

PRACTICE PAPER 01 (2026-27)
CHAPTER 09: LIGHT - REFLECTION AND REFRACTION
(STEP-BY-STEP SOLUTIONS)

SUBJECT: SCIENCE

MAX. MARKS : 40

CLASS : X

DURATION : 1½ hrs

General Instructions:

- (i) All questions are compulsory.
- (ii) This question paper contains **20** questions divided into five Sections A, B, C, D and E.
- (iii) **Section A** comprises 10 MCQs and Assertion-Reason questions of **1 mark** each. **Section B** comprises 4 Very Short Answer questions of **2 marks** each. **Section C** comprises 3 Short Answer questions of **3 marks** each. **Section D** comprises 1 Long Answer question of **5 marks**. **Section E** comprises 2 Case Study Based questions of **4 marks** each.
- (iv) There is no overall choice. Internal choice is provided in Section E.
- (v) Use of calculators is not permitted.

SECTION - A

Questions 1 to 10 carry 1 mark each.

1. Wherever an object is placed in front of a convex mirror, the image formed is always

- | | |
|-----------------------------------|-----------------------------------|
| (a) real, inverted and diminished | (b) virtual, erect and diminished |
| (c) virtual, erect and enlarged | (d) real, inverted and enlarged |

Solution:

Ans: (b) virtual, erect and diminished

- The image is always behind the mirror, between P and F (or at F when the object is at infinity).

2. The radius of curvature of a spherical mirror is 30 cm. Its focal length is

- | | |
|-----------|------------|
| (a) 60 cm | (b) 30 cm |
| (c) 15 cm | (d) 7.5 cm |

Solution:

Ans: (c) 15 cm

- $f = R/2 = 30/2 = 15 \text{ cm}$.

3. Convex mirrors are preferred as rear-view mirrors in vehicles because they

- (a) form real and enlarged images
- (b) always give an erect, diminished image and a wider field of view
- (c) form images at the centre of curvature
- (d) concentrate light to a point

Solution:

Ans: (b)

- Being curved outwards, a convex mirror lets the driver see a much larger area behind the vehicle, with erect images.

4. The speed of light in a medium is $2 \times 10^8 \text{ m s}^{-1}$. If the speed of light in vacuum is $3 \times 10^8 \text{ m s}^{-1}$, the refractive index of the medium is

- | | |
|----------|----------|
| (a) 0.67 | (b) 1.33 |
| (c) 1.5 | (d) 6.0 |

Solution:

Ans: (c) 1.5

- $n = c/v = (3 \times 10^8)/(2 \times 10^8) = 1.5$.

5. The refractive indices of four media are: water 1.33, kerosene 1.44, crown glass 1.52 and diamond 2.42. Light travels fastest in
- (a) water (b) kerosene
(c) crown glass (d) diamond

Solution:

Ans: (a) water

- $v = c/n$, so the medium with the **lowest** refractive index (optically rarest) has the highest speed.

6. A lens has a power of -2.5 D. The lens and its focal length are
- (a) convex, +40 cm (b) concave, -40 cm
(c) concave, -25 cm (d) convex, +25 cm

Solution:

Ans: (b) concave, -40 cm

- $f = 1/P = 1/(-2.5) \text{ m} = -0.4 \text{ m} = -40 \text{ cm}$. Negative power $\rightarrow$ concave (diverging) lens.

7. An object is placed at $2F_1$ in front of a convex lens. The image is formed
- (a) at F_2 ; real, inverted, diminished
(b) at $2F_2$; real, inverted, same size
(c) beyond $2F_2$; real, inverted, enlarged
(d) on the same side; virtual, erect, enlarged

Solution:

Ans: (b) at $2F_2$; real, inverted, same size

8. A spherical mirror and a thin spherical lens each have a focal length of +20 cm. The mirror and the lens are likely to be
- (a) both concave (b) both convex
(c) mirror concave, lens convex (d) mirror convex, lens concave

Solution:

Ans: (b) both convex

- By the New Cartesian Sign Convention, a positive focal length belongs to a convex mirror and a convex lens.

In the following questions 9 and 10, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

- (a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(c) (A) is true but (R) is false.
(d) (A) is false but (R) is true.

9. **Assertion (A):** A ray of light travelling obliquely from air into glass bends towards the normal.
Reason (R): Light slows down when it enters an optically denser medium.

Solution:

Ans: (a)

- Glass is optically denser than air; light slows down and bends towards the normal. R explains A.

