23 Ray Optics and Optical Instruments

1. A man runs towards a mirror at a speed of 15 m/s. The speed of the image relative to the man is
   (a) $15\,\text{ms}^{-1}$ (b) $30\,\text{ms}^{-1}$
   (c) $35\,\text{ms}^{-1}$ (d) $20\,\text{ms}^{-1}$

2. When light travels from one medium to the other of which the refractive index is different, then which of the following will change?
   (a) Frequency, wavelength and velocity
   (b) Frequency and wavelength
   (c) Frequency and velocity
   (d) Wavelength and velocity

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

4. If refractive index of glass is 1.50 and of water is 1.33, then critical angle is
   (a) $\sin^{-1}(8/9)$ (b) $\sin^{-1}\left(\dfrac{2}{3}\right)$

   (c) $\cos^{-1}\left(\dfrac{8}{9}\right)$ (d) None of these

5. A thin lens has focal length f_1 and its aperture has diameter d. It forms an image of intensity I. Now the central part of the aperture upto diameter $\dfrac{d}{2}$ is blocked by an opaque paper. The focal length and image intensity will change to
   (a) $\dfrac{f}{2}$ and $\dfrac{I}{2}$ (b) f and $\dfrac{I}{4}$

   (c) $\dfrac{3f}{4}$ and $\dfrac{I}{2}$ (d) f and $\dfrac{3I}{4}$

6. 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) $\dfrac{f}{2}$
   (b) f
   (c) $\dfrac{3f}{2}$
   (d) 2f

7. Two lenses of power + 12 and − 2 diopters are placed in contact. The combined focal length of the combination will be
   (a) 8.33 cm   (b) 16.6 cm   (c) 12.5 cm   (d) 10 cm

8. An object is placed at a distance of 20 cm from a convex lens of focal length 10 cm. The image is formed on the other side of the lens at a distance of
   (a) 10 cm   (b) 40 cm   (c) 25 cm   (d) 20 cm

9. Minimum deviation is observed with a prism having angle of prism A, angle of deviation δ, angle of incidence i and angle of emergence e. We then have generally
   (a) $i > e$ (b) $i < e$ (c) $i = e$ (d) $i = e = \delta$

10. White light is incident on face AB of a glass prism. The path of the green component is shown in the figure. If the green light is just totally internally reflected at face AC as shown, the light emerging from face AC will contain

    (a) Yellow, orange and red colours
    (b) Violet, Indigo and blue colours
    (c) All colours
    (d) All colours except green
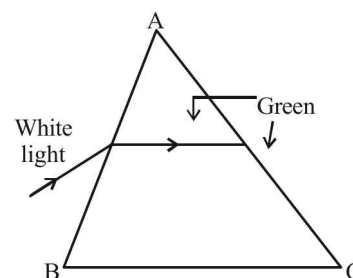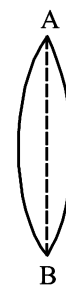
11. A Galileo telescope has an objective of focal length 100cm and magnifying power 50. The distance between the two lenses in normal adjustment will be
    (a) 96 cm
    (b) 98 cm
    (c) 102 cm
    (d) 104 cm

12. 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) $\dfrac{1}{200}$ cm
    (b) $\dfrac{1}{2}$ cm
    (c) 200 cm
    (d) 2 cm

13. A ray of light travelling in a transparent medium of refractive index μ, falls on a surface separating the medium from air at an angle of incidence of 45°. For which of the following value of μ the ray can undergo total internal reflection?
    (a) $\mu = 1.33$
    (b) $\mu = 1.40$
    (c) $\mu = 1.50$
    (d) $\mu = 1.25$

