CHAPTER

4

Light

SYNOPSIS

- Light is a form of electromagnetic radiation, it doesn't require any material medium to propagate.
- The real images of objects are formed when light rays after reflection (or) refraction meet at a point. If the rays appear to meet when produced backwards, the image formed is virtual.
- (a) Reflection of light: The bouncing of light into the same medium, from which the light ray is incident after striking the objects (or) surfaces is called reflection. There are two types of reflections, i.e., regular and irregular reflections.

  (b) Laws of reflection: The reflection of light rays at a particular point always satisfies the following laws.

  (i) The angle of incidence is equal to the angle of reflection i.e., $\angle i = \angle r$.

  (ii) The incident ray, the reflected ray and the normal all lie in the same plane.
- When a plane mirror is rotated through an angle θ about the point of incidence, the reflected ray rotates through an angle 2θ, irrespective of the angle of incidence.
- When two plane mirrors are placed at an angle 'θ', such that their reflecting surfaces face each other, then total number of images (n) formed is given by

  $n = \frac{360^\circ}{\theta} - 1$, if $\frac{360^\circ}{\theta}$ is even and

  $n = \frac{360^\circ}{\theta}$, if 360% in odd.
- The ratio of size of an image to the size of its object is known as magnification and it is denoted by 'm'.

  $$m = \frac{\text{size of the image}}{\text{size of the object}} = \frac{v}{u} = \frac{\text{image distance}}{\text{object distance}}$$

  For mirrors $(m) = \frac{-v}{u}$ and for lenses $(m) = \frac{v}{u}$

  m is positive for virtual images and m is negative for real images.
- The focal length of a spherical mirror 'f'

  $$= \frac{\text{radius of curvature}}{2}.$$

- (a) The mirror formula is given by $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$, where f, u and v are the focal length, object distance and image distance respectively.

  (b) Lens formula is given by $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, where f, u and v are the focal length, object distance and image distance respectively. While solving problem, sign convention has to be followed.

Refraction: When a light ray travels from one transparent medium to another, there is a deviation in the path of the light ray at the boundary of separation of the two media due to change in the velocity of light, this phenomena of light is called refraction.

- When light enters from one medium to another medium, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant called refractive index (μ) for a given pair of media and for a given colour of light. This law is known as snell's law

$\therefore \mu = \frac{\text{Sin}i}{\text{Sin}r}$

- (i) The absolute refractive index (μ) of a medium is the ratio of the velocity of light in air or vacuum (c) to its velocity in a given medium (v). $\mu = c/v$

(ii) If μ_1 and μ_2 are the absolute refractive indices of two media and v_1 and v_2 are the velocities of light in medium one and medium two respectively then, the refractive index of medium 2 with respect to medium 1 is given by $^1\mu_2 = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2}$

- When an object is placed in an optically denser medium and when it is seen from an optically rarer medium, the object appears to be raised from its actual position and the shift in the position of the object is given by shift (s) = $t\left[1 - 1/\mu\right]$, where t = thickness of medium (real depth) and μ = the refractive index of the denser medium with respect to the rarer medium

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

- When a light ray enters from a denser medium to a rarer medium, the angle of incidence for which the angle of refraction is 90° is called the critical angle (C). From snell's law, it can be proved that the refractive index of given denser medium with respect to rarer medium $\mu = \frac{1}{\text{Sin}C}$

The refractive index of a prism (μ), when it is in the minimum deviation condition is given by

$\mu = \frac{\text{Sin}\left(\frac{A+D}{2}\right)}{\text{Sin}\frac{A}{2}}$, where D = angle of minimum deviation.

A = refracting angle of the prism. If i_1, i_2 are the incident and emergent angles of the prism and r_1, r_2 are the angle of refraction and angle of incidence at the first and the second refracting surfaces respectively, then $i_1 + i_2 - A = d$ and $A = r_1 + r_2$

- If two or more thin lenses are kept in contact, then their equivalent focal length is given by

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + \ldots \Rightarrow P = P_1 + P_2 + P_3 + \ldots,$

where $f_1, f_2, f_3, \ldots$ and $P_1, P_2, P_3 \ldots$ are focal lengths and powers of the lenses which are in contact.

f-number is defined as the ratio of the focal length of the lens to the diameter of the aperture.

$\text{f-number} = \frac{\text{focal length of the lens}}{\text{Diameter of the aperture}}$

For a normal eye, least distance of distinct vision is 25 cm. Infinity is referred to as far point.

When an object is placed between the focus and the optic-centre of lens such that a magnified, virtual, erect image is formed at the least distance of distinct vision (D) then the magnification is given by $m = 1 + D/f$ where f is the focal length of lens.

