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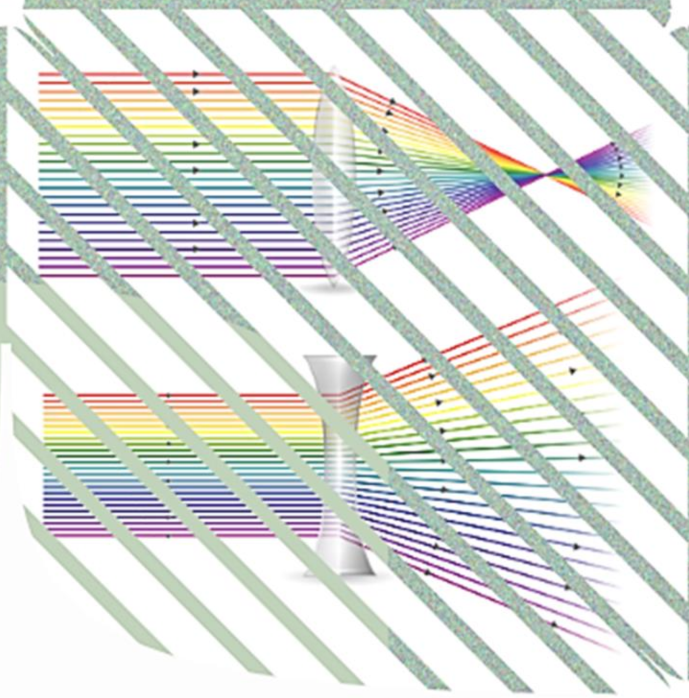
RAY OPTICS
Revision Module



THE
SUCCESS DESTINATION...

aepstudycircle@gmail.com

Connect with us.
+91-9939586130
+91-7739650505

2nd floor, Satkoudi complex, Thana chowk, RAMGARH -829122-JH

RAY – OPTICS

Multiple Choice Questions (MCQs)

DIRECTIONS : *This section contains multiple choice questions. Each question has four choices (a), (b), (c) and (d) out of which only one is correct.*

1. A ray of light passes from vacuum into a medium of refractive index μ, the angle of incidence is found to be twice the angle of refraction. Then the angle of incidence is

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

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

2. A rectangular tank of depth 8 meter is full of water ($\mu = 4/3$), the bottom is seen at the depth

(a) 6m (b) 8/3 m (c) 8 cm (d) 10 cm

3. When light is refracted from denser to rarer medium, then

(a) its wavelength, frequency both increase
(b) its wavelength increases, frequency remains unchanged
(c) its wavelength decreases, frequency remains unchanged
(d) its wavelength, frequency both decrease

4. Which of the following is/are true/false relations?

I. $n_{21} = \frac{1}{n_{12}}$ II. $n_{32} = n_{31} \times n_{12}$

III. $n_{21} = \frac{n_{1a}}{n_{2a}}$ IV. $n_{21} = \frac{n_{2a}}{n_{1a}}$

(a) T,T,F,T (b) T,F,T,T
(c) F,T,T,T (d) T,T,T,T

5. According to the total internal reflection which of the following statements is/are true/false?

I. Looming is an optical illusion in cold countries.
II. Mirage is an optical illusion in deserts.
III. Brilliance of diamond is due to repeated internal reflections.

(a) T,T,T (b) T,T,F
(c) T,F,T (d) None of these

6. Two thin lenses are in contact and the focal length of the combination is 80 cm. If the focal length of one lens is 20 cm, then the power of the other lens will be

(a) 1.66 D (b) 4.00 D (c) –100 D (d) –3.75 D

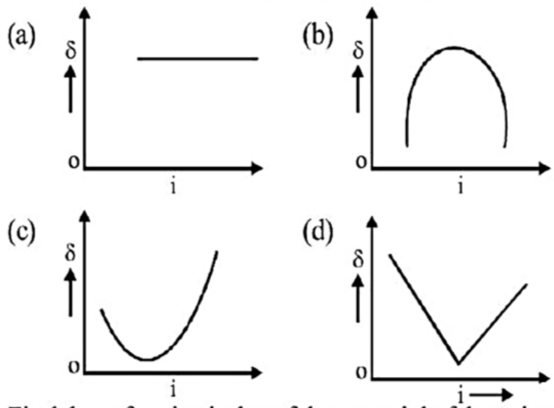
7. A lens made of glass whose index of refraction is 1.60 has a focal length of + 20 cm in air. Its focal length in water, whose refractive index is 1.33, will be

(a) three times longer than in air
(b) two times longer than in air
(c) same as in air
(d) None of these

8. A bi-convex lens made of glass (refractive index 1.5) is put in a liquid of refractive index 1.7. Its focal length will

(a) decrease and change sign
(b) increase and change sign
(c) decrease and remain of the same sign
(d) increase and remain of the same sign

9. The graph between angle of deviation (δ) and angle of incidence (i) for a triangular prism is represented by



10. Find the refractive index of the material of the prism, if the angle of minimum deviation from the prism is 37° and angle of prism is 53° [take sin 26.5° = 1/2.234]

(a) 1.58 (b) 1.99 (c) 2.88 (d) 3.1

11. The angle of prism is 60° and angle of deviation is 30°. In the position of minimum deviation, the values of angle of incidence and angle of emergence are:

(a) $i = 45°; e = 50°$ (b) $i = 30°; e = 45°$
(c) $i = 45°; e = 45°$ (d) $i = 30°; e = 30°$

12. The focal length of the objective of a telescope is 60 cm. To obtain a magnification of 20, the focal length of the eye piece should be

(a) 2 cm (b) 3 cm (c) 4 cm (d) 5 cm

13. The focal length of the objective and the eyepiece of a telescope are 50 cm and 5 cm respectively. If the telescope is focussed for distinct vision on a scale distant 2 m from its objective, then its magnifying power will be:

(a) –4 (b) –8 (c) +8 (d) –2

14. 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

15. Larger aperture of objective lens in an astronomical telescope

(a) increases the resolving power of telescope.
(b) decreases the brightness of the image.
(c) increases the size of the image.
(d) decreases the length of the telescope.

16. A biconvex lens of glass having refractive index 1.47 is immersed in a liquid. It becomes invisible and behaves as a plane glass plate. The refractive index of the liquid is

(a) 1.47 (b) 1.62 (c) 1.33 (d) 1.51

17. A ray of light incident at an angle θ on a refracting face of a prism emerges from the other face normally. If the angle of the prism is 5° and the prism is made of a material of refractive index 1.5, the angle of incidence is

(a) 7.5° (b) 5° (c) 15° (d) 2.5°

18. An object approaches a convergent lens from the left of the lens with a uniform speed 5 m/s and stops at the focus. The image

(a) moves away from the lens with an uniform speed 5 m/s
(b) moves away from the lens with an uniform acceleration
(c) moves away from the lens with a non-uniform acceleration
(d) moves towards the lens with a non-uniform acceleration

19. You are given four sources of light each one providing a light of a single colour - red, blue, green and yellow. Suppose the angle of refraction for a beam of yellow light corresponding to a particular angle of incidence at the interface of two media is 90°. Which of the following statements is correct if the source of yellow light is replaced with that of other lights without changing the angle of incidence?

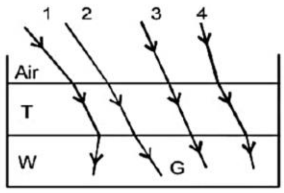
(a) The beam of red light would undergo total internal reflection
(b) The beam of red light would bend towards normal while it gets refracted through the second medium
(c) The beam of blue light would undergo total internal reflection
(d) The beam of green light would bend away from the normal as it gets refracted through the second medium

20. The radius of curvature of the curved surface of a plano-convex lens is 20 cm. If the refractive index of the material of the lens be 1.5, it will

(a) act as a convex lens only for the objects that lie on its curved side
(b) act as a concave lens for the objects that lie on its curved side
(c) act as a convex lens irrespective of the side on which the object lies
(d) act as a concave lens irrespective of side on which the object lies

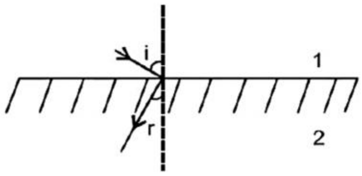
21. The optical density of turpentine is higher than that of water while its mass density is lower. Figure shows a layer of turpentine floating over water in a container. For which one of the four rays incident on turpentine in figure, the path shown is correct?