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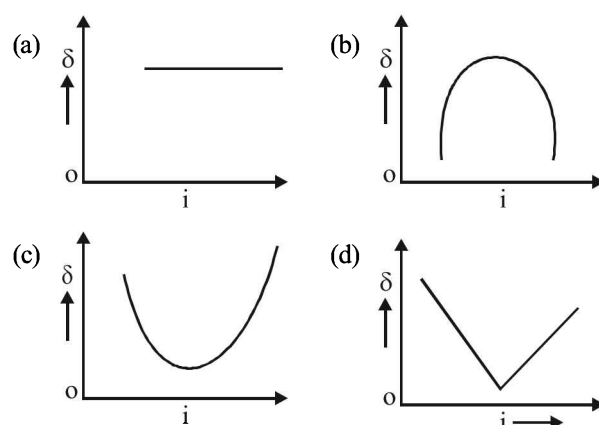

15. Which of the following is not due to total internal reflection?
    (a) Working of optical fibre
    (b) Difference between apparent and real depth of pond
    (c) Mirage on hot summer days
   (d) Brilliance of diamond

Application Based MCQs

16. A light beam is being reflected by using two mirrors, as in a periscope used in submarines. If one of the mirrors rotates by an angle θ, the reflected light will deviate from its original path by the angle.
    (a) 2θ
    (b) $0°$
    (c) θ
    (d) 4θ

17. A convex mirror of focal length f forms an image which is $\dfrac{1}{n}$ times the object. The distance of the object from the mirror is
    (a) $(n-1) f$
    (b) $\left(\dfrac{n-1}{n}\right) f$
    (c) $\left(\dfrac{n+1}{n}\right) f$
    (d) $(n+1) f$

18. A 2.0 cm tall object is placed 15 cm in front of a concave mirror of focal length 10 cm. What is the size and nature of the image?
    (a) 4 cm, real
    (b) 4 cm, virtual
    (c) 1.0 cm, real
    (d) None of these

19. The focal length of a concave mirror is f and the distance from the object to the principle focus is x. The ratio of the size of the image to the size of the object is
    (a) $\dfrac{f+x}{f}$
    (b) $\dfrac{f}{x}$
    (c) $\sqrt{\dfrac{f}{x}}$
    (d) $\dfrac{f^2}{x^2}$

20. Monochromatic light is refracted from air into the glass of refractive indiex μ. The ratio of the wavelength of incident and refracted waves is
    (a) $1 : \mu$
    (b) $1 : \mu^2$
    (c) $\mu : 1$
    (d) $1 : 1$

21. A light ray is incident at an angle of incidence i from a denser medium to a rarer medium so that reflected and refracted rays make an angle 90° mutually with each other. The angle of reflection and refraction are r and r' respectively. Then the critical angle is
    (a) $\tan^{-1} (\sin i)$
    (b) $\sin^{-1} (\tan i)$
    (c) $\sin^{-1} (\tan r')$
    (d) $\sin^{-1} (\tan r)$

22. The ratio of thickness of plates of two transparent medium A and B is 6 : 4. If light takes equal time in passing through them, then refractive index of A with respect to B will be
    (a) 1.33
    (b) 1.75
    (c) 1.4
    (d) 1.5

23. The ray diagram could be correct

Lens
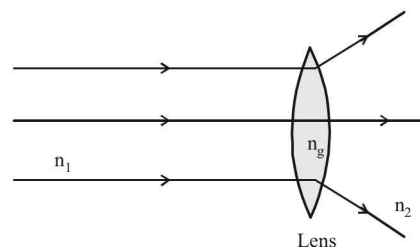
    (a) If $n_1 = n_2 = n_g$
    (b) If $n_1 = n_2$ and $n_1 < n_g$
    (c) If $n_1 = n_2$ and $n_1 > n_g$
    (d) Under no circumstances

24. 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°

25. 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 indiex μ_2. The apparent depth of the vessel seen perpendicularly is

(a) $d\left(\dfrac{\mu_1\mu_2}{\mu_1+\mu_2}\right)$ (b) $d\left(\dfrac{1}{\mu_1}+\dfrac{1}{\mu_2}\right)$

(c) $2d\left(\dfrac{1}{\mu_1}+\dfrac{1}{\mu_2}\right)$ (d) $2d\left(\dfrac{1}{\mu_1\mu_2}\right)$

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

(a) $\dfrac{t}{nc}$ (b) tnc

(c) $\dfrac{nt}{c}$ (d) $\dfrac{tc}{n}$

27. 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 $\left(\mu = \dfrac{4}{3}\right)$?

