UNIQUE STUDY POINT

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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. A spherical mirror having its reflecting surface curved inwards is called:

(a) Convex mirror

(b) Concave mirror

(c) Plane mirror

(d) Cylindrical mirror

2. The image formed by a convex lens when the object is placed beyond 2F is:

(a) Virtual and enlarged

(b) Real and diminished

(c) Real and enlarged

(d) Virtual and diminished

3. Two lenses of power +2 D and +3 D are placed in contact. The focal length of the combination is:

(a) 5 cm

(b) 20 cm

(c) 0.2 m

(d) 2.5 m

4. A light ray enters from medium A to medium B and bends towards the normal. The refractive index of medium B with respect to A is:

(a) Less than 1

(b) Equal to 1

(c) Greater than 1

(d) Cannot be determined

5. Which one of the following can make a parallel beam of light converge at a point?

(a) Concave mirror only

(b) Convex lens only

(c) Both concave mirror and convex lens

(d) Concave lens only

6. A ray of light passes from glass to air. The angle of refraction will be:

(a) Equal to angle of incidence

(b) Greater than angle of incidence

(c) Smaller than angle of incidence

(d) 45°

7. An object is placed at a distance of 12 cm from a convex lens of focal length 8 cm. The image will be:

(a) Virtual and erect

(b) Real and inverted

(c) Virtual and inverted

(d) Real and erect

8. In which of the following media does light travel fastest?

(a) Glass

(b) Water

(c) Air

(d) Diamond

9. The radius of curvature of a convex mirror used in a vehicle is 2.4 m. Its focal length is:

(a) 1.2 m

(b) 2.4 m

(c) 4.8 m

(d) 0.6 m

10. A lens always forms a virtual, erect and diminished image. The lens is:

(a) Convex lens

(b) Concave lens

(c) Plane lens

(d) Depends on position of object

SECTION B - Short Answer Questions (2 marks each)

11. Distinguish between a real image and a virtual image. State one situation where each is formed.

12. A doctor has prescribed a corrective lens of power +1.5 D. Find the focal length of the lens. Is the prescribed lens diverging or converging?

13. State Snell's law of refraction. Write the mathematical expression for it.

14. Why do stars appear to twinkle? Name the phenomenon responsible for it.

SECTION C - Short Answer Questions (3 marks each)

15. An object 4 cm high is placed at a distance of 6 cm from a concave lens of focal length 12 cm. Find the position, nature and size of the image.

16. Explain with a diagram why a stick partially immersed in water appears bent at the surface of water.

17. A concave mirror produces a real image that is twice the size of the object placed 15 cm in front of it. Find the position of the image and the focal length of the mirror.

SECTION D - Long Answer Question (5 marks)

18. (a) Draw labeled ray diagrams to show the formation of image by a concave mirror when the object is placed:

(i) Between F and C

(ii) At C

(b) State the position, nature and relative size of the image in each case.

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

19. Case Study 1: Magnifying Glass

A magnifying glass is a convex lens of short focal length. When an object (like small letters or an insect) is placed between the optical center and the principal focus of a convex lens, the lens forms a virtual, erect, and magnified image on the same side as the object. By adjusting the distance between the lens and the object, we can vary the magnification. Scientists, watchmakers, jewelers, and stamp collectors use magnifying glasses to see fine details. The most comfortable position for viewing is when the image is formed at a distance of 25 cm from the eye (near point of normal vision).

Based on the above information, answer the following questions:

(a) What type of lens is used as a magnifying glass? (1 mark)

(b) Where should the object be placed to use a convex lens as a magnifying glass? (1 mark)

(c) What is the nature of the image formed by a magnifying glass? (1 mark)

(d) Why is a lens of short focal length preferred for use as a magnifying glass? (1 mark)

20. Case Study 2: Periscope

A periscope is an optical instrument used to see objects that are not in the direct line of sight. It uses two plane mirrors arranged parallel to each other at 45° angles. Light from the object strikes the first mirror at the top, gets reflected downward through a tube, strikes the second mirror at the bottom, and gets reflected horizontally to reach the observer's eye. Periscopes are commonly used in submarines to see above the water surface while the submarine remains submerged. They are also used by soldiers in bunkers to observe enemy positions without exposing themselves.

Based on the above information, answer the following questions:

(a) How many mirrors are used in a simple periscope? (1 mark)

(b) At what angle are the mirrors placed in a periscope? (1 mark)

(c) State one application of periscope other than submarines. (1 mark)

(d) What would happen if one of the mirrors in the periscope is removed? (1 mark)

DETAILED ANSWER KEY - PAPER 04

SECTION A - Answers to MCQs

1. (b) Concave mirror

A concave mirror has its reflecting surface curved inwards, facing towards the center of the sphere of which it forms a part. It is also called a converging mirror as it can focus parallel rays of light at a point.

2. (b) Real and diminished

When an object is placed beyond 2F (twice the focal length) of a convex lens, the image is formed between F and 2F on the opposite side. The image is real, inverted, and diminished (smaller than the object).

