UNIQUE STUDY POINT

By Sumeet Sahu

www.uniquestudyonline.com

Unique Study Point, Amitesh Nagar, Indore, MP | Contact: 8103405051

Class: X	**Subject:** Science	**Session:** 2025-26
Chapter: 09 - Light - Reflection and Refraction	**Time:** 1½ Hours	**Max. Marks:** 40

General Instructions:

1. All questions are compulsory.
2. This question paper contains 20 questions divided into five sections A, B, C, D and E.
3. Section A contains 10 MCQs of 1 mark each.
4. Section B contains 4 questions of 2 marks each.
5. Section C contains 3 questions of 3 marks each.
6. Section D contains 1 question of 5 marks.
7. Section E contains 2 Case Study Based questions of 4 marks each.

SECTION A - Multiple Choice Questions (1 mark each)

1. The center of the reflecting surface of a spherical mirror is called:

(a) Principal focus

(b) Pole

(c) Center of curvature

(d) Principal axis

2. A ray of light is incident on a plane mirror at an angle of 30°. What is the angle of reflection?

(a) 0°

(b) 30°

(c) 60°

(d) 90°

3. The focal length of a concave mirror is 15 cm. Its radius of curvature is:

(a) 7.5 cm

(b) 15 cm

(c) 30 cm

(d) 45 cm

4. Which mirror is used as a rear-view mirror in vehicles?

(a) Plane mirror

(b) Concave mirror

(c) Convex mirror

(d) Parabolic mirror

5. When light travels from air to glass, it:

(a) Bends away from the normal

(b) Bends towards the normal

(c) Does not bend

(d) Reflects completely

6. The SI unit of refractive index is:

(a) meter

(b) m/s

(c) dioptre

(d) No unit

7. A convex lens of focal length 20 cm has power:

(a) +5 D

(b) -5 D

(c) +0.05 D

(d) -0.05 D

8. The image formed by a concave lens is always:

(a) Real and inverted

(b) Real and erect

(c) Virtual and erect

(d) Virtual and inverted

9. If the magnification produced by a mirror is +2, the image is:

(a) Real, inverted and enlarged

(b) Virtual, erect and enlarged

(c) Real, erect and diminished

(d) Virtual, inverted and diminished

10. The speed of light in vacuum is:

(a) 3×10^6 m/s

(b) 3×10^7 m/s

(c) 3×10^8 m/s

(d) 3×10^9 m/s

SECTION B - Short Answer Questions (2 marks each)

11. State the two laws of reflection of light.

12. A concave mirror has a focal length of 10 cm. Where should an object be placed to get a virtual and enlarged image? Draw a ray diagram.

13. Define refractive index. Write the formula relating refractive index with speed of light.

14. Why does a pencil partly immersed in water appear bent at the water surface?

SECTION C - Short Answer Questions (3 marks each)

15. An object is placed at a distance of 30 cm from a concave mirror and its real image is formed at a distance of 30 cm from the mirror. Find the focal length of the mirror.

16. Differentiate between a real image and a virtual image. Give one example of each.

17. A convex lens has a focal length of 15 cm. Calculate its power. If two such lenses are placed in contact, what will be the total power?

SECTION D - Long Answer Question (5 marks)

18. Draw neat ray diagrams showing the formation of images by a convex lens when the object is placed:

(i) Beyond 2F

(ii) At F

(iii) Between F and optical center

In each case, state the position, nature and relative size of the image formed.

SECTION E - Case Study Based Questions (4 marks each)

19. Case Study 1: Solar Cooker

A solar cooker uses a large concave mirror to focus sunlight onto a cooking vessel. The mirror has a large aperture and the cooking vessel is placed at the focus of the mirror. The concentrated sunlight produces enough heat to cook food. The mirror is usually made of polished metal or metallized plastic sheet.

Based on the above information, answer the following questions:

(a) Why is a concave mirror used in solar cookers? (1 mark)

(b) Where should the cooking vessel be placed for maximum heating? (1 mark)

(c) If the focal length of the mirror is 40 cm, what is its radius of curvature? (1 mark)

(d) Why is the mirror made with a large aperture? (1 mark)

20. Case Study 2: Optical Fibers

Optical fibers are thin glass or plastic fibers that can transmit light signals over long distances with very little loss. They work on the principle of total internal reflection. When light enters one end of the fiber at a suitable angle, it undergoes multiple reflections along the length of the fiber and emerges at the other end. Optical fibers are used in telecommunications, medical imaging, and internet connections.