(a) 4 cm   (b) 8 cm   (c) 16 cm   (d) 32 cm

28. A beam of light consisting of red, green and blue colours is incident on a right-angled prism ABC. The refractive indices of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. The colour/colours transmitted through the face AC of the prism will be
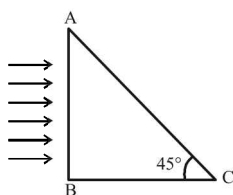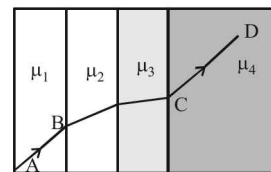

(a) Red only   (b) Red and Green
(c) All the three   (d) None of these

29. 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 $\dfrac{3}{4}$th of angle of prism. The angle of deviation is
(a) 25°   (b) 30°
(c) 45°   (d) 35°

30. 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) $36\sqrt{5}$

31. A ray of light passes through four transparent media with refractive indices μ_1, μ_2, μ_3, and μ_4 as shown in the figure. The surfaces of all media are parallel. If the emergent ray CD is parallel to the incident ray AB, we must have
(a) $\mu_1 = \mu_2$
(b) $\mu_2 = \mu_3$
(c) $\mu_3 = \mu_4$
(d) $\mu_4 = \mu_1$

32. Light travels in two media A and B with speeds $1.8 \times 10^8 \text{ ms}^{-1}$ and $2.4 \times 10^8 \text{ ms}^{-1}$ respectively. Then the critical angle between them is

(a) $\sin^{-1}\left(\dfrac{2}{3}\right)$ (b) $\tan^{-1}\left(\dfrac{3}{4}\right)$

(c) $\tan^{-1}\left(\dfrac{2}{3}\right)$ (d) $\sin^{-1}\left(\dfrac{3}{4}\right)$

33. Light of wavelength 4000 Å is incident at small angle on a prism of apex angle 4°. The prism has $n_v = 1.5$ and $n_r = 1.48$. The angle of dispersion produced by the prism in this light is
(a) 0.2°   (b) 0.08°
(c) 0.192°   (d) None of these

34. A planoconcave lens is placed on a paper on which a flower is drawn. How far above its actual position does the flower appear to be?
(a) 10 cm
(b) 15 cm
(c) 50 cm
(d) None of these
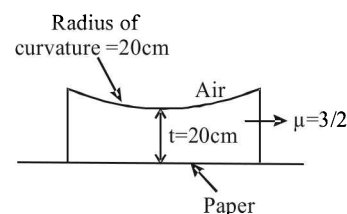
35. When plane face of planoconvex lens is silvered, it behaves as a concave mirror of focal length 30cm. But when its curved surface is silvered, it behaves as a concave mirror of focal length 10cm. The refractive index of lens material is
   (a) 1.25
   (b) 1.33
   (c) 1.732
   (d) 1.5

36. An observer can see through a pin-hole the top end of a thin rod of height h, placed as shown in the figure. The beaker height is 3h and its radius h. When the beaker is filled with a liquid up to a height 2h, he can see the lower end of the rod. Then the refractive index of the liquid is
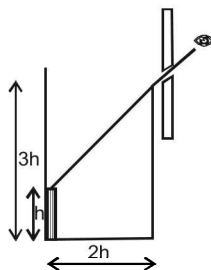
   (a) $\dfrac{5}{2}$
   (b) $\sqrt{\dfrac{5}{2}}$

   (c) $\sqrt{\dfrac{3}{2}}$
   (d) $\dfrac{3}{2}$

37. A double concave thin lens made out of glass ($\mu = 1.5$) 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

38. For a prism kept in air it is found that for an angle of incidence 60°, the angle of Prism A, angle of deviation δ and angle of emergence 'e' become equal. Then the refractive index of the prism is
   (a) 1.73
   (b) 1.15
   (c) 1.5
   (d) 1.33