When an optical system consists of large number of lenses (optical elements), the magnification of the system is the product of magnification of individual systems. Example: In the case of compound microscope, the magnification is given by $m = m_o \times m_e$

m_o = magnification produced by objective.

m_e = magnification produced by eye piece.

Solved Examples

1. Find the radius of curvature of a concave mirror of focal length 15 cm.

☝ ***Solution:*** Focal length = 1/2 radius of curvature (R)

Given f = 15 cm

$R = 2f = 2 \times 15 = 30$ cm

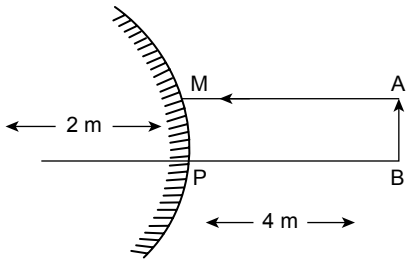
Since it is a concave mirror, 'R' is negative (from Cartesian sign convention).

2. A rear view mirror of an automobile has a focal length of 2 m. If it locates a person standing at a distance of 4 m from it, find the nature and distance of the image.

Solution: Since the mirror is a rear view mirror, it is a convex mirror.

Given Focal length = f = 2 m (focal length is positive)

Object distance = u = – 4 m



∴ From Cartesian sign convention, object distance is in the opposite direction to that of the incident ray

Using mirror formula, we get

$$\frac{1}{f}=\frac{1}{u}+\frac{1}{v} \Rightarrow \frac{1}{2}=\frac{1}{-4}+\frac{1}{v} \Rightarrow \frac{1}{v}=\frac{1}{2}+\frac{1}{4}$$

$$\frac{1}{v}=\frac{4+2}{4\times 2} \Rightarrow \frac{1}{v}=\frac{6}{8} \Rightarrow v=\frac{8}{6}=1.33 \text{ m}$$

Since v is positive, image is virtual (it is formed at the back of the convex mirror)

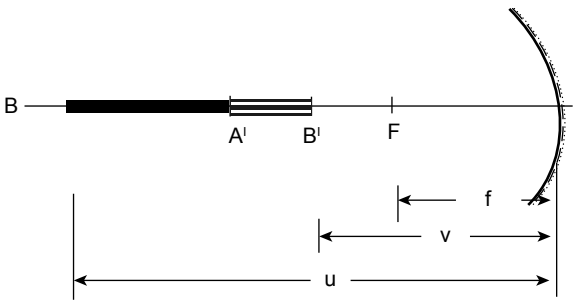
$$\text{Magnification } m=\frac{\text{height of the image}}{\text{height of the object}}=-\frac{v}{u};$$

$m=\frac{-1\cdot 33}{-4}=0\cdot 3325$ Since magnification is positive, the image is erect and virtual.

3. 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 the end close to the pole is 20 cm away from it. Find the length of the image of the rod.

Solution: AB – Object

AB' – Image



Focal length f = –10 cm

∴ Radius of curvature R = 2f = –20 cm;

Length of the rod AB = 10 cm; Distance of the end A = 20 cm = R; Since the end of the object 'A' is on the centre of curvature, the image A^1 will be at 'the same position'.

Distance of the end B = 20 + 10 = 30 cm

∴ u = –30 cm (from Cartesian sign convention)

f = –10 cm; ⇒ v = ?

From mirror formula $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}; \frac{1}{-10}=\frac{1}{-30}+\frac{1}{v}$

$$\Rightarrow \frac{1}{v}=\frac{-1}{10}+\frac{1}{30} \Rightarrow \frac{1}{v}=\frac{-30+10}{30\times 10}$$

$$\frac{1}{v}=\frac{-20}{300}; v=\frac{-30}{2}=-15 \text{ cm}$$

Length of the image = A^1B^1 = 20 – 15 = 5 cm

4. The velocity of light in air is 3×10^8 ms^{-1}. If the refractive index of water is 4/3, find the velocity of light in water.

Solution: Given velocity of light in air, c = 3×10^8 ms^{-1} Refractive index of water $\mu_w=\frac{4}{3}$; Refractive index of water = $\frac{c}{v_w}$; Where v_w is the velocity of light in water; $\frac{4}{3}=\frac{3\times 10^8}{v_w}$;

$$v_w=\frac{3\times 3\times 10^8}{4}$$

$v_w = 2.25 \times 10^8 ms^{-1}$

Velocity of light in water is 2.25×10^8 ms^{-1}.

5. The angle of incidence of a ray of light is 45°. If a light ray travels from air to glass, find the angle of refraction. Refractive index of glass, $\mu_g = 1.5$

Solution: Given i = 45° = angle of incidence

Refractive index of glass = $\mu_g = 1\cdot 5$ Angle of refraction r = ?

