm, 2\,cm$ (B) $11\,cm, 9\,cm$
(C) $10\,cm, 10\,cm$ (D) $15\,cm, 5\,cm$

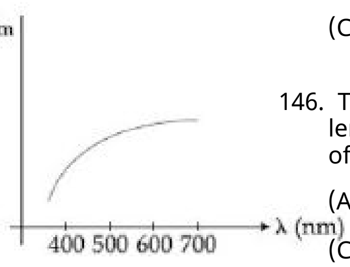
138. A point object is placed at the center of a glass sphere of radius $6cm$ and refractive index 1.5. The distance of the virtual image from the surface of the sphere is.......cm

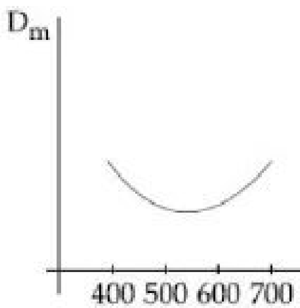
(A) 2 (B) 4
(C) 6 (D) 12

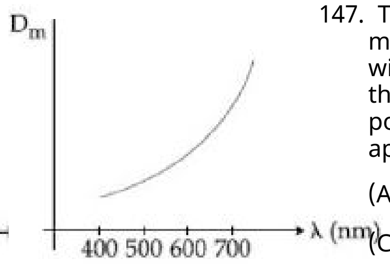
139. The variation of refractive index of a crown glass thin prism with wavelength of the incident light is shown. Which of the following, graph is the correct one, if D_m is the angle of minimum deviation?



(A)


(B)


(C)


(D)


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

(A) $\frac{t\,\theta\,(n-1)}{n}$ (B) $\frac{t\,\theta}{n}$
(C) $\frac{t\,\theta\,n}{n-1}$ (D) none

141. A person is suffering from myopic defect. He is able to see clear objects placed at $15\,cm$. What type and of what focal length of lens he should use to see clearly the object placed $60\,cm$ away

(A) Concave lens of $20\,cm$ focal length (B) Convex lens of $20\,cm$ focal length
(C) Concave lens of $12\,cm$ focal length (D) Convex lens of $12\,cm$ focal length

142. A convergent doublet of separated lenses, corrected for spherical aberration, has resultant focal length of $10\,cm$. The separation between the two lenses is $2\,cm$. The focal lengths of the component lenses

(A) $18\,cm, 20\,cm$ (B) $10\,cm, 12\,cm$
(C) $12\,cm, 14\,cm$ (D) $16\,cm, 18\,cm$

143. A thin glass (refractive index 1.5) lens has optical power of $-5D$ in air. It's optical power in a liquid medium with refractive index 1.6 will be

(A) $25D$ (B) $-25D$
(C) $1D$ (D) None of these

144. The refractive index of the material of a prism is $\sqrt{2}$ and the angle of the prism is 30^o . One of the two refracting surfaces of the prism is made a mirror inwards, by silver coating. A beam of monochromatic light entering the prism from the other face will retrace its path (after reflection from the silvered surface) if its angle of incidence on the prism is

(A) 60^o (B) 45^o
(C) 0^o (D) 30^o

145. A thin rod of $5cm$ length is kept along the axis of a concave mirror of $10cm$ focal length such that its image is real and magnified and one end touches the rod. Its magnification will be

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

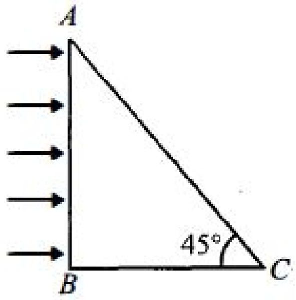
146. The dispersive power of the material of lens of focal length $20cm$ is 0.08. The longitudinal chromatic aberration of the lens is......cm

(A) 0.08 (B) $0.08/20$
(C) 1.6 (D) 0.16

147. The origin of x and y coordinates is the pole of a concave mirror of focal length $20\,cm$. The x -axis is the optical axis with $x > 0$ being the real side of mirror. A point object at the point $(25\,cm, 1\,cm)$ is moving with a velocity $10\,cm/s$ in positive x -direction. The velocity of the image in cm/s is approximately

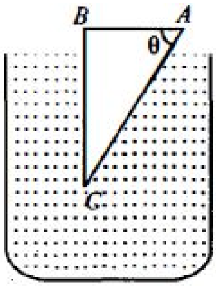
(A) $-80\,i + 8\,j$ (B) $160\,i + 8\,j$
(C) $-160\,i + 8\,j$ (D) $160\,i - 4\,j$

148. A beam of light consisting of red, green and blue colours is incident on a right-angled prism on face AB. The refractive indices of the material for the above red, green and blue colours are $1.39, 1.44$ and 1.47 respectively. A person looking on surface AC of the prism will see



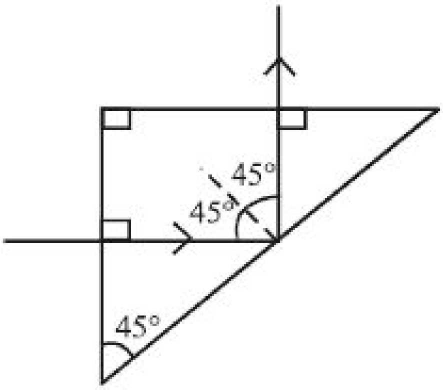
(A) no light (B) green and blue colours
(C) red and green colours (D) red colour only

149. A glass prism of refractive index 1.5 is immersed in water (refractive index $\frac{4}{3}$) as shown in figure. A light beam incident normally on the face AB is totally reflected to reach the face BC, if



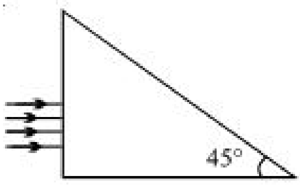
(A) $\sin\ \theta > \frac{5}{9}$ (B) $\sin\ \theta > \frac{2}{3}$
(C) $\sin\ \theta > \frac{8}{9}$ (D) $\sin\ \theta > \frac{1}{3}$

150. A light ray is incident perpendicularly to one face of a 90^o prism and is totally internally reflected at the glass-air interface. If the angle of reflection is 45^o, we conclude that the refractive index



(A) $n > \frac{1}{\sqrt{2}}$ (B) $n > \sqrt{2}$
(C) $n < \frac{1}{\sqrt{2}}$ (D) $n < \sqrt{2}$

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



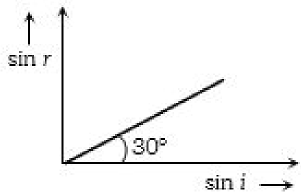
(A) separate part of the red color from the green and blue colors.
(B) separate part of the blue color from the red and green colours.
(C) separate all the three colors from the other two colors.
(D) not separate even partially any color from the other two colors.

152. A transparent cube of $15\,cm$ edge contains a small air bubble. Its apparent depth when viewed through one face is $6\,cm$ and when viewed through the opposite face is $4\,cm$. Then the refractive index of the material of the cube is
(A) 2 (B) 2.5
(C) 1.6 (D) 1.5

153. A prism has a refractive index $\sqrt{\frac{3}{2}}$ and refracting angle 90^o. Find the minimum deviation produced by prism........^{o}
(A) 40 (B) 45
(C) 30 (D) 49

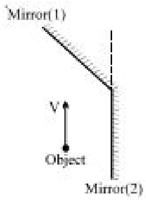
154. If convex lens of focal length $80cm$ and a concave lens of focal length $50cm$ are combined together, what will be their resulting power
(A) $+6.5D$ (B) $-6.5D$
(C) $+7.5D$ (D) $-0.75D$

155. When light is incident on a medium at angle i and refracted into a second medium at an angle r, the graph of $sin\,i$ vs $sin\,r$ is as shown in the graph. From this, one can conclude that



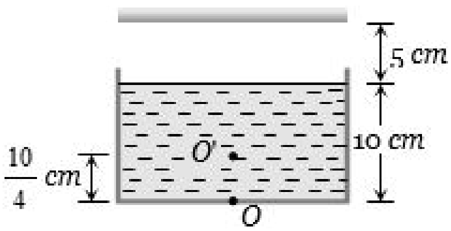
(A) Velocity of light in the second medium is 1.73 times the velocity of light in the I medium
(B) Velocity of light in the I medium is 1.73 times the velocity in the II medium
(C) The critical angle for the two media is given bysin $i_c = \frac{1}{\sqrt{3}}$
(D) Both (b) and (c)

156. In the diagram shown, all the velocities are given with respect to earth. What is the relative velocity of the image in mirror (1) with respect to the image in the mirror (2)? The mirror (1) forms an angle β with the vertical.



(A) $2V\,sin\,2\beta$ (B) $2V\,sin\beta$
(C) $2V\,/\,sin2\beta$ (D) none

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



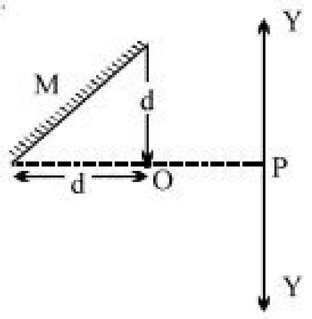
(A) 15 (B) 12.5
(C) 7.5 (D) 10

158. A concave mirror is placed on a horizontal surface and two thin uniform layers of different transparent liquids (which do not mix or interact) are formed on the reflecting surface. The refractive indices of the upper and lower liquids are μ_1 and μ_2 respectively. The bright point source at a height $'d'$ (d is very large in comparison to the thickness of the film) above the mirror coincides with its own final image. The radius of curvature of the reflecting surface therefore is

(A) $\frac{\mu_1 d}{\mu_2}$ (B) $\mu_1\mu_2 d$

(C) $\mu_1 d$ (D) $\mu_2 d$

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



(A) For all point on PY man can see the image of O

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

(C) For all point on PY' he can see the image but on PY he can see the image only upto distance d.

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

160. The focal length of the field lens (which is an achromatic combination of two lenses) of telescope is $90cm$. The dispersive powers of the two lenses in the combination are 0.024 and 0.036. The focal lengths of two lenses are

(A) $30cm$ and $60cm$ (B) $30cm$ and $-45cm$

(C) $45cm$ and $90cm$ (D) $15cm$ and $45cm$

161. A plano-convex lens of refractive index 1.5 and radius of curvature $30cm$ is silvered at the curved surface. Now this lens has been used to form the image of an object. At what distance from this lens an object be placed in order to have a real image of the size of the object.......cm

(A) 20 (B) 30

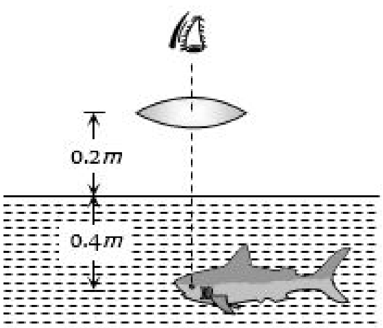
(C) 60 (D) 80

162. A bi-concave symmetric lens made of glass has refractive index 1.5. It has both surfaces of same radius of curvature R. On immersion in a liquid of refractive index 1.25, it will behave as a

(A) Converging lens of focal length $2.5\,R$ (B) Converging lens of focal length $2.0\,R$

(C) Diverging lens of focal length $4.5\,R$ (D) None of these

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



(A) A distance of $0.2\,m$ from the water surface (B) A distance of $0.6\,m$ from the water surface

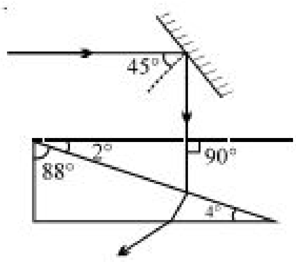
(C) A distance of $0.3\,m$ from the water surface (D) The same location of fish

164. In a plano-convex lens the radius of curvature of the convex lens is $10cm.$ If the plane side is polished, then the focal length will be.........cm (Refractive index $= 1.5$)

(A) 10.5 (B) 10

(C) 5.5 (D) 5

165. A ray of light strikes a plane mirror at an angle of incidence 45^o as shown in the figure.After reflection, the ray passes through a prism of refractive index 1.5, whose apex angle is 4^o. The angle through which the mirror should be rotated if the total deviation of the ray is to be 90^o is



(A) 1^o clockwise (B) 1^o anticlockwise

(C) 2^o clockwise (D) 2^o anticlockwise

166. For the angle of minimum deviation of a prism to be equal to its refracting angle, the prism must be made of a material whose refractive index

(A) lies between $\sqrt{2}$ and 1 (B) lies between 2 and $\sqrt{2}$

(C) > 1 (D) < 1

167. A ray of light is incident at an angle of incidence, i, on one face of prism of angle A (assumed to be small) and emerges normally from the opposite face. If the refractive index of the prism is μ, the angle of incidence i, is nearly equal to

(A) μA (B) $\frac{\mu A}{2}$

(C) $\frac{A}{\mu}$ (D) $\frac{A}{2\mu}$

168. A curved surface of radius R separates two medium of refractive indices μ_1 and μ_2 as shown in figures A and B Choose the correct statement (s) related to the real image formed by the object O placed at a distance x, as shown in figure A

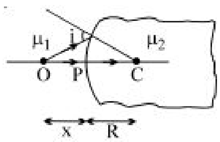


Fig. A

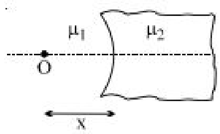


Fig. B

(A) Real image is always formed irrespective of the position of object if $\mu_2 > \mu_1$

(B) Real image is formed only when $x > R$

(C) Real image is formed due to the convex nature of the interface irrespective of μ_1 and μ_2

(D) None of these

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

(A) $2\sin A$ (B) $2\cos A$

(C) $\frac{1}{2}\cos A$ (D) $\tan A$

170. Match the corresponding entries of column 1 with column 2. [Where mis the magnification produced by the mirror]

$Column - I$	$Column - II$
1. $m = -2$	a. $Convex\ mirror$
2. $m = \frac{-1}{2}$	b. $Concave\ mirror$
3. $m = +2$	c. $Real\ Image$
4. $m = \frac{+1}{2}$	d. $Virtual\ image$

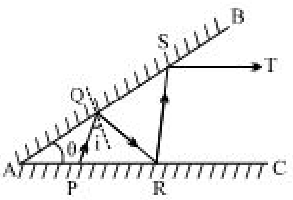
(A) $(1-a$ and $c), (2-a$ and $d), (3-a$ and $b)(4-c$ and $d)$

(B) $(1-a$ and $d), (2-b$ and $c), (3-b$ and $d)(4-b$ and $c)$

(C) $(1-c$ and $d), (2-b$ and $d), (3-b$ and $c)(4-a$ and $d)$

(D) $(1-b$ and $c), (2-b$ and $d), (3-a$ and $b)(4-c$ and $d)$

171. Two plane mirror AB and AC are inclined at an angle $\theta = 20^o$.A ray of light starting from point P is incident at point Q on the mirroe AB, then at R on mirror AC and again on S on AB finally the ray ST goes parallel to mirror AC. The angle iwhich the ray makes with the normal at point Q on mirror AB is



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

172. The focal length of an objective of a telescope is $3 metre$ and diameter $15cm$. Assuming for a normal eye, the diameter of the pupil is $3\ mm$ for its complete use, the focal length of eye piece must be......cm

(A) 6
(B) 6.3
(C) 20
(D) 60

173. The focal length of objective and eye-piece of a telescope are $100\,cm$ and $5\,cm$ respectively. Final image is formed at least distance of distinct vision. The magnification of telescope is

(A) 20
(B) 24
(C) 30
(D) 36

174. Two plane mirrors are inclined to each other such that a ray of light incident to the first mirror (M_1) and parallel to the second mirror (M_2) is finally reflected from the second mirror (M_2) parallel to the first mirror (M_1). The angle between the two mirrors will be......^{o}

(A) 45
(B) 60
(C) 75
(D) 90

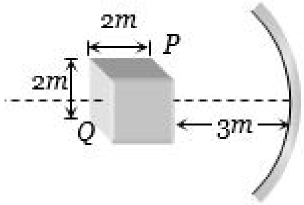
175. A square of side $3cm$ is placed at a distance of $25cm$ from a concave mirror of focal length $10cm$. The centre of the square is at the axis of the mirror and the plane is normal to the axis. The area enclosed by the image of the square is......cm^2

(A) 4
(B) 6
(C) 16
(D) 36

176. A luminous object is placed at a distance of $30\,cm$ from the convex lens of focal length $20\,cm$. On the other side of the lens, at what distance from the lens a convex mirror of radius of curvature $10\,cm$ be placed in order to have an upright image of the object coincident with it.....cm

(A) 12
(B) 30
(C) 50
(D) 60

177. A cube of side $2\,m$ is placed in front of a concave mirror focal length $1\,m$ with its face P at a distance of $3\,m$ and face Q at a distance of $5\,m$ from the mirror. The distance between the images of face P and Q and height of images of P and Q are



(A) $1\,m, 0.5\,m, 0.25\,m$
(B) $0.5\,m, 1\,m, 0.25\,m$
(C) $0.5\,m, 0.25\,m, 1\,m$
(D) $0.25\,m, 1\,m, 0.5\,m$

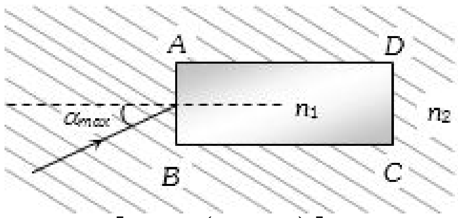
178. The relative luminosity of wavelength $600\,nm$ is 0.6. Find the radiant flux of $600\,nm$ needed to produce the same brightness sensation as produced by $120\,W$ of radiant flux at $555\,nm$.........W

(A) 50
(B) 72
(C) $120 \times (0.6)^2$
(D) 200

179. It is desired to make an achromatic combination of two lenses (L_1 & L_2) made of materials having dispersive powers ω_1 and $\omega_2 (< \omega_1)$. If the combination of lenses is converging then

(A) L_1 is converging
(B) L_2 is converging
(C) Power of L_1 is greater than the power of L_2
(D) None of these

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

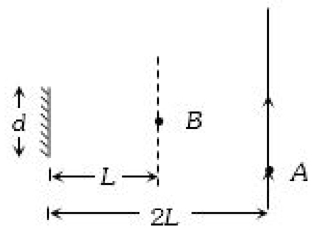


(A) $\sin^{-1}\left[\frac{n_1}{n_2}\cos\left(\sin^{-1}\frac{n_2}{n_1}\right)\right]$
(B) $\sin^{-1}\left[n_1\cos\left(\sin^{-1}\frac{1}{n_2}\right)\right]$
(C) $\sin^{-1}\left(\frac{n_1}{n_2}\right)$
(D) $\sin^{-1}\left(\frac{n_2}{n_1}\right)$

181. The unit of focal power of a lens is

(A) Watt
(B) Horse power
(C) Dioptre
(D) Lux

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



(A) $d/2$
(B) d
(C) $2d$
(D) $3d$

183. For the refraction of light through a prism

(A) Angle of minimum deviation will increase if refractive index of prism is increased keeping the outside medium unchanged if $\mu_P > \mu_S$.

(B) The light travelling inside an equilateral prism is necessarily parallel to the base when prism is set for minimum deviation.

(C) There are two angles of incidence for maximum deviation.

(D) All of the above

184. A microscope is focussed on a coin lying at the bottom of a beaker. The microscope is now raised up by $1\,cm$. To what depth should the water be poured into the beaker so that coin is again in focus ?........cm (Refractive index of water is $\frac{4}{3}$)

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

(C) 3 (D) 4

185. If luminous efficiency of a lamp is 2 lumen/watt and its luminous intensity is 42 candela, then power of the lamp is.......W

(A) 62 (B) 76

(C) 138 (D) 264

186. A concave mirror is placed at the bottom of an empty tank with face upwards and axis vertical. When sunlight falls normally on the mirror, it is focussed at distance of $32\,cm$ from the mirror. If the tank filled with water $\left(\mu=\frac{4}{3}\right)$ upto a height of $20\,cm$, then the sunlight will now get focussed at

(A) $16\,cm$ above water level (B) $9\,cm$ above water level

(C) $24\,cm$ below water level (D) $9\,cm$ below water level

187. A small source of light is to be suspended directly above the centre of a circular table of radius R. What should be the height of the light source above the table so that the intensity of light is maximum at the edges of the table compared to any other height of the source

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

(C) R (D) $\sqrt{2}R$

188. A plano convex lens of refractive index μ_1 and focal length f_1 is kept in contact with another plano concave lens of refractive index μ_2 and focal length f_2. If the radius of curvature of their spherical faces is R each and $f_1=2f_2$, then μ_1 and μ_2 are related as

(A) $\mu_1+2\mu_2=3$ (B) $2\mu_1+\mu_2=1$

(C) $3\mu_2+\mu_1=1$ (D) $2\mu_2+\mu_1=1$

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

(A) $f/2, I/2$ (B) $f, I/4$

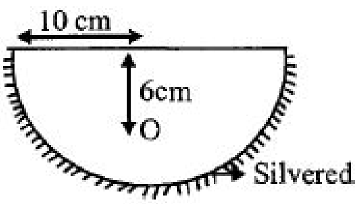
(C) $3f/4, I/2$ (D) $f, 3I/4$

190. An object is placed at a distance of $40\ cm$ from a concave mirror of focal length $15\ cm.$ If the object is displaced through a distance of $20\ cm$ towards the mirror, the displacement of the image will be

(A) $30cm$ away from the mirror (B) $36cm$ away from the mirror

(C) $36\ \mathrm{cm}$ towards the mirror (D) $30\ \mathrm{cm}$ towards the mirror

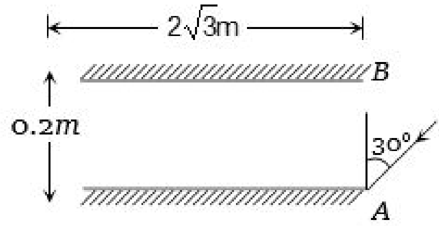
191. A hemispherical glass body of radius $10\,cm$ and refractive index 1.5 is silvered on its curved surface. A small air bubble is $6\,cm$ below the flat surface inside it along the axis. The position of the image of the air bubble made by the mirror is seen



(A) $14\,cm$ below flat surface (B) $20\,cm$ below flat surface

(C) $16\,cm$ below flat surface (D) $30\,cm$ below flat surface

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



(A) 28 (B) 30

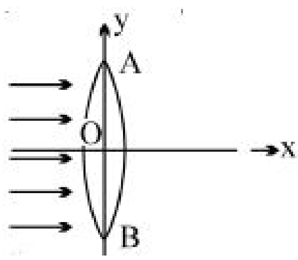
(C) 32 (D) 34

193. Two vertical plane mirrors are inclined at an angle of 60° with each other. A ray of light travelling horizontally is reflected first from one mirror and then from the other. The resultant deviation is.....^{o}

(A) 60 (B) 120

(C) 180 (D) 240

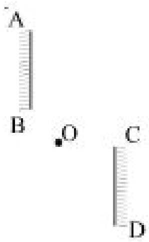
194. Monochromatic light rays parallel to x -axis strike a convex lens AB. If the lens oscillates such that AB tilts upto a small angle θ (in radian) on either side of y -axis, then the amplitude of oscillation of image will be (f = focal length of the lens):



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

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

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



(A) 1 (B) 2

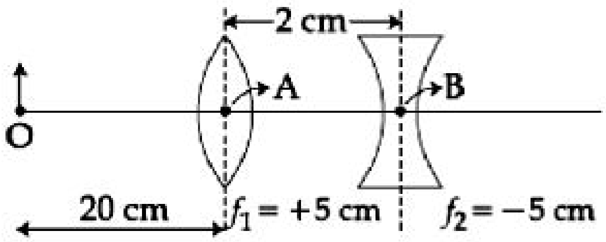
(C) 4 (D) Infinite

196. Two lenses are placed in contact with each other and the focal length of combination is $80cm$. If the focal length of one is $20cm$, then the power of the other will be

(A) $1.66D$ (B) $4.00D$

(C) $-1.00D$ (D) $-3.75D$

197. What is the position and nature of image formed by lens combination shown in figure? (f_1, f_2 are focal lengths)

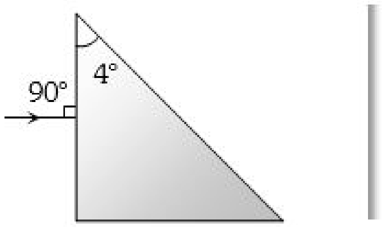


(A) $70\,cm$ from point B at left; virtual
(B) $40\,cm$ from point B at right; real
(C) $\frac{20}{3}cm$ from point B at right; real
(D) $70\,cm$ from point B at right ; real

198. A thin prism having refracting angle 10^o is made of glass of refractive index 1.42. This prism is combined with another thin prism of glass of refractive index 1.7. This combination produces dispersion without deviation. The refracting angle of second prism should be....^{o}

(A) 6
(B) 8
(C) 10
(D) 4

199. A prism having an apex angle 4^o and refraction index 1.5 is located in front of a vertical plane mirror as shown in figure. Through what total angle is the ray deviated after reflection from the mirror.....^{o}



(A) 176
(B) 4
(C) 178
(D) 2

200. A thin oil layer floats on water. A ray of light making an angle of incidence of 40^o shines on oil layer. The angle of refraction of light ray in water is......^{o}

($\mu_{oil} = 1.45,\ \mu_{water} = 1.33$)

(A) 36.1
(B) 44.5
(C) 26.8
(D) 28.9

ANSWER KEY

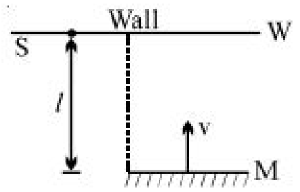
PHYSICS

1 - D	2 - A	3 - C	4 - A	5 - D	6 - C	7 - C	8 - B	9 - C	10 - B
11 - C	12 - D	13 - C	14 - A	15 - C	16 - A	17 - B	18 - B	19 - C	20 - B
21 - C	22 - B	23 - C	24 - A	25 - D	26 - C	27 - C	28 - D	29 - D	30 - A
31 - D	32 - A	33 - B	34 - A	35 - B	36 - B	37 - B	38 - B	39 - A	40 - C
41 - C	42 - C	43 - D	44 - C	45 - B	46 - B	47 - C	48 - A	49 - B	50 - A
51 - A	52 - D	53 - A	54 - A	55 - B	56 - D	57 - B	58 - A	59 - B	60 - B
61 - B	62 - C	63 - A	64 - C	65 - A	66 - B	67 - D	68 - C	69 - A	70 - B
71 - C	72 - C	73 - A	74 - B	75 - D	76 - D	77 - C	78 - C	79 - C	80 - C
81 - D	82 - B	83 - D	84 - C	85 - C	86 - B	87 - B	88 - B	89 - D	90 - A
91 - D	92 - C	93 - B	94 - B	95 - B	96 - C	97 - A	98 - C	99 - B	100 - A
101 - C	102 - D	103 - A	104 - D	105 - A	106 - B	107 - B	108 - C	109 - B	110 - D
111 - D	112 - A	113 - A	114 - A	115 - B	116 - D	117 - A	118 - D	119 - D	120 - A
121 - C	122 - A	123 - D	124 - A	125 - C	126 - A	127 - B	128 - A	129 - C	130 - D
131 - B	132 - C	133 - C	134 - B	135 - A	136 - C	137 - A	138 - C	139 - A	140 - A
141 - A	142 - A	143 - D	144 - B	145 - B	146 - C	147 - C	148 - D	149 - C	150 - B
151 - A	152 - D	153 - C	154 - D	155 - D	156 - B	157 - B	158 - D	159 - C	160 - B
161 - A	162 - D	163 - D	164 - B	165 - B	166 - B	167 - A	168 - D	169 - B	170 - D
171 - B	172 - A	173 - B	174 - B	175 - A	176 - C	177 - D	178 - D	179 - B	180 - A
181 - C	182 - D	183 - D	184 - D	185 - D	186 - B	187 - B	188 - A	189 - D	190 - B
191 - B	192 - B	193 - D	194 - D	195 - A	196 - D	197 - D	198 - A	199 - C	200 - D

SOLUTION

PHYSICS

1. A flat mirror M is arranged parallel to a wall W at a distance l from it. The light produced by a point source S kept on the wall is reflected by the mirror and produces a light spot on the wall. The mirror moves with velocity v towards the wall.