39. A light ray from air is incident (as shown in figure) at one end of a glass fiber (refractive index $\mu = 1.5$) making an incidence angle of 60° on the lateral surface, so that it undergoes a total internal reflection. How much time would it take to traverse the straight fiber of length 1 km?
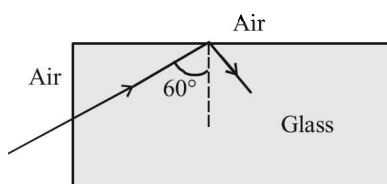
   (a) 3.33 μs
   (b) 6.67 μs
   (c) 5.77 μs
   (d) 3.85 μs

40. A telescope has an objective of focal length 100 cm and an eye piece of focal length 5 cm. What is the magnifying power of the telescope when it is in normal adjustment?
   (a) 0.2
   (b) 2.0
   (c) 20
   (d) 200

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

42. A thin prism of angle 15° made of glass of refractive index $\mu_1 = 1.5$ is combined with another prism of glass of refractive index $\mu_2 = 1.75$. The combination of the prism produces dispersion without deviation. The angle of the second prism should be
   (a) 7°
   (b) 10°
   (c) 12°
   (d) 5°

43. When a biconvex lens of glass having refractive index 1.47 is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index
   (a) equal to that of glass
   (b) less than one
   (c) greater than that of glass
   (d) less than that of glass
   (d) is greater than 2

44. Diameter of a plano-convex lens is 6 cm and thickness at the centre is 3 mm. If speed of light in material of lens is 2×10^8 m/s, the focal length of the lens is
   (a) 15 cm
   (b) 20 cm
   (c) 30 cm
   (d) 10 cm

45. 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) $\dfrac{\mu A}{2}$
   (c) $\dfrac{A}{\mu}$
   (d) $\dfrac{A}{2\mu}$

46. A concave mirror of focal length 'f_1' is placed at a distance of 'd' from a convex lens of focal length 'f_2'. A beam of light coming from infinity and falling on this convex lens-concave mirror combination returns to infinity. The distance 'd' must be equal to
   (a) $f_1 + f_2$
   (b) $-f_1 + f_2$
   (c) $2f_2 + f_1$
   (d) $-2f_1 + f_2$

47. The magnifying power of a telescope is 9. When it is adjusted for parallel rays the distance between the objective and eyepiece is 20 cm. The focal length of lenses are
   - (a) 10 cm, 10 cm
   - (b) 15 cm, 5 cm
   - (c) 18 cm, 2 cm
   - (d) 11 cm, 9 cm

48. 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) is less than 1
   - (d) is greater than 2

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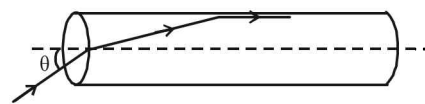

The incident angle θ for which the light ray grazes along the wall of the rod is
   - (a) $\sin^{-1}\left(\dfrac{\sqrt{3}}{2}\right)$
   - (b) $\sin^{-1}\left(\dfrac{2}{\sqrt{3}}\right)$
   - (c) $\sin^{-1}\left(\dfrac{1}{\sqrt{3}}\right)$
   - (d) $\sin^{-1}\left(\dfrac{1}{2}\right)$

50. An object 2.4 m in front of a lens forms a sharp image on a film 12 cm behind the lens. A glass plate 1 cm thick, of refractive index 1.50 is interposed between lens and film with its plane faces parallel to film. At what distance (from lens) should object shifted to be in sharp focus of film?
   - (a) 7.2 m
   - (b) 2.4 m
   - (c) 3.2 m
   - (d) 5.6 m

Skill Based MCQs

51. An object moving at a speed of 5m/s towards a concave mirror of focal length f = 1 m is at a distance of 9 m. The average speed of the image is
   - (a) $\dfrac{1}{5}m/s$
   - (b) $\dfrac{1}{10}m/s$
   - (c) $\dfrac{5}{9}m/s$
   - (d) $\dfrac{2}{5}m/s$