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

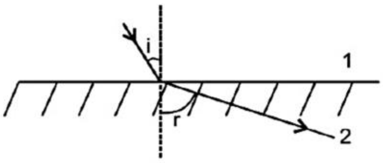


22. There are certain material developed in laboratories which have a negative refractive index figure. A ray incident from air (Medium 1) into such a medium (Medium 2) shall follow a path given by

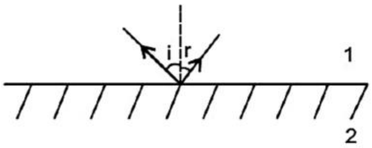
(a)



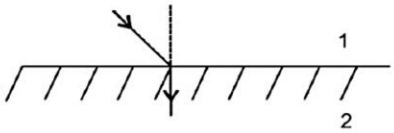
(b)



(c)



(d)



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

(a) 8 cm (b) 12 cm
(c) 16 cm (d) 24 cm

24. Dispersive power of a prism to depends on:

(a) angle of prism (b) material of prism
(c) incident angle (d) refraction angle

25. Total internal reflection can take place only if

(a) light goes from optically rarer medium (smaller refractive index) to optically denser medium
(b) light goes from optically denser medium to rarer medium
(c) the refractive indices of the two media are close to different
(d) the refractive indices of the two media are widely different

26. A biconvex lens of glass having refractive index 1.47 is immersed in a liquid. It becomes invisible and behaves as a plane glass plate. The refractive index of the liquid is **[CBSE 2020]**
(a) 1.47 (b) 1.62 (c) 1.33 (d) 1.51

27. For a glass prism, the angle of minimum deviation will be smallest for the light of **[CBSE 2020]**
(a) red colour. (b) blue colour.
(c) yellow colour. (d) green colour.

28. 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?
(a) Light can be totally internally reflected when it passes from B to A
(b) Light can be partially reflected when it passes from A to B
(c) Critical angle for total internal reflection is $i_B - i_A$
(d) Critical angle between A and B is $\sin^{-1}\left(\frac{\sin i_A}{\sin i_B}\right)$

29. Critical angle of light passing from glass to water is minimum for
(a) red colour (b) green colour
(c) yellow colour (d) violet colour

30. A ray of light travelling inside a rectangular glass block of refractive index $\sqrt{2}$ is incident on the glass-air surface at an angle of incidence of 45°. The refractive index of air is one. Under these conditions the ray will
(a) emerge into the air without any deviation
(b) be reflected back into the glass
(c) be absorbed
(d) emerge into the air with an angle of refraction equal to 90°

31. The refractive index of a piece of transparent quartz is greatest for
(a) violet light (b) green light
(c) yellow light (d) red light

32. If ${}_i\mu_j$ represents refractive index when a light ray goes from medium i to medium j, then the product ${}_2\mu_1 \times {}_3\mu_2 \times {}_4\mu_3$ is equal to
(a) ${}_3\mu_1$ (b) ${}_3\mu_2$ (c) $\frac{1}{{}_1\mu_4}$ (d) ${}_4\mu_2$

33. Dielectric constant of mica is 6. What is the velocity of light in this medium approximately?
(a) 1.2×10^7 m/s (b) 5.0×10^7 m/s
(c) 1.2×10^8 m/s (d) 3.0×10^8 m/s

34. A vessel is half filled with a liquid of refractive index μ. The other half of the vessel is filled with an immiscible liquid of refrative index 1.5 μ. The apparent depth of the vessel is 50% of the actual depth. Then μ is
(a) 1.4 (b) 1.5 (c) 1.6 (d) 1.67

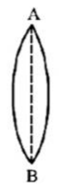
35. When light falls on a given plate at angle of incidence of 60°, the reflected and refracted rays are found to be normal to each other. The refractive index of the matertial of the plate is then
(a) 0.866 (b) 1.5 (c) 1.732 (d) 2

36. A real image is formed by a convex lens. If we put a concave lens in contact with it, the combination again forms a real image. The new image
(a) is closer to the lens system
(b) is farther form the lens system
(c) is at the original position.
(d) may be anywhere depending on the focal length of the concave lens

37. A parallel beam of light is incident on a converging lens parallel to its principal axis. As one moves away from the lens on the other side on its principal axis, the intensity of light
(a) remains constant
(b) continuously increases
(c) continuously decreases
(d) first increases then decreases

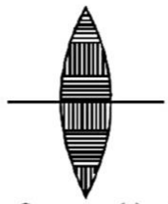
38. Which of the following is not the case with the image formed by a concave lens?
(a) It may be erect or inverted
(b) It may be magnified or diminished
(c) It may be real or virtual
(d) Real image may be between the pole and focus or beyond focus

39. The equi-convex lens, shown in the figure, has a focal length f. What will be the focal length of each half if the lens is cut along AB ?



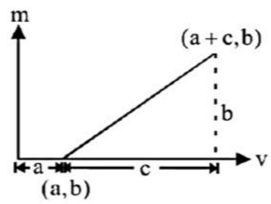
(a) $\frac{f}{2}$ (b) f
(c) $\frac{3f}{2}$ (d) 2f

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



(a) 1 (b) 2 (c) 3 (d) 6

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



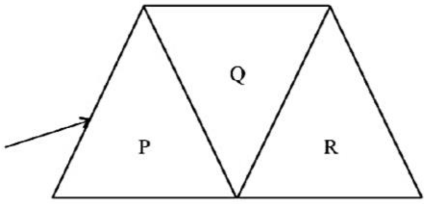
(a) $\frac{b}{c}$ (b) $\frac{c}{b}$ (c) b (d) $\frac{ab}{c}$

42. A convex lens of glass $(\mu = 1.5)$ has a focal length of 8 cm when placed in air. What is the focal length of lens when it is immersed in water $\left(\mu = \frac{4}{3}\right)$?
(a) 4 cm (b) 8 cm (c) 16 cm (d) 32 cm

43. When the incidence angle is equal to the angle of emergence of light from the prism, the refracted ray inside the prism
(a) becomes parallel to the right face of prism
(b) becomes perpendicular to the base of prism
(c) becomes parallel to the base of prism
(d) becomes perpendicular to the left face of prism

44. By properly combining two prisms made of different materials, it is not possible to have
(a) dispersion without average deviation
(b) deviation without dispersion
(c) both dispersion and average deviation
(d) neither dispersion nor average deviation

45. A ray of light suffers minimum deviation in equilateral prism P. Additional prisms Q and R of identical shape and of same material as that of P are now combined as shown in figure. The ray will now suffer



(a) greater deviation
(b) no deviation
(c) same deviation as before
(d) total internal reflection

46. The sunlight reaches us as white light and not as its components because
(a) air medium is dispersive
(b) air medium is non-dispersive
(c) air medium scatter the sunlight
(d) air medium absorbs the sunlight

47. Chromatic aberration in a lens is caused by
(a) reflection (b) interference
(c) diffraction (d) dispersion

48. Spherical aberration in a lens is
(a) is minimum when most of the deviation is at 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 surfaces
(d) does not depend on the above considerations

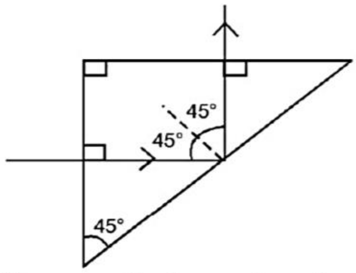
49. When a glass prism of refracting angle 60° is immersed in a liquid, its angle of minimum deviation is 30°. The critical angle of glass with respect to the liquid medium is
(a) 42° (b) 45° (c) 50° (d) 52°