(A) The spot of light will move with the speed v on the wall.

(B) The spot of light will not move on the wall.

(C) The size of the light spot on the wall remains the same.

(D) ✓Both (B) and (C)

Sol : since the mirror M is perfectly parallel to the wall w, its distance from the wall does not matter for the light spot. So the spot light will remain stationary. Also the source being point source, the image size will also remain a point. Hence correct Answer are option B, C

2. Choose the correct statement (s) related to the motion of object and its image in the case of mirrors

(A) ✓Object and its image always move along normal $w.r.t.$ mirror in opposite directions

(B) Only in the case of convex mirror, it may happen that the object and its image move in the same direction

(C) Only in the case of concave mirror, it may happen that the object and its image move in the same direction

(D) Only in case of plane mirrors, object and its image move in opposite directions

Sol : In all the types of mirror (i.e.plane mirror, convex mirror, concave mirror) object and its image always move along normal w.r.t mirror in opposite directions.

3. A small source of light is $4m$ below the surface of a liquid of refractive index $5/3$. In order to cut off all the light coming out of liquid surface, minimum diameter of the disc placed on the surface of liquid is ....m

(A) 3

(B) 4

(C) ✓6

(D) ∞

Sol : Taking refraction at B

$$\frac{5}{3} \times \sin C = 1 \times \sin 90^{\circ}$$

$$\sin C = \frac{3}{5}$$

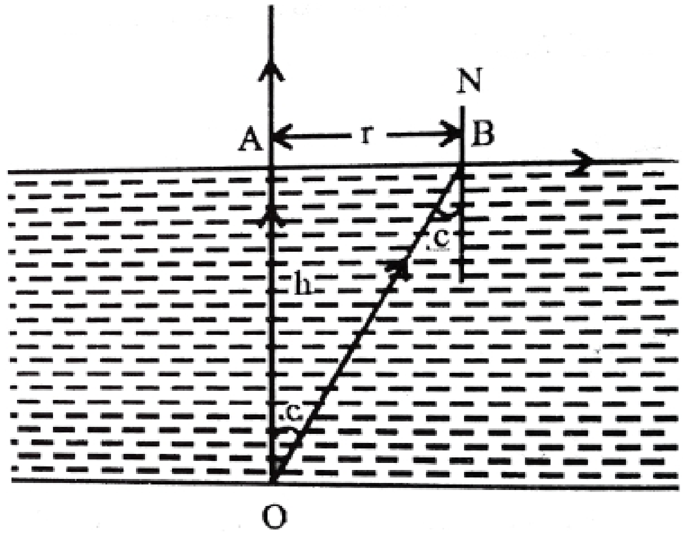
From rightangled triangle OAB

$$\frac{r}{\sqrt{r^2 + h^2}} = \frac{3}{5}$$

$$25r^2 = 9r^2 + 9h^2 \Rightarrow 16r^2 = 9h^2$$

$$r = \frac{3}{4} \times h \Rightarrow r = \frac{3}{4} \times 4 \Rightarrow r = 3m$$

diameter $= 6m$



4. A telescope has an objective lens of focal length $200\,cm$ and an eye piece with focal length $2\,cm$. If this telescope is used to see a 50 meter tall building at a distance of $2\,km$, what is the height of the image of the building formed by the objective lens......cm

(A) ✓5

(B) 10

(C) 1

(D) 2

Sol : (a) Magnification of objective lens

$$m = \frac{I}{O} = \frac{v_0}{u_0} = \frac{f_0}{u_0}$$

$$==> \frac{I}{50} = \frac{200 \times 10^{-2}}{2 \times 10^3}$$

$$==> I = 5 \times 10^{-2} m = 5\,cm.$$

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

(A) the angle between the mirror is 60^o

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

(C) the no. of images will be 5 if an object is kept unsymmetrically between the mirrors.

(D) ✓All of the above

6. Two stars situated at distances of 1 and 10 light years respectively from the earth appear to possess the same brightness. The ratio of their real brightness is

(A) $1:10$

(B) $10:1$

(C) ✓$1:100$

(D) $100:1$

Sol : (c) $I = \frac{L}{r^2} \Rightarrow \frac{L_1}{r_1^2} = \frac{L_2}{r_2^2}$ (I is same)

$$\Rightarrow \frac{L_1}{L_2} = \frac{r_1^2}{r_2^2} = \left(\frac{1}{10}\right)^2 = 1:100.$$

7. A lens having focal length and aperture of diameter d forms an image f of intensity I. Aperture of diameter $\frac{d}{2}$ in central region of lens is covered by a black paper. Focal length of lens and intensity of image now will be respectively

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

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

(C) ✓$f, \frac{3I}{4}$

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

Sol : Focal length of the lens remains same. Intensity of image formed by lens is proportional to area exposed to incident light from object.

i.e. Intensity $\propto$ area

or $\frac{I_2}{I_1} = \frac{A_2}{A_1}$

Initial area, $A_1 = \pi\left(\frac{d}{2}\right)^2 = \frac{\pi d^2}{4}$

After blocking, exposed area,

$$A_2 = \frac{\pi d^2}{4} - \frac{\pi(d/2)^2}{4} = \frac{\pi d^2}{4} - \frac{\pi d^2}{16} = \frac{3\pi d^2}{16}$$

$$\frac{I_2}{I_1} = \frac{A_2}{A_1} = \frac{\frac{3\pi d^2}{16}}{\frac{\pi d^2}{4}} = \frac{3}{4}$$

or $I_2 = \frac{3}{4}I_1 = \frac{3}{4}I \quad (\because I_1 = I)$

Hence, focal length of a lens $= f$, intensity of the image $= \frac{3I}{4}$

8. An achromatic convergent doublet of two lens in contact has a power of $+2\,D$. The convex lens is 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) $5:3$

Sol : Goven: $P_1 = 5D$

$P - 2 = P - P_1 = 2 - 5 = -3D$

$$\frac{\omega_1}{\omega_2} = -\frac{f_1}{f_2} = \frac{-P_2}{P_1} = \frac{3}{5}$$

9. Two plane mirrors are inclined at an angle of 72^0. The number of images of a point object placed between them will be

(A) 2 (B) 3
(C) ✓4 (D) 5

Sol : (c)$n = \left(\frac{360}{\theta} - 1\right) \Rightarrow n = \left(\frac{360}{72} - 1\right) = 4$

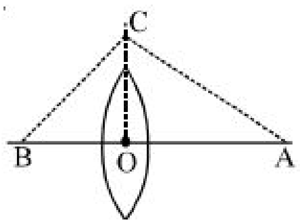
10. The focal lengths of the objective and eye lenses of a telescope are respectively $200\,cm$ and $5\,cm$. The maximum magnifying power of the telescope will be

(A) -40 (B) ✓-48
(C) -60 (D) -100

Sol : (b) Magnifying power of astronomical telescope

$$m = -\frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) = -\frac{200}{5}\left(1 + \frac{5}{25}\right) = -48.$$

11. If an object is placed at $A(OA > f)$; Where f is the focal length of the lens the image is found to be formed at $B.A$ perpendicular is erected at o and C is chosen on it such that the angle $\angle BCA$ is a right angle. Then the value of f will be



(A) AB/OC^2 (B) $(AC)(BC)/OC$
(C) ✓OC^2/AB (D) $(OC)(AB)/AC + BC$

Sol : $\frac{1}{f} = \frac{1}{OB} - \frac{1}{-OA} = \frac{1}{OB} + \frac{1}{OA}$

$$f = \frac{(OA)(OB)}{AB + OB}$$

$$\therefore f = \frac{(OA)(OB)}{AB} \ldots (i)$$

Now, $AB^2 = AC^2 + BC^2$

or $(OA + OB)^2 = AC^2 + BC^2$

or $OA^2 + OB^2 + 2(OA)(OB) = AC^2 + BC^2$

$\therefore (AC^2 - OC^2) + (BC^2 - OC^2)$

$+2(OA)(OB) = AC^2 + BC^2$

Solving, we get

$(OA)(OB) = OC^2$

Substituting in Eq. (i), we get

$$f = \frac{OC^2}{AB}$$

12. A lamp is hanging along the axis of a circular table of radius r. At what height should the lamp be placed above the table, so that the illuminance at the edge of the table is $\frac{1}{8}$ of that at its center

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

Sol : (d)$\frac{I_{center}}{I_{edge}} = \frac{(r^2+h^2)^{3/2}}{h^3}$

$\Rightarrow 8 = \frac{(r^2+h^2)^{3/2}}{h^3} \Rightarrow 2h = (r^2+h^2)^{1/2}$

$\Rightarrow 4h^2 = r^2 + h^2 \Rightarrow 3h^2 = r^2$==>$h = \frac{r}{\sqrt{3}}$

13. A biconvex lens has a radius of curvature of magnitude $20\ cm$. Which one of the following options describe best the image formed of an object of height $2\ cm$ placed $30\ cm$ from the lens?

(A) Virtual, upright, height $= 1cm$ (B) Virtual, upright, height $= 0.5cm$
(C) ✓Real, inverted, height $= 4cm$ (D) Real, inverted, height $= 1cm$

Sol : In general we have assumed $\mu = 1.5$ So, $\mathrm{f} = 20\,\mathrm{cm}$

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

$\frac{1}{20} = \frac{1}{v} + \frac{1}{30}$

$\frac{1}{v} = \frac{1}{20} - \frac{1}{30} = \frac{10}{600}$

$v = 60\,\mathrm{cm}$

$\frac{\mathrm{h_i}}{\mathrm{h_o}} = 2$

$h_i = 2 \times |h_0|$

$\mathrm{h_i} = 4\,\mathrm{cm}$

Here, image is real, inverted, magnified field and height of image is $4\,\mathrm{cm}$

14. Two plane mirrors are placed parallel to each other at a distance L apart.A point object O is placed between them, at a distance $L/3$ from one mirror. Both mirrors form multiple images. The distance between any two images cannot be

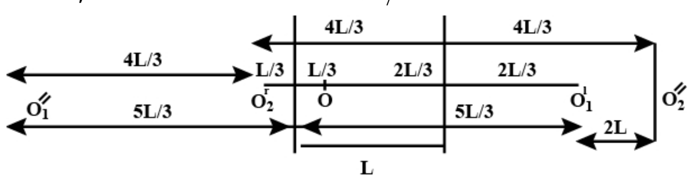
(A) ✓$3L/2$ (B) $2L/3$
(C) $2L$ (D) None

Sol : Please refer below image.

On the left side the distance between two images will be $= 4L/3$ and on

the right side the distance between the two adjacent image is $= 2L$

Hence, the distance cannot be $3L/2$



15. Spherical aberration in a lens

(A) Is minimum when most of the deviation is at the first surface

(B) Is minimum when most of the deviation is at the second surface

(C) ✓Is minimum when the total deviation is equally distributed over the two surface

(D) Does not depend on the above consideration

Sol : (c)

16. A point object is placed at a distance of $10\,cm$ and its real image is formed at a distance of $20\,cm$ from a concave mirror. If the object is moved by $0.1cm$ towards the mirror, the image will shift by about

(A) ✓$0.4cm$ away from the mirror

(B) $0.4cm$ towards the mirror

(C) $0.8cm$ away from the mirror

(D) $0.8cm$ towards the mirror

Sol : (a)Mirror formula

$\frac{1}{f}=\frac{1}{v}+\frac{1}{u}\Rightarrow\frac{1}{f}=\frac{1}{-20}+\frac{1}{(-10)}\Rightarrow f=\frac{20}{3}\,cm.$

If object moves towards the mirror by $0.1\,cm$ then.

$u=(10-0.1)=9.9\,cm.$ Hence again from mirror formula

$\frac{1}{-20/3}=\frac{1}{v'}+\frac{1}{-9.9}\Rightarrow v'=20.4\,cm$ i.e. image shifts away from the mirror by $0.4\,cm.$

17. A concave mirror of focal length $100\,cm$ is used to obtain the image of the sun which subtends an angle of $30°$. The diameter of the image of the sun will be.....cm

(A) 1.74

(B) ✓0.87

(C) 0.435

(D) 100

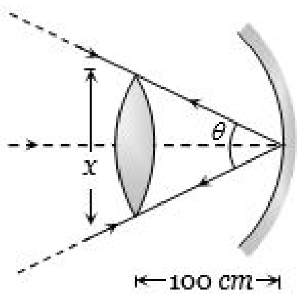
Sol : (b) The angle subtended by the image of the sun at the mirror

$=30'=\left(\frac{1}{2}\right)^o=\frac{\pi}{360}\,rad$

If x be the diameter of the image of the sun, then

$\frac{\text{Arc}}{\text{Radius}}=\frac{x}{100}=\frac{1}{2}.\frac{2\pi}{360}=\frac{\pi}{360}$

$\Rightarrow\; x=\frac{100\pi}{360}=0.87\,cm$



18. A vessel of depth 2h is half filled with a liquid of refractive index $2\sqrt{2}$ and the upper half with another liquid of refractive index $\sqrt{2}$. The liquids are immiscible. The apparent depth of the inner surface of the bottom of vessel will be

(A) $\frac{\text{h}}{\sqrt{2}}$

(B) ✓$\frac{3}{4}\text{h}\sqrt{2}$

(C) $\frac{\text{h}}{2(\sqrt{2}+1)}$

(D) $\frac{\text{h}}{3\sqrt{2}}$

Sol : For near normal incidence,

$\text{h}_{\text{app}}=\frac{\text{h}_{\text{actal}}}{\left(\frac{\mu_{\text{in}}}{\mu_{\text{rat}}}\right)}$

$\text{h}_{\text{apparent}}=\frac{\frac{\text{h}}{\left(\frac{2\sqrt{2}}{\sqrt{2}}\right)}+\text{h}}{\frac{\sqrt{2}}{1}}=\frac{3\text{h}}{2\sqrt{2}}=\frac{3}{4}\text{h}\sqrt{2}$

19. An object has image thrice of its original size when kept at $8cm$ and $16cm$ from a convex lens. Focal length of the lens is

(A) $8cm$

(B) $16cm$

(C) ✓Between $8cm$ and $16cm$

(D) Less than $8cm$

Sol : (c) $m=\pm3$, using $m=\frac{f}{f+u}$

For virtual image $3=\frac{f}{f-8}$ .....(i)

For real image $-3=\frac{f}{f-16}$ .....(ii)

Solving (i) and (ii) we get $f=12\,cm$

20. The focal length of a convex lens is $10cm$ and its refractive index is 1.5. If the radius of curvature of one surface is $7.5cm$, the radius of curvature of the second surface will be......cm

(A) 7.5

(B) ✓15

(C) 75

(D) 5

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

$\Rightarrow\frac{1}{+10}=(1.5-1)\left(\frac{1}{+7.5}-\frac{1}{R_2}\right)\frac{1}{f_e}$

21. A converging lens forms an image of an object on a screen. The image is real and twice the size of the object. If the positions of the screen and the object are interchanged, leaving the lens in the original position, the new image size on the screen is

(A) twice the object size

(B) same as the object size

(C) ✓half the object size

(D) can't say as it depends on the focal length of the lens.

22. When a glass prism of refracting angle 60^o is immersed in a liquid its angle of minimum deviation is 30^o. The critical angle of glass with respect to the liquid medium is......^{o}

(A) 42

(B) ✓45

(C) 50

(D) 52

Sol : (b)$A=60^o,\;\delta_m=30^o$so $\mu=\frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$\mu=\frac{\sin\left(\frac{60°+30°}{2}\right)}{\sin\left(\frac{60°}{2}\right)}=\frac{\sin45°}{\sin30°}=\sqrt{2}$

Also $\mu=\frac{1}{\sin C}\Rightarrow C=\sin^{-1}\left(\frac{1}{\mu}\right)\Rightarrow C=45^o$

23. To determine refractive index of glass slab using a travelling microscope, minimum number of readings required are

(A) 2

(B) 4

(C) ✓3

(D) 5

Sol : Reading one ⇒ without slab
Reading two ⇒ with slab
Reading three ⇒ with saw dust
Minimum three readings are required to determine refractive index of glass slab using a travelling microscope

24. A spherical surface of radius of curvature R separates air (refractive index 1.0) from glass (refractive index 1.5). The centre of curvature is in the glass. A point object P placed in air is found to have a real image Q in the glass. The lime PQ cuts the surface at the point O, and $PO=OQ$. The distance PO is equal to :

(A) ✓$5\,R$

(B) $3\,R$

(C) $2\,R$

(D) $1.5\,R$

Sol : When a ray light travels from μ_1 to μ_2 after refraction at a single curved surface,

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

As per sign convention,

$u = -x, v = +x, R$ is $+ve$

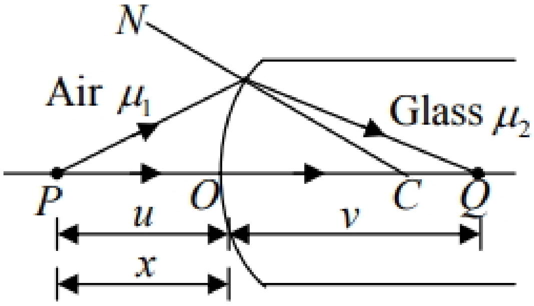
$\mu_1 = 1, \mu_2 = 1.5$

$\therefore \frac{1.5}{x} - \frac{1}{-x} = \frac{1.5 - 1}{R}$

or , $\frac{1.5}{x} + \frac{1}{x} = \frac{0.5}{R}$ or $\frac{2.5}{x}$

$= \frac{0.5}{R}$ or $x = 5R$

Distance $PO = 5R$



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

Sol : (d)In this case $|m| = \frac{f_o}{f_e} = 5$.... (i)

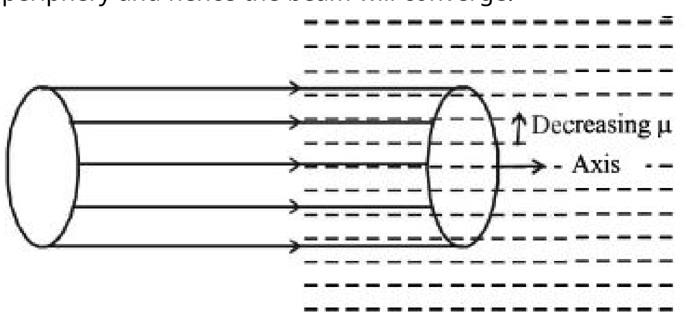
and length of telescope $= f_o + f_e = 36$.... (ii)

Solving (i) and (ii),

we get f_e = 6 cm,$f_o = 30\,cm$.

26. An initially parallel cylindrical beam travels in a medium of refractive index $\mu(I) = \mu_0 + \mu_2 I$ where μ_0 and μ_2 are positive constants and I is the intensity of the light beam. The intensity of the beam is decreasing with increasing radius.
As the beam enters the medium , it will
(A) travel as a cylindrical beam
(B) diverge
(C) ✓converge
(D) diverge near the axis and converge near the periphery

Sol : In the medium, the refractive index will decrease from the axis towards the periphery of the beam. Therefore, the beam will move as one move from the axis to the periphery and hence the beam will converge.



27. The objective lens of a compound microscope produces magnification of 10. In order to get an overall magnification of 100 when image is formed at $25\,cm$ from the eye, the focal length of the eye lens should be
(A) $4\,cm$
(B) $10\,cm$
(C) ✓ $\frac{25}{9}$cm
(D) $9cm$

Sol : (c) $m = m_o \times m_e \Rightarrow m = m_o \times \left(1 + \frac{D}{f_e}\right)$

$\Rightarrow 100 = 10 \times \left(1 + \frac{25}{f_e}\right) \Rightarrow f_e = \frac{25}{9}\,cm$

28. For a prism of apex angle 45^o, it is found that the angle of emergence is 45^o for grazing incidence. Calculate the refractive index of the prism.
(A) $(2)^{1/2}$
(B) $(3)^{1/2}$
(C) 2
(D) ✓$(5)^{1/2}$

Sol : $i = \frac{\pi}{2}, e = \frac{\pi}{4}, A = \frac{\pi}{4}$

$\frac{\sin i}{\sin r_1} = \frac{\sin e}{\sin r_2} = \mu$

$\Rightarrow \sin r_1 = \frac{1}{\mu}$ and $\sin r_2 = \frac{1}{\sqrt{2}\mu}$ since

$r_1 + r_2 = A = \frac{\pi}{4} \Rightarrow r_1 = \frac{\pi}{4} - r_2$

$\Rightarrow \sin r_1 = \frac{1}{\sqrt{2}} \cos r_2 - \frac{1}{\sqrt{2}} \sin r_2$

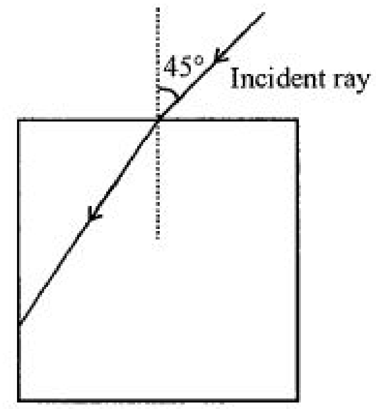
$= \sqrt{2} \sin r_1 + \sin r_2 = \cos r_2$

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

$= \frac{1}{\mu^2}\left(\frac{9}{2} + \frac{1}{2}\right) = 1$

$\mu^2 = 5 \Rightarrow \mu = \sqrt{5}$

29. A light ray falls on a square glass slab as shown in the diagram. The index of refraction of the glass, if total internal reflection is to occur at the vertical face, is equal to



(A) $\frac{(\sqrt{2} + 1)}{2}$
(B) $\sqrt{\frac{5}{2}}$
(C) $\frac{3}{2}$
(D) ✓ $\sqrt{\frac{3}{2}}$

Sol : At point A by Snell's law

$\mu = \frac{\sin 45^o}{\sin r} \Rightarrow \sin r = \frac{1}{\mu\sqrt{2}}$ ..... (i)

At point B, for total internal reflection,

$\sin i_1 = \frac{1}{\mu}$

From figure, $\mathrm{i}_1 = 90^\circ - \mathrm{r}$

$\therefore (\sin 90^o - r) = \frac{1}{\mu}$

$\Rightarrow \cos r = \frac{1}{\mu}$ ...... (ii)

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

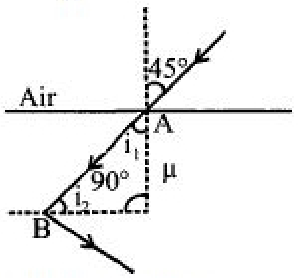
$= \sqrt{\frac{2\mu^2 - 1}{2\mu^2}}$ ...... (iii)

From eqs (ii) and (iii)

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

Squaring both sides and then solving, we get

$\mu = \sqrt{\frac{3}{2}}$



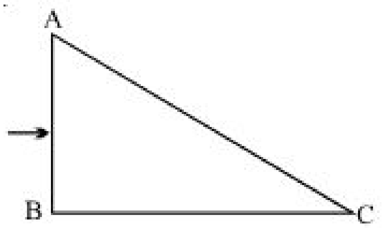
30. A convex lens produces a real image m times the size of the object. What will be the distance of the object from the lens

(A) ✓ $\left(\frac{m+1}{m}\right) f$ (B) $(m-1)f$

(C) $\left(\frac{m-1}{m}\right) f$ (D) $\frac{m+1}{f}$

Sol : (a) $m = \frac{f}{f+u} \Rightarrow -m = \frac{f}{f+u} \Rightarrow u = -\left(\frac{m+1}{m}\right) f$

31. A ray of light is incident normally on a prism of refractive index 1.5, as shown. The prism is immersed in a liquid of refractive index $'\mu'$. The largest value of the angle ACB, so that the ray is totally reflected at the face AC, is 30^o. Then the value of μ must be :



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

(C) $\frac{4}{3}$ (D) ✓ $\frac{3\sqrt{3}}{4}$

32. A spherical surface of radius of curvature $10\,cm$ separates two media X and Y of refractive indices $3/2$ and $4/3$ respectively. Centre of the spherical surface lies in denser medium. An object is placed in medium X. For image to be real, the object distance must be

(A) ✓greater than $90\,cm$ (B) less than $90\,cm.$

(C) greater than $80\,cm$ (D) less than $80\,cm.$

33. An electric bulb illuminates a plane surface. The intensity of illumination on the surface at a point $2m$ away from the bulb is 5×10^{-4} $phot$ $(lumen/cm^2)$. The line joining the bulb to the point makes an angle of 60^o with the normal to the surface. The intensity of the bulb in candela is

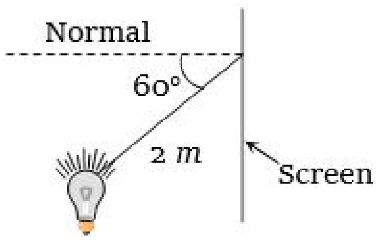
(A) $40\sqrt{3}$ (B) ✓40

(C) 20 (D) 40×10^{-4}

Sol : (b) $I = \frac{L\cos\theta}{r^2}$

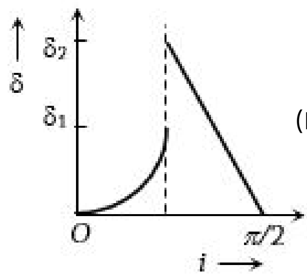
$\Rightarrow \quad L = \frac{I \times r^2}{\cos\theta}$

$= \frac{5 \times 10^{-4} \times 10^4 \times 2^2}{\cos 60°} \; = \; 40\,Candela$

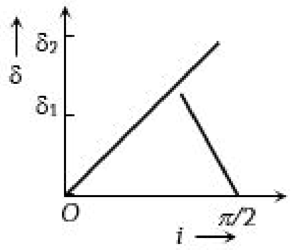


34. A ray of light travels from a medium of refractive index μ to air. Its angle of incidence in the medium is i, measured from the normal to the boundary, and its angle of deviation is δ. δ is plotted against i which of the following best represents the resulting curve

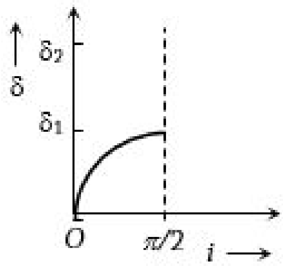
(A) ✓



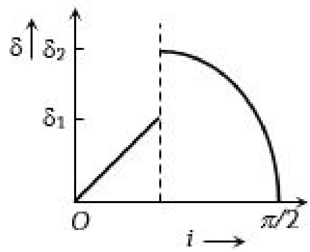
(B)



(C)



(D)



Sol : (a)The ray of light is refracted at the plane surface. However, since the ray is travelling from a denser to a rarer medium, for an angle of incidence (i) greater then the critical angle (c) the ray will be totally internally reflected.