3. (c) 0.2 m

When lenses are in contact, total power $P = P_1 + P_2$
$P = 2 + 3 = 5$ D
Focal length $f = 1/P = 1/5 = 0.2$ m $= 20$ cm
The focal length of the combination is 0.2 m or 20 cm.

4. (c) Greater than 1

When light bends towards the normal while entering medium B from medium A, it means medium B is optically denser than A. Therefore, the refractive index of B with respect to A is greater than 1.

5. (c) Both concave mirror and convex lens

Both a concave mirror and a convex lens have the property of converging parallel rays of light to a single point called the principal focus. They are both converging optical devices.

6. (b) Greater than angle of incidence

When light passes from glass (denser medium) to air (rarer medium), it speeds up and bends away from the normal. Therefore, the angle of refraction is greater than the angle of incidence.

7. (b) Real and inverted

Object distance $u = 12$ cm, focal length $f = 8$ cm
Since $u > f$, the object is beyond the focus of the convex lens.
The image formed will be real and inverted, located on the opposite side of the lens.

8. (c) Air

Among the given options, light travels fastest in air because it has the lowest refractive index (≈1.0003, closest to vacuum). The speed decreases in water, glass, and diamond due to their higher refractive indices.

9. (a) 1.2 m

For a spherical mirror, focal length f = R/2
Given R = 2.4 m
f = 2.4/2 = 1.2 m
For a convex mirror, the focal length is positive, so f = +1.2 m

10. (b) Concave lens

A concave lens (diverging lens) always forms a virtual, erect, and diminished image regardless of the position of the object. This is a characteristic property of concave lenses.

SECTION B - Answers to Short Answer Questions

11. Real Image vs Virtual Image

Real Image:
- Formed by actual intersection of light rays
- Can be obtained on a screen
- Always inverted
- Formed on the opposite side of the optical device from the object

Situation: Image formed by a cinema projector on screen

Virtual Image:
- Formed by apparent intersection of light rays (rays appear to meet)
- Cannot be obtained on a screen
- Always erect
- Formed on the same side of the optical device as the object

Situation: Image formed by a plane mirror when you look into it

12. Finding Focal Length

Given:
Power, P = +1.5 D
Focal length, f = ?

Using formula:

P = 1/f (where f is in meters)
1.5 = 1/f
f = 1/1.5
f = 0.67 m ≈ 67 cm

Answer: The focal length is approximately 0.67 m or 67 cm.

Nature: Since the power is positive (+1.5 D), the prescribed lens is a **converging lens (convex lens)**. Convex lenses are used to correct hypermetropia (long-sightedness).

13. Snell's Law of Refraction

Snell's Law states: The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant for a given pair of media and for light of a given wavelength. This constant is called the refractive index.

Mathematical Expression:
$\sin i / \sin r = \text{constant}$

Or, more specifically:
$n_2/n_1 = \sin i / \sin r$

Where:
- i = angle of incidence
- r = angle of refraction
- n_1 = refractive index of first medium
- n_2 = refractive index of second medium

This law is also known as the second law of refraction.

14. Twinkling of Stars

Stars appear to twinkle due to **atmospheric refraction**.

Explanation:
- Starlight has to travel through different layers of Earth's atmosphere before reaching our eyes
- These atmospheric layers have varying densities and temperatures
- As light passes through these layers, it undergoes continuous refraction
- The refractive index of air keeps changing slightly due to atmospheric turbulence
- This causes the apparent position of the star to change slightly and continuously
- The amount of starlight entering our eyes fluctuates, making the star appear to twinkle

Phenomenon: Atmospheric refraction

Note: Planets do not twinkle because they are much closer to Earth and appear as extended sources rather than point sources.

SECTION C - Answers to Short Answer Questions

15. Image by Concave Lens

Given:
Object height, h = 4 cm
Object distance, u = -6 cm
Focal length, f = -12 cm (concave lens)

Step 1: Find image distance
Using lens formula: 1/v - 1/u = 1/f
1/v = 1/f + 1/u
1/v = 1/(-12) + 1/(-6)
1/v = -1/12 - 1/6
1/v = -1/12 - 2/12
1/v = -3/12 = -1/4
v = -4 cm

Position: Image is formed at 4 cm on the same side as the object (in front of the lens).

Step 2: Find image height
Using magnification: m = v/u = h'/h
m = (-4)/(-6) = 4/6 = 2/3
h'/4 = 2/3
h' = (2/3) × 4 = 8/3 ≈ 2.67 cm

Size: Image height is approximately 2.67 cm (diminished)

Nature: Virtual (negative v, same side as object), erect (positive magnification), and diminished (smaller than object)

16. Stick Appearing Bent in Water

Diagram should show:
- A container with water
- A straight stick partially immersed in water

- Light rays from the immersed part of the stick traveling from water to air
- Rays bending away from normal at the water-air interface
- Extended rays (dotted) showing apparent raised position
- Observer's eye receiving the refracted rays
- Labels: Air, Water, Incident ray, Refracted ray, Normal, Actual position, Apparent position

Explanation:
A stick partially immersed in water appears bent at the water surface due to refraction of light.