50. When sunlight is scattered by atmospheric atoms and molecules, the amount of scattering of light of wavelength 440 nm is A. The amount of scattering for the light of wavelength 660 nm is approximately

(a) $\frac{4}{9}A$ (b) 2.25A (c) 1.5A (d) $\frac{A}{5}$

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

(a) $n > \frac{1}{\sqrt{2}}$
(b) $n > \sqrt{2}$
(c) $n < \frac{1}{\sqrt{2}}$
(d) $n < \sqrt{2}$



52. A ray incident at 15° on one refracting surface of a prism of angle 60° suffers a deviation of 55°. What is the angle of emergence ?
(a) 95° (b) 45° (c) 30° (d) 100°

53. A normal eye is not able to see objects closer than 25 cm because
(a) the focal length of the eye is 25 cm
(b) the distance of the retina from the eye-lens is 25 cm
(c) the eye is not able to decrease the distance between the eye-lens and the retina beyond a limit
(d) the eye is not able to decrease the focal length beyond a limit

54. A telescope has an objective of focal length 100 cm and an eyepiece of focal length 5 cm. What is the magnifying power of the telescope when the final image is formed at the least distance of distinct vision ?
(a) 20 (b) 24 (c) 28 (d) 32

55. The focal lengths of objective and eye lens of an astronomical telelscope are respectively 2 meter and 5 cm. Final image is formed at (i) least distance of distinct vision (ii) infinity Magnifying power in two cases will be
(a) – 48, – 40 (b) – 40, – 48
(c) – 40, + 48 (d) – 48, + 40

56. A person can see clearly only upto a distance of 30 cm. He wants to read a book placed at a distance of 50 cm from his eyes. What is the power of the lens of his spectacles ?
(a) –1.0 D (b) –1.33 D (c) –1.67 D (d) –2.0 D

57. 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

58. The focal lengths of the objective and the eyepiece of the telescope are 225 cm and 5 cm respectively. The magnifying power of the telescope will be
(a) 49 (b) 45 (c) 35 (d) 60

59. A telescope consists of two thin lenses of focal lengths, 0.3 m and 3 cm respectively. It is focused on moon which subtends an angle of 0.5° at the objective. Then the angle subtended at the eye by the final image will be
(a) 5° (b) 0.25° (c) 0.5° (d) 0.35°

60. A double concave thin lens made out of glass (μ = 1.5) have radii of curvature 500cm. This lens is used to rectify the defect in vision of a person. The far point of the person will be at
(a) 5m (b) 2.5m (c) 1.25m (d) 1m

61. Magnifying power of an objective of a compound microscope is 8. If the magnifying power of microscope is 32 then magnifying power of eye piece is
(a) 7 (b) 5 (c) 4 (d) 3

62. An astronomical telescope has a magnifying power 10, the focal length of the eyepiece is 20 cm. The focal length of the objective is

(a) $\frac{1}{200}$ cm (b) $\frac{1}{2}$ cm (c) 200 cm (d) 2 cm

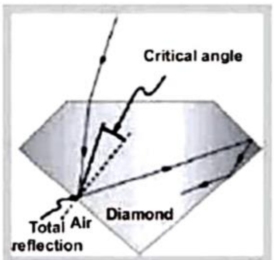
63. When a ray of light enters a glass slab from air
(a) its wavelength increases
(b) neither wavelength nor frequency changes
(c) its wavelength decreases
(d) its frequency increases

64. Absolute refractive index of glass and water is $\frac{3}{2}$ and $\frac{4}{3}$. The ratio of velocity of light in glass and water is
(a) 8 : 9 (b) 3 : 4 (c) 8 : 7 (d) 4 : 3

Case/Passage Based Questions

DIRECTIONS : *Study the given Case/Passage and answer the following questions.*

Case/Passage-I



The total internal reflection of the light is used in polishing diamonds to create a sparking brilliance. By polishing the diamond with specific cuts, it is adjusted the most of the light rays approaching the surface are incident with an angle of incidence more than critical angle. Hence, they suffer multiple reflections and ultimately come out of diamond from the top. This gives the diamond a sparking brilliance.

[CBSE Sample 2021]

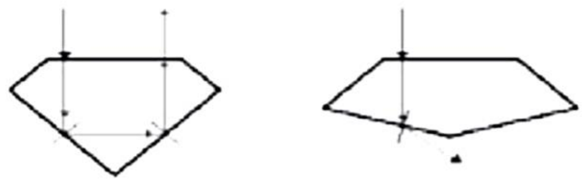
65. Light cannot easily escape a diamond without multiple internal reflections. This is because:
(a) Its critical angle with reference to air is too large
(b) Its critical angle with reference to air is too small
(c) The diamond is transparent
(d) Rays always enter at angle greater than critical angle.

66. The critical angle for a diamond is 24.4 . Then its refractive index is
(a) 2.42 (b) 0.413 (c) 1 (d) 1.413

67. The basic reason for the extraordinary sparkle of suitably cut diamond is that
(a) It has low refractive index
(b) It has high transparency
(c) It has high refractive index
(d) It is very hard

68. A diamond is immersed in a liquid with a refractive index greater than water. Then the critical angle for total internal reflection will
(a) will depend on the nature of the liquid
(b) decrease
(c) remains the same
(d) increase

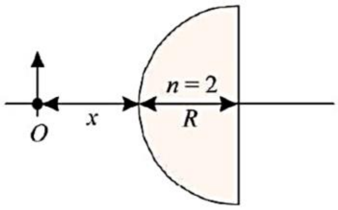
69. The following diagram shows same diamond cut in two different shapes.



The brilliance of diamond in the second diamond will be:
(a) less than the first
(b) greater than first
(c) same as first
(d) will depend on the intensity of light

Case/Passage-II

Consider a transparent hemisphere ($n = 2$) in front of which a small object is placed in air ($n = 1$) as shown in Fig.



70. For which value of x, of the following, will the final image of the object at O be virtual?
(a) $2R$ (b) $3R$ (c) $R/2$ (d) $1.5R$

71. What is the nature of final image of the object when $x = 2R$?
(a) Erect and magnified (b) Inverted and magnified
(c) Erect and same size (d) Inverted and same size

72. Consider a ray starting from O which strikes the spherical surface at grazing incidance ($i = 90°$). Taking $x = R$, what will be the angle (from normal) at which the ray may emerge from the plane surface
(a) 90° (b) 0° (c) 30° (d) 60°

73. Which one of the following is correct? For a spherical surface

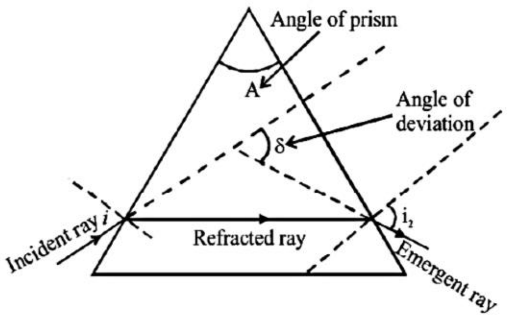
(a) $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$ (b) $\frac{\mu_2}{v} + \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$

(c) $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 + \mu_1}{R}$ (d) $\frac{\mu_2}{v} + \frac{\mu_1}{u} = \frac{\mu_2 + \mu_1}{R}$

74. A spherical convex surface separates object and image spaces of refractive indices 1.0 and 4/3. If radius of curvature of the surface is 10 cm, find its focal length.
(a) 3.5 D (b) 2.5 D (c) 25 D (d) 1.5 D

Case/Passage-III

Consider a triangular glass prism. It has two triangular bases and three rectangular lateral surfaces. These surfaces are inclined to each other. The angle between its two lateral faces is called the angle of the prism A.