(1) For $i < c$; deviation = $r - i$ with $\frac{1}{\mu} = \frac{\sin i}{\sin r}$

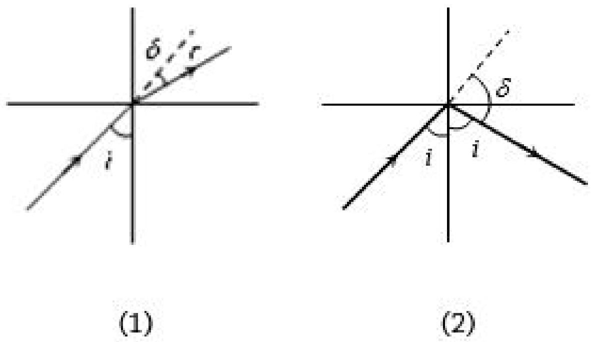
Hence $\delta = \sin^{-1}(\mu \sin i) - i$

This is a non-linear relation. The maximum value of δ is $\delta_1 = \frac{\pi}{2} - c$; where $i = c$ and $\mu = \frac{1}{\sin c}$

(2) For $i > c$, deviation δ = π - $2i$

δ decreases linearly with i

$\delta_2 = \pi - 2c = 2\delta_1$



(1) (2)

35. 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 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) $2d\left(\frac{1}{\mu_1\mu_2}\right)$

Sol : (b)$h' = \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2} = d\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}\right)$

36. A combination of two thin lenses with focal lengths f_1 and f_2 respectively forms an image of distant object at distance $60cm$ when lenses are in contact. The position of this image shifts by $30cm$ towards the combination when two lenses are separated by $10cm$. The corresponding values of f_1 and f_2 are

(A) $30\ cm, -60cm$ (B) ✓$20cm,\ -30cm$

(C) $15cm,\ -20cm$ (D) $12\ cm,\ -15cm$

Sol : (b) $\frac{1}{60}=\frac{1}{f_1}+\frac{1}{f_2}...(i)$

and $\frac{1}{30}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{10}{f_1f_2}...(ii)$

On solving (i) and (ii) $f_1f_2=-600$ and $f_1+f_2=-10$

Hence $f_1=20cm$ and $f_2=-30cm$

37. An object is placed infront of a convex mirror at a distance of $50\,cm$. A plane mirror is introduced covering the lower half of the convex mirror. If the distance between the object and plane mirror is $30\,cm$, it is found that there is no parallax between the images formed by two mirrors. Radius of curvature of mirror will be......cm

(A) 12.5 (B) ✓25

(C) $\frac{50}{3}$ (D) 18

Sol : (b) Since there is no parallex, it means that both images (By plane mirror and convex mirror) coinciding each other.

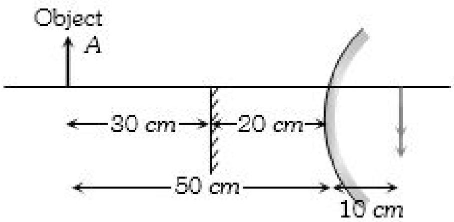
According to property of plane mirror it will form image at a distance of $30cm$ behind it. Hence for convex mirror $u=-50cm,\ v=+10cm$

By using $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$

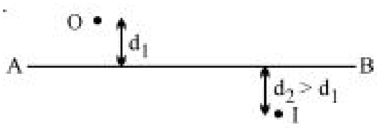
$\Rightarrow\ \frac{1}{f}=\frac{1}{+10}+\frac{1}{-50}=\frac{4}{50}$

$\Rightarrow f=\frac{25}{2}cm$

$\Rightarrow\ R=2f=25cm.$



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



(A) concave & placed towards right I (B) ✓concave & placed towards left of I

(C) convex and placed towards right of I (D) convex & placed towards left of I.

Sol : since image is magnified and inverted so mirrro in concave and placed also towards left of I.

39. A ray of light from a denser medium strike a rarer medium. The angle of reflection is r and that of refraction is r'. The reflected and refracted rays make an angle of 90^o with each other. The critical angle will be :

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

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

Sol : According to Snell's law,

$\mu=\frac{\sin i}{\sin r'}=\frac{\sin i}{\sin(90^\circ-r)}=\frac{\sin i}{\cos r}$

From law of reflection, $i=r$

$\therefore \mu=\frac{\sin r}{\cos r}=\tan r$

Critical angle $=\sin^{-1}(\mu)=\sin^{-1}(\tan r)$

40. The focal lengths of the objective and eye-lens of a microscope are $1\,cm$ and $5\,cm$ respectively. If the magnifying power for the relaxed eye is 45, then the length of the tube is.......cm

(A) 30 (B) 25

(C) ✓15 (D) 12

Sol : (c)By using $m_\infty=\frac{(L_\infty-f_o-f_e).D}{f_of_e}$

$\Rightarrow 45=\frac{(L_\infty-1-5)\times 25}{1\times 5}\Rightarrow L_\infty=15\,cm.$

41. A tiny air bubble in a glass slab $(\mu=1.5)$ appears from one side to be $6\,cm$ from the glass surface and from other side, $4\,cm$. The thickness of the glass slab is......cm

(A) 10 (B) 6.67

(C) ✓15 (D) None of these

Sol : We know that $\mu=\frac{\text{real depth}}{\text{apparent depth}}$

Let the thickness of the slab be t and real depth of the bubble from one side be x. Then

$\mu=\frac{x}{6}=\frac{(t-x)}{4}$ or $1.5=\frac{x}{6}=\frac{t-x}{4}$

This gives $x=9$ and $1.5=\frac{t-9}{4}$ or $t=15$cm

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

(A) 30 (B) 60

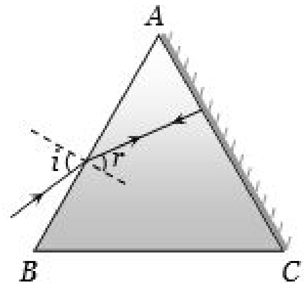
(C) ✓45 (D) $\sin^{-1}\sqrt{1.5}$

Sol : (c) $A=r+0\Rightarrow r=30^o$

From Snell's law at surface AB

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

$\Rightarrow\sqrt{2}=\frac{\sin i}{\sin 30^o}\Rightarrow i=45^o$



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

(A) 10 (B) 15

(C) 2.5 (D) ✓5

Sol : Here, $f=-10\,\text{cm}$

For end $A, u_A=-20\,\text{cm}$

Image position of end A

$\frac{1}{v_A}+\frac{1}{u_A}=\frac{1}{f}$

$\frac{1}{v_A}+\frac{1}{(-20)}=\frac{1}{(-10)}$ or $\frac{1}{v_A}=\frac{1}{-10}+\frac{1}{20}=-\frac{1}{20}$

$v_A=-20\,\text{cm}$

For end $B, u_B=-30\,\text{cm}$

Image position of end B

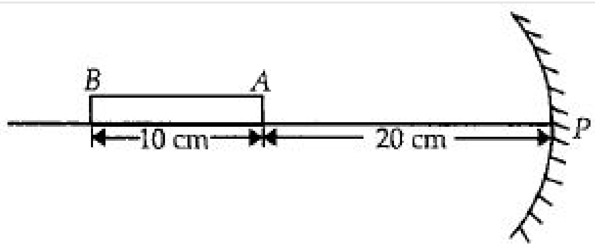
$\frac{1}{v_B}+\frac{1}{u_B}=\frac{1}{f}$

$\frac{1}{v_B}+\frac{1}{(-30)}=\frac{1}{(-10)}$ or $\frac{1}{v_B}=\frac{1}{-10}+\frac{1}{30}=-\frac{2}{30}$

$v_B=-15\,\text{cm}$

Length of the image

$=|v_A|-|v_B|=20$cm -15cm $=5$cm



44. The focal length of lens of refractive index 1.5 in air is $30cm$. When it is immersed in a liquid of refractive index $\frac{4}{3}$, then its focal length in liquid will be......cm

(A) 30 (B) 60

(C) ✓120 (D) 240

Sol : (c) By using $\frac{f_l}{f_a} = \frac{({}_a\mu_g - 1)}{({}_l\mu_g - 1)} \Rightarrow f_w = 4f_a = 4 \times 30 = 120cm.$

45. We wish to see inside an atom. Assuming the atom to have a diameter of $100\ pm$, this means that one must be able to resolved a width of say $10\ p.m.$ If an electron microscope is used, the minimum electron energy required is about.......KeV

(A) 1.5 (B) ✓15

(C) 150 (D) 1.5

Sol : (b) Wave length of the electron wave be $10 \times 10^{-12}m$,

Using $\lambda = \frac{h}{\sqrt{2mE}} \Rightarrow E = \frac{h^2}{\lambda^2 \times 2m}$

$= \frac{(6.63 \times 10^{-34})^2}{(10 \times 10^{-12})^2 \times 2 \times 9.1 \times 10^{-31}} Joule$

$= \frac{(6.63 \times 10^{-34})^2}{(10 \times 10^{-12})^2 \times 2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19}} eV$

$= 15.1\ KeV.$

46. The separation between the screen and a concave mirror is $2r$. An isotropic point source of light is placed exactly midway between the mirror and the point source. Mirror has a radius of curvature r and reflects 100% of the incident light. Then the ratio of illuminances on the screen with and without the mirror is

(A) $10:1$ (B) ✓$2:1$

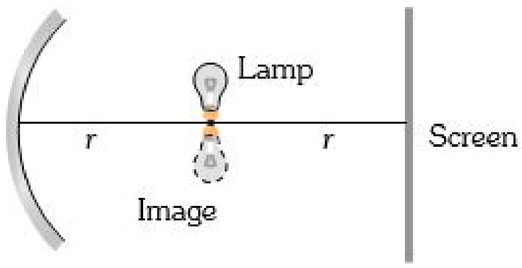
(C) $10:9$ (D) $9:1$

Sol : (b) Illuminance on the screen without mirror is

$I_1 = \frac{L}{r^2}$

Illuminance on the screen with mirror

$I_2 = \frac{L}{r^2} + \frac{L}{r^2} = \frac{2L}{r^2}$ ==> $\frac{I_2}{I_1} = 2:1$



47. There is an equiconvex glass lens with radius of each face as R and ${}_a\mu_g = 3/2$ and ${}_a\mu_w = 4/3$. If there is water in object space and air in image space, then the focal length is

(A) $2R$ (B) R

(C) ✓$3\frac{R}{2}$ (D) R^2

Sol : (c) Consider the refraction of the first surface $i.e.$ refraction from rarer medium to denser medium

$\frac{\mu_2 - \mu_1}{R} = \frac{\mu_1}{-u} + \frac{\mu_2}{v_1}$

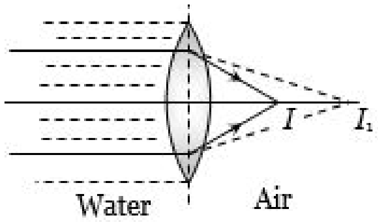
$\Rightarrow \frac{\left(\frac{3}{2}\right) - \left(\frac{4}{3}\right)}{R} = \frac{\frac{4}{3}}{\infty} + \frac{\frac{3}{2}}{v_1} \Rightarrow v_1 = 9R$

Now consider the refraction at the second surface of the lens i.e. refraction from denser medium to rarer medium

$\frac{1 - \frac{3}{2}}{-R} = -\frac{\frac{3}{2}}{9R} + \frac{1}{v_2} \Rightarrow v_2 = \left(\frac{3}{2}\right)R$

The image will be formed at a distance of $\frac{3}{2}R$.

This is equal to the focal length of the lens.



48. The magnifying power of an astronomical telescope is 8 and the distance between the two lenses is $54\,cm$. The focal length of eye lens and objective lens will be respectively

(A) ✓$6\,cm$ and $48\,cm$ (B) $48\,cm$ and $6\,cm$

(C) $8\,cm$ and $64\,cm$ (D) $64\,cm$ and $8\,cm$

Sol : (a)$f_o + f_e = 54$ and $\frac{f_o}{f_e} = m = 8 \Rightarrow f_o = 8f_e$

$\Rightarrow 8f_e + f_e = 54 \Rightarrow f_e = \frac{54}{9} = 6$

$\Rightarrow f_o = 8f_e = 8 \times 6 = 48$

49. A simple telescope, consisting of an objective of focal length $60\,cm$ and a single eye lens of focal length $5\,cm$ is focussed on a distant object is such a way that parallel rays comes out from the eye lens. If the object subtends an angle 2^o at the objective, the angular width of the image........^{o}

(A) 10 (B) ✓24

(C) 50 (D) $1/6$

Sol : (b)Since $m = \frac{f_o}{f_e}$

Also $m = \frac{Angle\ subtended\ by\ the\ image}{Angle\ subtended\ by\ the\ object}$

$\therefore \frac{f_o}{f_e} = \frac{\alpha}{\beta} \Rightarrow \alpha = \frac{f_o \times \beta}{f_e} = \frac{60 \times 2}{5} = 24^o$

50. In a parallel beam of white light is incident on a converging lens, the colour which is brought to focus nearest to the lens is

(A) ✓Violet (B) Red

(C) The mean colour (D) All the colours together

Sol : (a)Focal length for voilet is minimum.

51. Assertion: A double convex lens $(\mu = 1.5)$ has focal length $10\,cm$. When the lens is immersed in water $(\mu = 4/3)$ its focal length becomes $40\,cm$

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

(A) ✓If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(B) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(C) If the Assertion is correct but Reason is incorrect.

(D) If both the Assertion and Reason are incorrect.

Sol : Using the given relation,

$\frac{1}{10} = \left(\frac{1.5 - 1}{1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{10} = 0.5\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ....(i)

In the second case, $\mu = \frac{4}{3}$;

$\frac{1}{f} = \left(\frac{1.5 - \frac{4}{3}}{4/3}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ....(ii)

Dividing (ii) from (i),

$\frac{f}{10} = \frac{0.5}{0.5/4} = \frac{4 \times 0.5}{0.5}$

$f = 4 \times 10 = 40\,\text{cm}$

52. Material A has critical angle i_A, and material B has critical angle $i_B (i_B > i_A)$. Then which of the following is true

(i) Light can be totally internally reflected when it passes from B to A

(ii) Light can be totally internally reflected when it passes from A to B

(iii) Critical angle for total internal reflection is $i_B - i_A$

(iv) Critical angle between A and B is $\sin^{-1}\left(\frac{\sin i_A}{\sin i_B}\right)$

(A) (i) and (iii) (B) (i) and (iv)

(C) (ii) and (iii) (D) ✓(ii) and (iv)

Sol : (d) We know $C = \sin^{-1}\left(\frac{1}{\mu}\right)$

Given critical angle $i_B > i_A$
So $\mu_B < \mu_A$ i.e. B is rarer and A is denser.
Hence light can be totally internally reflected when it passes from A to B
Now critical angle for A to B

$$C_{AB} = \sin^{-1}\left(\frac{1}{{}_B\mu_A}\right) = \sin^{-1}[{}_A\mu_B]$$

$$= \sin^{-1}\left[\frac{\mu_B}{\mu_A}\right] = \sin^{-1}\left[\frac{\sin i_A}{\sin i_B}\right]$$

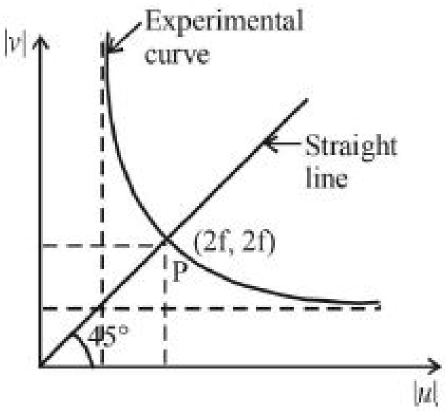
53. In an optics experiment, with the position of the object fixed, a student varies the position of a convex lens and for each position, the screen is adjusted to get a clear image of the object. A graph between the object distance u and the image distance v, from the lens, is plotted using the same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

(A) ✓$(2f, 2f)$ (B) $(f/2, f/2)$

(C) (f, f) (D) $(4f, 4f)$

Sol : Here $u = -2f, v = 2f$

As $|u|$ increases, v decreases for $|u| > f$. The graph between $|v|$ and $|u|$ is shown in the figure. A straight line passing through the origin and making an angle of $45°$ with the x -axis meets the experimental curve at $P(2f, 2f)$



54. A man can see only between $75\,cm$ and $100\,cm$. The power of lens to correct the near point will be

(A) ✓$+\frac{8}{3}D$ (B) $+3\,D$

(C) $-3\,D$ (D) $-\frac{8}{3}D$

Sol : (a) For improving near point, convex lens is required and for this convex lens
$u = -25\ cm, v = -75\ cm$

$$\therefore \frac{1}{f} = \frac{1}{-75} - \frac{1}{-25} \Rightarrow f = \frac{75}{2}cm$$

So power $P = \frac{100}{f} = \frac{100}{75/2} = +\frac{8}{3}D$

55. A concave mirror is used to form image of the Sun on a white screen. If the lower half of the mirror were covered with an opaque card, the effect on the image on the screen would be

(A) negligible (B) ✓to make the image less bright than before

(C) to make the upper half of the image disappear (D) to make the lower half of the image disappear

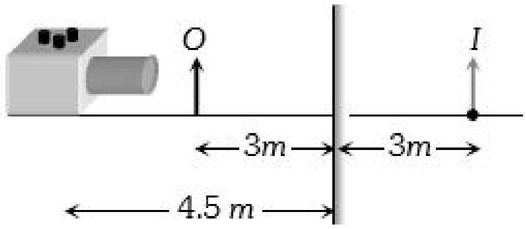
Sol : The complete image is formed but intensity of image will decrease. intensity $\propto$ (area of mirror reflecting the light).

56. It is desired to photograph the image of an object placed at a distance of $3m$ from the plane mirror. The camera which is at a distance of $4.5m$ from the mirror should be focussed for a distance of......m

(A) 3 (B) 4.5

(C) 6 (D) ✓7.5

Sol : (d) F_o using distance of image $= 4.5\,m + 3\,m = 7.5\,m$.



57. Each quarter of a vessel of depth H is filled with liquids of the refractive indices n_1, n_2, n_3 and n_4 from the bottom respectively. The apparent depth of the vessel when looked normally is

(A) $\frac{H(n_1 + n_2 + n_3 + n_4)}{4}$ (B) ✓$\frac{H\left(\frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3} + \frac{1}{n_4}\right)}{4}$

(C) $\frac{(n_1 + n_2 + n_3 + n_4)}{4H}$ (D) $\frac{H\left(\frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3} + \frac{1}{n_4}\right)}{2}$

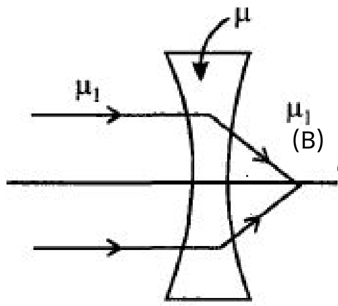
Sol : (b) Apparent depth of bottom

$$= \frac{H/4}{\mu_1} + \frac{H/4}{\mu_2} + \frac{H/4}{\mu_3} + \frac{H/4}{\mu_4}$$

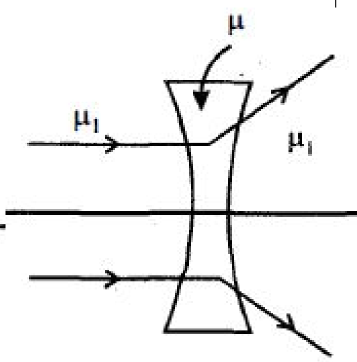
$$= \frac{H}{4}\left(\frac{1}{\mu_1} + \frac{1}{\mu_2} + \frac{1}{\mu_3} + \frac{1}{\mu_4}\right)$$

58. The refractive index of the material of a concave lens is μ. It is immersed in a medium of refractive index μ_1 . A parallel beam of light is incident on the lens. The path of the emergent rays when $\mu_1 > \mu$ is

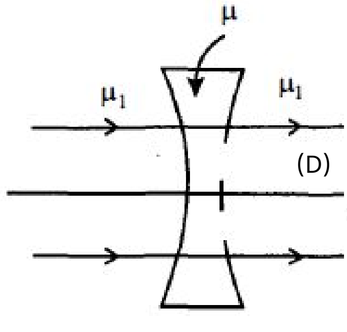
(A) ✓



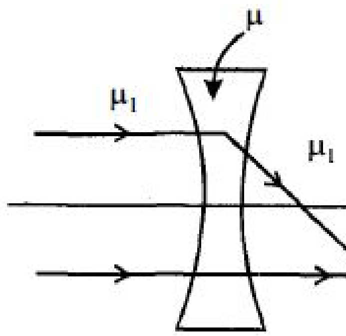
(B)



(C)



(D)



Sol : If a lens of refractive index μ is immersed in a medium of refractive index μ_1, then its focal length in medium is given by

$$\frac{1}{f_m} = ({}_m\mu_l - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

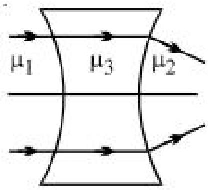
If f_a is the focal length of lens in air, then

$$\frac{1}{f_a} = ({}_a\mu_l - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Rightarrow \frac{f_m}{f_a} = \frac{({}_a\mu_l - 1)}{({}_m\mu_l - 1)}$$

If $\mu_l > \mu$, then f_m and f_a have opposite signs and the nature of lenschanges i.e. a convex lens diverges the light rays and concave lens converges the light rays. Thus given option (a) is correct.