When light rays from the part of the stick inside water travel to our eyes:
1. They move from water (denser medium) to air (rarer medium)
2. At the water-air interface, these rays bend away from the normal (refraction)
3. Our eyes receive these bent rays
4. Our brain traces these rays backward in straight lines
5. The apparent position of the immersed part appears raised and closer to the surface
6. The part above water is seen normally
7. This difference in apparent positions makes the stick appear bent at the surface

This is why the stick appears discontinuous or bent at the point where it enters water.

17. Finding Image Position and Focal Length

Given:
Object distance, u = -15 cm
Magnification, m = -2 (real image, twice the size, so m = -2)
Image distance, v = ?
Focal length, f = ?

Step 1: Find image distance
Using magnification formula: m = -v/u
-2 = -v/(-15)
-2 = v/15
v = -2 × 15
v = -30 cm

The negative sign indicates the image is formed on the same side as the object (in front of the mirror), which is correct for a real image formed by a concave mirror.

Position of image: 30 cm in front of the mirror

Step 2: Find focal length

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

$1/f = 1/(-30) + 1/(-15)$

$1/f = -1/30 - 1/15$

$1/f = -1/30 - 2/30$

$1/f = -3/30 = -1/10$

f = -10 cm

Focal length of the mirror: 10 cm (concave mirror)

SECTION D - Answer to Long Answer Question

18. Image Formation by Concave Mirror

(a) Ray Diagrams:

(i) Object placed between F and C:

[Diagram should show:]

- Concave mirror with pole (P), focus (F), and center of curvature (C) marked
- Object AB placed between F and C
- Ray 1: From A parallel to principal axis, reflecting through F
- Ray 2: From A through C, reflecting back along same path
- Image A'B' formed beyond C
- Labels: Object, Image, P, F, C, Principal axis

(ii) Object placed at C:

[Diagram should show:]

- Concave mirror with P, F, and C marked
- Object AB placed at C
- Ray 1: From A parallel to principal axis, reflecting through F
- Ray 2: From A through F, reflecting parallel to axis
- Image A'B' formed at C itself
- Labels: Object, Image, P, F, C, Principal axis

(b) Characteristics of Images:

Case (i) - Object between F and C:

- **Position:** Beyond C (beyond center of curvature)
- **Nature:** Real and inverted
- **Size:** Enlarged (magnified, larger than object)

Case (ii) - Object at C:

- **Position:** At C (at center of curvature)
- **Nature:** Real and inverted
- **Size:** Same size as object (magnification = 1)

Note: In both cases, images are real (can be obtained on screen), inverted, and formed on the same side as the object in a concave mirror.

SECTION E - Answers to Case Study Based Questions

19. Case Study 1: Magnifying Glass

(a) Type of lens used as magnifying glass:
A convex lens (converging lens) of short focal length is used as a magnifying glass. The convex lens has the ability to produce an enlarged, virtual, and erect image when the object is placed between the optical center and the focus.

(b) Where should the object be placed:
To use a convex lens as a magnifying glass, the object should be placed between the optical center (O) and the principal focus (F) of the lens. More specifically, it should be placed within the focal length of the lens. The exact position can be adjusted to get the desired magnification and comfortable viewing distance.

(c) Nature of the image formed:
The image formed by a magnifying glass has the following characteristics:
- Virtual (cannot be obtained on screen)
- Erect (upright, same orientation as object)
- Magnified/Enlarged (bigger than the object)
- Formed on the same side of the lens as the object

(d) Why short focal length is preferred:
A lens of short focal length is preferred for use as a magnifying glass because:
1. It provides greater magnification for the same object distance
2. The formula for magnification shows that smaller focal length gives larger magnification when the image is at near point (25 cm)
3. It allows the user to place the object closer to the lens while still getting a clear, enlarged image
4. Higher power (P = 1/f) means better magnifying capability
5. More practical for handheld use and examining small objects

20. Case Study 2: Periscope

(a) Number of mirrors used:

A simple periscope uses two plane mirrors. These mirrors are placed parallel to each other inside a tube, one at the top and one at the bottom, to change the path of light by two successive reflections.

(b) Angle at which mirrors are placed:

The mirrors in a periscope are placed at an angle of 45° to the direction of light. Each mirror makes a 45° angle with the horizontal, so they are parallel to each other but inclined at 45°. This angle ensures that light entering horizontally gets reflected downward, then horizontally again.

(c) One application other than submarines:

Applications of periscope include:

- Used by soldiers in trenches and bunkers to observe enemy positions without exposing themselves
- Used in nuclear reactors to observe radioactive materials from a safe distance
- Used in some military vehicles for observation
- Used by people in crowded places to see over the heads of others

(Any one correct answer is acceptable)

(d) What happens if one mirror is removed:

If one of the mirrors in the periscope is removed:

- The periscope will not function properly
- Light will not reach the observer's eye
- If the top mirror is removed, light from the object will not enter the periscope and will pass straight
- If the bottom mirror is removed, light will travel down through the tube but will not be reflected toward the observer's eye
- In both cases, the observer will not be able to see the object
- Both reflections are necessary for the periscope to work