In figure you can see the incident ray, the refracted ray inside the prism and the emergent ray. You may note that a ray of light is entering from air to glass at the first surface. The light ray on refraction has bent towards the normal. At the second surface, the light ray has entered from glass to air. Hence it has bent away from the normal.

The peculiar shape of the prism makes the emergent ray bend at an angle to the direction of the incident ray. This angle is called **the angle of deviation.**

75. The angular dispersion produced by a prism
(a) increases if the average refractive index increases
(b) increases if the average refractive index decreases
(c) remains constant whether the average refractive index increases or decreases
(d) has no relation with average refractive index.

76. The refracting angle of a prism is 'A', and refractive index of the material of the prism is cot(A/2). The angle of minimum deviation is :
(a) $180° - 2A$ (b) $90° - A$
(c) $180° + 2A$ (d) $180° - 3A$

77. Yellow light is refracted through a prism producing minimum deviation. If i_1 and i_2 denote the angle of incidence and emergence for this prism, then
(a) $i_1 = i_2$ (b) $i_1 > i_2$
(c) $i_1 < i_2$ (d) $i_1 + i_2 = 90°$

78. By properly combining two prisms made of different materials, it is not possible to have
(a) dispersion without average deviation
(b) deviation without dispersion
(c) both dispersion and average deviation
(d) neither dispersion nor average deviation

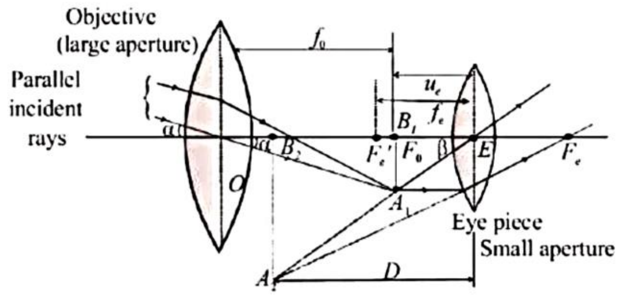
79. When the incidence angle is equal to the angle of emergence of light from the prism the refracted ray inside the prism
(a) becomes parallel to the right face of prism
(b) becomes perpendicular to the base of prism
(c) becomes parallel to the base of prism
(d) becomes perpendicular to the left face of prism

Case/Passage-IV

A refracting type astronomical telescope, used to see the distant objects at large distances, consists of objective, i.e., a converging lens, or lens combination of larger focal length f_0 and larger aperture, and an eyepiece, i.e., also a converging lens, or lens combination, but of smaller focal length f_e and smaller aperture, placed coaxially.

Magnifying power (*M*), also called angular magnification of a telescope is defined as *the ratio of the visual angle subtended by the final image at the eye and the visual angle subtended by the object when the object lies in the actual position.* (In contrast to the definition of magnifying power of a microscope, the object is not placed at the near point in case of telescope)

$$M = \frac{\beta}{\alpha} = \frac{\tan\beta}{\tan\alpha} \quad (\because \alpha, \beta \text{ are small})$$



80. A student look at distant tree of height 15m with a telescope of magnifying powre 25. To the student, the tree appears.
(a) 20 times taller (b) 15 times taller
(c) 15 times nearer (d) 25 times nearer

81. A telescope has an objective lens of focal length 150 cm and an eyepiece of focal length 5 cm. If a 50 m tall tower at a distance of 1 km is observed through this telescope in normal setting, the angle formed by the image of the tower is θ, then θ is close to :
(a) 6.1 rad (b) 3.2 rad (c) 1.5 rad (d) 0.2 rad

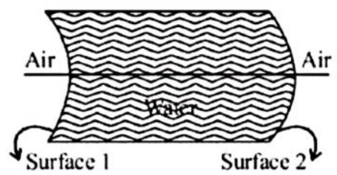
82. The focal lengths of objective and eye lens of an astronomical telelscope are respectively 2 meter and 5 cm. Final image is formed at (i) least distance of distinct vision (ii) infinity Magnifying power in two cases will be
(a) $-48, -40$ (b) $-40, -48$
(c) $-40, +48$ (d) $-48, +40$

83. 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 lenses are
(a) 18 cm, 2 cm (b) 11 cm, 9 cm
(c) 10 cm, 10 cm (d) 15 cm, 5 cm

84. The focal lengths of objective lens and eye lens of a Galilean telescope are respectively 30 cm and 3.0 cm. telescope produces virtual, erect image of an object situated far away from it at least distance of distinct vision from the eye lens. In this condition, the magnifying power of the Galilean telescope should be:
(a) +11.2 (b) −11.2 (c) −8.8 (d) +8.8

Case/Passage-V

All objects referred to the subsequent problems lie on the principle axis.



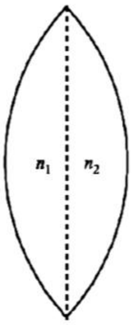
85. If light is incident on surface 1 from left, the image formed after the first refraction is definitely
(a) real for a real object
(b) virtual for a real object
(c) real for a virtual object
(d) virtual for a virtual object

86. In above question if the object is real, then the final image formed after two refractions
(a) may be real
(b) may be virtual
(c) must be virtual
(d) Both (a) and (b)

87. If light is incident on surface 2 from right then which of the following is true for image formed after a single refraction
(a) real object will result in a real image
(b) virtual object will result in a virtual image
(c) real object will result in a virtual image
(d) virtual object will result in a real image

Case/Passage-VI

A thin convex lens is made of two materials with refractive indices n_1 and n_2, as shown in figure. The radius of curvature of the left and right spherical surface are equal. f is the focal length of the lens when $n_1 = n_2 = n$. The focal length is $f + \Delta f$ when $n_1 = n$ and $n_2 = n + \Delta n$. Assuming $\Delta n << (n - 1)$ and $1 < n < 2$.



(i) If $\frac{\Delta n}{n} < 0$ then $\frac{\Delta f}{f} > 0$

(ii) The relation between $\frac{\Delta f}{f}$ and $\frac{\Delta n}{n}$ remains unchanged if both the convex surfaces are replaced by concave surface of the same radius of curvature.

(iii) For $n = 1.5$, $\Delta n = 10^{-3}$ and $f = 20$ cm, the value of $|\Delta f|$ will be 0.02 cm (round off to 2nd decimal place).

(iv) $\left|\frac{\Delta f}{f}\right| < \left|\frac{\Delta n}{n}\right|$

88. If $\frac{\Delta n}{n} < 0$ then
(a) $\frac{\Delta f}{f} > 0$
(b) $\frac{\Delta f}{f} < 0$
(c) $\frac{\Delta f}{f} = 0$
(d) Cannot find

89. If both the convex surfaces are replaced by concave surface of the same radius of curvature then
(a) the relation between $\frac{\Delta f}{f}$ and $\frac{\Delta n}{n}$ will be change
(b) the relation between $\frac{\Delta f}{f}$ and $\frac{\Delta n}{n}$ remains unchanged
(c) there is no relation between $\frac{\Delta f}{f}$ and $\frac{\Delta n}{n}$
(d) None of these

90. Which of the following is correct?
(a) $\left|\frac{\Delta f}{f}\right| = \left|\frac{\Delta n}{n}\right|$
(b) $\left|\frac{\Delta f}{f}\right| < \left|\frac{\Delta n}{n}\right|$
(c) $\left|\frac{\Delta f}{f}\right| > \left|\frac{\Delta n}{n}\right|$
(d) $\frac{\Delta f}{f} = \left|\frac{n}{\Delta n}\right|$

91. For $n = 1.5$, $\Delta n = 10^{-3}$ and $f = 20$ cm, the value of $|\Delta f|$ is
(a) 2 cm
(b) 0.2 cm
(c) 0.02 cm
(d) 0.002 cm

92. Which of the following is correct?
(a) $\frac{\Delta f}{f} = \frac{-\Delta n}{2(n-1)}$
(b) $\frac{\Delta f}{f} = \frac{\Delta n}{2(n-1)}$
(c) $\frac{\Delta f}{f} = \frac{2(n-1)}{\Delta n}$
(d) None of these

Assertion & Reason

DIRECTIONS : *Each of these questions contains an assertion followed by reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.*
(a) If both **Assertion** and **Reason** are **correct** and the Reason is the **correct explanation** of the Assertion.
(b) If both **Assertion** and **Reason** are correct but Reason is **not the correct explanation** of the Assertion.
(c) If the **Assertion** is **correct** but **Reason** is **incorrect**.
(d) If the **Assertion** is **incorrect** but the **Reason** is **correct**.