59. From the figure shown establish a relation between, μ_1, μ_2, μ_3.



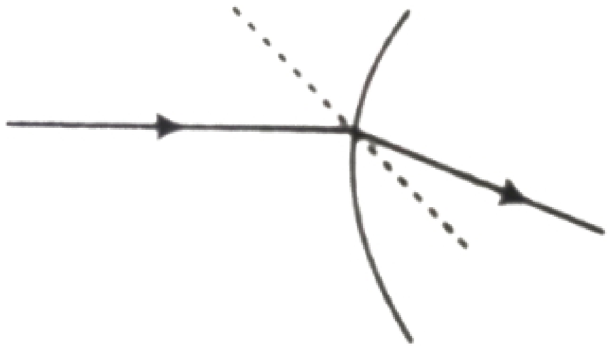
(A) $\mu_1 < \mu_2 < \mu_3$
(B) $\checkmark \mu_3 < \mu_2; \mu_3 = \mu_1$
(C) $\mu_3 > \mu_2; \mu_3 = \mu_1$
(D) None of these

Sol : Between 1 and 3there is no deviation. Hence, $\mu_1 = \mu_3$

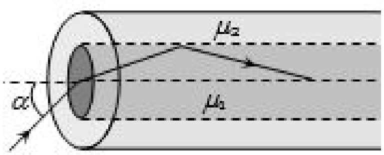
Between 3 and 2

Ray to light binds towards normal. Hence,

$\mu_2 > \mu_3$



60. An optical fibre consists of core of μ_1 surrounded by a cladding of μ_2 < μ_1. A beam of light enters from air at an angle α with axis of fibre. The highest α for which ray can be travelled through fibre is



(A) $\cos^{-1}\sqrt{\mu_2^2 - \mu_1^2}$
(B) $\checkmark \sin^{-1}\sqrt{\mu_1^2 - \mu_2^2}$
(C) $\tan^{-1}\sqrt{\mu_1^2 - \mu_2^2}$
(D) $\sec^{-1}\sqrt{\mu_1^2 - \mu_2^2}$

Sol : (b) Here the requirement is that $i > c$

$$\Rightarrow \sin i > \sin c \ \Rightarrow \ \sin i > \frac{\mu_2}{\mu_1} \ldots..(i)$$

From Snell's law $\mu_1 = \dfrac{\sin\alpha}{\sin r} \ldots.(ii)$

Also in ΔOBA

$r + i = 90^o \Rightarrow \ r = (90 - i)$

Hence from equation (ii)

$\sin\alpha = \mu_1 \sin(90 - i)$

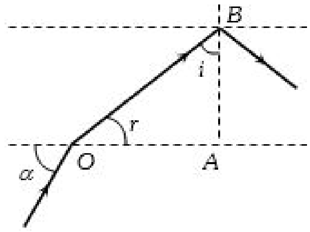
$$\Rightarrow \ \cos i = \frac{\sin\alpha}{\mu_1}$$

$$\sin i = \sqrt{1 - \cos^2 i} = \sqrt{1 - \left(\frac{\sin\alpha}{\mu_1}\right)^2} \ldots.(iii)$$

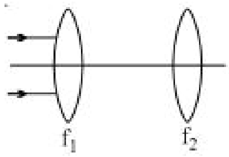
From equation (i) and (iii) $\sqrt{1 - \left(\dfrac{\sin\alpha}{\mu_1}\right)^2} > \dfrac{\mu_2}{\mu_1}$

==>$\sin^2\alpha < (\mu_1^2 - \mu_2^2)$ ==>$\sin\alpha < \sqrt{\mu_1^2 - \mu_2^2}$

$\alpha_{\max} = \sin^{-1}\sqrt{\mu_1^2 - \mu_2^2}$



61. Parallel beam of light is incident on a system of two convex lenses of focal lengths $f_1 = 20\,cm$ and $f_2 = 10\,cm$. What should be the distance between the two lenses so that rays after refraction from both the lenses pass undeviated :........cm



(A) 60
(B) ✓30
(C) 90
(D) 40

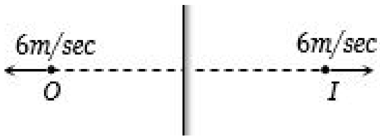
Sol : The image formed by first lens will lie at its second lens focus. This image will act as an object for the second lens. For the rays to become parallel after passing through the second lens, the object for second lens should lie on its first focus. Thus the distance between the two lenses will be equal to sum of their focal lengths.

$\mathrm{D = f_1 + f_2 = 20cm + 10cm = 30cm}$

62. If an observer is walking away from the plane mirror with $6m/sec$. Then the velocity of the image with respect to observer will be........m/sec

(A) 6
(B) -6
(C) ✓12
(D) 3

Sol : (c)Relative velocity of image $w.r.t.$ object $= 6 - (-6) = 12\, m/\sec$



63. A convex lens of focal length $40cm$ is in contact with a concave lens of focal length $25cm$. The power of combination is

(A) ✓$-1.5D$
(B) $-6.5D$
(C) $+6.5D$
(D) $+6.67D$

Sol : (a) Focal length of the combination can be calculated as

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} \Rightarrow \frac{1}{F} = \frac{1}{(+40)} + \frac{1}{(-25)}$$

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

$$\therefore P = \frac{100}{F} = \frac{100}{-200/3} = -1.5\ D$$

64. A parallel beam of white light falls on a convex lens. Images of blue, yellow and red light are formed on other side of the lens at a distance of $0.20m, 0.205m$ and $0.214m$ respectively. The dispersive power of the material of the lens will be

(A) $619/1000$
(B) $9/200$
(C) ✓$14/205$
(D) $5/214$

Sol : (c) For a lens $f_r - f_v = \omega\, f_y$

==>$\omega = \dfrac{f_r - f_v}{f_y} = \dfrac{0.214 - 0.200}{0.205} = \dfrac{14}{205}$.

65. If the refractive indices of crown glass for red, yellow and violet colours are $1.5140, 1.5170$ and 1.5318 respectively and for flint glass these are $1.6434, 1.6499$ and 1.6852 respectively, then the dispersive powers for crown and flint glass are respectively

(A) ✓0.034 and 0.064 (B) 0.064 and 0.034
(C) 1.00 and 0.064 (D) 0.034 and 1.0

Sol : (a) The dispersive power for crown glass $\omega = \dfrac{n_v - n_r}{n_y - 1}$

$= \dfrac{1.5318 - 1.5140}{(1.5170 - 1)} = \dfrac{0.0178}{0.5170} = 0.034$

and for flint glass $\omega' = \dfrac{1.6852 - 1.6434}{(1.6499 - 1)} = 0.064$

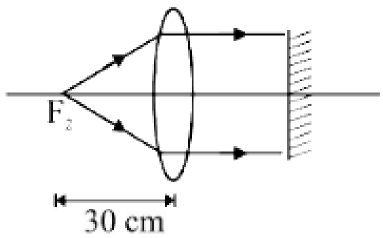
66. An object is placed in front of a thin convex lens of focal length $30\,cm$ and a plane mirror is placed $15\,cm$ behind the lens. If the final image of the object coincides with the object, the distance of the object from the lens is.....cm

(A) 60 (B) ✓30
(C) 15 (D) 25

Sol : For autocallination by system, light should fall normally on plane mirror, since mirror is $\perp_r$ to principal axis, light must be parallel to principle axis. Hence the object must lie on secondary focus of the lens. From the Ray diagram:

$u = 30cm$

So, object is placed at focus of convex lens.



67. The light ray is incidence at angle of 60^o on a prism of angle 45^o . When the light ray falls on the other surface at 90^o , the refractive index of the material of prism μ and the angle of deviation δ are given by

(A) $\mu = \sqrt{2}$, $\delta = 30^o$ (B) $\mu = 1.5$, $\delta = 15^o$
(C) $\mu = \dfrac{\sqrt{3}}{2}, \delta = 30^o$ (D) ✓$\mu = \sqrt{\dfrac{3}{2}}, \delta = 15^o$

Sol : (d) From figure it is clear that $\angle e = \angle r_2 = 0$

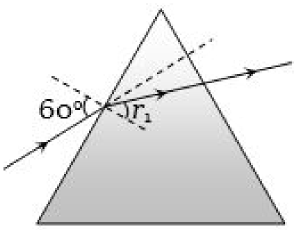
From $A = r_1 + r_2 \Rightarrow r_1 = A = 45^o$

$\therefore \mu = \dfrac{\sin i}{\sin r_1} = \dfrac{\sin 60}{\sin 45} = \sqrt{\dfrac{3}{2}}$

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

$\Rightarrow 60 + 0 = 45 + \delta$

$\Rightarrow \delta = 15^o$



68. To prepare a print the time taken is $5\,sec$ due to lamp of $60\,watt$ at $0.25\,m$ distance. If the distance is increased to $40\,cm$ then what is the time taken to prepare the similar print......sec

(A) 3.1 (B) 1
(C) ✓12.8 (D) 16

Sol : (c) To develop a print a fix amount of energy is required. Total light energy incident on photo print

$I \times A\,t = \dfrac{L}{r^2} A\,t \Rightarrow \dfrac{L_1}{r_1^2} A_1 t_1 = \dfrac{L_2}{r_2^2} A_2 t_2$

$\Rightarrow \dfrac{t_1}{r_1^2} = \dfrac{t_2}{r_2^2}$ ($\because$ $L_1 = L_2$ and $A_1 = A_2$)

$\Rightarrow t_2 = \dfrac{r_2^2}{r_1^2} . t_1 = \left(\dfrac{0.40}{0.25}\right) 2 \times 5$

$= 12.8 sec.$

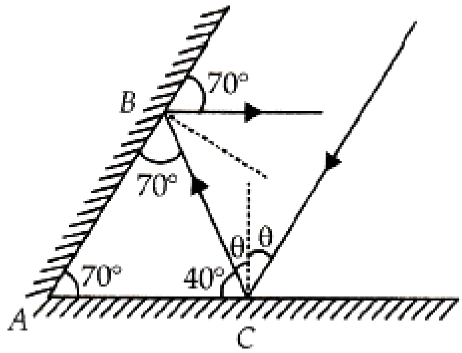
69. Two plane mirrors are inclined at 70^o. Aray incident on one mirror at angle θ after reflection falls on the second mirror and is reflected from there parallel to the first mirror, θ is ......^{o}

(A) ✓50 (B) 45
(C) 30 (D) 55

Sol : Different angles as shown in the figure.

$\theta + 40^\circ = 90^\circ$

$\theta = 90^\circ - 40^\circ = 50^\circ$



70. A Galileo telescope has an objective of focal length $100\,cm$ and magnifying power 50. The distance between the two lenses in normal adjustment will be......cm

(A) 96 (B) ✓98
(C) 102 (D) 104

Sol : (b) By using $m = \dfrac{f_o}{f_e} \Rightarrow f_e = \dfrac{100}{50} = 2\ cm$

Also $L = f_o - f_e = 100 - 2 = 98\ cm$

71. A plano-convex lens is made of refractive index of 1.6. The radius of curvature of the curved surface is $60 cm$. The focal length of the lens is.....cm

(A) 400 (B) 200
(C) ✓100 (D) 50

Sol : (c) $\dfrac{1}{f} = (\mu - 1)\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$

$\dfrac{1}{f} = (1.6 - 1)\left(\dfrac{1}{60} - \dfrac{1}{\infty}\right) = \dfrac{1}{100} \Rightarrow f = 100\,cm$

72. A telescope has an objective of focal length $50 cm$ and an eye piece of focal length $5 cm$. The least distance of distinct vision is $25 cm$. The telescope is focussed for distinct vision on a scale $200 cm$ away. The separation between the objective and the eye-piece is.......cm

(A) 75 (B) 60
(C) ✓71 (D) 74

Sol : (c) $f_o = 50\ cm$,$f_e = 5\ cm$,$D = 25\ cm$ and $u_o = 200\ cm.$

Separation between the objective and the eye lens is

$$L = \frac{u_o f_o}{(u_o - f_o)} + \frac{f_e D}{(f_e + D)} = \frac{200 \times 50}{(200 - 50)} + \frac{5 \times 25}{(5 + 25)} = 71\ cm$$

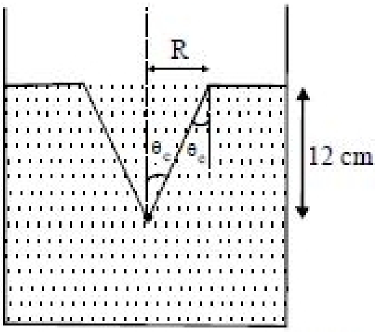
73. A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is $\dfrac{4}{3}$ and the fish is $12\,cm$ below the surface, the radius of this circle in cm is

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

Sol : $\sin\theta_c = \frac{1}{\mu} = \frac{3}{4}$

or $\tan\theta_c = \frac{3}{\sqrt{16-9}} = \frac{3}{\sqrt{7}} = \frac{R}{12}$

$\Rightarrow \quad \mathrm{R} = \frac{36}{\sqrt{7}}\mathrm{cm}$



74. The power (in diopters) of an equiconvex lens with radii of curvature of $10\,cm$ and refractive index of 1.6 is :

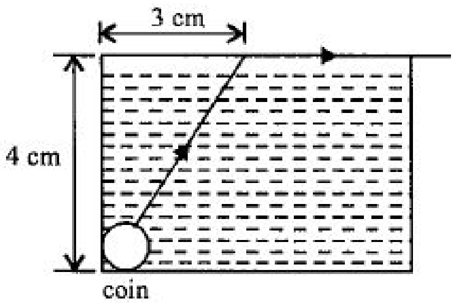
(A) -12
(B) ✓$+12$
(C) $+1.2$
(D) -1.2

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

$= (1.6 - 1)\left(\frac{1}{0.1} - \frac{1}{-0.1}\right)$

$= +12D$

75. A small coin is resting on the bottom of a beaker filled with liquid. A ray of light from the coin travels upto the surface of the liquid and moves along its surface. How fast is the light travelling in the liquid?



(A) $2.4\times\ 10^8 m/s$
(B) $3.0\times\ 10^8 m/s$
(C) $1.2\times\ 10^8 m/s$
(D) ✓$1.8\times\ 10^8 m/s$

Sol : From figure, $\sin C = \frac{3}{\sqrt{(4)^2+(3)^2}} = \frac{3}{5}$

where C is the critical angle.

Also, $\sin C = {}^l\mu_a$

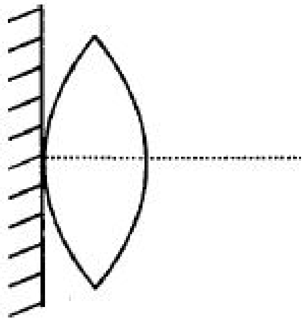
$\sin C = \frac{1}{{}^a\mu_l}$ $\left[\text{since } {}^l\mu_a = \frac{1}{{}^a\mu_l}\right]$

Also ${}^a\mu_l = \frac{\text{velocity of light in air } (c)}{\text{velocity of light in liquid } (v)}$

$\therefore \quad \sin C = \frac{v}{c} = \frac{v}{3\times 10^8}$

or, $\quad v = 3\times 10^8 \times \frac{3}{5} = 1.8\times 10^8\ \mathrm{ms}^{-1}$

76. A thin convex lens of focal length $'f'$ is put on a plane mirror as shown in the figure. When an object is kept at a distance $'a'$ from the lens - mirror combination, its image is formed at a distance $\frac{a}{3}$ in front of the combination. The value of $'a'$ is



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

Sol : When object is keept at a distance $'a'$ from thin covex lens

By lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{V} - \frac{1}{(-a)} = \frac{1}{f}$

or, $\frac{1}{v} = \frac{1}{f} - \frac{1}{a}$ ...... (i)

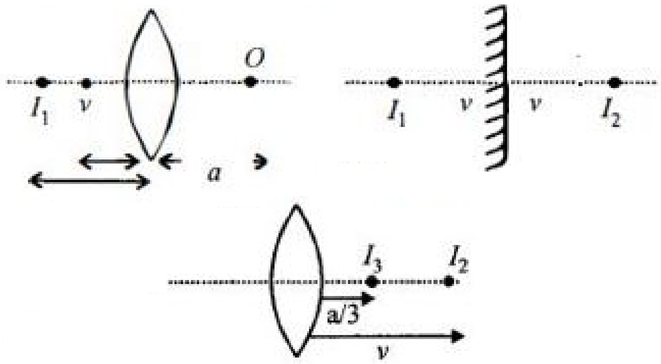
Mirror forms image at equal distance from mirror

Now, again from lens formula

$\frac{3}{a} - \frac{1}{V} = \frac{1}{f}$

$\frac{3}{a} - \frac{1}{f} + \frac{1}{a} = \frac{1}{f}$ [From eqn. (i)]

Hence, $a = 2f$



77. A person is in a room whose ceiling and two adjacent walls are mirrors. How many images are formed

(A) 5
(B) 6
(C) ✓7
(D) 8

Sol : (c) The walls will act as two mirrors inclined to each other at $90°$

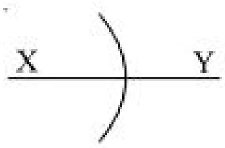
and so will form $\left(\frac{360}{90} - 1\right)$ $=4-1$ i.e. 3 images of the person.

Now these images with person will act as objects for the ceiling mirror and so ceiling mirror will form 4 images further.

Therefore total number of images formed $= 3+3+1 = 7$

Note : He can see. 6 images of himself.

78. A concave spherical surface of radius of curvature $10cm$ separates two medium x & y of refractive index $4/3$ & $3/2$ respectively. If the object is placed along principal axis in medium X then



(A) image is always real
(B) image is real if the object distance is greater than $90cm$
(C) ✓image is always virtual
(D) image is virtual if the object distance is less than $90cm$

Sol : Given : $R=-10\text{cm} n_2=3/2 n_1=4/3$

Let the object is placed at a distance x in front of the spherical surface i.e. $u=-x$

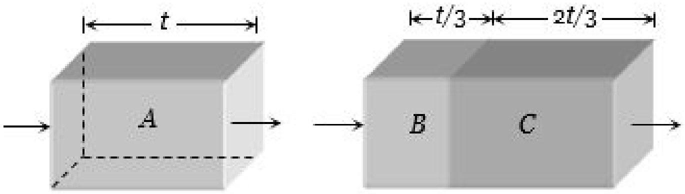
Using: $\frac{n_2}{v}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$

$\frac{3/2}{v}-\frac{4/3}{-x}=\frac{3/2-4/3}{-10}$

$\Longrightarrow v=\frac{-1.5x}{0.017x+1.33}$

$v<o$ ie. the image formed is always virtual in nature.

79. Two transparent slabs have the same thickness as shown. One is made of material A of refractive index 1.5. The other is made of two materials B and C with thickness in the ratio $1:2$. The refractive index of C is 1.6. If a monochromatic parallel beam passing through the slabs has the same number of waves inside both, the refractive index of B is



(A) 1.1 (B) 1.2

(C) ✓1.3 (D) 1.4

Sol : (c) For A

Total number of waves = $\frac{(1.5)t}{\lambda}$ ....(i)

$\because \left(\begin{matrix}\text{Total number}\\ \text{of waves}\end{matrix}\right)=\left(\frac{\text{optical path length}}{\text{wavelength}}\right)$

For B and C

Total number of waves = $\frac{n_B\left(\frac{t}{3}\right)}{\lambda}+\frac{(1.6)\left(\frac{2t}{3}\right)}{\lambda}$ ....(ii)

Equating (i) and (ii) $n_B=1.3$

80. Diameter of a plano-convex lens is $6\,cm$ and thickness at the centre is $3\,mm$. If the speed of light in the material of the lens is $2\times10^8 m/sec$, the focal length of the lens is.......cm

(A) 15 (B) 20

(C) ✓30 (D) 10

Sol : (c) According to lens formula $\frac{1}{f}=(\mu-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$

The lens is plano-convex i.e., $R_1=R$ and $R_2=\infty$

Hence $\frac{1}{f}=\frac{\mu-1}{R}\Rightarrow f=\frac{R}{\mu-1}$

Speed of light in medium of lens $v=2\times10^8\ m/s$

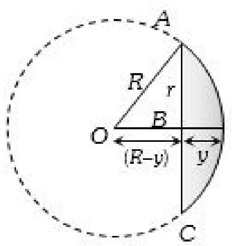
==>$\mu=\frac{c}{v}=\frac{3\times10^8}{2\times10^8}=\frac{3}{2}=1.5$

If r is the radius and y is the thickness of lens (at the centre), the radius of curvature R of its curved surface in accordance with the figure is given by

$R^2=r^2+(R-y)^2\Rightarrow r^2+y^2-2Ry=0$

Neglecting y^2; we get $R=\frac{r^2}{2y}=\frac{(6/2)^2}{2\times0.3}=15cm$

Hence $f=\frac{15}{1.5-1}=30cm$



81. An object $2.5\,cm$ high is placed at a distance of $10\,cm$ from a concave mirror of radius of curvature $30\,cm$ The size of the image is........cm

(A) 9.2 (B) 10.5

(C) 5.6 (D) ✓7.5

Sol : (d)$R=-30\,cm\Rightarrow f=-15\,cm$
$O=+2.5\,cm,\ u=-10\,cm$

By mirror formula $\frac{1}{-15}=\frac{1}{v}+\frac{1}{(-10)}\Rightarrow v=30\,cm.$

Also $\frac{I}{O}=-\frac{v}{u}\Rightarrow\frac{I}{(+2.5)}=-\frac{30}{(-10)}\Rightarrow I=+7.5\,cm.$

82. A short sighted person can see distinctly only those objects which lie between $10\,cm$ and $100\,cm$ from him. The power of the spectacle lens required to see a distant object is

(A) $+0.5\,D$ (B) ✓$-1.0\,D$

(C) $-10\,D$ (D) $+4.0\,D$

Sol : (b) $f=-d=-100\ cm=-1\ m$

$\therefore P=\frac{1}{f}=\frac{1}{-1}=-1\ D$

83. A ray of light is incident upon an air/water interface (it passes from air into water) at an angle of 45^o. Which of the following quantities change as the light enters the water?

(I) wavelength (II) frequency

(III) speed of propagation (IV) direction of propagation

(A) I,III only (B) III,IV only

(C) I,II,IV only (D) ✓I,III,IV only

Sol : As Speed of light in $vaccum/air$

$\mu=$ Speed of light if medium

$=\mu=\frac{c}{v}\Rightarrow$ velocity is different in different medium From $v=n\lambda$

But frequency is the fundamental property. It never change by changing the medium hence λ is also changed as v is change.

84. A thin prism of angle 5^o is placed at a distance of $10\,cm$ from object. What is the distance of the image from object? (Given μ of prism $=1.5$)

(A) $\frac{\pi}{8}cm$ (B) $\frac{\pi}{12}cm$

(C) ✓$\frac{5\pi}{36}cm$ (D) $\frac{\pi}{7}cm$

Sol : Deviation angle of light caused by a prism of prism angle $A=A(\mu-1)=\left(5\times\frac{\pi}{180}\right)\times0.5$ radians $=\frac{5\pi}{360}$ radians

Hence the total deviation after travelling back a distance of $10\text{cm}=\frac{5\pi}{360}\times10\text{cm}=\frac{5\pi}{36}\text{cm}$

85. A concave lens and a convex lens have same focal length of $20cm$ and both put in contact this combination is used to view an object $5cm$ long kept at $20cm$ from the lens combination. As compared to object the image will be

(A) Magnified and inverted (B) Reduced and erect

(C) ✓Of the same size and erect (D) Of the same size and inverted

Sol : (c) Combination of lenses will act as a simple glass plate.

86. A convex lens (of focal length $20\,cm$) and a concave mirror, having their principal axes along the same lines, are kept $80\,cm$ apart from each other. The concave mirror is to the right of the convex lens. When an object is kept at a distance of $30\,cm$ to the left of the convex lens, its image remains at the same position even if the concave mirror is removed. The maximum distance of the object for which this concave mirror, by itself would produce a virtual image would be.....cm

(A) 20 (B) ✓10

(C) 30 (D) 40

Sol : Image formed by lens

$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$; $\frac{1}{v}+\frac{1}{30}=\frac{1}{20}$

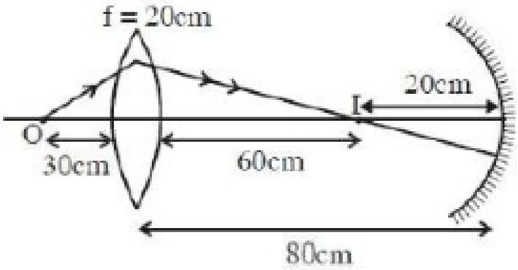
$v=+60\,\text{cm}$

If image position does not change even when mirror is removed it means image formed by lens is formed at centre of curvature of spherical mirror.

Radius of curvature of mirror $=80-60=20\,cm$

$\Rightarrow$ Focal length of mirror $f=10\,\text{cm}$ for virtual image, object is to be kept between focus and pole.

$\Rightarrow$ Maximum distance of object from spherical mirror for which virtual image is formed, is $10\,\text{cm}$.



87. A thin rod of length $f/3$ lies along the axis of a concave mirror of focal length f. One end of its magnified image touches an end of the rod. The length of the image is

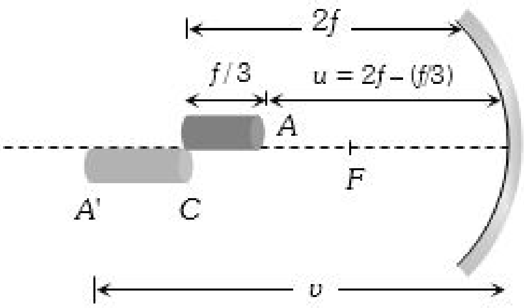
(A) f
(B) ✓$\frac{1}{2}f$
(C) $2f$
(D) $\frac{1}{4}f$

Sol : (b) If end A of rod acts an object for mirror then it's image will be A' and if

$u=2f-\frac{f}{3}=\frac{5f}{3}$ so by using $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$

$\Rightarrow \quad \frac{1}{-f}=\frac{1}{v}+\frac{1}{\frac{-5f}{3}} \Rightarrow \quad v=-\frac{5}{2}f$

$\therefore$ Length of image $=\frac{5}{2}f-2f=\frac{f}{2}$



88. A movie projector forms an image $3.5m$ long of an object $35mm$. Supposing there is negligible absorption of light by aperture then illuminance on slide and screen will be in the ratio of

(A) $100:1$
(B) ✓$10^4:1$
(C) $1:100$
(D) $1:100^4$

Sol : (b) $I \propto \frac{1}{r^2}$ so,

$$\frac{\text{Illuminance on slide}}{\text{Illuminance on screen}}=\frac{(\text{Length of image on screen})^2}{(\text{Length of object on slide})^2}$$

$$=\left(\frac{3.5\ m}{35\ mm}\right)^2=10^4:1$$

89. If a convex lens of focal length $80cm$ and a concave lens of focal length $50cm$ are combined together, what will be their resulting power

(A) $+6.5D$
(B) $-6.5D$
(C) $+7.5D$
(D) ✓$-0.75D$

Sol : (d) $P=\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{(+0.8)}+\frac{1}{(-0.5)}=-0.75\ D$

90. The distance of the moon from earth is 3.8×10^5km. The eye is most sensitive to light of wavelength 5500. The separation of two points on the moon that can be resolved by a $500\ cm$ telescope will be......m

(A) ✓51
(B) 60
(C) 70
(D) All the above

Sol : (a) As limit of resolution $\Delta\theta=\frac{1}{Resolving\ Power(RP)}$

and if x is the distance between points on the surface of moon which is at a distance r from the telescope.