Based on the above information, answer the following questions:

(a) What is the principle on which optical fibers work? (1 mark)

(b) Name two applications of optical fibers. (1 mark)

(c) Why is glass or plastic used to make optical fibers? (1 mark)

(d) What happens to light when it enters an optical fiber at the correct angle? (1 mark)

DETAILED ANSWER KEY - PAPER 01

SECTION A - Answers to MCQs

1. (b) Pole

The pole is the center point of the reflecting surface of a spherical mirror. It lies on the surface of the mirror.

2. (b) 30°

According to the law of reflection, the angle of incidence equals the angle of reflection. Therefore, if the angle of incidence is 30°, the angle of reflection is also 30°.

3. (c) 30 cm

The relationship between focal length (f) and radius of curvature (R) is: $R = 2f$
Given $f = 15$ cm
Therefore, $R = 2 \times 15 = 30$ cm

4. (c) Convex mirror

Convex mirrors are used as rear-view mirrors in vehicles because they always form virtual, erect, and diminished images, and they have a wider field of view, allowing drivers to see more area behind them.

5. (b) Bends towards the normal

When light travels from a rarer medium (air) to a denser medium (glass), it slows down and bends towards the normal.

6. (d) No unit

Refractive index is the ratio of two speeds (speed of light in vacuum/speed of light in medium), so it has no unit. It is a dimensionless quantity.

7. (a) +5 D

Power $P = 1/f$ (in meters)
$f = 20$ cm $= 0.20$ m
$P = 1/0.20 = +5$ D
The positive sign indicates it is a convex lens.

8. (c) Virtual and erect

A concave lens always forms a virtual, erect, and diminished image regardless of the position of the object.

9. (b) Virtual, erect and enlarged

A positive magnification (+2) indicates that the image is virtual and erect. The magnitude being 2 shows that the image is enlarged (twice the size of the object).

10. (c) 3×10^8 m/s

The speed of light in vacuum is approximately 3×10^8 meters per second, which is the maximum speed at which light can travel.

SECTION B - Answers to Short Answer Questions

11. Two Laws of Reflection

The two laws of reflection of light are:

First Law: The angle of incidence is equal to the angle of reflection.
($\angle i = \angle r$)

Second Law: The incident ray, the reflected ray, and the normal to the surface at the point of incidence all lie in the same plane.

12. Object Placement for Virtual and Enlarged Image

Position: The object should be placed between the pole (P) and the principal focus (F) of the concave mirror, i.e., within the focal length (less than 10 cm from the mirror).

Ray Diagram: [Students should draw a ray diagram showing:]
- Concave mirror with pole P, focus F at 10 cm
- Object placed between P and F
- Two rays: one parallel to principal axis reflecting through F, another directed towards C reflecting back
- Virtual, erect, and enlarged image formed behind the mirror

Nature of Image: Virtual, erect, and enlarged

13. Definition of Refractive Index

Definition: The refractive index of a medium is defined as the ratio of the speed of light in vacuum (or air) to the speed of light in that medium.

Formula:
Refractive index (n) = Speed of light in vacuum (c) / Speed of light in medium (v)

$n = c/v$

Where:
$c = 3 \times 10^8$ m/s (speed of light in vacuum)
v = speed of light in the medium

14. Pencil Appearing Bent in Water

A pencil partly immersed in water appears bent at the water surface due to **refraction of light**.

Explanation:
- Light rays coming from the part of the pencil inside water travel from a denser medium (water) to a rarer medium (air)
- These rays bend away from the normal when they emerge from water
- Our eyes trace these refracted rays backward in straight lines
- The apparent position of the immersed part appears raised, making the pencil look bent at the interface

SECTION C - Answers to Short Answer Questions

15. Finding Focal Length

Given:
Object distance, u = -30 cm (sign convention)
Image distance, v = -30 cm (real image, same side as object)
Focal length, f = ?

Using mirror formula:
$1/f = 1/v + 1/u$

$1/f = 1/(-30) + 1/(-30)$

$1/f = -1/30 - 1/30$

$1/f = -2/30$

$1/f = -1/15$

f = -15 cm

The focal length of the concave mirror is 15 cm.