$\mu_g=\frac{\sin i}{\sin r}$ (from Snell's law);

$$1.5=\frac{\sin 45}{\sin r} \Rightarrow 1.5=\frac{\frac{1}{\sqrt{2}}}{\sin r} \Rightarrow \sin r=\frac{1}{1.5\times\sqrt{2}}$$

sin r = 0.4728. From sine trigonometric table, we get r ≈ 28°.

6. Refractive index of diamond is 2.5 and that of glass is 1.5. Calculate the refractive index of diamond with respect to glass.

☝ ***Solution:*** Refractive index of glass μ_g = 1.5; Refractive index of diamond μ_d = 2.5; From relative refractive index; $^{g}\mu_d = \frac{\mu_d}{\mu_g} = \frac{2\cdot5}{1\cdot5} = 1\cdot667$

7. A coin placed in a beaker containing water appears at a depth of 3 cm from the water surface. What is the real depth of the coin? Refractive index of water = 4/3

☝ ***Solution:*** Real depth = ?; Apparent depth = 3 cm

Refractive index of water = 4/3;

Refractive index = $\frac{\text{real depth}}{\text{apparent depth}}$;

$\Rightarrow \frac{4}{3} = \frac{\text{real depth}}{3}$; $\frac{4}{3} \times 3 = \text{real depth}$,

$\therefore$ Real depth = 4 cm

8. A bird flying above a pond starts moving vertically down towards the water below at a speed of 6 ms^{-1}. Find its apparent velocity as viewed by a fish located at a depth of 2 m below the surface of water. Refractive index of water is 4/3.

☝ ***Solution:*** Let the initial height of the bird above the surface of water be h_1 and the apparent height be h'_1.

Thus we have,

$$\frac{\mu_{air}}{\mu_{water}} = \frac{\text{real height in air}}{\text{apparent height in air}}$$

$\therefore \frac{1}{\mu} = \frac{h_1}{h_1'}$

i.e., $h_1' = \mu h_1$

Let the final height of the bird after t be h_2 and the corresponding apparent height be h_2'.

$\therefore \frac{1}{\mu} = \frac{h_2}{h_2^1}$;

$\therefore h_2^1 = \mu h_2$

apparent displacement $= h_2' - h_1'$

$= \mu (h_2 - h_1) \rightarrow (1)$

Apparent velocity, $v^1 = \frac{h_2' - h_1'}{t}$;

Real velocity $v = \frac{h_2 - h_1}{t}$

From these two relations we have $\frac{v'}{v} = \frac{h_2' - h_1'}{h_2 - h_1}$

combining with equation (1)

$$v' = v\frac{\mu(h_2 - h_1)}{(h_2 - h_1)} = \mu v = \frac{4}{3} \times 6 = 8\ ms^{-1}$$

since μ is greater than one, v' > v, i.e., the bird appears to move down faster.

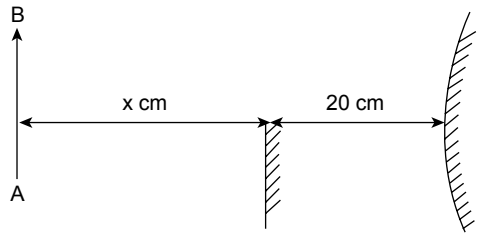
PRACTICE EXERCISE 4 (A)

Directions for questions 1 to 35: Select the correct alternative from the given choices.

1. The velocity of light in air is 3×10^8 ms^{-1} wavelength of visible light is 400 nm to 800 nm (4000 A° to 8000 A°). Its corresponding frequency is _____ H_z to _____ H_z.

(1) $7 \times 5 \times 10^{14}$, 3.75×10^{14}
(2) 6.3×10^{14}, 2.3×10^{14}
(3) 3×10^{14}, 8×10^4
(4) 0.4×10^{-8}, 0.8×10^{-8}

2. Ram was playing with a convex mirror and a plane mirror. When an object AB is placed in front of the mirrors he could see two virtual images. When the object is placed at a position as shown in the figure, he found that both the images coincide with each other. If the focal length of the convex mirror is 30 cm, find the value of 'x'.



(1) 80 cm (2) 40 cm
(3) 60 cm (4) 30 cm

3. An observer moves towards a stationary plane mirror at a speed of 4 ms^{-1}. Determine the velocity of image with respect to the mirror.

(1) 8 ms^{-1} (2) 4 ms^{-1}
(3) 2 ms^{-1} (4) 16 ms^{-1}

4. A convex mirror of radius of curvature 2 m is used as rear–view mirror in an automobile.

If a vehicle of size 1 m is at a distance of 5 m from the mirror, the image distance and magnification produced by the mirror are ___ m and ___ respectively.