10. **Assertion (A):** Kerosene is optically denser than water.
Reason (R): The mass density of kerosene is greater than that of water.

Solution:

Ans: (c)

- (A) is true: $n(\text{kerosene}) = 1.44 > n(\text{water}) = 1.33$. (R) is false: kerosene has a **lower** mass density than water. Optical density is not the same as mass density.

SECTION - B

Questions 11 to 14 carry 2 marks each.

- 11.** (a) State the two laws of refraction of light.
(b) The refractive index of diamond is 2.42. What does this statement mean?

Solution:

(a) (i) The incident ray, the refracted ray and the normal to the interface at the point of incidence all lie in the **same plane**. (ii) For a given pair of media and a given colour of light, **$\sin i / \sin r = \text{constant}$** (Snell's law); this constant is the refractive index of the second medium with respect to the first. [$\frac{1}{2} + \frac{1}{2}$]

(b) The ratio of the speed of light in air (vacuum) to the speed of light in diamond is 2.42, i.e. light travels **2.42 times slower** in diamond than in air. [1]

- 12.** (a) The speed of light in a medium is $2.25 \times 10^8 \text{ m s}^{-1}$. Find its refractive index. ($c = 3 \times 10^8 \text{ m s}^{-1}$)
(b) The refractive indices of glass and water are 1.50 and 1.33. Find the refractive index of glass with respect to water.

Solution:

(a) $n = c/v = (3 \times 10^8) \div (2.25 \times 10^8) = \mathbf{1.33}$. [1]

(b) $n_{gw} = (\text{speed in water})/(\text{speed in glass}) = (c/n_w)/(c/n_g) = n_g/n_w = 1.50/1.33 \approx \mathbf{1.13}$. [1]

- 13.** An object 4 cm tall is placed 20 cm in front of a convex mirror of radius of curvature 40 cm. Find the position, size and nature of the image.

Solution:

Given: $R = +40 \text{ cm} \rightarrow f = R/2 = \mathbf{+20 \text{ cm}}$; $u = -20 \text{ cm}$; $h = +4 \text{ cm}$.

Mirror formula: $1/v + 1/u = 1/f \rightarrow 1/v = 1/f - 1/u = 1/20 - 1/(-20) = 1/20 + 1/20 = 2/20 = 1/10$.

$\mathbf{v = +10 \text{ cm}}$ $\rightarrow$ image is 10 cm **behind** the mirror. [1]

$m = -v/u = -(10)/(-20) = +0.5$; $h' = m \times h = 0.5 \times 4 = \mathbf{+2 \text{ cm}}$.

Nature: **virtual, erect and diminished**. [1]

- 14.** (a) A doctor prescribes a corrective lens of power -2.0 D . Find its focal length and state whether it is converging or diverging.
(b) Find the power of a convex lens of focal length 25 cm.

Solution:

(a) $f = 1/P = 1/(-2.0) \text{ m} = -0.5 \text{ m} = \mathbf{-50 \text{ cm}}$. Negative focal length $\rightarrow$ **concave, diverging** lens. [1]

(b) $f = +25 \text{ cm} = +0.25 \text{ m}$; $P = 1/f = 1/0.25 = \mathbf{+4 \text{ D}}$. [1]

SECTION - C

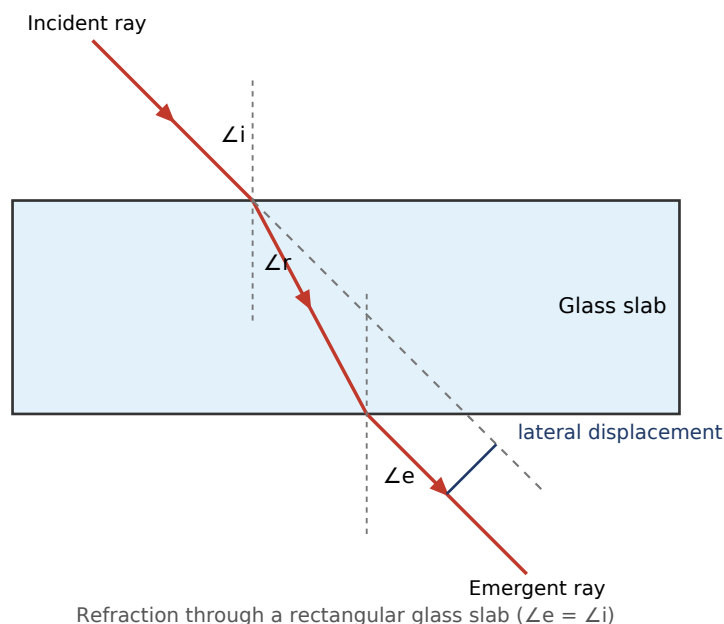
Questions 15 to 17 carry 3 marks each.