93. **Assertion :** The air bubble shines in water.
Reason : Air bubble in water shines due to refraction of light.

94. **Assertion :** Diamond glitters brilliantly.
Reason : Diamond does not absorb sunlight.

95. **Assertion:** Critical angle is minimum for violet colour.
Reason : Because critical angle $\theta_c = \sin^{-1}\left(\frac{1}{\mu}\right)$ and $\mu \propto \frac{1}{\lambda}$.

96. **Assertion :** A ray passing through optical centre proceeds undeviated through the lens.
Reason : For lens Snell's law is not valid.

97. **Assertion :** If objective and eye lens of a microscope are interchanged then it can work as telescope.
Reason : The objective of telescope has large focal length.

98. **Assertion :** If the rays are diverging after emerging from a lens; the lens must be concave.
Reason : The convex lens can give diverging rays.

99. **Assertion :** When a convex lens ($\mu_g = 3/2$) of focal length f is dipped in water, its focal length becomes $\frac{4}{3}f$.
Reason : The focal length of convex lens in water becomes $3f$.

100. **Assertion :** Dispersion of light occurs because velocity of light in a material depends upon its colour.

Reason : The dispersive power depends only upon the material of the prism, not upon the refracting angle of the prism.

101. **Assertion :** There exists two angles of incidence for the same magnitude of deviation (except minimum deviation) by a prism kept in air.

Reason : In a prism kept in air, a ray is incident on first surface and emerges out of second surface. Now if another ray is incident on second surface (of prism) along the previous emergent ray, then this ray emerges out of first surface along the previous incident ray. This particle is called principle of reversibility of light.

102. **Assertion :** A ray passing through optical centre proceeds undeviated through the lens.

Reason : For lens Snell's law is not valid.

Match the Following

DIRECTIONS : *Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column-I have to be matched with statements (1, 2, 3, 4) in column-II.*

103. Match the Column-I and Column-II

Column I	Column II
(A) Bi-convex lens	(1) $f=-\frac{R}{2(\mu-1)}$
(B) Plano-convex lens	(2) $f=\frac{R}{2(\mu-1)}$
(C) Bi-concave lens	(3) $f=-\frac{R}{(\mu-1)}$
(D) Plano-concave lens	(4) $f=\frac{R}{(\mu-1)}$

(a) (A)→(2); (B)→(3); (C)→(4); (D)→(5)
(b) (A)→(5); (B)→(4); (C)→(3); (D)→(1)
(c) (A)→(2); (B)→(4); (C)→(1); (D)→(3)
(d) (A)→(1); (B)→(5); (C)→(2); (D)→(4)

Fill in the Blanks

DIRECTIONS : *Complete the following statements with an appropriate word / term to be filled in the blank space(s).*

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

105. A double convex lens of focal length 6 cm is made of glass of refractive index 1.5. The radius of curvature of one surface is double that of other surface. The value of small radius of curvature is _________ .

(a) 6 cm (b) 4.5 cm (c) 9 cm (d) 4 cm

106. A convex lens is immersed in a liquid of refractive index greater than that of glass. It will behave as a _________ lens.

107. A ray of light passes through an equilateral prism such that the angle of incidence is equal to the angle of emergence and the latter is equal to 3/4th of the angle of prism. Then_____ is angle of deviation.

108. The image formed by an objective of a compound microscope is ___________ and ____________.

True / False

DIRECTIONS : *Read the following statements and write your answer as true or false.*

109. If a glass prism is dipped in water, its dispersive power increases.

110. To increase the angular magnification of a simple microscope, one should increase the power of the lens.

111. For a glass prism, the angle of minimum deviation will be smallest for the light of red colour.

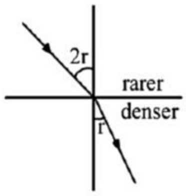
112. A short pulse of white light is incident from air to a glass slab at normal incidence. After travelling through the slab, the first colour to emerge is violet.

ANSWER KEY & SOLUTIONS

1. **(a)** $\mu = \frac{\sin i}{\sin r} \quad \because i = 2r$

$\Rightarrow \mu = \frac{\sin 2r}{\sin r} = \frac{2\sin r.\cos r}{\sin r}$

$r = \cos^{-1}\left(\frac{\mu}{2}\right) \quad \therefore \quad i = 2\cos^{-1}\left(\frac{\mu}{2}\right)$



2. **(a)** $\mu = \frac{h}{h'} \Rightarrow h' = \frac{8}{4/3} = 6m$

3. **(b)** According to Snell's law

$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{\mu_2}{\mu_1}$

From fig. we see that

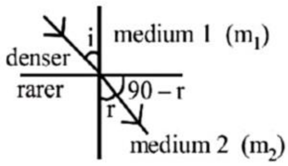
$r > i \Rightarrow v_2 > v_1$

from Snell's Law

So $v_2 = n\lambda_2 > v_1 = n\lambda_1$

$\Rightarrow \lambda_2 > \lambda_1$

(Frequency of wave does not change on refraction)



4. **(a)** When light travels from medium (1) to medium (2) then refractive index of medium (2) with respect to medium (1) is called it's relative refractive index,

$${}_1n_2 = \frac{n_2}{n_1} \text{ or } n_{12} = \frac{n_2}{n_1}$$

5. **(a)**

6. **(d)** $P_2 = P - P_1 = \frac{100}{80} - \frac{100}{20} = -3.75 \text{ D}$

7. **(a)** ${}_an_\ell = 1.6, {}_an_w = 1.33$

f= 20 cm

We have,

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

$$\frac{1}{20} = (1.6 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{..... (1)}$$

Also, $\frac{1}{f'} = ({}_wn_\ell - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$= \left(\frac{{}_an_\ell}{{}_an_w} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f'} = \left(\frac{1.6}{1.33} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{..... (2)}$$

Dividing equation (1) by (2)

$\Rightarrow \frac{f'}{20} = \frac{0.6}{(1.2 - 1)} \quad f' = \frac{0.6 \times 20}{0.2} = 60 \text{ cm.}$

Hence it's focal length is three times longer than in air.

8. **(b)**

9. **(c)** For the prism as the angle of incidence (i) increases, the angle of deviation (δ) first decreases goes to minimum value and then increases.

10. **(a)** $\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin(A/2)} = \frac{\sin 45°}{\sin 26.5°} = 1.58$

11. **(c)** In the position of minimum deviation

$$i = e = \frac{A + \delta m}{2} = \frac{60 + 30}{2} = 45°$$

12. **(b)** In normal adjustment,

$$M = \frac{f_0}{f_e} = 20, \; f_e = \frac{f_0}{20} = \frac{60}{20} = 3 \text{ cm}$$

13. **(d)**

14. **(a)** **Given :** $f_0 = 1.2$ cm; $f_e = 3.0$ cm

$u_0 = 1.25$ cm; $M_\infty = ?$

From $\frac{1}{f_0} = \frac{1}{v_0} - \frac{1}{u_0} \Rightarrow \frac{1}{1.2} = \frac{1}{v_0} - \frac{1}{(-1.25)}$

$\Rightarrow \frac{1}{v_0} = \frac{1}{1.2} - \frac{1}{1.25} \Rightarrow v_0 = 30$ cm

Magnification at infinity,

$$M_\infty = -\frac{v_0}{u_0} \times \frac{D}{f_e} = \frac{30}{1.25} \times \frac{25}{3}$$

($\because D = 25$cm least distance of distinct vision)

$= 200$

Hence the magnifying power of the compound microscope is 200

15. **(a)** **16.** **(a)**

17. **(a)** As we know that the deviation

$\delta = (\mu - 1)A$ ..... (i)

By geometry, the angle of refraction by first surface is 5° and given $\mu = 1.5$

So, $\delta = (1.5 - 1) \times 5° = 2.5°$

also, $\delta = \theta - r$, ... (ii)

By putting the value of δ and r in equation (ii)

$2.5° = \theta - 5°$

So, $\theta = 5 + 2.5 = 7.5°$

18. **(c)** According to the question, when object is at different position, and if an object approaches towards a convergent lens from the left of the lens with a uniform speed of 5 m/s, the image move away from the lens to infinity with a non-uniform acceleration.