16. Difference Between Real and Virtual Images

Real Image	Virtual Image
Formed by actual intersection of light rays	Formed by apparent intersection of light rays
Can be obtained on a screen	Cannot be obtained on a screen
Always inverted	Always erect

Example of Real Image: Image formed by a concave mirror when object is placed beyond its focus

Example of Virtual Image: Image formed by a plane mirror

17. Power of Convex Lens and Combined Power

Given:
Focal length, f = 15 cm = 0.15 m

Step 1: Calculate power of one lens
Power, P = 1/f (in meters)
P = 1/0.15
P = +6.67 D

Step 2: Calculate total power when two lenses are in contact
When lenses are placed in contact, total power is the algebraic sum:
$P(total) = P_1 + P_2$
P(total) = 6.67 + 6.67
P(total) = +13.34 D

The power of one lens is +6.67 D and total power of two lenses in contact is +13.34 D.

SECTION D - Answer to Long Answer Question

18. Image Formation by Convex Lens

(i) Object placed beyond 2F:

[Ray Diagram should show:]

- Object beyond $2F_1$
- Two rays: one parallel to axis passing through F_2, another through optical center
- Image formed between F_2 and $2F_2$

Position: Between F_2 and $2F_2$

Nature: Real and inverted

Size: Diminished (smaller than object)

(ii) Object placed at F:

[Ray Diagram should show:]

- Object at F_1
- Ray parallel to axis passing through F_2
- Ray through F_1 emerging parallel to axis
- Rays parallel after refraction, meeting at infinity

Position: At infinity

Nature: Real and inverted

Size: Highly enlarged (infinitely large)

(iii) Object placed between F and optical center:

[Ray Diagram should show:]

- Object between F_1 and O
- Ray parallel to axis passing through F_2
- Ray through optical center going straight
- Diverging rays traced backward to form image

Position: On the same side as object, beyond object

Nature: Virtual and erect

Size: Enlarged (magnified)

Note: Students should draw neat, labeled ray diagrams for each case showing principal axis, optical center (O), foci (F_1, F_2), object, and image with proper ray paths.

SECTION E - Answers to Case Study Based Questions

19. Case Study 1: Solar Cooker

(a) Why is a concave mirror used in solar cookers?

A concave mirror is used in solar cookers because it converges (focuses) the parallel rays of sunlight coming from the sun to a single point (focus), producing a high concentration of heat energy at that

point, which is sufficient to cook food.

(b) Where should the cooking vessel be placed for maximum heating?

The cooking vessel should be placed at the principal focus (F) of the concave mirror for maximum heating, as this is where all the reflected rays converge and maximum heat is concentrated.

(c) If the focal length of the mirror is 40 cm, what is its radius of curvature?

Given: f = 40 cm

Using the relation: R = 2f

R = 2 × 40 = 80 cm

The radius of curvature is 80 cm.

(d) Why is the mirror made with a large aperture?

The mirror is made with a large aperture to collect more sunlight and reflect a larger amount of light rays to the focus. This increases the total heat energy available for cooking, making the solar cooker more efficient.

20. Case Study 2: Optical Fibers

(a) What is the principle on which optical fibers work?

Optical fibers work on the principle of total internal reflection. Light entering the fiber at one end undergoes repeated total internal reflections at the walls and travels through the fiber without significant loss.

(b) Name two applications of optical fibers.

Two applications of optical fibers are:

1. Telecommunications and internet connections (data transmission)
2. Medical imaging (endoscopy)

(Other valid answers: cable television, decorative lighting, etc.)

(c) Why is glass or plastic used to make optical fibers?

Glass or plastic is used to make optical fibers because:

1. They are transparent materials that allow light to pass through
2. They have appropriate refractive indices to ensure total internal reflection
3. They are flexible and can be drawn into thin fibers

(d) What happens to light when it enters an optical fiber at the correct angle?

When light enters an optical fiber at the correct angle (angle of incidence greater than the critical angle), it undergoes multiple total internal reflections along the length of the fiber, traveling from one end to the other with minimal loss of intensity, and emerges at the other end.

Made with ❤ by Sumeet Sahu

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