(1) $\frac{5}{6}, \frac{1}{6}$ (2) $\frac{6}{7}, \frac{1}{5}$
(3) $\frac{6}{5}, \frac{7}{6}$ (4) $\frac{1}{5}, \frac{1}{6}$

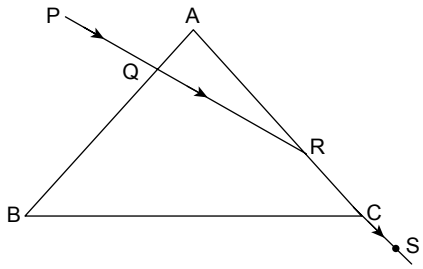
5. In an equilateral prism if the angle of incidence for minimum angle of deviation is 35°, then what is the minimum angle of deviation?

(1) 30° (2) 20°
(3) 10° (4) 45°

6. Two light rays of different wavelengths λ_1 and λ_2 fall respectively, on two glass slabs S_1 and S_2 normally and come out of the glass slabs simultaneously. If $\lambda_1 > \lambda_2$, and if t_1 and t_2 are the thickness of the glass slabs s_1 and s_2 respectively, which among the following is the correct relation between them?

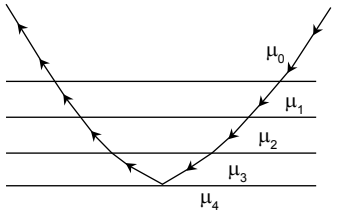
(1) $t_1 = t_2$ (2) $t_1 < t_2$
(3) $t_1 > t_2$ (4) $t_1 \geq t_2$

7. ABC represents the principal cross-section of an equilateral prism made with a transparent material. If PQRS indicates the path of a light ray, find the refractive index of the material.



(1) $\frac{1}{\sqrt{2}}$ (2) $\frac{2}{\sqrt{3}}$
(3) $\sqrt{2}$ (4) $\frac{\sqrt{3}}{2}$

8. A ray of monochromatic light follows the path shown in the figure as it passes through five layers of different optical media of refractive indices μ_0, μ_1, μ_2, μ_3 and μ_4. If the angle of incidence in the first medium is 30°, determine the angle of deviation on the whole.



(1) 60° (2) 120°
(3) 30° (4) 45°

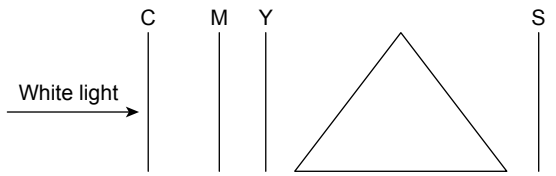
9. A bird is flying 12 m above the surface of a pond. What is the apparent position of the bird as viewed by a fish 1 m below the surface? $\left({}_a\mu_w = \frac{4}{3}\right)$

(1) 15 m (2) 17 m
(3) 13 m (4) 16 m

10. In which colour, a yellow coloured dress would appear when viewed through a blue filter?

(1) red (2) blue
(3) yellow (4) black

11. Three filters, one of cyan (C), one of magenta (M) and the last, yellow (Y) are placed in front of a 100% transparent equilateral glass prism as shown in the figure. A screen (S) is placed on the other side of the prism. When a white light ray is allowed to pass through the filters as shown in the figure and incident on the prism, what colours are obtained on the screen?

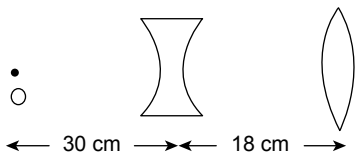


(1) cyan (2) white
(3) black (4) yellow

12. A convex lens of focal length 0.12 m produces a virtual n image which is thrice the size of the object. Find the distance between the object and the lens.

(1) 0.04 m (2) 0.08 m
(3) 0.12 m (4) 0.24 m

13. An object (O) is placed in front of a concave lens of focal length 20 cm as shown in figure. Determine the focal length of the convex lens if a real image is formed at a distance of 30 cm by the convex lens.



(1) 15 cm (2) 30 cm
(3) 45 cm (4) 60 cm

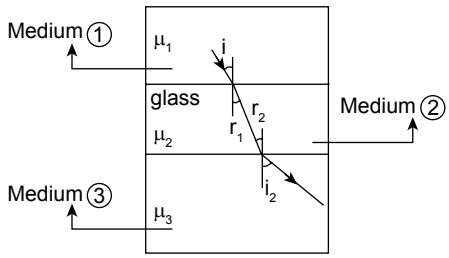
14. The focal lengths of the eye piece and objective lens of a compound microscope are 10 cm and 20 cm respectively. If the length of the tube is 100 cm, what is the magnification obtained at the least distance of distinct vision?

(1) 25 (2) 12.5
(3) 50 (4) 60

15. An object of length 2 cm is placed at distance 2.5 f from a concave mirror where 'f' is its focal length. Find the length of the image.

(1) 2.33 cm (2) 0.88 cm
(3) 0.66 cm (4) 1.33 cm

16.