19. **(c)** Among all given sources of light, the bule light have smallest wavelength. According to Cauchy relationship, smaller the wavelength higher the refractive index and consequently smaller the critical angle as $\mu = \frac{1}{\sin c}$.

Hence, corresponding to blue colour, the critical angle is least which facilitates total internal reflection for the beam of blue light and the beam of green light would also undergo total internal reflection.

20. **(c)** Using lens maker's formula for plano-convex lens, so focal length is

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

If object on curved suface

so, $R_2=\infty$ then, $f=\frac{R_1}{(\mu_2-\mu_1)}$

Lens placed in air, $\mu_1 = 1$.

(As given that, R = 20cm, μ_2 = 1.5, on substituting the values in)

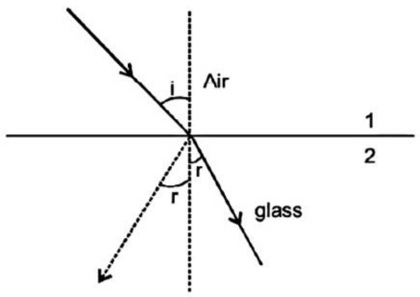
$$f=\frac{R_1}{\mu-1}=\frac{20}{1.5-1}=40\text{ cm}$$

So, f is converging nature, as f > 0. Hence, lens will always act as a convex lens irrespective of the side on which the object lies.

21. **(b)** As we know, when the ray goes from rarer medium air to optically denser turpentine, then it bends towards the normal i.e., i > r whereas when it goes from optically denser medium turpentine to rarer medium water, then it bends away from normal i.e., i < r.

So, the path of ray 2 is correct.

22. **(a)** When the negative refractive index materials are those in which incident ray from air (Medium 1) to them refract or bend differently to that of positive refractive index medium.



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

$$\frac{1}{16}=(1.5-1)\left(\frac{1}{R}-\frac{1}{\infty}\right)\Rightarrow\frac{1}{16}=0.5\times\frac{1}{R}\Rightarrow R=8\text{ cm}$$

24. **(b)** Dispersive power $w=\frac{\delta_v-\delta_R}{\delta_y}=\frac{(n_v-n_R)A}{(n_y-1)A}$

$$=\frac{n_v-n_R}{n_y-1}$$

So, it depends only on the material of the prism

25. **(b)** **26.** **(a)**

27. **(a)** Angle of minimum deviation δ.

$\delta=(\mu-1)A$

Now $\lambda_{red} > \lambda_{violet}$

$\therefore\ \mu_{red} < \mu_{violet}$

So δ_{red} is smallest.

28. **(d)** $i_B > i_A$ or $\sin^{-1}\left(\frac{1}{\mu_B}\right) > \sin^{-1}\left(\frac{1}{\mu_A}\right)$ or $\mu_A > \mu_B$

Hence medium A is denser and B is rarer.

Total internal Reflection : When the object is placed in a optically denser medium. and if the incident angle is greater than the critical angle then the ray of light gets reflected back to the originating medium.

For critical angle (α) from medium A to B, ${}_B\mu_A$

$${}_B\mu_A=\frac{1}{\sin\alpha}\text{ or }\sin\alpha=\frac{1}{{}_B\mu_A}=\frac{\mu_B}{\mu_A}$$

$$\Rightarrow\sin\alpha=\frac{1}{\sin i_B}\times\frac{\sin i_A}{1}\Rightarrow\alpha=\sin^{-1}\left[\frac{\sin i_A}{\sin i_B}\right]$$

29. **(d)**

30. **(d)** $\sin C=\frac{1}{\mu}=\frac{1}{\sqrt{2}}$

$$\therefore\ C=\sin^{-1}\left(\frac{1}{\sqrt{2}}\right)=45^\circ$$

Now $\frac{\sin C}{\sin r}=\frac{1}{\mu}$ or $\frac{\sin 45^\circ}{\sin r}=\frac{1}{\sqrt{2}}$

$\sin r = 1$ or $r = 90^\circ$

31. **(a)** In terms of wavelength, $\mu\propto\frac{1}{\lambda}$.

So shorter the wavelength, greater is the refractive index. λ is minimum for violet so μ is maximum.

32. **(c)** ${}_2\mu_1\times{}_3\mu_2\times{}_4\mu_3=\frac{\mu_1}{\mu_2}\times\frac{\mu_2}{\mu_3}\times\frac{\mu_3}{\mu_4}=\frac{\mu_1}{\mu_4}=\frac{1}{{}_1\mu_4}$.

33. **(a)** Velocity in medium, $=\frac{c}{\sqrt{\mu_r\,\epsilon_r}}\simeq\frac{3\times10^8}{\sqrt{\epsilon_r}}$

($\because\ \mu_r < 1$ for mica)

$$=\frac{3\times10^8}{\sqrt{6}}\simeq1.2\times10^7\ \text{m/s}.$$

34. **(d)** Let d be the depth of two liquids.

Then apparent depth

$$\frac{(d/2)}{\mu}+\frac{(d/2)}{1.5\mu}=\frac{d}{2}\text{ or }\frac{1}{\mu}+\frac{2}{3\mu}=1$$

Solving we get $\mu = 1.671$

35. **(c)** Here i = 60°. As the angle between reflected and refracted ray is 90°, then i + r = 90 or r = 30°

$$\text{Now }\mu=\frac{\sin i}{\sin r}=\frac{\sin 60}{\sin 30}=\frac{\sqrt{3}/2}{1/2}=\sqrt{3}=1.732$$

The angle for which i + r = 90°, called Brewster' Angle.

36. **(b)** When we bring in contact a concave lens the effective focal length of the combination decreases.

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

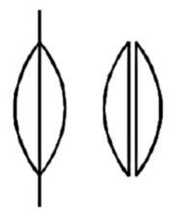
according to above relation as f reduces, v increases.

37. **(a)** **38.** **(d)**

39. **(d)** $\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$

This is combination of two lenses of equal focal lengths

$$\therefore\ \frac{1}{f}=\frac{1}{f'}+\frac{1}{f'}=\frac{2}{f'}\Rightarrow f'=2f.$$



40. **(b)** Due to difference in refractive indices images obtained will be two. Two media will form images at two different points due to difference in focal lengths.

41. **(b)** $m = \frac{v}{u}$ and $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

Multiply the equation by v

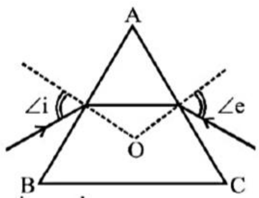
$$1 - \frac{v}{u} = \frac{v}{f} \Rightarrow \frac{v}{u} = 1 - \frac{v}{f} \Rightarrow \therefore m = 1 - \frac{v}{f}$$

$$\text{Slope} = -\frac{1}{f} = \frac{b}{c} \Rightarrow f = \frac{c}{b}$$

42. **(d)** $$\frac{f_a}{f_\omega} = \frac{\left(\frac{\mu_g}{\mu_\omega} - 1\right)}{(\mu_g - 1)} = \frac{\left(\frac{1.5}{\left(\frac{4}{3}\right)} - 1\right)}{1.5 - 1} = \frac{\frac{1}{8}}{\frac{1}{2}} = \frac{1}{4}$$

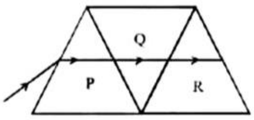
$f_\omega = 4f_a = 4 \times 8 = 32$ cm

43. **(c)** At the minimum deviation, f = D_m angle of incidence ∠i = angle of emergence ∠e and inside the prism refracted ray parallel to the base of the prism



44. **(d)** We can combine two prisms in such a way
(i) deviation is zero but dispersion not
(ii) dispersion is zero but deviation is not.
But in any situation both deviation & dispersion can not be zero simultaneously.