15. A ray of light falls obliquely on one face of a rectangular glass slab.

- (a) Draw a ray diagram showing its path through the slab and mark the angles of incidence, refraction and emergence.
(b) Why does the emergent ray come out parallel to the incident ray?
(c) What is meant by lateral displacement?

Solution:

(a)



[1½ marks: correct path, normals and angles]

(b) Refraction occurs at two parallel faces. At the air-glass face the ray bends **towards** the normal; at the glass-air face it bends **away** by the same amount, so $\angle e = \angle i$ and the emergent ray is parallel to the incident ray. [1]

(c) The emergent ray is **shifted sideways** from the line of the incident ray; this perpendicular shift is the lateral displacement. [½]

16. Name the type of mirror used in each case and give a reason:

- (a) headlights of a car (b) a dentist's mirror to see large images of teeth (c) a solar furnace

Solution:

(a) Concave mirror - with the bulb at its focus, it sends out a **powerful parallel beam** of light. [1]

(b) Concave mirror - a tooth placed between P and F gives a **virtual, erect and enlarged** image. [1]

(c) Large concave mirror - it **concentrates sunlight** at its focus to produce heat. [1]

17. An object 5 cm tall is placed 30 cm in front of a concave lens of focal length 20 cm. Find the position, size and nature of the image.

Solution:

Given: $f = -20$ cm (concave lens), $u = -30$ cm, $h = +5$ cm.

Lens formula: $1/v - 1/u = 1/f \rightarrow 1/v = 1/f + 1/u = -1/20 + 1/(-30) = -3/60 - 2/60 = -5/60 = -1/12$.

$v = -12$ cm $\rightarrow$ image is 12 cm from the lens on the **same side** as the object. [1½]

$m = v/u = (-12)/(-30) = +0.4$; $h' = m \times h = 0.4 \times 5 = +2$ cm. [1]

Nature: **virtual, erect and diminished**. [½]

SECTION - D

Question 18 carries 5 marks.

18. An object 3 cm tall is placed 18 cm in front of a convex lens of focal length 12 cm.

(a) Find the position, size and nature of the image.

(b) Draw a ray diagram to show the image formation.

(c) If the object is moved to 6 cm from the lens, find the new image position and magnification. State one practical use of this arrangement.

(d) Find the power of the lens.

Solution:

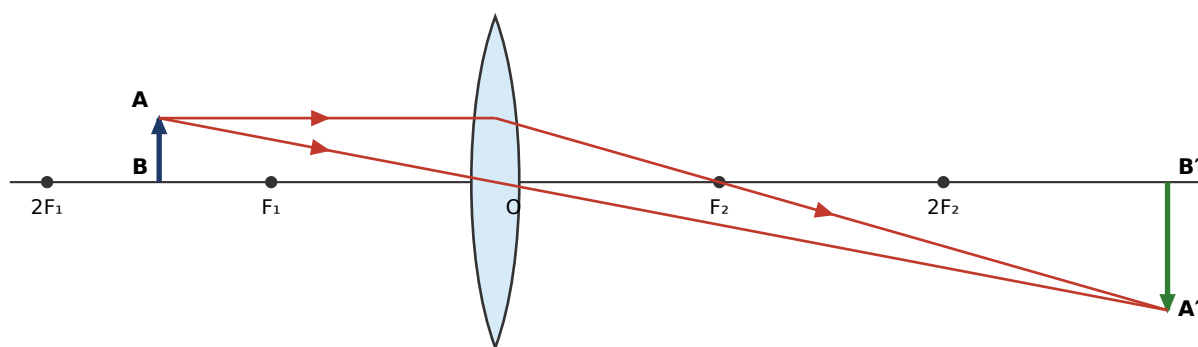
(a) Given: $f = +12$ cm, $u = -18$ cm, $h = +3$ cm.

$1/v = 1/f + 1/u = 1/12 + 1/(-18) = 3/36 - 2/36 = 1/36 \rightarrow v = +36$ cm (on the other side of the lens).

$m = v/u = 36/(-18) = -2$; $h' = m \times h = -2 \times 3 = -6$ cm.