Consider the figure and select the correct statements from the following.

(1) Since, $\sin i_1 \neq \sin i_2$, the emergent ray in medium (3) is parallel to the incident ray in medium (1).
(2) The optical density of medium (3) is less than the optical density of medium (1).
(3) The optical density of medium (2) is greater than that of both media (1) and (3).
(4) Both (2) and (3)

17. Choose the correct statement.

(A) The angle of deviation for Indigo is greater than the angle of deviation of the orange colour.
(B) The angle of deviation increases with increase in the wavelength of the incident light.

(1) Only A is true.
(2) Only B is true.
(3) Both A and B are true.
(4) Both A and B are false.

18. Two convex lenses A and B of focal lengths 0.3 m and 0.2 m respectively are placed in contact. Calculate the effective power of the combination.

(1) 36/7 D (2) 25/3 D
(3) 3/25 D (4) 63/11 D

19. An object is placed on the principal axis of a convex mirror of focal length 15 cm. If the distance of the

object from the mirror is 30 cm, determine the image distance.

(1) 15 cm (2) 20 cm
(3) 10 cm (4) 30 cm

20. An object is placed at a distance of 40 cm in front of a concave mirror of focal length 20 cm. Determine the ratio of the size of the image and the size of object.

(1) 2 : 1 (2) 1 : 2
(3) 1 : 1 (4) 4 : 1

21. The reflected ray from a plane mirror is incident on another plane mirror which is placed perpendicular to the first. If the angle of incidence on the first mirror is 30°, determine the glancing angle of reflection on the second mirror.

(1) 15° (2) 120°
(3) 60° (4) 30°

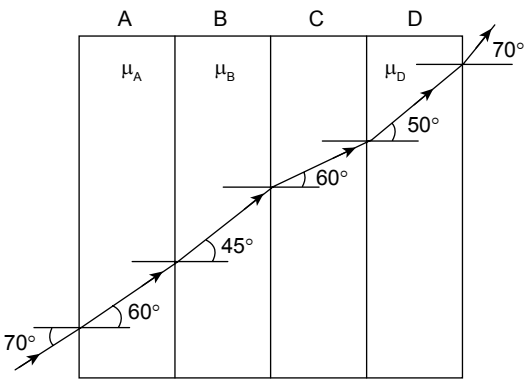
22. An object is placed at a distance of 20 cm from a convex mirror of radius of curvature 40 cm. At what distance from the object should a plane mirror be placed so that the images due to the mirror and the plane mirror are in the same plane?

(1) 15 cm (2) 30 cm
(3) 60 cm (4) 40 cm

23. A diver under water sees a bird in air, vertically above him. If the actual height of the bird above the water surface is h, If μ_w is the refractive index of water, find the shift in the bird's position as observed by the diver.

(1) $h(\mu_\omega - 1)$ (2) $\mu_\omega h$
(3) $(\mu_\omega + 1)\, h$ (4) $\dfrac{\mu_\omega - 1}{h}$

24. A, B, C and D are four transparent sheets of equal thickness and made of material of refractive indices μ_A, μ_B, μ_C, and μ_D. If a light ray propagates through them as shown in the figure, which among the following is the correct relation?



(1) $\mu_A > \mu_B > \mu_C > \mu_D$
(2) $\mu_A = \mu_C < \mu_D < \mu_B$
(3) $\mu_A < \mu_B < \mu_D < \mu_C$
(4) $\mu_A = \mu_B = \mu_C = \mu_D$

25. A convex lens and a convex mirror are separated by a distance of 10 cm such that the reflecting surface of the mirror faces the lens. The image of an object placed in front of the convex lens at a distance of 20 cm is found to coincide with the object. If the focal length of the convex lens is 15 cm, determine the focal length of the mirror.

(1) 35 cm (2) 30 cm
(3) 15 cm (4) 25 cm

26. A telescope has an objective of focal length 100 cm and eye piece of focal length 6 cm and the least distance of distinct vision is 25 cm. The telescope is focused for distinct vision of an object at a distance 100 m from the objective. What is the distance of separation between the objective and the eye piece?

(1) 2.5 m (2) 1.5 m
(3) 1.06 m (4) 98 cm

27. A student with a normal eye observes the reading on a vernier scale using a magnifying glass of focal length 10 cm. What are the minimum and the maximum distances between the scale and the magnifying glass at which he can read the scale when viewing through the magnifying glass?

(1) 7.14 cm, ∞ (2) 7.14 cm, 10 cm
(3) 10 cm, 20 cm (4) 25 cm, ∞

28. When the photograph of an object is taken by using a pinhole camera the magnification is found to be 0.05. When the pin hole camera is moved through a distance 2 m towards the object the magnification is found to be 0.0625. Determine the width of the pin hole camera.