45. **(c)** When the ray suffers minimum deviation, it becomes parallel to the base of prism P. As prisms Q and R are of same material and have identical shape, therefore, the ray continues to be parallel to base of Q and R. Hence final deviation of the ray remains the same as before.



46. **(b)** Air medium is non-dispersive in nature.

47. **(d)**

48. **(c)** To minimise spherical aberration in a lens, the total deviation should be equally distributed over the two surfaces.

49. **(b)** We have,

$${}_a\mu_g = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\frac{A}{2}} = \frac{\sin\left(\frac{60° + 30°}{2}\right)}{\sin\left(\frac{60°}{2}\right)}$$

$$= \frac{\sin 45°}{\sin 30°} = \frac{1}{\sqrt{2}} \times 2 = \sqrt{2}$$

Now, $\sin C = \frac{1}{{}_a\mu_g} = \frac{1}{\sqrt{2}} \quad \therefore \quad C = 45°$.

50. **(d)** Amount of scattering of light $I_s \propto \frac{1}{\lambda^4}$

As given $\lambda_1 = 440$ nm, $I_s = A$

For $\lambda_2 = 660$ nm, let $I_s = A'$

then $\frac{A'}{A} = \left(\frac{440}{660}\right)^4 \quad A' = \left(\frac{2}{3}\right)^4 A \simeq \frac{A}{5}$.

51. **(b)** The incident angle is 45°.
Incident angle > critical angle, $i > i_c$

$\therefore \sin i > \sin i_c$ *or* $\sin 45 > \sin i_c$

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

$\therefore \sin 45° > \frac{1}{n}$ *or* $\frac{1}{\sqrt{2}} > \frac{1}{n} \Rightarrow n > \sqrt{2}$

52. **(d)** Here, $i_1 = 15°, A = 60°, \delta = 55°, i_2 = e = ?$
As $i_1 + i_2 = A + \delta$
$i_2 = A + \delta - i_1 = 60° + 55° - 15° = 100°$.

53. **(d)** Because, the focal length of eye lens cannot decrease beyond a certain limit.

54. **(b)** $f_0 = 100$ cm, $f_e = 5$ cm
When final image is formed at least distance of distinct vision (d), then

$$M = \frac{f_0}{f_e}\left(1 + \frac{f_e}{d}\right) = \frac{100}{5}\left(1 + \frac{5}{25}\right) \quad [\because D = 25 \text{ cm}]$$

$$M = 20 \times \frac{6}{5} = 24$$

55. **(a)** (i) $M = -\frac{f_0}{f_e}\left(1 + \frac{f_e}{d}\right) = -\frac{200}{5}\left(1 + \frac{5}{25}\right) = -48$

(since least distance d = 25cm)

(ii) $M = -\frac{f_0}{f_e} = -\frac{200}{5} = -40$

56. **(b)** u = –50 cm = –0.5 m, v = –30 cm = –0.3 m

$$P = \frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{-1}{0.3} + \frac{1}{0.5} = \frac{-0.2}{0.15} = -1.33 \text{ D}.$$

57. **(a)** $m = \frac{v_0}{|u_0|}\left(1 + \frac{d}{f_e}\right) = \frac{20}{5}\left(1 + \frac{20}{10}\right) = 12$

58. **(b)** Magnifying power of telescope is

$$M = \frac{f_0}{f_e} = \frac{225}{5} \Rightarrow M = 45 \text{ cm}.$$

59. **(a)** Magnification $= \frac{f_0}{f_e} = \Rightarrow \frac{30\text{cm}}{3\text{cm}} = \frac{\beta}{0.5°} \Rightarrow \beta = 5°$

60. **(a)** Lens is concave. So defect is myopia.
So | focal length of lens | = far point

$$f = \frac{-R}{2(\mu - 1)} \Rightarrow |f| = \frac{R}{2(\mu - 1)} \Rightarrow |f| = 500 \text{ cm} = 5\text{m}.$$

61. **(c)** Let magnifying power of eye and objective is m_e and m_0. therefore, $m = m_0 \times m_e \Rightarrow 32 = 8 \times m_e$
$\Rightarrow m_e = 4$

62. **(c)** The magnifying power of telescope in normal adjustment is given by, $M = \frac{f_0}{f_e}$

$$\Rightarrow 10 = \frac{f_0}{20} \Rightarrow f_0 = 200 \text{ cm}.$$

63. **(c)** When a ray of light travels in glass, the velocity of light as well as wavelength decreases while frequency remains constant, according to Snell's law

$$\mu = \frac{\text{wavelength in air}}{\text{wavelength in glass}}$$

[$\because$ v = nλ, v $\downarrow$ λ $\downarrow$ as n = constant]

64. **(a)** $\mu_g = \frac{c}{v_g} \Rightarrow \frac{3}{2} = \frac{c}{v_g}$

$\mu_\omega = \frac{c}{v_\omega} \Rightarrow \frac{4}{3} = \frac{c}{v_\omega}$

Dividing, $\frac{v_\omega}{v_g} = 9:8$

or $v_g : v_\omega = 8:9$

65. **(b)** Its critical angle with reference to air is too small.

66. **(a)** 2.42

67. **(c)** high refractive index

68. **(d)** increase

69. **(a)** less than first

70. **(c)** $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$

Taking refraction first at curved surface,

$$\frac{2}{v_1} + \frac{1}{x} = \frac{1}{R} \Rightarrow v_1 = \frac{2Rx}{x - R}$$

For plane surface,

$$v' = v_1 - R \Rightarrow v' = \frac{xR + R^2}{x - R}$$

$$\Rightarrow \frac{1}{v} - \frac{2(x-R)}{R(x+R)} = 0$$

$$\frac{1}{v} = \frac{2(x-R)}{R(x+R)}$$

For virtual image,

$$\frac{1}{v} < 0 \Rightarrow \frac{2(x-R)}{R(x+R)} < 0$$

$x < R$

71. **(d)** For $x = 2R$

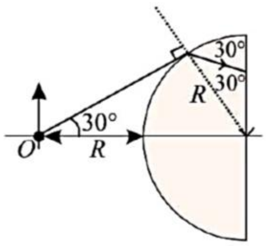
$$v_1 = \frac{4R^2}{R} = 4R \Rightarrow u = -2R$$

$$m_1 = \frac{\mu_1}{\mu_2}, \frac{v}{u} = \frac{1}{2}, \frac{4R}{(-2R)} = -1$$

$m_2 = 1 \Rightarrow m_1 m_2 = -1$

Image is real, inverted, and of same size.

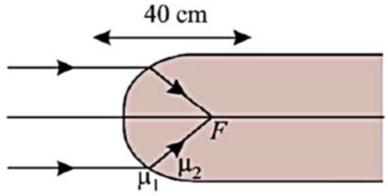
72. **(a)**



73. **(a)** For spherical surface

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

74. **(b)**



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

With proper values and signs, we have

$$\frac{4/3}{f} - \frac{1.0}{\infty} = \frac{4/2 - 1.0}{+10}$$

or f = 40 cm = 0.4 m

Since the rays are converging, its power should be positive Hence,

$$P(\text{in dioptre}) = \frac{+1}{f(\text{meter})} = \frac{1}{0.4}$$

or P = 2.5 D

75. **(a)** The angular dispersion θ *i.e.*, the angle between the extreme rays of light, $\theta = (\delta_V - \delta_R)$ where $\delta_V = (\mu_V - 1)A$, $\delta_R = (\mu_V - 1)A$ & A is angle of prism.