Nature: **real, inverted and enlarged** (twice the size). [2]

(b)



Object between F_1 and $2F_1 \rightarrow$ real, inverted, enlarged image beyond $2F_2$

[1 mark: ray parallel to axis refracting through F_2 , ray through O undeviated]

(c) $u = -6$ cm: $1/v = 1/12 + 1/(-6) = 1/12 - 2/12 = -1/12 \rightarrow v = -12$ cm (same side as object).

$m = v/u = (-12)/(-6) = +2 \rightarrow$ virtual, erect, enlarged. Use: **magnifying glass** (reading small print). [$1\frac{1}{2}$]

(d) $f = 12$ cm = 0.12 m; $P = 1/0.12 \approx +8.33$ D. [$\frac{1}{2}$]

SECTION - E (Case Study Based Questions)

Questions 19 and 20 carry 4 marks each.

- 19.** A student placed a lit candle at different distances in front of a concave mirror and moved a screen to obtain a sharp image. Her observations are recorded below.

Observation	Distance of candle from mirror (cm)	Distance of sharp image on screen from mirror (cm)
1	60	20
2	30	30
3	20	60
4	10	No image obtained on the screen

- (a) Using observation 2, find the focal length of the mirror. Explain your reasoning. **(1)**
(b) Find the magnification in observation 3. What does its sign indicate? **(1)**
(c) Why could no image be obtained on the screen in observation 4? Calculate the image position and state its nature. Give one use of this arrangement. **(2)**

OR

- (c) Using the mirror formula, find the image distance and magnification if the candle is placed 45 cm from the mirror. **(2)**

Solution:

(a) When object distance = image distance, the object is at the **centre of curvature**. So $R = 30$ cm and $f = R/2 = \mathbf{15\text{ cm}}$ ($f = -15$ cm by sign convention). [1]

(b) $u = -20$ cm, $v = -60$ cm; $m = -v/u = -(-60)/(-20) = \mathbf{-3}$. Negative sign $\rightarrow$ image is **real and inverted** (3 times enlarged). [1]

(c) The object (10 cm) is **between P and F**, so the image is virtual and forms behind the mirror. $1/v = 1/f - 1/u = -1/15 + 1/10 = -2/30 + 3/30 = 1/30 \rightarrow \mathbf{v = +30\text{ cm}}$ (behind the mirror). [1]

$m = -v/u = -30/(-10) = +3 \rightarrow \mathbf{\text{virtual, erect and enlarged}}$. Use: shaving mirror / dentist's mirror. [1]

OR

(c) $f = -15$ cm, $u = -45$ cm: $1/v = 1/f - 1/u = -1/15 + 1/45 = -3/45 + 1/45 = -2/45 \rightarrow \mathbf{v = -22.5\text{ cm}}$. [1]

$m = -v/u = -(-22.5)/(-45) = \mathbf{-0.5} \rightarrow$ real, inverted, diminished (half size). [1]

20. The refractive indices of some media are given below. (Speed of light in vacuum = $3 \times 10^8 \text{ m s}^{-1}$)

Medium	Water	Kerosene	Turpentine oil	Benzene	Crown glass	Diamond
Refractive index	1.33	1.44	1.47	1.50	1.52	2.42

- (a) Which of these media is optically the densest, and which the rarest? **(1)**
 (b) Calculate the speed of light in diamond. **(1)**
 (c) A ray of light travels obliquely from kerosene into water. Will it bend towards or away from the normal? Explain, and comment on why kerosene floats on water even though it is optically denser. **(2)**

OR

- (c) Find the ratio of the speed of light in water to that in benzene. In which of these two does light travel faster? **(2)**

Solution:

(a) Densest: **diamond** (2.42); rarest: **water** (1.33). [$\frac{1}{2} + \frac{1}{2}$]

(b) $v = c/n = (3 \times 10^8)/2.42 \approx 1.24 \times 10^8 \text{ m s}^{-1}$. [1]

(c) Kerosene (1.44) is optically denser than water (1.33). Going from denser to rarer, light **speeds up and bends away from the normal**. [1]

Floating depends on **mass density**, which is lower for kerosene; optical density is a different property (ability to refract light), so a liquid can be optically denser yet float. [1]

OR

(c) $v_{\text{water}}/v_{\text{benzene}} = (c/1.33)/(c/1.50) = 1.50/1.33 \approx 1.13$. [1]

Light travels **faster in water** (lower refractive index). [1]