(1) 30 cm (2) 120 cm
(3) 60 cm (4) 50 cm

29. An object is placed at 40 cm from the optic centre of a convex lens on its principal axis. If the focal length of the lens is 24 cm, find how far from the lens the screen should be placed to obtain a well-defined image.

(1) 48 cm (2) 38 cm
(3) 50 cm (4) 60 cm

30. A concave mirror is made from a hollow sphere of radius of curvature 30 cm. If an object of height

2 cm is placed at 10 cm from the pole of the mirror, determine the size of the image.

(1) 3 cm (2) 6 cm
(3) 12 cm (4) 24 cm

31. Facts about the light

(A) Light is a form of electromagnetic radiation and a non-mechanical wave.

(B) Light waves do not require a material as a medium for propagation.

(1) Only A is true.
(2) Only B is true.
(3) Both A and B are true
(4) Both A and B are false

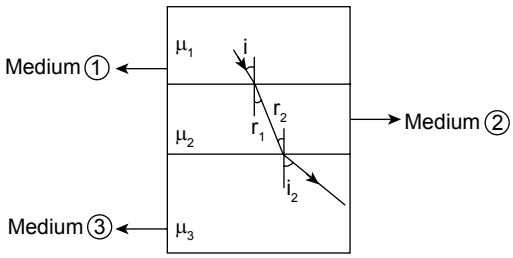
32. When a light ray is directed towards the principal focus of a concave mirror

(1) real image is formed
(2) a dmonished image is formed
(3) inverted image is formed
(4) All the above

33. Total reflecting prisms are _____ prism.

(1) right angled.
(2) acute angled isosceles.
(3) right angled isosceles.
(4) obtuse angled isosceles.

34. Light is made to travel from medium 1 to medium 3 through medium 2 as shown in figure. If μ_1, μ_2 and μ_3 are the refractive indices of first, second and third media and $i_2 > i_1$, then



(1) $\sin r_1 = \sin r_2$; $\sin i_1 < \sin i_2$.
(2) ${}^1\mu_2 > {}^2\mu_1$; ${}^2\mu_3 < {}^3\mu_2$.
(3) ${}^1\mu_3 < {}^3\mu_1$.
(4) All the above

35. The lateral displacement depends on _____.

(1) thickness of the medium
(2) refractive index of the medium
(3) angle of incidence
(4) All the above

PRACTICE EXERCISE 4 (B)

Directions for questions 1 to 35: Select the correct alternative from the given choices.

1. An object of height 10 cm is placed at a distance of 100 cm before the convex mirror perpendicular below the principal axis. If the focal length of the mirror is 10 cm, on applying the Cartesian sign convention, find the object distance.

(1) –100 cm (2) +100 cm
(3) 50 cm (4) –50 cm

2. An object is placed on the principal axis of a concave mirror at a distance of 60 cm. If the focal length of the concave mirror is 40 cm then determine the magnification of the obtained image.

(1) 4 (2) –2
(3) –4 (4) +2

3. A convex mirror of radius of curvature 4 m is used as rear–view mirror in an automobile. If a vehicle of size 4 m is at a distance of 5 m from the mirror, what is the position of the image and size of the image?

(1) $\frac{5}{6}$ m, $\frac{1}{6}$ m (2) $\frac{10}{7}$ m, $\frac{4}{7}$ m
(3) $\frac{6}{5}$ m, $\frac{1}{16}$ m (4) $\frac{10}{13}$ m, $\frac{4}{17}$ m

4. A light ray travels from optically denser medium to optically rarer medium, if the angle of incidence and refraction at point of incidence are $\angle i$ and $\angle r$ respectively, then find the angle of deviation in terms of $\angle i$ and $\angle r$.

(1) $\angle i + \angle r$ (2) $\frac{\angle i}{\angle r}$
(3) $\angle i - \angle r$ (4) $\angle r - \angle i$

5. The apparent vertical shift of the image of a coin placed at the bottom of a container filled with a liquid having depth d and refractive index 'μ' is _____

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

(3) $d\left(1 - \frac{1}{\mu}\right)$ (4) $d(\mu + 1)$

6. The refractive index of a given glass is $\sqrt{2}$, find the angle of minimum deviation produced by an equilateral prism made of this glass.

(1) 60° (2) 30°

(3) 45° (4) 15°

7. μ_1, μ_2 are the refractive indices of two media A and B. If $\mu_1 > \mu_2$, when two light rays travel from air to medium A and air to medium B with the same angle of incidence then the angle of refractions are r_1 and r_2 respectively. What is the relation between r_1 and r_2?

(1) $r_1 = r_2$ (2) $r_1 < r_2$

(3) $r_1 > r_2$ (4) $r_1 \geq r_2$

8. The critical angle for a medium X is 60° and for another medium Y is 45°. Calculate the ratio of velocity of light in the medium X to that in medium Y.