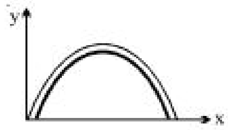
$\Delta\theta=\frac{x}{r}$

So $\Delta\theta=\frac{1}{RP}=\frac{x}{r} i.e.\ x=\frac{r}{RP}=\frac{r}{d/1.22\ \lambda}$

$\Rightarrow x=\frac{1.22\ \lambda r}{d}$

$=\frac{1.22\times5500\times10^{-10}\times(3.8\times10^8)}{500\times10^{-2}}=51\ m$

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



(A) $\left(\frac{L}{4},\frac{\sqrt{2}\,L}{\pi}\right)$
(B) $\left(\frac{L}{3},\frac{\sqrt{3}\,L}{\pi}\right)$
(C) $\left(\frac{2L}{3},\frac{\sqrt{3}\,L}{\pi}\right)$
(D) ✓Both (B) and (C)

Sol : As the Incident ray is horizontal 0 deg, and reacted ray is vertical 90 deg.

So the slope at point of reaction should be $90-0/2=45^\circ$

The derivative of equation of mirror surface, we get

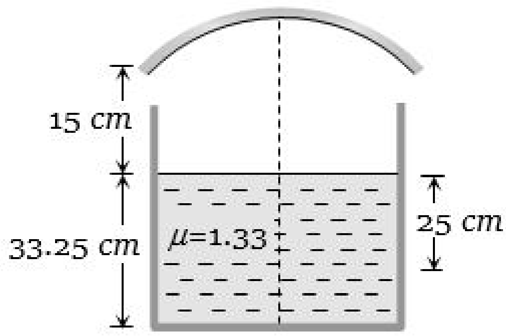
$\frac{dy}{dx}=2\cos\left(\frac{\pi x}{L}\right)=\tan(45^\circ)=1$

so, $x=\frac{L}{3}$

and using equation of mirror surface,

$y=\frac{\sqrt{3}L}{\pi}$

92. A container is filled with water $(\mu=1.33)$ upto a height of $33.25\ cm$. A concave mirror is placed $15\ cm$ above the water level and the image of an object placed at the bottom is formed $25\ cm$ below the water level. The focal length of the mirror is



(A) 10
(B) 15
(C) ✓20
(D) 25

Sol : (c) Distance of object from mirror $=15+\frac{33.25}{4}\times3=39.93cm$

Distance of image from mirror $=15+\frac{25}{4}\times3=33.75$

For mirror, $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$

==>$\frac{1}{-33.75}-\frac{1}{39.93}=\frac{1}{f}$==> $f\approx-18.3cm.$

93. The diameter of moon is $3.5 \times 10^3 km$ and its distance from the earth is $3.8 \times 10^5 km$. If it is seen through a telescope whose focal length for objective and eye lens are $4\ m$ and $10\ cm$ respectively, then the angle subtended by the moon on the eye will be approximately.......^{o}

(A) 15 (B) $\checkmark 20$

(C) 30 (D) 35

Sol : (b) $|m| = \frac{f_o}{f_e} = \frac{400}{10} = 40$

Angle subtented by moon on the objective of telescope

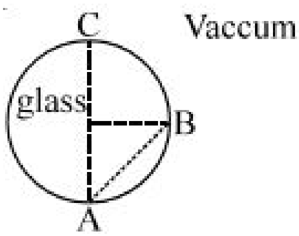
$$\alpha = \frac{3.5 \times 10^3}{3.8 \times 10^3} = \frac{3.5}{3.8} \times 10^{-2} rad$$

Also $|m| = \frac{\beta}{\alpha} \Rightarrow$ Angular size of final image

$$\beta = |m| \times \alpha = 40 \times \frac{3.5}{3.8} \times 10^{-2} = 0.36\, rad$$

$$= 0.3 \times \frac{180}{\pi} \approx 21^o$$

94. It is found that electromagnetic signals sent inside glass sphere from A towards B reach point C. The speed of electromagnetic signals in glass cannot be:



(A) $1.0 \times 10^8 m/s$ (B) $\checkmark 2.4 \times 10^8 m/s$

(C) $2 \times 10^7 m/s$ (D) $4 \times 10^7 m/s$

Sol : This is a case of total internal reflection.

Here $\theta = 45^\circ$ and $\theta > \theta_C$

$\Rightarrow 45^\circ > \theta_C \Rightarrow \sin 45^\circ > \sin\theta_C$

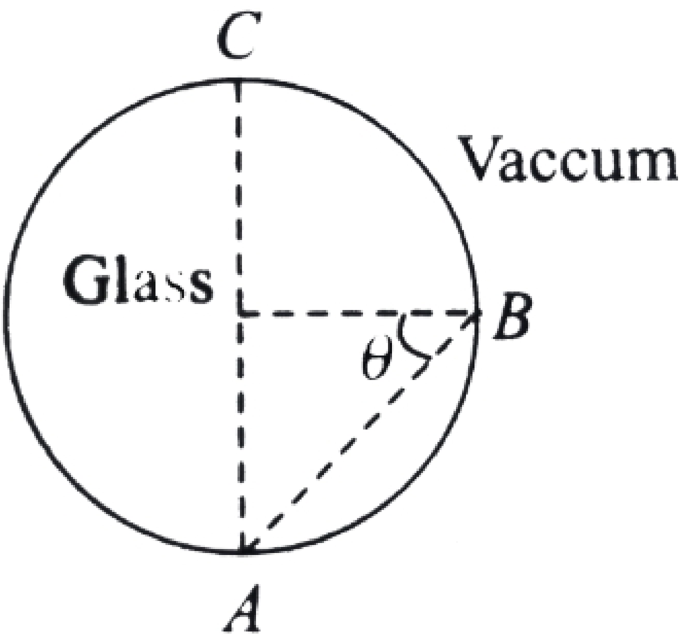
$\Rightarrow \frac{1}{\sqrt{2}} > \frac{1}{\mu}$

$\Rightarrow \mu > \sqrt{2} \quad \left(\text{As } v = \frac{c}{\mu}\right)$

$\Rightarrow \frac{c}{v} > \sqrt{2}$

$$v < \frac{c}{\sqrt{2}} = \frac{3 \times 10^8}{\sqrt{2}} \Rightarrow v < 2.1 \times 10^8$$

Only (b) is not possible.



95. Light is incident from a medium into air at two possible angles of incidence $(A)\ 20^o$ and $(B)\ 40^o$. In the medium light travels $3.0\, cm$ in $0.2\, ns$. The ray will

(A) suffer total internal reflection in both cases (A) and (B)

(B) ✓suffer total internal reflection in case (B) only

(C) have partial reflection and partial transmission in case (B)

(D) have 100% transmission in case (A)

Sol : Velocity of light in medium

$$V_{\text{treat}} = \frac{3\,\text{cm}}{0.2\,\text{ns}} = \frac{3 \times 10^{-2}\text{m}}{0.2 \times 10^{-9}\text{s}} = 1.5\,\text{m/s}$$

Refractive index of the medium

$$\mu = \frac{V_{\text{air}}}{V_{\text{med}}} = \frac{3 \times 10^8}{1.5} = 2\,\text{m/s}$$

As $\mu = \frac{1}{\sin C}$

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

Condition of TIR is angle of incidence i must be greater than critical angle. Hence ray will suffer TIR in case of (B) $(i = 40^o > 30^o)$ only.

96. A boy is trying to start a fire by focusing sunlight on a piece of paper using an equiconvex lens of focal length $10\ cm$. The diameter of the sun is $1.39 \times 10^9\ m$ and its mean distance from the earth is $1.5 \times 10^{11}\ m$. What is the diameter of the sun's image on the paper?

(A) $6.5 \times 10^{-5} m$ (B) $12.4 \times 10^{-4} m$

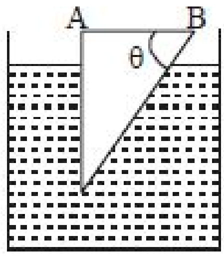
(C) $\checkmark 9.2 \times 10^{-4} m$ (D) $6.5 \times 10^{-4} m$

Sol : $\frac{\text{size of image}}{\text{size of object}} = \left|\frac{v}{u}\right|$

$\Rightarrow$ size of the image $= \frac{1.39 \times 10^9 \times 10^{-1}}{1.5 \times 10^{11}} = 0.92 \times 10^{-3}\,\text{m}$

size of the image $= 9.2 \times 10^{-4}\,\text{m}$

97. A glass prism of refractive index 1.5 is immersed in water (refractive index $4/3$). A light beam incident normally on the face AB is totally reflected to reach on the face BC if



(A) $\checkmark \sin\theta \geqslant \frac{8}{9}$ (B) $\frac{2}{3} < \sin\theta < \frac{8}{9}$

(C) $\sin\theta \leqslant \frac{2}{3}$ (D) None of these

Sol : The phenomenon of total internal reflection takes place during reflection at P.

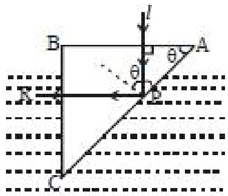
$$\sin\theta = \frac{1}{{}_g^\omega\mu} \quad ....(i)$$

When θ is the angle of incidence at P

Now, ${}_g^\omega\mu = \frac{{}_g^a h}{{}_g^\omega\mu} = \frac{1.5}{4/3} = 1.125$

Putting in (i), $\sin\theta = \frac{1}{1.125} = \frac{8}{9}$

$\therefore \sin\theta$ should be greater than or equal to $\frac{8}{9}$



98. How much water should be filled in a container $21 cm$ in height, so that it appears half filled when viewed from the top of the container......cm (given that ${}_a\mu_\omega = 4/3$)

(A) 8 (B) 10.5

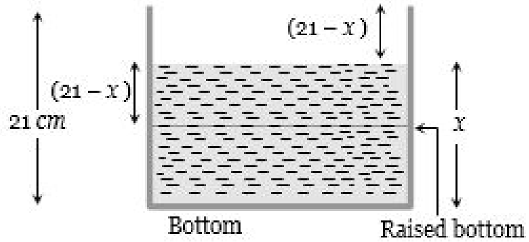
(C) $\checkmark 12$ (D) None of the above

Sol : (c) To see the container half-filled from top, water should be filled up to height x

so that bottom of the container should appear to be raised upto height $(21-x)$.

As shown in figure apparent depth $h' = (21-x)$
Real depth $h = x$

$\therefore \mu = \dfrac{h}{h'} \Rightarrow \dfrac{4}{3} = \dfrac{x}{21-x} \Rightarrow x = 12cm$



99. A ray of light is incident at an angle of 75^o into a medium having refractive index μ . The reflected and the refracted rays are found to suffer equal deviations in opposite direction μ equals

(A) $\dfrac{\sqrt{3}\ +1}{\sqrt{3}\ -1}$ (B) ✓$\dfrac{\sqrt{3}\ +1}{2}$

(C) $\dfrac{2\sqrt{2}}{\sqrt{3}\ +1}$ (D) None of these

100. A thin convex lens made from crown glass $\left(\mu = \dfrac{3}{2}\right)$ has focal length f. When it is measured in two different liquids having refractive indices $\dfrac{3}{2}$ and $\dfrac{3}{2}$ it has the focal lengths f_1 and f_2 respectively. The correct relation between the focal lengths is:

(A) ✓$f_1 > f$ and f_2 becomes negative (B) $f_2 > f$ and f_1 becomes negative

(C) f_1 and f_2 both becomes negative (D) $f_1 = f_2 < f$

Sol : By Lens maker's formula for convex lens

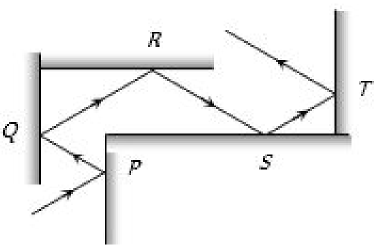
$\dfrac{1}{f} = \left(\dfrac{\mu}{\mu_L} - 1\right)\left(\dfrac{2}{R}\right)$

for, $\mu_{L_1} = \dfrac{4}{3}, f_1 = 4R$

for $\mu_{L_2} = \dfrac{5}{3}, f_2 = -5R$

$\Rightarrow f_2 = (-)\text{ve}$

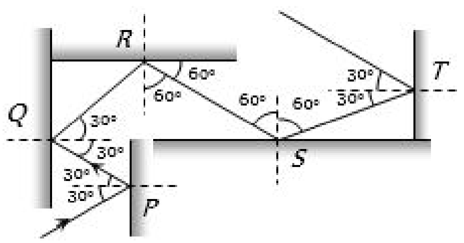
101. Following figure shows the multiple reflections of a light ray along a glass corridor where the walls are either parallel or perpendicular to one another. If the angle of incidence at point P is 30^o , what are the angles of reflection of the light ray at points Q, R, S and T respectively



(A) 30^o , 30^o , 30^o , 30^o (B) 30^o , 60^o , 30^o , 60^o

(C) ✓30^o , 60^o , 60^o , 30^o (D) 60^o , 60^o , 60^o , 60^o

Sol :



102. The refracting angle of prism is A and refractive index of material of prism is $\cot\dfrac{A}{2}$. The angle of minimum deviation is

(A) $180^\circ - 3A$ (B) $180^\circ + 2A$

(C) $90^\circ - A$ (D) ✓$180^\circ - 2A$

Sol : (d) By using $\mu = \dfrac{\sin\dfrac{A+\delta_m}{2}}{\sin\dfrac{A}{2}} \Rightarrow \cot\dfrac{A}{2} = \dfrac{\sin\dfrac{A+\delta_m}{2}}{\sin\dfrac{A}{2}}$

$\Rightarrow \dfrac{\cos\dfrac{A}{2}}{\sin\dfrac{A}{2}} = \dfrac{\sin\dfrac{A+\delta_m}{2}}{\sin\dfrac{A}{2}}$

$\Rightarrow \sin\left(90^\circ - \dfrac{A}{2}\right) = \sin\left(\dfrac{A+\delta_m}{2}\right)$

$\Rightarrow \delta_m = 180 - 2A$

103. A screen is placed $90\,cm$ from a object. The image of an object on the screen is formed by a convex lens at two different locations separated by $20\,cm.$ if the size of the image formed at the positions are $6\,cm$ and $3\,cm$, then the highest of the object is.....cm

(A) ✓4.2 (B) 4.5

(C) 5 (D) none of these

104. A prism of refracting angle 60^o is made with a material of refractive index μ. For a certain wavelength of light, the angle of minimum deviation is 30^o. For this, wavelength the value of refractive index of the material is

(A) 1.231 (B) 1.82

(C) 1.503 (D) ✓1.414

Sol : (d) $\mu = \dfrac{\sin\left(\dfrac{A+\delta_m}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

$= \dfrac{\sin\left(\dfrac{60^\circ + 30^\circ}{2}\right)}{\sin\dfrac{60^\circ}{2}}$

$= \dfrac{\sin 45^o}{\sin 30^o} = 1.414$

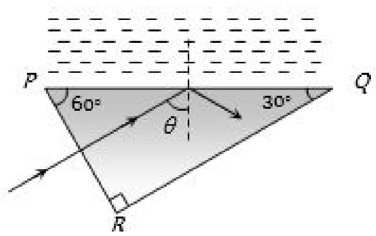
105. If two lenses of $+5$ diopters are mounted at some distance apart, the equivalent power will always be negative if the distance is

(A) ✓Greater than $40cm$ (B) Equal to $40cm$

(C) Equal to $10cm$ (D) Less than $10cm$

Sol : (a) Using $P = P_1 + P_2 - d \times P_1P_2$
for equivalent power to be negative
$d \times P_1P_2 > P_1 + P_2$ ==>$d \times 25 > 10$
==>$d > \dfrac{10}{25}m$ ==>$d > \dfrac{10 \times 100}{25}$ ==>$d > 40cm.$

106. PQR is a right angled prism with other angles as 60^o and 30^o. Refractive index of prism is 1.5. PQ has a thin layer of liquid. Light falls normally on the face PR. For total internal reflection, maximum refractive index of liquid is



(A) 1.4 (B) ✓1.3

(C) 1.2 (D) 1.6

Sol : (b) For TIR at PQ ; $\theta < C$
From geometry of figure $\theta = 60$ i.e. $60 > C \Rightarrow \sin 60 > \sin C$

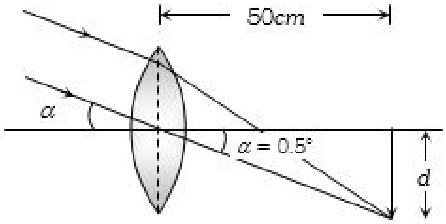
$\Rightarrow \dfrac{\sqrt{3}}{2} > \dfrac{\mu_{Liquid}}{\mu_{Prism}} \Rightarrow \mu_{Liquid} < \dfrac{\sqrt{3}}{2} \times \mu_{Prism}$

$\Rightarrow \mu_{Liquid} < \dfrac{\sqrt{3}}{2} \times 1.5 \Rightarrow \mu_{Liquid} < 1.3.$

107. The sun makes 0.5^o angle on earth surface. Its image is made by convex lens of $50cm$ focal length. The diameter of the image will be......mm

(A) 5
(B) ✓4.36
(C) 7
(D) None of these

Sol : (b) Diameter of image $d = \left(0.5 \times \frac{\pi}{180}\right) \times 500 = 4.36\ mm$



108. One face of a rectangular glass plate $6\,cm$ thick is silvered. An object held $8\,cm$ in front of the first face, forms an image $12\,cm$ behind the silvered face. The refractive index of the glass is

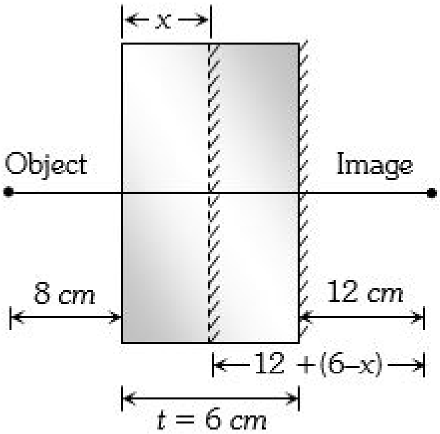
(A) 0.4
(B) 0.8
(C) ✓1.2
(D) 1.6

Sol : (c) Let x be the apparent position of the silvered surface.

According to property of plane mirror

$x + 8 = 12 + 6 - x \ \Rightarrow x = 5cm$

Also $\mu = \frac{t}{x} \Rightarrow \mu = \frac{6}{5} = 1.2$



109. 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

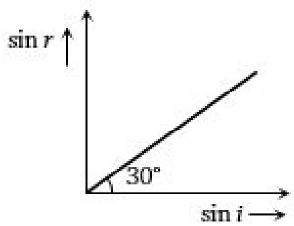
Sol : (b) For objective lens $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$\Rightarrow \frac{1}{(+4)} = \frac{1}{v_o} - \frac{1}{(-4.5)}$

$\Rightarrow v_o = 36\ cm$

$\therefore |m_D| = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right) = \frac{36}{4.5}\left(1 + \frac{24}{8}\right) = 32$

110. A medium shows relation between i and r as shown. If speed of light in the medium is nc then value of n is



(A) 1.5
(B) 2
(C) 2^{-1}
(D) ✓$3^{-1/2}$

Sol : (d) From graph it is clear that $\tan 30^o = \frac{\sin r}{\sin i}$

==>$\frac{1}{\sqrt{3}} = \frac{\sin r}{\sin i} = \frac{1}{\mu}$ ==>$\mu = \sqrt{3}$

Also $v = \frac{c}{\mu} = nc$

==>$n = \frac{1}{\mu} = \frac{1}{\sqrt{3}} = (3)^{-1/2}$

111. A curved surface of radius R separates two medium of refractive indices μ_1 and μ_2 as shown in figures A and B Identify the correct statement (s) related to the formation of images of a real object O placed at x from the pole of the concave surface, as shown in figure B

(A) If $\mu_2 > \mu_1$, then virtual image is formed for any value of x

(B) If $\mu_2 < \mu_1$, then virtual image is formed if $x < \frac{\mu_1 R}{\mu_1 - \mu_2}$

(C) If $\mu_2 < \mu_1$, then real image is formed for any value of x

(D) ✓Both (A) and (B)

Sol : $v\ gt\ 0$

$\therefore \frac{\mu_2}{v} = \frac{\mu_2 - \mu_1}{-R} + \frac{\mu_1}{u} >$ and if$\mu_2 < \mu_1$

$\frac{\mu_1 - \mu_2}{R} - \frac{\mu_1}{x} > 0, \frac{\mu_1 - \mu_2}{R} > \frac{u_1}{x}$

$\therefore x > \frac{\mu_1 R}{\mu_1 - \mu_2} \therefore (B)\text{if}\mu_2 < \mu_1$

Then virtual image is formed of $x < \frac{\mu_1 R}{\mu_1 - \mu_2}$

112. A prism $(\mu = 1.5)$ has the refracting angle of 30^o . The deviation of a monochromatic ray incident normally on its one surface will be $(sin 48^o\ 36' = 0.75)$

(A) ✓$18^o\ 36'$
(B) $20^o\ 30'$
(C) 18^o
(D) $22^o\ 1'$

Sol : (a) For surface $AC \frac{1}{\mu} = \frac{\sin 30°}{\sin e}$

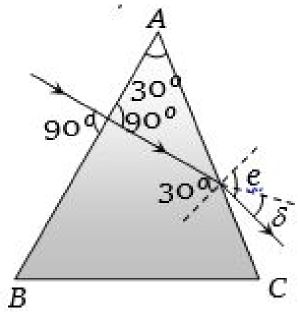
$\Rightarrow \sin e = \mu \sin 30°$

$\Rightarrow \sin e = 1.5 \times \frac{1}{2} = 0.75$

$\Rightarrow$ e = $\sin^{-1}(0.75) = 48^o 36'$

From figure $\delta = e - 30^o$

$= 48^o\ 36' - 30^o$=$18^o 36'$



113. In a compound microscope the focal length of objective lens is $1.2\,cm$ and focal length of eye piece is $3.0\,cm$. When object is kept at $1.25\,cm$ in front of objective, final image is formed at infinity. Magnifying power of the compound microscope should be

(A) ✓200
(B) 100
(C) 400
(D) 150

Sol : Given : $f_0 = 1.2\,\text{cm}; f_e = 3.0\,\text{cm}$
$u_0 = 1.25\,\text{cm}; M_\infty = ?$

From $\frac{1}{f_0} = \frac{1}{v_0} - \frac{1}{u_0}$

$\Rightarrow \frac{1}{1.2} = \frac{1}{v_0} - \frac{1}{(-1.25)}$

$\Rightarrow \frac{1}{v_0} = \frac{1}{1.2} - \frac{1}{1.25}$

$\Rightarrow v_0 = 30\,\text{cm}$

Magnification at infinity,

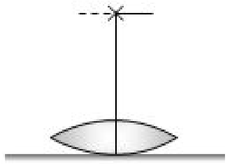
$M_\infty = -\frac{v_0}{u_0} \times \frac{D}{f_e}$

$= \frac{30}{1.25} \times \frac{25}{3}$ ($\because D = 25\,\text{cm}$ least distance of distinct vision)

$= 200$

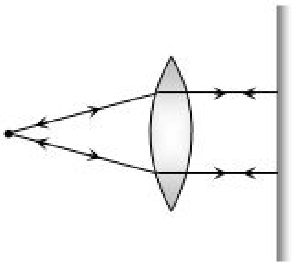
Hence the magnifying power of the compound microscope is 200

114. A lens when placed on a plane mirror then object needle and its image coincide at $15\,cm$. The focal length of the lens is......cm



(A) ✓15 (B) 30
(C) 20 (D) ∞

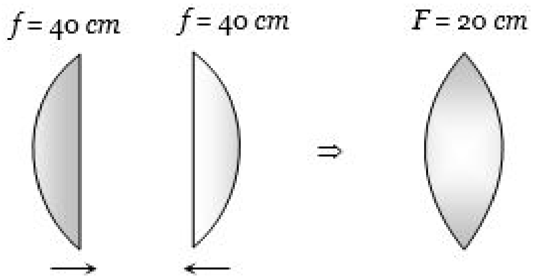
Sol : (a) When the object is placed at focus the rays are parallel. The mirror placed normal sends them back. Hence image is formed at the object itself as illustrated in figure.



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

(A) 80 (B) ✓40
(C) 20 (D) 162

Sol : (b) To obtain, an inverted and equal size image, object must be paced at a distance of $2f$ from lens, i.e. $40cm$ in this case.