So if refractive index increases, then δ increases & hence θ increases.

76. **(a)**

77. **(a)** In the position of minimum deviation, $i_1 = i_2$.

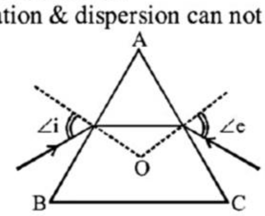
78. **(d)** We can combine two prisms in such a way

(i) deviation is zero but dispersion not

(ii) dispersion is zero but deviation is not.

But in any situation both deviation & dispersion can not be zero simultaneously.

79. **(c)** At the minimum deviation, f = D_m angle of incidence $\angle i$ = angle of emergence $\angle e$ and inside the prism refracted ray parallel to the base of the prism



80. **(d)**

81. **(c)** Magnifying power of telescope,

$$MP = \frac{\beta\ (\text{angle subtended by image at eye piece})}{\alpha\ (\text{angle subtended by object on objective})}$$

Also, $MP = \frac{f_o}{f_e} = \frac{150}{5} = 30$

$$\alpha = \frac{50}{1000} = \frac{1}{20}\text{rad}$$

$$\therefore \quad \beta = \theta = MP \times \alpha = 30 \times \frac{1}{20} = \frac{3}{2} = 1.5\,\text{rad}$$

82. **(a)** (i) $M = -\frac{f_0}{f_e}\left(1 + \frac{f_e}{d}\right) = -\frac{200}{5}\left(1 + \frac{5}{25}\right) = -48$

(since least distance d = 25cm)

(ii) $M = -\frac{f_0}{f_e} = -\frac{200}{5} = -40$

83. **(a)** $\frac{f_0}{f_e} = 9$, $\therefore f_0 = 9f_e$

Also $f_0 + f_e = 20$ ($\because$ final image is at infinity)

$9f_e + f_e = 20, f_e = 2$ cm, $\therefore f_0 = 18$ cm

84. **(d)** Given, Focal length of objective, $f_0 = 30$ cm

focal length of eye lens, $f_e = 3.0$ cm

Magnifying power, M = ?

Magnifying power of the Galilean telescope,

$$M_D = \frac{f_0}{f_e}\left(1 - \frac{f_e}{D}\right) = \frac{30}{3}\left(1 - \frac{3}{25}\right) \quad [\because D = 25 \text{ cm}]$$

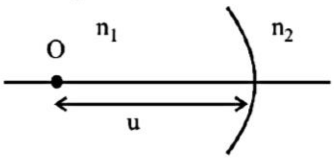
$$= 10 \times \frac{22}{25} = 8.8$$

85. **(b)** **86.** **(d)**

87. **(d)** $\frac{\mu_2}{v} = \frac{\mu_1}{u} + \left(\frac{\mu_2 - \mu_1}{R}\right)$

$(\mu_2 - \mu_1)$ is +ve and R is –ve, if u is –ve, v will always be –ve. i.e., for real object image is always virtual.

Consider object on left side of spherical surface seperating two media. If real object is in rarer media i.e., $n_1 < n_2$



Then, $\frac{n_2}{v} = \frac{n_2 - n_1}{(-u)} + \frac{n_1}{(-R)} = -ve$

Hence image shall be virtual for a real object lying on concave side with rarer media. ....(1)

If real object is in denser media i.e., $n_1 > n_2$

$$\frac{n_2}{v} = \frac{-(n_1 - n_2)}{(-u)} + \frac{n_1}{(-R)} = \frac{n_1 - n_2}{u} - \frac{n_1}{R}$$

$\therefore$ Image is real if $\frac{n_1 - n_2}{u} > \frac{n_1}{R}$

or $u < \frac{(n_1 - n_2)R}{n_1}$ ....(2)

and image is virtual if $u > \left(\frac{n_1 - n_2}{n_1}\right)R$ ....(3)

From statements 1, 2 and 3 we can easily conclude the answers.

88. **(a)** From (i), if $\frac{\Delta n}{n} < 0$, then $\frac{\Delta f}{f} > 0$.

89. **(b)** The relation between $\frac{\Delta f}{f}$ and $\frac{\Delta n}{n}$ remains unchanged, if convex surface are replaced by concave surface of the same radius of curvature.

90. **(c)** Also, $\left|\frac{\Delta f}{f}\right| > \left|\frac{\Delta n}{n}\right|$

91. **(c)** For $n = 1.5$, $\Delta n = 10^{-3}$ and $f = 20$ cm then

$$\frac{\Delta f}{20} = -\frac{10^{-3}}{2(1.5-1)} \Rightarrow \Delta f = -0.02 \text{ cm}$$

or $|\Delta f| = 0.02$ cm

92. **(a)**

93. **(c)** Shining of air bubble in water is on account of TIR.

94. **(b)** Diamond glitters brilliantly because light enters in diamond suffers total internal reflection. All the light entering in it comes out of diamond after number of reflections and no light is absorbed by it.

95. **(b)**

96. **(c)** Snell's law is valid for lens too.

97. **(d)**

98. **(b)** When object is placed between F and optical center of convex lens then the emerging rays is diverging.

99. **(d)** $f_w = f\frac{{}_a\mu_g - 1}{\left(\frac{{}_a\mu_g}{{}_a\mu_w} - 1\right)} = f\frac{\left(\frac{3}{2} - 1\right)}{\left(\frac{3/2}{4/3} - 1\right)} = 4f$

100. **(d)** **101.** **(b)** **102.** **(c)**

103. **(c)** (A) → (2); (B) → (4); (C) → (1); (D) → (3)

for bi-convex lens, $R_1 = R$ and $R_2 = -R$

for plano-convex lens, $R_1 = \infty$ and $R_2 = -R$

for bi-concave lens, $R_1 = -R$ and $R_2 = +R$

for plano-concave, $R_1 = \infty$ and $R_2 = R$

104. (100) $R_1 = 60$ cm, $R_2 = \infty$, $\mu = 1.6$

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

$$\frac{1}{f} = (1.6 - 1)\left(\frac{1}{60}\right) \Rightarrow f = 100 \text{ cm}$$

105. (4.5 cm) If $R_1 = R$, $R_2 = -2R$, $f = 6$ cm

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

$$\frac{1}{6} = (1.5 - 1)\left(\frac{1}{R} + \frac{1}{2R}\right) = \frac{0.5 \times 3}{2R}$$

R = 4.5 cm

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

As $\frac{\mu_2}{\mu_1} < 1$

$\therefore$ f is negative. It acts as divergent lens.

107. (30°) $i_1 = i_2 = \frac{3}{4}A$ [A = angle of Prism]

As $A + \delta = i_1 + i_2$

$$\therefore \delta = i_1 + i_2 - A = \frac{3}{4}A + \frac{3}{4}A - A = \frac{A}{2} = \frac{60^\circ}{2} = 30^\circ$$

108. (real, enlarged) The image formed by objective lens of compound microscope is real and enlarged, while final image formed by compound microscope is inverted, virtual, enlarged and at a distance D to infinite or from an eye, on same side of eye piece.

109. (False) Dispersive power of a prism $\omega = \frac{\mu_V - \mu_R}{\mu_y - 1} = \frac{d\mu}{\mu - 1}$,

where $\mu = \mu_y = \frac{\mu_V + \mu_R}{2}$

110. (True) One should increase the power of lens i.e., decrease the focal length of a lens.

111. (True) Angle of minimum deviation δ.

$\delta = (\mu - 1)A$

Now $\lambda_{red} > \lambda_{violet}$

$\therefore \mu_{red} < \mu_{violet}$

So δ_{red} is smallest.

112. (False) As we know that when light ray goes from one medium to other medium, the frequency of light remains unchanged.

And, $c = \nu\lambda$

So, $c \propto \lambda$ the light of red colour is of highest wavelength and therefore of highest speed. Thus, after travelling through the slab, the red colour emerge first.