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

(3) 1 : 1 (4) $\sqrt{\frac{1}{2}}$

9. The power of a lens is +8 D. What kind of lens is this?

(1) Convex (2) Concave

(3) Concavo convex (4) Convexo concave

10. What is the colour of a green leaf, when white light passing through a yellow filter is incident on it?

(1) black (2) blue

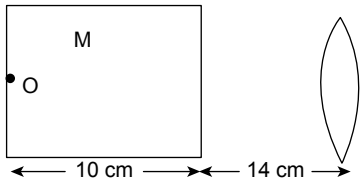
(3) yellow (4) green

11. A ray of white light is incident on a green pigment after passing through a magenta filter. The reflected ray is allowed to pass through a cyan filter. What would be the colour of the emergent ray? Comment on the brightness of the emergent ray.

(1) dark green (2) dark blue

(3) dull blue (4) dull green

12. An object (O) is placed in a medium M of refractive index 5/3. A convex lens of focal length 15 cm is placed infront of the object as shown in the figure. Determine the position of the image formed by the lens.



(1) 15 cm (2) 20 cm

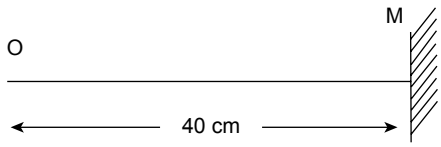
(3) 30 cm (4) 60 cm

13. An object is placed at a distance 20 cm in front of a concave lens of focal length 10 cm. Where should a plane mirror be placed so that the image formed on the plane mirror coincides with the image formed on the concave mirror.

(1) 20/3 cm (2) 10/3 cm

(3) 10 cm (4) 20 cm

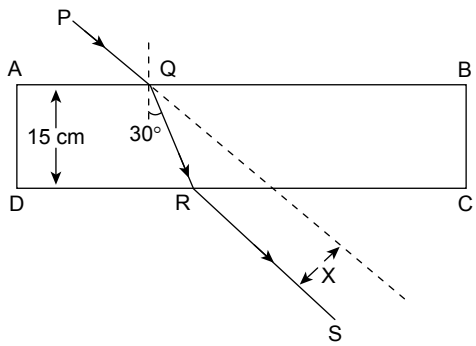
14. An object (O) and a plane mirror (M) are placed in the positions as shown in the figure. If the object and the mirror move simultaneously towards side in a straight path at uniform speeds of 2 cm s^{-1} and 5 cm s^{-1} respectively, find the shift in the position of the image of the object at the end of 10 seconds.



(1) 160 cm (2) 140 cm

(3) 80 cm (4) 120 cm

15. ABCD represents a glass slab and PQRS indicates the path of a light ray passing through the slab. If the refractive index of the glass is $\sqrt{3}$, find the lateral displacement (x).



(1) 15 cm (2) 16.33 cm

(3) 8.66 cm (4) 12.33 cm

16. If the speed of light in medium – 1 and medium –2 are 2.5×10^8 ms^{-1} and 2×10^8 ms^{-1} respectively then what is the refractive index of medium – 1 with respect to medium – 2?

(1) $\frac{4}{5}$ (2) $\frac{3}{2}$

(3) $\frac{4}{3}$ (4) $\frac{3}{4}$

17. Determine the refractive index of an equilateral prism if the angle of minimum deviation is 30°.

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

(3) $\sqrt{\frac{3}{2}}$ (4) $\sqrt{2}$

18. A tree, which is 200 m away from the pinhole, produces an image of height 1 cm, in a pinhole camera of width 20 cm. Find the height of the tree.

(1) 30 m (2) 20 m

(3) 10 m (4) 40 m

19. Two plane mirrors X and Y are placed parallel to each other and are separated by a distance of 20 cm. An object is placed between the two mirrors at a distance 5 cm from the mirror X. Find the distance of the first three images formed in the mirror X.

(1) 5 cm, 30 cm, 40 cm

(2) 5 cm, 35 cm, 45 cm

(3) 10 cm, 45 cm, 65 cm

(4) 5 cm, 45 cm, 85 cm

20. A rod of length f/2 is placed along the axis of a concave mirror of focal length f. If the near end of the real image formed by the mirror just touches the far end of the rod, find its magnification.

(1) 4 (2) 3

(3) 1 (4) 2

21. Determine time taken for the sunlight to pass through a window glass of 5 mm thickness when incident normally. ($\mu_{glass} = 1.5$)

(1) 4×10^{-7} s (2) 2×10^{-8} s

(3) 2.5×10^{-11} s (4) 3×10^{-8} s

22. A light ray passes from air to denser medium of certain thickness and emerges on the other side. If the emergent ray is parallel to the incident ray, the distance travelled by the ray of light in the denser medium is 6 cm, and the angle of incidence and refraction are 60° and 30° respectively, find the lateral displacement of the light ray.