116. The magnifying power of a telescope with tube 60 cm is 5. What is the focal length of its eye piece?......cm

(A) 30 (B) 40
(C) 20 (D) ✓10

Sol : $\mathrm{L = f_0 + f_e = 60\ cm}$

$\mathrm{M = \frac{f_0}{f_e} = 5}$

$\Rightarrow \mathrm{f_0 = 5f_e}$

$\therefore\ \ \mathrm{6f_e = 60cm}$

$\mathrm{f_e = 10cm}$

117. An achromatic convergent lens of focal length $20\,cms$ is made of two lenses (in contact) of materials having dispersive powers in the ratio of $1:2$ and having focal lengths f_1 and f_2. Which of the following is true ?

(A) ✓$f_1 = 10\,cms,\ f_2 = -20\,cms,$ (B) $f_1 = 20\,cms,\ f_2 = 10\,cms,$
(C) $f_1 = -10\,cms,\ f_2 = -20\,cms,$ (D) $f_1 = 20\,cms,\ f_2 = -20\,cms,$

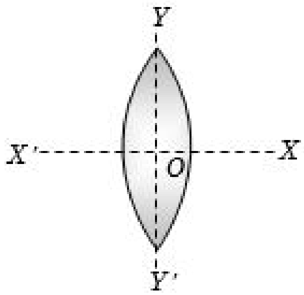
Sol : $\frac{f_1}{f_2} = -\frac{\omega_1}{\omega_2} = -\frac{1}{2}\quad \therefore f_2 = -2f_1$

As $\frac{1}{\mathrm{F}} = \frac{1}{\mathrm{f_1}} + \frac{1}{\mathrm{f_2}}$

$\therefore \frac{1}{20} = \frac{1}{\mathrm{f_1}} - \frac{1}{2\mathrm{f_1}} = \frac{1}{2\mathrm{f_1}}\quad \therefore \mathrm{f_1 = 10\,cm}$

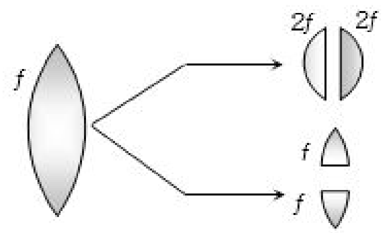
$f_2 = -20\,\text{cm}$

118. An equiconvex lens is cut into two halves along $(i) XOX'$ and $(ii) YOY'$ as shown in the figure. Let $f, f', f"$ be the focal lengths of the complete lens, of each half in case (i), and of each half in case (ii), respectively Choose the correct statement from the following



(A) $f' = 2f,\ f'' = f$ (B) $f' = f,\ f'' = f$
(C) $f' = 2f,\ f'' = 2f$ (D) ✓$f' = f,\ f'' = 2f$

Sol : (d)



119. Let the refractive index of a denser medium with respect to a rarer medium be n_{12} and its critical angle be θ_C. At an angle of incidence A when light is travelling from denser medium to rarer medium, a part of the light is reflected and the rest is refracted and the angle between reflected and refracted rays is 90^o. Angle A is given by

(A) $\frac{1}{\cos^{-1}(\sin\theta_C)}$ (B) $\frac{1}{\tan^{-1}(\sin\theta_C)}$
(C) $\cos^{-1}(\sin\theta_C)$ (D) ✓$\tan^{-1}(\sin\theta_C)$

Sol : From Snell's law, $\frac{\mu_\mathrm{R}}{\mu_\mathrm{D}} = \frac{\sin \mathrm{i}}{\sin \mathrm{r}}$ ..... (i)

$\because \angle \mathrm{i} = \mathrm{A}$ and $\angle \mathrm{r} = (90^o - \mathrm{A})$

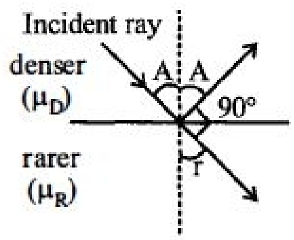
We also know that, $\sin\theta_C = \frac{\mu_R}{\mu_D}$

From $eq^n\ (i),\ \sin\theta_C = \frac{\sin A}{\sin(90^o - A)}$

$\sin\theta_\mathrm{C} = \frac{\sin \mathrm{A}}{\cos \mathrm{A}}$

$\sin\theta_\mathrm{C} = \tan \mathrm{A}$

$\mathrm{A} = \tan^{-1}(\sin\theta_\mathrm{C})$



120. The refracting angle of prism is 60^o and the index of refraction is $\sqrt{7/3}$ relative to surrounding. The limiting angle of incidence of a ray that the will be transmitted through the prism is ......^{o}

(A) ✓30
(B) 45
(C) 15
(D) 50

Sol : A ray is projected on face LM of the prism gets refracted from the two faces of the prism and finally emerges out of it.

For minimum i, the emergent ray must graze on the face LN i-e.e $= 90^\circ$

Using Snell's law for face $LN, n_2 \sin r_2 = n_1$ sine

$$\sqrt{\frac{7}{3}}\mathrm{sinr}_2 = 1 \times \sin 90^\circ$$

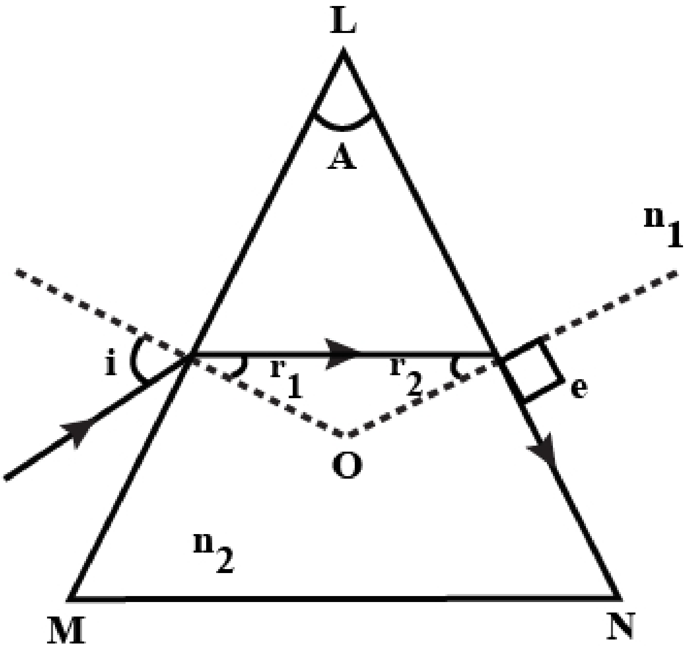
This gives $r_2 = 40.89^\circ$

As $A = r_1 + r_2, A = 60^\circ$

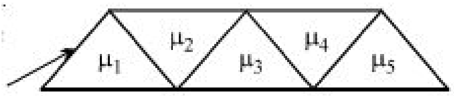
$r_2 = 19.11^\circ$

Using snell's law for face $\mathrm{LN}, 1\times\ sini = \sqrt{\frac{7}{3}} \times \sin 19.11^\circ$

This gives $i = 30^\circ$



121. The diagram shows five isosceles right angled prisms.Alight ray incident at 90^o at the first face emerges at same angle with the normal from the last face. Which of the following relations will hold regarding the refractive indices?



(A) $\mu_1^2 + \mu_3^2 + \mu_5^2 = \mu_2^2 + \mu_4^2$
(B) $\mu_1^2 + \mu_3^2 + \mu_5^2 = 1 + \mu_2^2 + \mu_4^2$
(C) ✓$\mu_1^2 + \mu_3^2 + \mu_5^2 = 2 + \mu_2^2 + \mu_4^2$
(D) none

Sol : $r_1 + r_2 = r_3 + r_4 = r_5 + r_6$
$= r_7 + r_8 = r_9 + r_{10} = 90^\circ \ldots (viii)$

From equations (i), (ii) and $(viii)$ we get,

$1 = \mu_1 \mathrm{sinr}_1; \mu_2 \sin r_3 = \mu_1 \cos r_1$

$\Rightarrow \mu_1^2 = 1 + \mu_2^2 \sin^2 r_3$

From (iii) $\mu_3 \sin \mathrm{r}_5 = \mu_2 \cos \mathrm{r}_3$ ...(A)

(A) and (B) gives

$\mu_1^2 + \mu_3^2 \sin^2 r_5 = 1 + \mu_2^2 \ldots (C)$

From (iv)

$\mu_3 \cos r_5 = \mu_4 \sin r_7 \ldots (D)$

(C) and (D) gives

$\mu_1^2 + \mu_3^2 = 1 + \mu_2^2 + \mu_4^2 \sin^2 r_7 \ldots\ldots (E)$

From (v) $\mu_5\, \mathrm{sinr}_9 = \mu_4 \cos r_7 \ldots\ldots (F)$

(E) and (F) gives $\mu_1^2 + \mu_3^2 + \mu_5^2 \sin^2 r_9 = 1 + \mu_2^2 + \mu_4^2 \ldots .(G)$

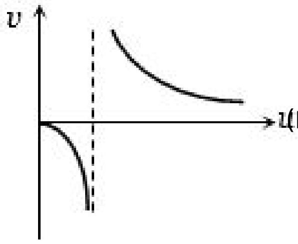
From (vi) $\mu_5 \cos r_9 = 1$

(G) and (H) gives

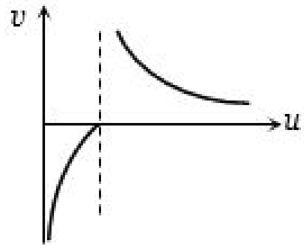
$\Rightarrow \mu_1^2 + \mu_3^2 + \mu_5^2 = 2 + \mu_2^2 + \mu_4^2$

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

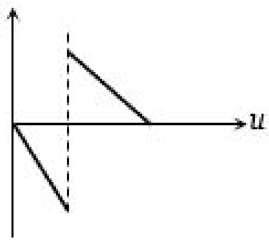
(A) ✓



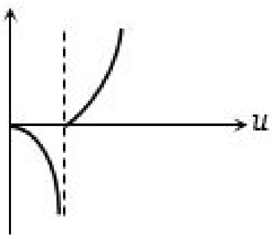
(B)



(C)



(D)

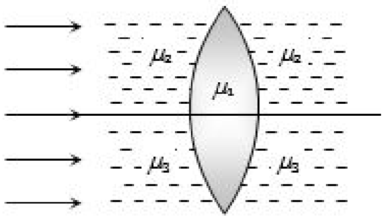


Sol : (a)At $u = f, v = \infty$

At $u = 0, v = 0$ (i.e. object and image both lies at pole)

Satisfying these two conditions, only option (a) is correct.

123. A double convex lens, lens made of a material of refractive index μ_1, is placed inside two liquids or refractive indices μ_2 and μ_3, as shown. $\mu_2 > \mu_1 > \mu_3$. A wide, parallel beam of light is incident on the lens from the left. The lens will give rise to



(A) A single convergent beam
(B) Two different convergent beams
(C) Two different divergent beams
(D) ✓A convergent and a divergent beam

Sol : (d) As $\mu_2 > \mu_1$, the upper half of the lens will become diverging.

As $\mu_1 > \mu_3$, the lower half of the lens will become converging

124. The diameter of the objective lens of a telescope is $5.0\, m$ and wavelength of light is 6000. The limit of resolution of this telescope will be......sec

(A) ✓0.03
(B) 3.03
(C) 0.06
(D) 0.15

Sol : (a) Limit of resolution $= \frac{1.22\, \lambda}{a} \times \frac{180}{\pi}$ (in degree)

$$= \left(\frac{1.22 \times (6000 \times 10^{-10})}{5} \times \frac{180}{\pi} \right)^o = 0.03\ sec$$

125. A magnifying glass is to be used at the fixed object distance of 1 inch. If it is to produce an erect image magnified 5 times its focal length should be........$inch$

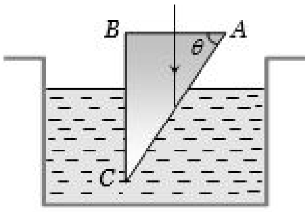
(A) 0.2
(B) 0.8
(C) ✓1.25
(D) 5

Sol : (c) $m = \frac{v}{u} = 5 \Rightarrow v = 5$ inch (Given $u = 1$ inch)

Using sign convention $u = -1\ inch,\ \ v = -5\ inch$

$\therefore \frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{-5} - \frac{1}{-1} \Rightarrow f = 1.25\ inch$

126. A glass prism ($\mu = 1.5$) is dipped in water ($_a\mu_w = 4/3$) as shown in figure. A light ray is incident normally on the surface AB. It reaches the surface BC after totally reflected, if



(A) ✓$sin\theta \ \geq \ 8/9$ (B) $2/3 < sin\theta < 8/9$

(C) $sin\theta \ \leq \ 2/3$ (D) It is not possible

Sol : (a) For TIR at AC

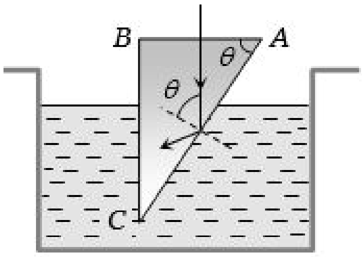
$\theta > C$

$\Rightarrow \sin\theta \geq \sin C$

$\Rightarrow \sin\theta \geq \frac{1}{_w\mu_g}$

$\Rightarrow \sin\theta \geq \frac{\mu_w}{\mu_g}$

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



127. 1% of light of a source with luminous intensity 50 candela is incident on a circular surface of radius $10\,cm$. The average illuminance of surface is

(A) $100\,lux$ (B) ✓$200\,lux$

(C) $300\,lux$ (D) $400\,lux$

Sol : (b) $\phi = 4\pi L = 200\ \pi\ lumen.$

so $I = \frac{\varphi}{100\,A} = \frac{200\,\pi}{100 \times \pi r^2} = \frac{2}{(0.1)^2}$

$= 200\,lux.$

128. A compound microscope has an eye piece of focal length $10\,cm$ and an objective of focal length $4\,cm$. Calculate the magnification, if an object is kept at a distance of $5\,cm$ from the objective so that final image is formed at the least distance vision $(20\,cm)$

(A) ✓12 (B) 11

(C) 10 (D) 13

Sol : (a) For objective lens $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

==>$\frac{1}{v_o} = \frac{1}{f_o} + \frac{1}{u_o} = \frac{1}{4} + \frac{1}{-5} = \frac{1}{20}$==>$v_o = 20cm$

Now $M = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right) = \frac{20}{5}\left(1 + \frac{20}{10}\right)$

$= 12\,.$

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

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

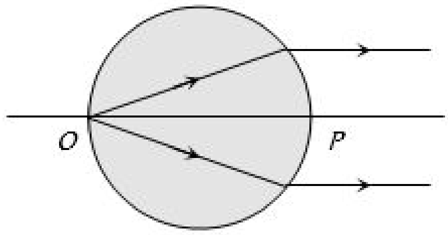
(C) ✓2 (D) $\frac{5}{2}$

Sol : (c) Considering pole at P, we have

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

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

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



130. A convex lens is in contact with concave lens. The magnitude of the ratio of their focal length is $2/3$. Their equivalent focal length is $30cm.$ What are their individual focal lengths

(A) $-75, 50$ (B) $-10, 15$

(C) $75, 50$ (D) ✓$-15, 10$

Sol : (d) $\frac{f_1}{f_2} = \frac{2}{3}$.....$(i)$

$\frac{1}{f_1} - \frac{1}{f_2} = \frac{1}{30}$.....$(ii)$

Solving equation

(i) and (ii) $f_2 = -15\,cm$ (Concave)

$f_1 = 10\,cm$(Convex)

131. Two thin lenses of focal lengths f_1 and f_2 are in contact. The focal length of this combination is

(A) $\frac{f_1 f_2}{f_1 - f_2}$ (B) ✓$\frac{f_1 f_2}{f_1 + f_2}$

(C) $\frac{2 f_1 f_2}{f_1 - f_2}$ (D) $\frac{2 f_1 f_2}{f_1 + f_2}$

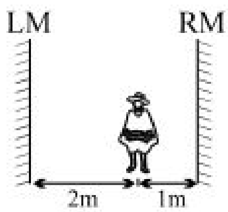
Sol : (b) If two thin lenses of focal lengths f_1 and f_2 are placed in contact coaxially, then equivalent focal length of combination is

$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{0}{f_1 f_2} = \frac{1}{f_1} + \frac{1}{f_2}$

Power for the combination is

$P = \frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{f_1 + f_2}{f_1 f_2}$

132. Two mirrors, labeled LM for left mirror and RM for right mirror in the adjacent figure, are parallel to each other and $3.0\,m$ apart. A person standing $1.0\,m$ from the right mirror (RM) looks into this mirror and sees a series of images. How far from the person is the second closest image seen in the right mirror (RM)?......m



(A) 10 (B) 4

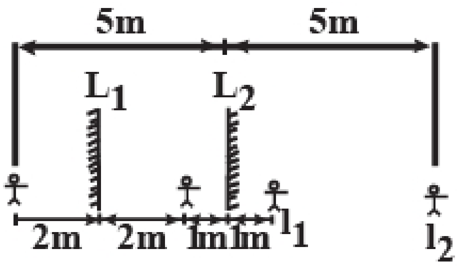
(C) ✓6 (D) 8

Sol : The nearest image in the right mirror forms with the man as the object.

The second nearest image in the right mirror forms with the nearest image of the man in the left mirror as the object as shown in the figure.

So the distance of the second nearest image from the man is:

$1 + 5 = 6m$



133. A astronomical telescope has objective and eyepiece of focal lengths $40\ cm$ and $4\ cm$ respectively. To view an object $200\ cm$ away from the objective, the lenses must be separated by a distance.....cm

(A) 46 (B) 50

(C) ✓54 (D) 37.3

Sol : Here $f_o = 40\,\text{cm}$, $f_e = 4\,\text{cm}$

Tube length(l) = Distance between lenses $= v_o + f_e$ For objective lens,

$u_o = -200\text{cm}, v_o = ?$

$\frac{1}{v} - \frac{1}{u_o} = \frac{1}{f_o}$ or $\frac{1}{v_o} - \frac{1}{-200} = \frac{1}{40}$

or $\frac{1}{v_0} = \frac{1}{40} - \frac{1}{200} = \frac{4}{200}$ $\therefore v_0 = 50\,\text{cm}$

$\therefore \quad l = 50 + 4 = 54\,\text{cm}$

134. Two lenses have focal lengths f_1 and f_2 and their dispersive powers are ω_1 and ω_2 respectively. They will together form an achromatic combination if

(A) $\omega_1 f_1 = \omega_2 f_2$ (B) ✓$\omega_1 f_2 + \omega_2 f_1 = 0$

(C) $\omega_1 + f_1 = \omega_2 + f_2$ (D) $\omega_1 - f_1 = \omega_2 - f_2$

Sol : (b)For achromatic combination, $\frac{w_1}{f_1} + \frac{w_2}{f_2} = 0$==> $w_1 f_2 + w_2 f_1 = 0$

135. Two parallel pillars are $11\,km$ away from an observer. The minimum distance between the pillars so that they can be seen separately will be.....m

(A) ✓3.2 (B) 20.8

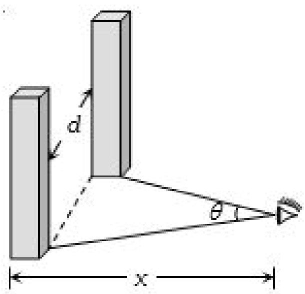
(C) 91.5 (D) 183

Sol : (a) As limit of resolution of eye is $\left(\frac{1}{60}\right)^o$, the pillars will be seen distinctly if $\theta > \left(\frac{1}{60}\right)^o$

i.e., $\frac{d}{x} > \left(\frac{1}{60}\right) \times \frac{\pi}{180}$

$\Rightarrow d > \frac{\pi \times x}{60 \times 180}$

$\Rightarrow d > \frac{3.14 \times 11 \times 10^3}{60 \times 180} \Rightarrow d > 3.2\ m$



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

Sol : (c) ${}_1\mu_2 = \frac{1}{\sin C} \Rightarrow \frac{\mu_2}{\mu_1} = \frac{\lambda_1}{\lambda_2} = \frac{1}{\sin C}$

$\Rightarrow \frac{6000}{4000} = \frac{1}{\sin C} \Rightarrow C = \sin^{-1}\left(\frac{2}{3}\right)$

137. The magnifying power of a telescope is 9. When it is adjusted for parallel rays, the distance between the objective and the eye-piece is found to be $20\,cm$. The focal length of the two lenses are

(A) ✓$18\,cm, 2\,cm$ (B) $11\,cm, 9\,cm$

(C) $10\,cm, 10\,cm$ (D) $15\,cm, 5\,cm$

Sol : (a) In this case $|m| = \frac{f_o}{f_e} = 9$ ....(i)

and length of telescope $= f_o + f_e = 20$ ....(ii)

Solving (i) and (ii), we get $f_o = 18\,cm.\ \ f_e = 2\,cm.$

138. A point object is placed at the center of a glass sphere of radius $6cm$ and refractive index 1.5. The distance of the virtual image from the surface of the sphere is.......cm

(A) 2 (B) 4

(C) ✓6 (D) 12

Sol : (c) Using refraction formula $\frac{{}_1\mu_2 - 1}{R} = \frac{{}_1\mu_2}{v} - \frac{1}{u}$

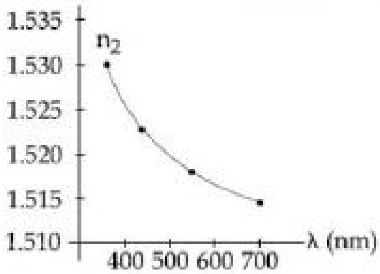
in given case, medium (1) is glass and (2) is air

So $\frac{{}_g\mu_a - 1}{R} = \frac{{}_g\mu_a}{v} - \frac{1}{u} \Rightarrow \frac{\frac{1}{1.5} - 1}{-6} = \frac{1}{1.5\,v} - \frac{1}{-6}$

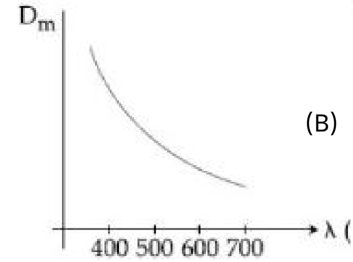
$\Rightarrow \frac{1 - 1.5}{-6} = \frac{1}{v} + \frac{1.5}{6} \Rightarrow \frac{0.5}{6} = \frac{1}{v} + \frac{1}{4}$

$\Rightarrow \frac{1}{v} = \frac{1}{12} - \frac{1}{4} = -\frac{2}{12} = -\frac{1}{6}$==>$v = 6cm.$

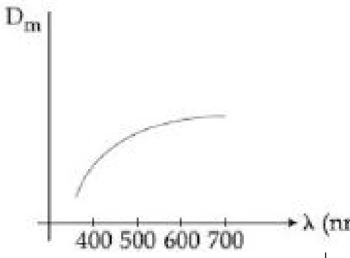
139. The variation of refractive index of a crown glass thin prism with wavelength of the incident light is shown. Which of the following, graph is the correct one, if D_m is the angle of minimum deviation?



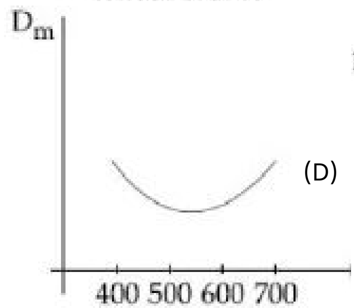
(A) ✓



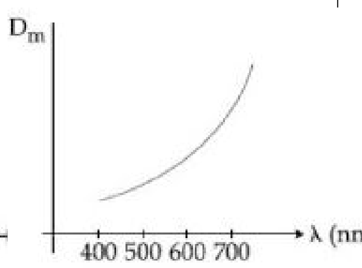
(B)



(C)



(D)



Sol : Prism formula

$D_m = S_m = (n-1)A$ (for thin prism)

So, answer is 1.

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

(A) ✓$\frac{t\,\theta\,(n-1)}{n}$ (B) $\frac{t\,\theta}{n}$

(C) $\frac{t\,\theta\,n}{n-1}$ (D) none

Sol : We have, Lateral shift $= \frac{t\sin(i-r)}{\cos r}$ and $\frac{\sin i}{\sin r} = n$

Lateral shift $= t.\frac{(\sin i \cos r - \cos i \sin r)}{\cos r}$

$= t.\left(\sin i - \frac{\cos i \sin r}{\cos r}\right)$

since i is very small, r is also very small.