52. A ray PQ incident on the refracting face BA is refracted in the prism BAC as shown in the figure and emerges from the other
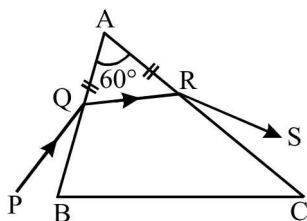
refracting face AC as RS such that AQ = AR. If the angle of prism A = 60° and the refractive index of the material of prism is $\sqrt{3}$, then the angle of deviation of the ray is
   - (a) 60°
   - (b) 45°
   - (c) 30°
   - (d) None of these

53. A ray of light is incident on the surface of a glass plate of thickness t, If the angle of incidence θ is small, the emerging ray would be displaced side ways by an amount [take n = refractive index of glass]
   - (a) $\dfrac{t\theta n}{(n+1)}$
   - (b) $\dfrac{t\theta(n-1)}{n}$
   - (c) $\dfrac{t\theta n}{(n-1)}$
   - (d) $\dfrac{t\theta(n+1)}{n}$

54. The refractive index of a glass is 1.520 for red light and 1.525 for blue light. Let D_1 and D_2 be angles of minimum deviation for red and blue light respectively in a prism of this glass. Then,
   - (a) $D_1 < D_2$
   - (b) $D_1 = D_2$
   - (c) D_1 can be less than or greater than D_2 depending upon the angle of prism
   - (d) $D_1 > D_2$

55. 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?
   - (a) 12 cm
   - (b) 30 cm
   - (c) 50 cm
   - (d) 60 cm

56. A thin glass (refractive index 1.5) lens has optical power of $-5\,D$ in air. Its optical power in a liquid medium with refractive index 1.6 will be
   - (a) $-1\,D$
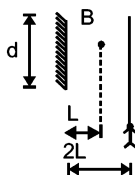   - (b) $1\,D$
   - (c) $-25\,D$
   - (d) $25\,D$

57. A double convex lens is made of glass which has its refractive index 1.45 for violet rays and 1.50 for red rays. If the focal length for violet ray is 20cm, the focal length for red ray will be
(a) 9 cm   (b) 18 cm
(c) 20 cm   (d) 22 cm

58. Refractive index of a prism is $\sqrt{7/3}$ and the angle of prism is $60°$. The minimum angle of incidence of a ray that will be transmitted through the prism is
(a) $30°$ (b) $4°$
(c) $15°$ (d) $5°$

59. 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 in fig. 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) $3d$

60. An object is placed at a distance of 40 cm from a convex mirror of radius of curvature 20 cm. At what distance from the object a plane mirror be placed so that image in the convex mirror and plane mirror coincides?
(a) 20cm   (b) 24cm
(c) 28cm   (d) 32cm

ANSWER KEY																			
Conceptual MCQs																			
1	(b)	3	(a)	5	(d)	7	(d)	9	(c)	11	(b)	13	(c)	15	(b)				
2	(d)	4	(a)	6	(d)	8	(d)	10	(a)	12	(c)	14	(c)						
Application Based MCQs																			
16	(a)	20	(c)	24	(d)	28	(a)	32	(d)	36	(b)	40	(c)	44	(c)	48	(b)		
17	(a)	21	(c)	25	(b)	29	(b)	33	(d)	37	(a)	41	(c)	45	(a)	49	(c)		
18	(a)	22	(d)	26	(c)	30	(a)	34	(a)	38	(a)	42	(b)	46	(c)	50	(d)		
19	(b)	23	(c)	27	(d)	31	(d)	35	(d)	39	(d)	43	(a)	47	(c)				
Skill Based MCQs																			
51	(a)	52	(a)	53	(b)	54	(a)	55	(c)	56	(b)	57	(b)	58	(a)	59	(d)	60	(b)