(1) 9 cm (2) 2 cm

(3) 3 cm (4) 6 cm

23. A lean boy named Ramesh placed a glass slab of refractive index 3/2 on his photograph.He felt it more interesting as his face appeared bigger than the original size, when observed from the top of the glass slab. He also observed that the photo appears at a height of 1.5 cm from the bottom. He then placed another glass cube made of different material and having the same thickness over the first glass cube. Now, he himself started to laugh by seeing his photograph as it appeared still bigger than the previous. When observed from the top the photograph appears to be at a height of 4 cm from the bottom. Determine the refractive index of the second glass cube.

(1) 1.5 (2) 2.25

(3) 3.75 (4) 1.75

24. A cyan colour light ray is passed through a blue filter. What is the colour of the light which comes out through the filter?

(1) green (2) cyan

(3) yellow (4) blue

25. The ciliary muscles can change the focal length of the eye lens. Find the ratio of focal lengths of the eye lens when it is focused on two different objects, one at a distance of 2 m and the other at a distance of 1 m. The diameter of normal eye is 2.5 cm.

(1) 17 : 16 (2) 42 :41

(3) 41 : 42 (4) 82 : 81

26. A light ray is incident at one face of an equilateral prism such that the angle of incidence is 45°. If the light ray emerges from the other face of the prism by making the same angle with the normal, determine the refractive index of the material of the prism.

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

(3) $\sqrt{3}$ (4) $\sqrt{2}$

27. In an optical instrument a convex lens of focal length 20 cm is used and kept in contact with a concave lens of focal length 40 cm. What is the power of this combination?

(1) 4.5 D (2) 3.5 D

(3) 1.5 D (4) 2.5 D

28. Light rays from the sun after reflection at a plane mirror pass through a hole in a wall. After some time due to the shift in the position of the sun, the angle of incidence of sun light increases by 10°. By what angle should the mirror be rotated such that the reflected rays continue to pass through the hole in the wall?

(1) 20° (2) 15°
(3) 5° (4) 10°

29. A convex mirror is used

(1) by a dentist.
(2) for shaving.
(3) as a rear view mirror in vehicles.
(4) as a light reflector for obtaining a parallel beam of light.

30. Find the correct statement/s related to the image formed by the plane mirror form the given below.

(1) The image formed is laterally inverted, virtual and erect.
(2) The size of the image is equal to the size of the object.
(3) The object distance from the plane mirror is equal to the image distance from the plane mirror.
(4) All the above

31. The nature of image formed when an object is placed near to a concave lens is _____.

(1) virtual diminished (2) real magnified
(3) virtual magnified (4) real diminished

32. The final image formed by the refracting periscope is _____ than the reflecting periscope.

(1) bright (2) sharp
(3) dimmer (4) Both (1) and (2)

33. What are the factors that determine the angle of deviation in a prism?

(1) Angle of incidence (2) Wavelength
(3) Angle of the prism (4) All the above

34. Astigmatism can be rectified by a suitable _____ lens.

(1) concave (2) convex
(3) cylindrical (4) None of the above

35. A concave mirror is placed on a table with its pole touching the table. The mirror is rotated about its principal axis in clockwise direction. The image of a person looking straight into it

(1) rotates in clockwise direction.
(2) rotates in anti-clockwise direction.
(3) is inverted.
(4) does not rotate

ANSWER KEYS

PRACTICE EXERCISE 4 (A)

1. 1	**2.** 2	**3.** 2	**4.** 1	**5.** 3	**6.** 3	**7.** 2	**8.** 2	**9.** 2	**10.** 4
11. 3	**12.** 2	**13.** 1	**14.** 2	**15.** 4	**16.** 4	**17.** 1	**18.** 2	**19.** 3	**20.** 3
21. 4	**22.** 1	**23.** 1	**24.** 2	**25.** 4	**26.** 3	**27.** 2	**28.** 4	**29.** 4	**30.** 2
31. 3	**32.** 4	**33.** 3	**34.** 4	**35.** 4					

PRACTICE EXERCISE 4 (B)

1. 1	**2.** 2	**3.** 2	**4.** 4	**5.** 3	**6.** 2	**7.** 2	**8.** 2	**9.** 1	**10.** 4
11. 3	**12.** 4	**13.** 1	**14.** 1	**15.** 3	**16.** 1	**17.** 4	**18.** 3	**19.** 2	**20.** 4
21. 3	**22.** 3	**23.** 2	**24.** 4	**25.** 4	**26.** 4	**27.** 4	**28.** 3	**29.** 3	**30.** 4
31. 1	**32.** 4	**33.** 4	**34.** 3	**35.** 4					