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

Here $i = \theta$

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

since i and r are small,

$\sin i \Rightarrow i$

$\sin r \Rightarrow r$

$\cos i \Rightarrow 1$

$\cos r \Rightarrow 1$

Lateral shift $= t\left(\theta - \frac{1 \times \frac{\theta}{n}}{1}\right)$

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

141. A person is suffering from myopic defect. He is able to see clear objects placed at $15\,cm$. What type and of what focal length of lens he should use to see clearly the object placed $60\,cm$ away

(A) ✓Concave lens of $20\,cm$ focal length
(B) Convex lens of $20\,cm$ focal length
(C) Concave lens of $12\,cm$ focal length
(D) Convex lens of $12\,cm$ focal length

Sol : (a) For viewing far objects, concave lenses are used and for concave lens

$u =$ wants to see $= -60\,cm$;

$v =$ can see $= -15\,cm$

so from $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow f = -20\,cm.$

142. A convergent doublet of separated lenses, corrected for spherical aberration, has resultant focal length of $10\,cm$. The separation between the two lenses is $2\,cm$. The focal lengths of the component lenses

(A) ✓$18\,cm, 20\,cm$
(B) $10\,cm, 12\,cm$
(C) $12\,cm, 14\,cm$
(D) $16\,cm, 18\,cm$

Sol : For minimum spherical aberration separation

$d = f_1 - f_2 = 2\,cm$

Resultant focal lenght $= F = 10\,cm$

Using $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$ and solving we get f_1, f_2 $18\,cm$ and $20\,cm$ respectively

143. A thin glass (refractive index 1.5) lens has optical power of $-5D$ in air. It's optical power in a liquid medium with refractive index 1.6 will be

(A) $25D$
(B) $-25D$
(C) $1D$
(D) ✓None of these

Sol : $\frac{f_l}{f_a} = \frac{({}_a\mu_g - 1)}{({}_l\mu_g - 1)}$

==>$\frac{f_l}{f_a} = \frac{{}_a\mu_g - 1}{{}_l\mu_g - 1} = \frac{1.5-1}{\frac{1.5}{1.6} - 1} = \frac{0.5 \times 1.6}{-0.1} = -8$

==>$P_l = \frac{P_a}{8} = \frac{5}{8}$

144. The refractive index of the material of a prism is $\sqrt{2}$ and the angle of the prism is 30^o . One of the two refracting surfaces of the prism is made a mirror inwards, by silver coating. A beam of monochromatic light entering the prism from the other face will retrace its path (after reflection from the silvered surface) if its angle of incidence on the prism is

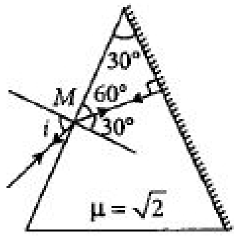
(A) 60^o
(B) ✓45^o
(C) 0^o
(D) 30^o

Sol : For retracing the path shown in figure, light ray should be incident normally on the silvered face.

Applying Snell's law at point M,

$\frac{\sin i}{\sin 30°} = \frac{\sqrt{2}}{1} \Rightarrow \sin i = \sqrt{2} \times \frac{1}{2}$

$\sin i = \frac{1}{\sqrt{2}} i.e., i = 45°$



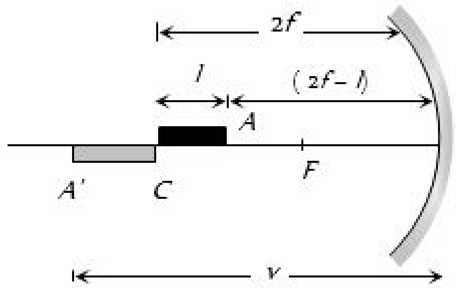
145. A thin rod of $5cm$ length is kept along the axis of a concave mirror of $10cm$ focal length such that its image is real and magnified and one end touches the rod. Its magnification will be

(A) 1
(B) ✓2
(C) 3
(D) 4

Sol : (b) End A of the rod acts as an object for mirror and A' will be its image so $u = 2f - l = 20 - 5 = 15\,cm$

$\because \frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ ==>$\frac{1}{-10} = \frac{1}{v} - \frac{1}{15}$ ==>$v = -30\,cm$.

Now $m = \frac{\text{Length of image}}{\text{Length of object}} = \frac{(30-20)}{5} = 2$



146. The dispersive power of the material of lens of focal length $20cm$ is 0.08. The longitudinal chromatic aberration of the lens is......cm

(A) 0.08
(B) $0.08/20$
(C) ✓1.6
(D) 0.16

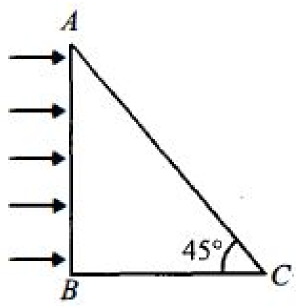
Sol : (c) Longitudinal chromatic aberration

$= \omega f = 0.08 \times 20 = 1.6cm.$

147. The origin of x and y coordinates is the pole of a concave mirror of focal length $20\,cm$. The x -axis is the optical axis with $x > 0$ being the real side of mirror. A point object at the point $(25\,cm, 1\,cm)$ is moving with a velocity $10\,cm/s$ in positive x -direction. The velocity of the image in cm/s is approximately

(A) $-80\,i + 8\,j$
(B) $160\,i + 8\,j$
(C) ✓$-160\,i + 8\,j$
(D) $160\,i - 4\,j$

148. A beam of light consisting of red, green and blue colours is incident on a right-angled prism on face AB. The refractive indices of the material for the above red, green and blue colours are $1.39, 1.44$ and 1.47 respectively. A person looking on surface AC of the prism will see



(A) no light
(B) green and blue colours
(C) red and green colours
(D) ✓red colour only

Sol : For light to come out through face $'AC'$, total internal reflection must not take place.

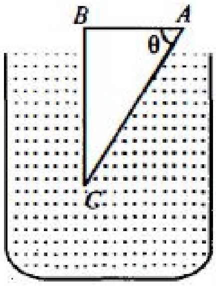
i.e, $\theta < c \Rightarrow \sin\theta < \sin c$

$\Rightarrow \sin\theta < \dfrac{1}{\mu}$

or $\quad \mu < \dfrac{1}{\sin\theta} \Rightarrow \mu < \dfrac{1}{\sin 45^o}$

$\Rightarrow \mu < \sqrt{2} \Rightarrow \mu < 1.414$

149. A glass prism of refractive index 1.5 is immersed in water (refractive index $\frac{4}{3}$) as shown in figure. A light beam incident normally on the face AB is totally reflected to reach the face BC, if



(A) $\sin\ \theta > \dfrac{5}{9}$ (B) $\sin\ \theta > \dfrac{2}{3}$

(C) ✓$\sin\ \theta > \dfrac{8}{9}$ (D) $\sin\ \theta > \dfrac{1}{3}$

Sol : For total internal reflection on face AC

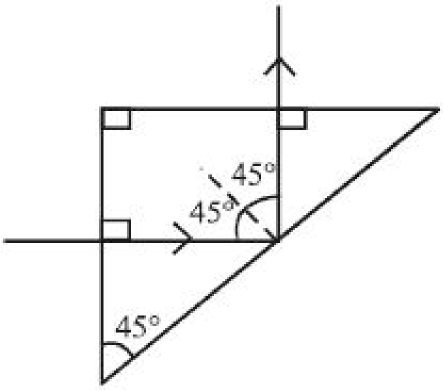
$0 >$ critical angle (C) and $\sin\theta \geq \sin C$

$\sin\theta \geq \dfrac{1}{{}_w\mu_g}$

$\sin\theta \ \geqslant \dfrac{\mu_w}{\mu_g} \Rightarrow \sin\theta \ \geqslant \dfrac{\frac{4}{3}}{\frac{3}{2}}$

$\therefore \sin\theta \geq \dfrac{8}{9}$

150. A light ray is incident perpendicularly to one face of a 90^o prism and is totally internally reflected at the glass-air interface. If the angle of reflection is 45^o, we conclude that the refractive index



(A) $n > \dfrac{1}{\sqrt{2}}$ (B) ✓$n > \sqrt{2}$

(C) $n < \dfrac{1}{\sqrt{2}}$ (D) $n < \sqrt{2}$

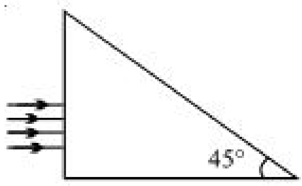
Sol : The incident angle is $45°$ incident angle $>$ critical angle, $i > i_c$

$\therefore \sin i > \sin i_c$ or $\sin 45 > \sin i_c$

$\sin i_c = \dfrac{1}{n}$

$\therefore \sin 45° > \dfrac{1}{\mathrm{n}}$ or $\dfrac{1}{\sqrt{2}} > \dfrac{1}{\mathrm{n}} \Rightarrow \mathrm{n} > \sqrt{2}$

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



(A) ✓separate part of the red color from the green and blue colors.

(B) separate part of the blue color from the red and green colours.

(C) separate all the three colors from the other two colors.

(D) not separate even partially any color from the other two colors.

Sol : For total internal reflection, $i > i_c$

Here $i = 45^0$

$\dfrac{\sin i}{\sin r} = \mu$

$\sin 45^0 > \dfrac{1}{\mu}$

$\mu > \dfrac{1}{\sqrt{2}} = 1.414$

$\mu_{red} < 1.414$ but $\mu_{green} > 1.414$ and $\mu_{\text{violet}} > 1.414$

Hence, green and violet will be totally internally reflected. Red will be refracted.

152. A transparent cube of $15\,cm$ edge contains a small air bubble. Its apparent depth when viewed through one face is $6\,cm$ and when viewed through the opposite face is $4\,cm$. Then the refractive index of the material of the cube is

(A) 2 (B) 2.5

(C) 1.6 (D) ✓1.5

Sol : (d) When viewed from face (1)

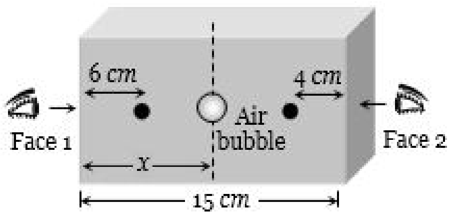
$\mu = \dfrac{u}{v} = \dfrac{x}{v} = \dfrac{x}{6}$ .....(i)

Now when viewed from face (2)

$\mu = \dfrac{15 - x}{v} = \dfrac{15 - x}{4}$ .....(ii)

From equation (i) and (ii)

$\mu = \dfrac{15 - 6\mu}{4} \Rightarrow \mu = 1.5.$



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

(A) 40 (B) 45

(C) ✓30 (D) 49

Sol : $u = \dfrac{\sin\left(\dfrac{A + \delta_m}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

154. If convex lens of focal length $80cm$ and a concave lens of focal length $50cm$ are combined together, what will be their resulting power

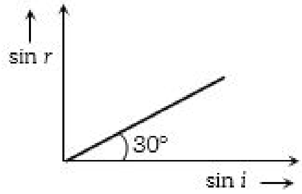
(A) $+6.5D$ (B) $-6.5D$

(C) $+7.5D$ (D) ✓$-0.75D$

Sol : (d) $\dfrac{1}{F} = \dfrac{1}{f_1} + \dfrac{1}{f_2} \Rightarrow \dfrac{1}{F} = \dfrac{1}{+80} + \dfrac{1}{-50}$

$\Rightarrow F = -\dfrac{400}{3} \Rightarrow P = \dfrac{-3}{4}D$

155. When light is incident on a medium at angle i and refracted into a second medium at an angle r, the graph of $sin\,i$ vs $sin\,r$ is as shown in the graph. From this, one can conclude that



(A) Velocity of light in the second medium is 1.73 times the velocity of light in the I medium

(B) Velocity of light in the I medium is 1.73 times the velocity in the II medium

(C) The critical angle for the two media is given by $sin\, i_c = \frac{1}{\sqrt{3}}$

(D) ✓Both (b) and (c)

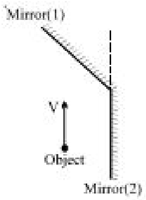
Sol : (b, c) From graph $\tan 30^o = \frac{\sin r}{\sin i} = \frac{1}{{}_1\mu_2}$

==> ${}_1\mu_2 = \sqrt{3}$ ==> $\frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = 1.73$ ==> $v_1 = 1.73\, v_2$

Also from $\mu = \frac{1}{\sin C}$ ==> $\sin C = \frac{1}{{}_{Rarer}\mu_{Denser}}$

==> $\sin C = \frac{1}{{}_1\mu_2} = \frac{1}{\sqrt{3}}$.

156. In the diagram shown, all the velocities are given with respect to earth. What is the relative velocity of the image in mirror (1) with respect to the image in the mirror (2)? The mirror (1) forms an angle β with the vertical.



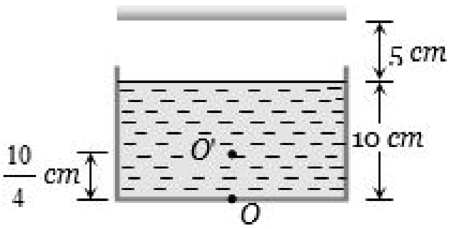
(A) $2V\, sin\, 2\beta$

(B) ✓$2V\, sin\beta$

(C) $2V\, /\, sin2\beta$

(D) none

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



(A) 15

(B) ✓12.5

(C) 7.5

(D) 10

Sol : (b) From figure it is clear that object appears to be raised by $\frac{10}{4} cm\ (2.5\, cm)$

Hence distance between mirror and $O' = 5 + 7.5 = 12.5\, cm$

So final image will be formed at $12.5\, cm$ behind the plane mirror.

158. A concave mirror is placed on a horizontal surface and two thin uniform layers of different transparent liquids (which do not mix or interact) are formed on the reflecting surface. The refractive indices of the upper and lower liquids are μ_1 and μ_2 respectively. The bright point source at a height $'d'$ (d is very large in comparison to the thickness of the film) above the mirror coincides with its own final image. The radius of curvature of the reflecting surface therefore is

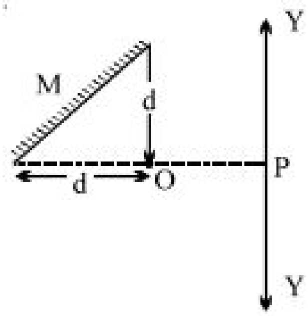
(A) $\frac{\mu_1\, d}{\mu_2}$

(B) $\mu_1 \mu_2 d$

(C) $\mu_1 d$

(D) ✓$\mu_2 d$

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



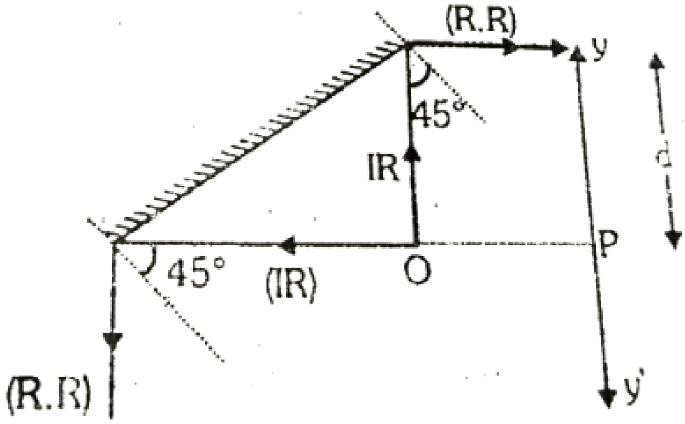
(A) For all point on PY man can see the image of O

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

(C) ✓For all point on PY' he can see the image but on PY he can see the image only upto distance d.

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

Sol : Field fo view of image is decided by the reflected rays. As we can see that the reflected rays from the extreme end points of mirror at a height $'d'$ from P and below P all points on PY . Hence (C).



160. The focal length of the field lens (which is an achromatic combination of two lenses) of telescope is $90 cm$. The dispersive powers of the two lenses in the combination are 0.024 and 0.036. The focal lengths of two lenses are

(A) $30cm$ and $60cm$

(B) ✓$30cm$ and $-45cm$

(C) $45cm$ and $90cm$

(D) $15cm$ and $45cm$

Sol : (b) For achromatic combination $\frac{f_1}{f_2} = -\frac{\omega_2}{\omega_1} = -\frac{0.036}{0.024} = -\frac{3}{2}$

and $\frac{1}{f_1} - \frac{1}{f_2} = \frac{1}{90}$

solving above equations be get $f_1 = 30cm,\ f_2 = -45cm$

161. A plano-convex lens of refractive index 1.5 and radius of curvature $30cm$ is silvered at the curved surface. Now this lens has been used to form the image of an object. At what distance from this lens an object be placed in order to have a real image of the size of the object.......cm

(A) ✓20

(B) 30

(C) 60

(D) 80

Sol : Focal length of the system (concave mirror)

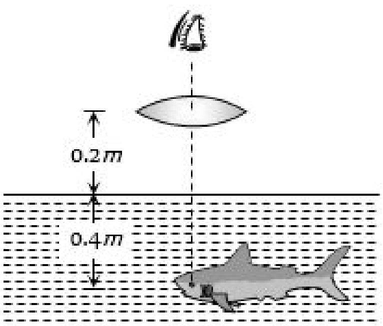
$F = \frac{R}{2\,\mu} = \frac{30}{2 \times 1.5} = 10cm$

In order to have a real image of the same size of the object, object must be placed at centre of curvature $u = (2f)$.

162. A bi-concave symmetric lens made of glass has refractive index 1.5. It has both surfaces of same radius of curvature R. On immersion in a liquid of refractive index 1.25, it will behave as a

(A) Converging lens of focal length $2.5\,R$
(B) Converging lens of focal length $2.0\,R$
(C) Diverging lens of focal length $4.5\,R$
(D) ✓None of these

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



(A) A distance of $0.2\,m$ from the water surface
(B) A distance of $0.6\,m$ from the water surface
(C) A distance of $0.3\,m$ from the water surface
(D) ✓The same location of fish

Sol : (d) Apparent distance of fish from lens $u=0.2+\frac{h}{\mu}$

$=0.2+\frac{0.4}{4/3}=0.5\,m$

From $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}\Rightarrow\frac{1}{(+3)}=\frac{1}{v}-\frac{1}{(-0.5)}$ $v=-0.6\,m$

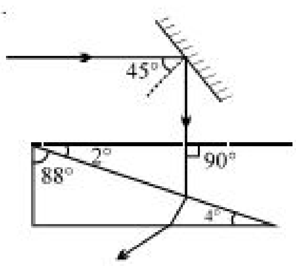
The image of the fish is still where the fish is $0.4\,m$ below the water surface.

164. In a plano-convex lens the radius of curvature of the convex lens is $10cm$. If the plane side is polished, then the focal length will be.........cm (Refractive index $=1.5$)

(A) 10.5
(B) ✓10
(C) 5.5
(D) 5

Sol : (b) $f=\frac{R}{2(\mu-1)}=\frac{10}{2(1.5-1)}=10\,cm$

165. A ray of light strikes a plane mirror at an angle of incidence 45^o as shown in the figure.After reflection, the ray passes through a prism of refractive index 1.5, whose apex angle is 4^o. The angle through which the mirror should be rotated if the total deviation of the ray is to be 90^o is



(A) 1^o clockwise
(B) ✓1^o anticlockwise
(C) 2^o clockwise
(D) 2^o anticlockwise

Sol : The deviation produced by small angled prism,

$\delta_1=(\mu-1)\alpha=(1.5-1)4^0=2^0$ (always)

Deviation caused by mirror,

$\delta_2=180^\circ-2i=180^\circ-2\times45^\circ=90^\circ$

Net deviation produced by system $=\delta_1+\delta_2=2^\circ+90^\circ=92^\circ$

This is more than 90°

Greater is angle of incidence on the mirror, smaller is the deviation.

If β is the angle of rotation of mirror is clockwise direction mirror will be

$180^\circ-2\left(45^\circ+\beta\right)=90^\circ-2\beta$

Therefore, total deviation produced

$=90^\circ-2\beta+2^\circ=92^\circ-2\beta$ Given, $92^\circ-2\beta=90^\circ\Rightarrow\beta=1^\circ$

166. For the angle of minimum deviation of a prism to be equal to its refracting angle, the prism must be made of a material whose refractive index

(A) lies between $\sqrt{2}$ and 1
(B) ✓lies between 2 and $\sqrt{2}$
(C) >1
(D) <1

Sol : As $\mu=\dfrac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$$\mu=\frac{\sin\left(\frac{A+A}{2}\right)}{\sin\left(\frac{A}{2}\right)}=\frac{\sin A}{\sin\left(\frac{A}{2}\right)}\quad(\because\delta_m=A(\text{ Given }))$$

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

As $\delta=i+e-A$

At minimum deviation, $\delta=\delta_m, i=e$

$\therefore\delta_m=2i-A$

$2i=\delta_m+A$

$i=\frac{\delta_m+A}{2}=\frac{A+A}{2}=A\quad(\because\ \delta_m=A(\text{ given }))$

$i_{\min}=0^o\Rightarrow A_{\min}=0^o$

Then, $\mu_{\max}=2\cos0^o=2$

$\therefore i_{\max}=\frac{\pi}{2}\Rightarrow A_{\max}=\frac{\pi}{2}$

Then, $\mu_{\min}=2\cos45^o=2\times\frac{1}{\sqrt{2}}=\sqrt{2}$

167. A ray of light is incident at an angle of incidence, i, on one face of prism of angle A (assumed to be small) and emerges normally from the opposite face. If the refractive index of the prism is μ, the angle of incidence i, is nearly equal to

(A) ✓μA
(B) $\frac{\mu A}{2}$
(C) $\frac{A}{\mu}$
(D) $\frac{A}{2\mu}$

Sol : For normally emerge $e=0$

Therefore $r_2=0$ and $r_1=A$

Snell's Law for Incident ray's

$1\,sin\,i=\mu\,sin\,r_1=\mu\,sin\,A$

For small angle

$i=\mu A$

168. A curved surface of radius R separates two medium of refractive indices μ_1 and μ_2 as shown in figures A and B Choose the correct statement (s) related to the real image formed by the object O placed at a distance x, as shown in figure A

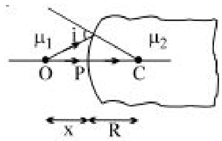


Fig. A

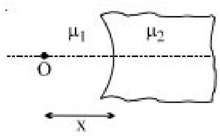
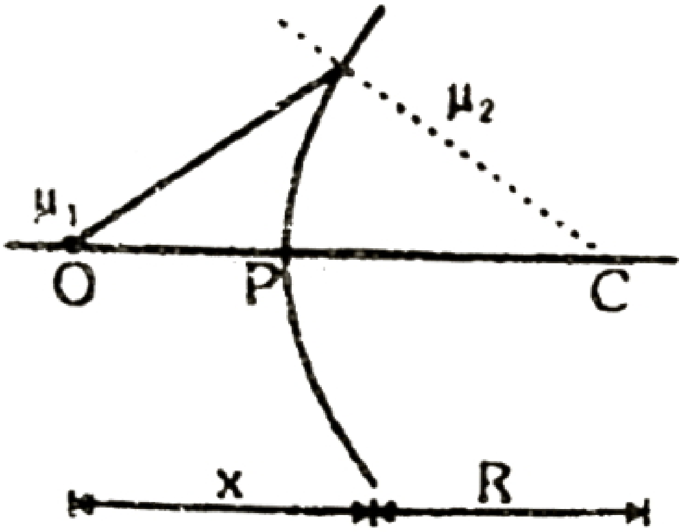


Fig. B

(A) Real image is always formed irrespective of the position of object if $\mu_2>\mu_1$
(B) Real image is formed only when $x>R$
(C) Real image is formed due to the convex nature of the interface irrespective of μ_1 and μ_2
(D) ✓None of these

Sol : Real image can't be formed always virtual.



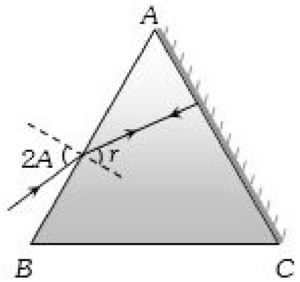
169. Angle of prism is A and its one surface is silvered. Light rays falling at an angle of incidence $2A$ on first surface return back through the same path after suffering reflection at second silvered surface. Refractive index of the material of prism is

(A) $2 \sin A$
(B) ✓$2 \cos A$
(C) $\frac{1}{2} \cos A$
(D) $\tan A$

Sol : (b) $A = r + 0$ and $\mu = \frac{\sin i}{\sin r}$

$\Rightarrow \mu = \frac{\sin 2A}{\sin A}$

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



170. Match the corresponding entries of column 1 with column 2. [Where mis the magnification produced by the mirror]

$Column - I$	$Column - II$
1. $m = -2$	a. $Convex\ mirror$
2. $m = \frac{-1}{2}$	b. $Concave\ mirror$
3. $m = +2$	c. $Real\ Image$
4. $m = \frac{+1}{2}$	d. $Virtual\ image$

(A) $(1 - a$ and $c), (2 - a$ and $d), (3 - a$ and $b)(4 - c$ and $d)$
(B) $(1 - a$ and $d), (2 - b$ and $c), (3 - b$ and $d)(4 - b$ and $c)$
(C) $(1 - c$ and $d), (2 - b$ and $d), (3 - b$ and $c)(4 - a$ and $d)$
(D) ✓$(1 - b$ and $c), (2 - b$ and $d), (3 - a$ and $b)(4 - c$ and $d)$

Sol : Magnification in the mirror, $m = -\frac{v}{u}$

$m = -2 \Rightarrow v = 2u$

As v and u have same signs so the mirror is concave and image formed is real.

$m = -\frac{1}{2} \Rightarrow v = \frac{u}{2} \Rightarrow$ Concave mirror and real image.

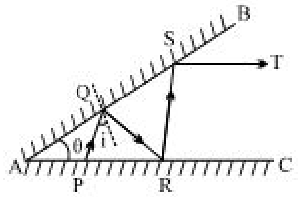
$m = +2 \Rightarrow v = -2u$

As v and u have different signs but magnification is 2 so the mirror is concave and image formed is virtual.

$m = +\frac{1}{2} \Rightarrow v = -\frac{u}{2}$

As v and u have different signs with magnification $\left(\frac{1}{2}\right)$ so the mirror is convex and image formed is virtual.

171. Two plane mirror AB and AC are inclined at an angle $\theta = 20^o.A$ ray of light starting from point P is incident at point Q on the mirroe AB, then at R on mirror AC and again on S on AB finally the ray ST goes parallel to mirror AC. The angle iwhich the ray makes with the normal at point Q on mirror AB is



(A) 20
(B) ✓30
(C) 40
(D) 60

Sol : $90^\circ - i(\theta) + 2r = 180^\circ$

$\therefore r - \left(\frac{90^\circ + i - \theta}{2}\right)$

$p = 180^\circ - (90^\circ - r) - 2i$

$= 180^\circ - 90^\circ + \left(\frac{90^\circ + i + \theta}{2}\right) - 2i$

$90^\circ - r$

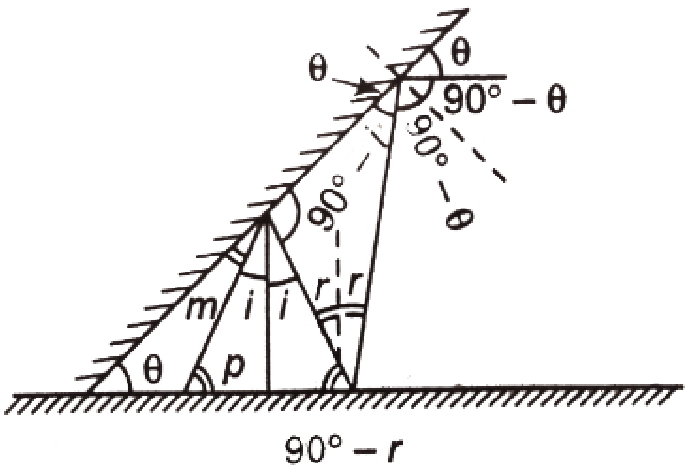
$= \frac{180^\circ - 4i + 90^\circ + i - \theta}{2}$

$= \frac{270^\circ - 3i - \theta}{2}$

$m = p - (\theta) = 180^\circ - (90^\circ - i) - 2i$

$\therefore \left(\frac{270^\circ - 3i - (\theta)}{2} - \theta\right) = 90^\circ - i$

Substituting $(\theta = 20^\circ,$ we get $\mathrm{i} = 30^\circ)$

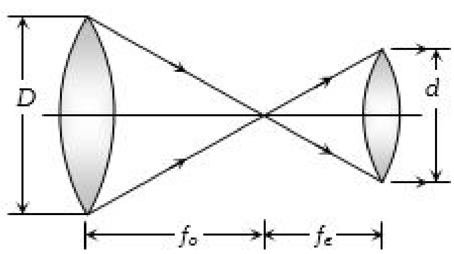


172. The focal length of an objective of a telescope is $3metre$ and diameter $15cm$. Assuming for a normal eye, the diameter of the pupil is $3\ mm$ for its complete use, the focal length of eye piece must be......cm

(A) ✓6
(B) 6.3
(C) 20
(D) 60

Sol : (a) Full use of resolving power means whole aperture of objective in use. And for relaxed vision.

$\frac{f_o}{f_e} = \frac{D}{d} \Rightarrow \frac{300}{f_e} = \frac{15}{0.3} \Rightarrow f_e = 6\ cm$



173. The focal length of objective and eye-piece of a telescope are $100\,cm$ and $5\,cm$ respectively. Final image is formed at least distance of distinct vision. The magnification of telescope is

(A) 20 (B) ✓24

(C) 30 (D) 36

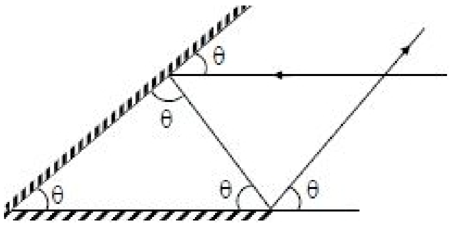
Sol : (b)$|m| = \frac{f_o}{f_e}\left(1+\frac{f_e}{D}\right) = \frac{100}{5}\left(1+\frac{5}{25}\right) = 24$

174. Two plane mirrors are inclined to each other such that a ray of light incident to the first mirror (M_1) and parallel to the second mirror (M_2) is finally reflected from the second mirror (M_2) parallel to the first mirror (M_1). The angle between the two mirrors will be......^{o}

(A) 45 (B) ✓60

(C) 75 (D) 90

Sol : $\theta = 60^o$



175. A square of side $3cm$ is placed at a distance of $25cm$ from a concave mirror of focal length $10cm$. The centre of the square is at the axis of the mirror and the plane is normal to the axis. The area enclosed by the image of the square is......cm^2

(A) ✓4 (B) 6

(C) 16 (D) 36

Sol : (a) $m = \frac{I}{O} = \frac{f}{u-f} = \frac{10}{25-10} = \frac{10}{15} = \frac{2}{3} m^2 = \frac{A_i}{A_o} \Rightarrow$
$A_i = m^2 \times A_o = \left(\frac{2}{3}\right)^2 \times (3)^2 = 4\,cm^2$

176. A luminous object is placed at a distance of $30\,cm$ from the convex lens of focal length $20\,cm$. On the other side of the lens, at what distance from the lens a convex mirror of radius of curvature $10\,cm$ be placed in order to have an upright image of the object coincident with it.....cm

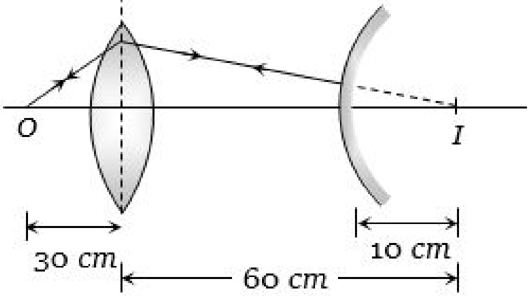
(A) 12 (B) 30

(C) ✓50 (D) 60

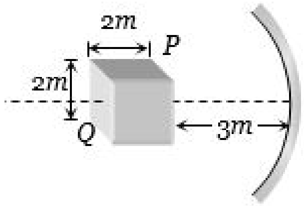
Sol : (c) For lens $u = 30\ cm,\ \ f = 20\,cm$, hence by using
$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{+20} = \frac{1}{v} - \frac{1}{-30} \Rightarrow v = 60\ cm$

The final image will coincide the object, if light ray falls normally on convex mirror as shown.

From figure it is seen clear that separation between lens and mirror is $60-10 = 50cm$.



177. A cube of side $2\,m$ is placed in front of a concave mirror focal length $1\,m$ with its face P at a distance of $3\,m$ and face Q at a distance of $5\,m$ from the mirror. The distance between the images of face P and Q and height of images of P and Q are



(A) $1\,m, 0.5\,m, 0.25\,m$ (B) $0.5\,m, 1\,m, 0.25\,m$
(C) $0.5\,m, 0.25\,m, 1\,m$ (D) ✓$0.25\,m, 1\,m, 0.5\,m$

Sol : (d) For surface P,
$\frac{1}{v_1} = \frac{1}{f} - \frac{1}{u} = 1 - \frac{1}{3} = \frac{2}{3}$==>$v_1 = \frac{3}{2}m$

For surface Q,
$\frac{1}{v_2} = \frac{1}{f} - \frac{1}{u} = 1 - \frac{1}{5} = \frac{4}{5}$==>$v_2 = \frac{5}{4}m$

$\therefore\ v_1 - v_2 = 0.25m$

Magnification of $P = \frac{v_1}{u} = \frac{3/2}{3} = \frac{1}{2}$

$\Rightarrow$ Height of $P = \frac{1}{2} \times 2 = 1m$

Magnification of $Q = \frac{v_2}{u} = \frac{5/4}{5} = \frac{1}{4}$

$\Rightarrow$ Height of $Q = \frac{1}{4} \times 2 = 0.5m$

178. The relative luminosity of wavelength $600\,nm$ is 0.6. Find the radiant flux of $600\,nm$ needed to produce the same brightness sensation as produced by $120\,W$ of radiant flux at $555\,nm$.........W

(A) 50 (B) 72
(C) $120 \times (0.6)^2$ (D) ✓200

Sol : (d) If η is the luminous efficiency of the bulb then.

luminous flux by $120\,watt$ at $555\,nm = \eta \times 120$

Let bulb of P watt at $600\,nm$ produces the same luminous flux as by $120\,watt$ at $555\,nm$ then

$\eta \times 120 = \eta P \times 0.6 \Rightarrow P = \frac{120}{0.6} = 200\ watt.$

179. It is desired to make an achromatic combination of two lenses (L_1 & L_2) made of materials having dispersive powers ω_1 and $\omega_2 (< \omega_1)$. If the combination of lenses is converging then

(A) L_1 is converging (B) ✓L_2 is converging
(C) Power of L_1 is greater than the power of L_2 (D) None of these

Sol : Dispersive power $\omega \propto \frac{1}{\mu - 1}$

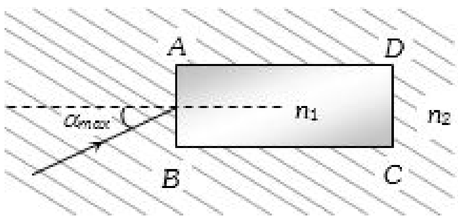
From lens maker's formula, $\frac{1}{f} \propto (\mu - 1)$

Power $\propto \mu - 1 \propto \frac{1}{\omega}$

Thus power of L_2 power of L_1

Hence if the combination is converging the L_2 has to be converging

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



(A) ✓$\sin^{-1}\left[\frac{n_1}{n_2}\cos\left(\sin^{-1}\frac{n_2}{n_1}\right)\right]$ (B) $\sin^{-1}\left[n_1\cos\left(\sin^{-1}\frac{1}{n_2}\right)\right]$
(C) $\sin^{-1}\left(\frac{n_1}{n_2}\right)$ (D) $\sin^{-1}\left(\frac{n_2}{n_1}\right)$

Sol : (a) Ray comes out from CD, means rays after refraction from AB get, total internally reflected at AD

$\frac{n_1}{n_2} = \frac{\sin\alpha_{\max}}{\sin r_1} \Rightarrow \alpha_{\max} = \sin^{-1}\left[\frac{n_1}{n_2}\sin r_1\right] \ldots (i)$

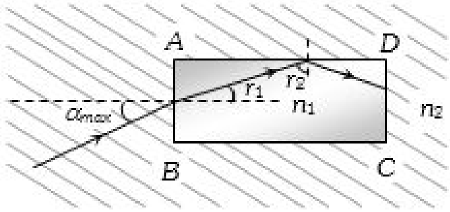
Also $r_1 + r_2 = 90^o \Rightarrow r_1 = 90 - r_2 = 90 - C$

$\Rightarrow r_1 = 90 - \sin^{-1}\left(\frac{1}{2\mu_1}\right) \Rightarrow r_1 = 90 - \sin^{-1}\left(\frac{n_2}{n_1}\right)$ ...(ii)

Hence from equation (i) and (ii)

$\alpha_{\max} = \sin^{-1}\left[\frac{n_1}{n_2}\sin\left\{90 - \sin^{-1}\frac{n_2}{n_1}\right\}\right]$

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



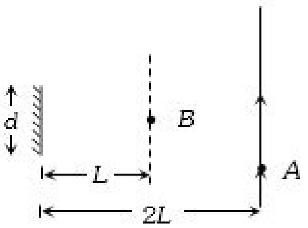
181. The unit of focal power of a lens is

(A) Watt (B) Horse power

(C) ✓Dioptre (D) Lux

Sol : (c)

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



(A) $d/2$ (B) d

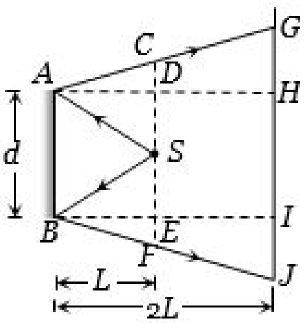
(C) $2d$ (D) ✓$3d$

Sol : (d) According to the following ray diagram $HI = AB = d$

and $DS = CD = \frac{d}{2}$

$\because\ AH = 2AD \Rightarrow\ GH = 2CD = \frac{2d}{2} = d$

Similarly $IJ = d$so $GJ = GH + HI + IJ = d + d + d = 3d$



183. For the refraction of light through a prism

(A) Angle of minimum deviation will increase if refractive index of prism is increased keeping the outside medium unchanged if $\mu_P > \mu_S$.

(B) The light travelling inside an equilateral prism is necessarily parallel to the base when prism is set for minimum deviation.

(C) There are two angles of incidence for maximum deviation.

(D) ✓All of the above

184. A microscope is focussed on a coin lying at the bottom of a beaker. The microscope is now raised up by $1\,cm$. To what depth should the water be poured into the beaker so that coin is again in focus ?........cm (Refractive index of water is $\frac{4}{3}$)

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

(C) 3 (D) ✓4

Sol : (d)Suppose water is poured up to the height h,

So $h\left(1 - \frac{1}{\mu}\right) = 1 \Rightarrow h = 4\ cm$

185. If luminous efficiency of a lamp is 2 lumen/watt and its luminous intensity is 42 candela, then power of the lamp is.......W

(A) 62 (B) 76

(C) 138 (D) ✓264

Sol : (d) Luminous flux $= 4\pi\ L = 4 \times 3.14 \times 42\ =\ 528\ Lumen$

Power of lamp $= \frac{\text{Luminous flux}}{\text{Luminous efficiency}} = \frac{528}{2} = 264\ W$

186. A concave mirror is placed at the bottom of an empty tank with face upwards and axis vertical. When sunlight falls normally on the mirror, it is focussed at distance of $32\,cm$ from the mirror. If the tank filled with water $\left(\mu = \frac{4}{3}\right)$ upto a height of $20\,cm$, then the sunlight will now get focussed at

(A) $16\,cm$ above water level (B) ✓$9\,cm$ above water level

(C) $24\,cm$ below water level (D) $9\,cm$ below water level

Sol : (b) Sun is at infinity i.e. $u = \infty$ so from mirror formula we have

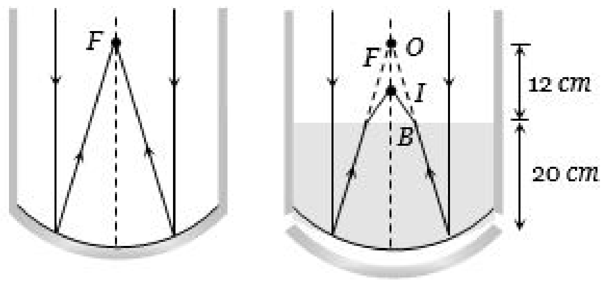
$\frac{1}{f} = \frac{1}{-32} + \frac{1}{(-\infty)} \Rightarrow f = -32cm.$

When water is filled in the tank upto a height of $20cm,$ the image formed by the mirror will act as virtual object for water surface.

Which will form it's image at I such that

$\frac{\text{Actual height}}{\text{Apperant height}} = \frac{\mu_w}{\mu_a}$ i.e. $\frac{BO}{BI} = \frac{4/3}{1}$

$\Rightarrow BI = BO \times \frac{3}{4} = 12 \times \frac{3}{4} = 9cm.$



187. A small source of light is to be suspended directly above the centre of a circular table of radius R. What should be the height of the light source above the table so that the intensity of light is maximum at the edges of the table compared to any other height of the source

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

(C) R (D) $\sqrt{2}R$

Sol : (b) $I_{edge} = \frac{L\cos\theta}{(h^2 + r^2)} = \frac{Lh}{(h^2 + r^2)^{3/2}}$

For maximum extensity $\frac{dI}{dh} = 0$

Applying this condition have get $h = \frac{r}{\sqrt{2}}$

188. A plano convex lens of refractive index μ_1 and focal length f_1 is kept in contact with another plano concave lens of refractive index μ_2 and focal length f_2. If the radius of curvature of their spherical faces is R each and $f_1 = 2f_2$, then μ_1 and μ_2 are related as

(A) ✓$\mu_1 + 2\mu_2 = 3$ (B) $2\mu_1 + \mu_2 = 1$
(C) $3\mu_2 + \mu_1 = 1$ (D) $2\mu_2 + \mu_1 = 1$

Sol : $\frac{1}{f_1} = (\mu_1 - 1)\left(\frac{1}{R} - \frac{1}{\infty}\right)$; $\frac{1}{f_2} = (\mu_2 - 1)\left(\frac{1}{\infty} - \frac{1}{R}\right)$

$\frac{1}{f_1} = \frac{(\mu\ -1)}{R}$; $\frac{1}{f_2} = -\left(\frac{\mu_2 - 1}{R}\right)$

$\mathrm{f_2 = 2f_1}$; $\frac{1}{\mathrm{f_1}} = \frac{2}{\mathrm{f_2}}$

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

$\mu_1 + 2\mu_2 = 3$

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

(A) $f/2, I/2$ (B) $f, I/4$
(C) $3f/4, I/2$ (D) ✓$f, 3I/4$

Sol : Covering a part of the surface will not change the focal length of the lens, as the focal length depends only on the refractive index of the lens and the radius of curvature of the lens.
For the intensity, the amount of light blocked when half of the lens will be covered by an opaque cloth, $= \left(\frac{1}{2}\right)^2$
Thus, the intensity of light gets reduced to $i - \frac{i}{4} = \frac{3i}{4}$

190. An object is placed at a distance of $40\ cm$ from a concave mirror of focal length $15\ cm$. If the object is displaced through a distance of $20\ cm$ towards the mirror, the displacement of the image will be

(A) $30cm$ away from the mirror (B) ✓$36cm$ away from the mirror
(C) 36 cm towards the mirror (D) 30 cm towards the mirror

Sol : Using mirror formula,

$\frac{1}{f} = \frac{1}{v_1} + \frac{1}{u_1}; -\frac{1}{15} = \frac{1}{v_1} - \frac{1}{40} \Rightarrow \frac{1}{v_1} = \frac{1}{-15} + \frac{1}{40}$

$v_1 = -24\,\mathrm{cm}$

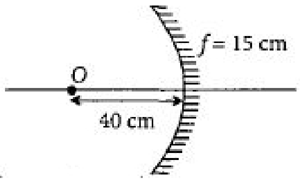
When object is displaced by $20\,\mathrm{cm}$ towards mirror Now,

$u_2 = -20\,\mathrm{cm}$

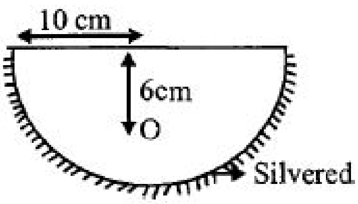
$\frac{1}{f} = \frac{1}{v_2} + \frac{1}{u_2}; \frac{1}{-15} = \frac{1}{v_2} - \frac{1}{20} \Rightarrow \frac{1}{v_2} = \frac{1}{20} - \frac{1}{15}$

$v_2 = -60\,\mathrm{cm}$

So, the image will be shift away from mirror by $(60 - 24)\mathrm{cm} = 36\,\mathrm{cm}$



191. A hemispherical glass body of radius $10\,cm$ and refractive index 1.5 is silvered on its curved surface. A small air bubble is $6\,cm$ below the flat surface inside it along the axis. The position of the image of the air bubble made by the mirror is seen



(A) $14\,cm$ below flat surface (B) ✓$20\,cm$ below flat surface
(C) $16\,cm$ below flat surface (D) $30\,cm$ below flat surface

Sol : Given, radius of herrispherical glass $\mathrm{R} = 10\,\mathrm{cm}$

$\therefore$ Focal length $\mathrm{f} = \frac{10}{2} = -5\,\mathrm{cm}$

$\mathrm{u} = (10 - 6) = -4\,\mathrm{cm}$

By using mirror formula,

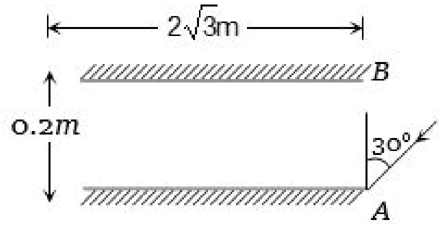
$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} + \frac{1}{-4} = \frac{1}{-5}$

$\Rightarrow v = 20\,\mathrm{cm}$

Apparen the height,

$\mathrm{h_a} = \mathrm{h_r}\frac{\mu_1}{\mu_2} = 30 \times \frac{1}{15} = 20\,\mathrm{cm}$ below flat surface.

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



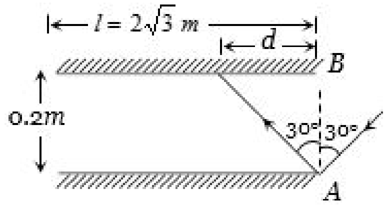
(A) 28 (B) ✓30
(C) 32 (D) 34

Sol : (b) From the following ray diagram

$d = 0.2\tan 30^\circ = \frac{0.2}{\sqrt{3}}$

==>$\frac{l}{d} = \frac{2\sqrt{3}}{0.2/\sqrt{3}} = 30$

Therefore maximum number of reflections are 30.

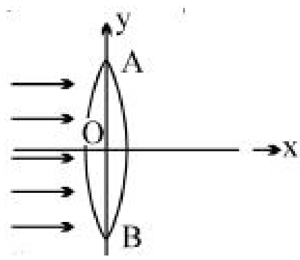


193. Two vertical plane mirrors are inclined at an angle of 60° with each other. A ray of light travelling horizontally is reflected first from one mirror and then from the other. The resultant deviation is.....^{o}

(A) 60 (B) 120
(C) 180 (D) ✓240

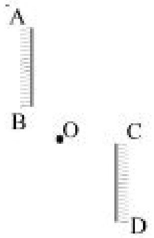
Sol : (d)$\delta = (360 - 2\theta) = (360 - 2 \times 60) = 240^o$

194. Monochromatic light rays parallel to x -axis strike a convex lens AB. If the lens oscillates such that AB tilts upto a small angle θ (in radian) on either side of y -axis, then the amplitude of oscillation of image will be (f = focal length of the lens):



(A) $f\,sec\,\theta$ (B) $f\,sec^2\,\theta$
(C) $\frac{\mathrm{f}\,\theta^2}{2}$ (D) ✓$\frac{\mathrm{f}\,\theta^2}{4}$

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



(A) ✓1 (B) 2

(C) 4 (D) Infinite

196. Two lenses are placed in contact with each other and the focal length of combination is $80cm$. If the focal length of one is $20cm$, then the power of the other will be

(A) $1.66D$ (B) $4.00D$

(C) $-1.00D$ (D) ✓$-3.75D$

Sol : (d) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$

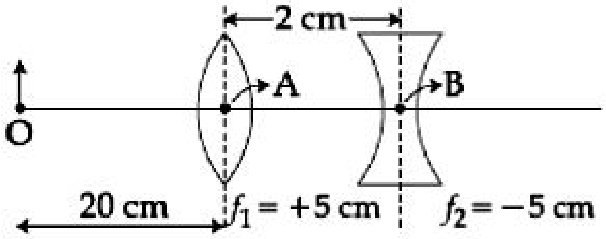
$\Rightarrow \frac{1}{80}=\frac{1}{20}+\frac{1}{f_2}$

$\Rightarrow f_2=-\frac{80}{3}cm$

Power of second lens

$P_2=\frac{100}{f_2}=\frac{100}{-80/3}=-3.75\ D$

197. What is the position and nature of image formed by lens combination shown in figure? (f_1, f_2 are focal lengths)



(A) $70\,cm$ from point B at left; virtual

(B) $40\,cm$ from point B at right; real

(C) $\frac{20}{3}cm$ from point B at right; real

(D) ✓$70\,cm$ from point B at right ; real

Sol : Image by convex lens:

$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$; $\frac{1}{v}+\frac{1}{20}=\frac{1}{5}$

$v=\frac{20}{3}\,\mathrm{cm}$

Image by concave lens:

$u=\left[\frac{20}{3}-2\right]=\frac{14}{3}\,\mathrm{cm}$

$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$; $\frac{1}{v}-\frac{3}{14}=-\frac{1}{5}$

$v=70\,\mathrm{cm}$

198. A thin prism having refracting angle 10^o is made of glass of refractive index 1.42. This prism is combined with another thin prism of glass of refractive index 1.7. This combination produces dispersion without deviation. The refracting angle of second prism should be....^{o}

(A) ✓6 (B) 8

(C) 10 (D) 4

Sol : The condition for dispersion without deviation is given as $(\mu-1)A=(\mu'-1)\,A'$

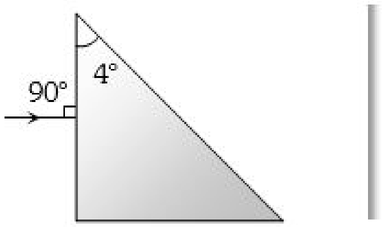
Given $\mu=1.42, A=10^\circ, \mu'=1.7, A'=?$

$\therefore\quad (1.42-1)\times 10=(1.7-1)A'$

$(0.42)\times 10=0.7\times A'$

or $\quad A'=\frac{0.42\times 10}{0.7}=6^\circ$

199. A prism having an apex angle 4^o and refraction index 1.5 is located in front of a vertical plane mirror as shown in figure. Through what total angle is the ray deviated after reflection from the mirror.....^{o}



(A) 176 (B) 4

(C) ✓178 (D) 2

Sol : (c) $\delta_{\Pr ism}=(\mu-1)A=(1.5-1)4^o=2^o$

$\therefore \delta_{Total}=\delta_{\Pr ism}+\delta_{Mirror}$

$=(\mu-1)A+(180-2i)=2^o+(180-2\times 2)=178^o$

200. A thin oil layer floats on water. A ray of light making an angle of incidence of 40^o shines on oil layer. The angle of refraction of light ray in water is......^{o}

($\mu_{oil}=1.45,\ \mu_{water}=1.33$)

(A) 36.1 (B) 44.5

(C) 26.8 (D) ✓28.9

Sol : (d) Refraction at air-oil point $\mu_{oil}=\frac{\sin i}{\sin r_1}$

$\therefore \sin r_1=\frac{\sin 40}{1.45}=0.443$

Refraction at oil-water point ${}_{oil}\mu_{water}=\frac{\sin r_1}{\sin r}$

$\therefore \frac{1.33}{1.45}=\frac{0.443}{\sin r}$ or

$\sin r=\frac{0.443\times 1.45}{1.33}$==>$r=28.9^o$