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. An object is placed at the center of curvature of a concave mirror. The image formed will be:

(a) At the focus

(b) At the center of curvature

(c) Beyond the center of curvature

(d) Between focus and center of curvature

2. Which of the following can make a parallel beam of light when light from a point source is incident on it?

(a) Concave mirror as well as convex lens

(b) Convex mirror as well as concave lens

(c) Two plane mirrors placed at 90° to each other

(d) Concave mirror as well as concave lens

3. A lens has a power of -2.5 D. The focal length and nature of the lens is:

(a) 40 cm, concave

(b) 40 cm, convex

(c) 0.4 m, concave

(d) 0.4 m, convex

4. The refractive index of diamond is 2.42. This means:

(a) Speed of light in diamond is 2.42 times the speed in vacuum

(b) Speed of light in vacuum is 2.42 times the speed in diamond

(c) Diamond is 2.42 times denser than water

(d) Diamond has 2.42 times more carbon atoms

5. A virtual image larger than the object can be produced by:

(a) Concave lens only

(b) Convex lens only

(c) Concave mirror only

(d) Both concave mirror and convex lens

6. A ray of light traveling in air enters obliquely into water. It will:

(a) Slow down and bend away from normal

(b) Speed up and bend towards normal

(c) Slow down and bend towards normal

(d) Speed up and bend away from normal

7. The image formed by a convex mirror is always:

(a) Real and enlarged

(b) Virtual and diminished

(c) Real and diminished

(d) Virtual and enlarged

8. If the magnification of a lens is -0.5, then:

(a) Image is virtual and half the size of object

(b) Image is real and half the size of object

(c) Image is virtual and twice the size of object

(d) Image is real and twice the size of object

9. The phenomenon responsible for the twinkling of stars is:

(a) Reflection of light

(b) Refraction of light

(c) Diffraction of light

(d) Dispersion of light

10. A dentist uses which type of mirror to examine teeth?

(a) Plane mirror

(b) Concave mirror

(c) Convex mirror

(d) Cylindrical mirror

SECTION B - Short Answer Questions (2 marks each)

11. What is meant by the term 'aperture' of a mirror? Why do we use mirrors of small aperture in laboratories?

12. A light ray passes through a rectangular glass slab. Draw a labeled diagram showing the path of the ray. What can you say about the emergent ray and incident ray?

13. Define the principal focus of a convex lens. How does it differ from the principal focus of a concave lens?

14. Why does the bottom of a swimming pool appear raised when viewed from above the water surface?

SECTION C - Short Answer Questions (3 marks each)

15. An object 5 cm high is placed 20 cm away from a convex lens of focal length 10 cm. Find the position and size of the image.

16. Explain with the help of a diagram how a concave mirror can be used to converge a parallel beam of light at a point. Mention one practical application of this property.

17. Light enters from air to glass having refractive index 1.50. What is the speed of light in glass? The speed of light in vacuum is 3×10^8 m/s.

SECTION D - Long Answer Question (5 marks)

18. (a) State the relationship between radius of curvature and focal length of a spherical mirror.
(b) An object 2 cm tall is placed 15 cm in front of a concave mirror of focal length 10 cm. At what distance from the mirror should a screen be placed to obtain a sharp image? Calculate the height of the image. Also state its nature.

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

19. Case Study 1: Rear-View Mirror in Vehicles

The side mirrors (rear-view mirrors) used in vehicles are convex mirrors. These mirrors are labeled with the safety warning: "Objects in the mirror are closer than they appear." The convex mirror always produces an erect, virtual, and diminished image of objects. Due to their curved outward surface, they provide a much wider field of view compared to plane mirrors of the same size. This helps drivers see traffic behind them over a larger area.

Based on the above information, answer the following questions:

(a) Why are convex mirrors preferred over plane mirrors for rear-view purposes? (1 mark)

(b) What is meant by the statement "Objects in the mirror are closer than they appear"? (1 mark)

(c) What is the nature of the image formed by a convex mirror? (1 mark)

(d) Can a convex mirror form a real image? Justify your answer. (1 mark)

20. Case Study 2: The Human Eye and Lenses

The human eye has a natural convex lens called the eye lens (or crystalline lens). This lens focuses light coming from objects onto the retina at the back of the eye, forming a real and inverted image. The brain interprets this image as erect. The focal length of the eye lens can be adjusted by ciliary muscles to focus on objects at different distances. When this natural adjustment fails, people need to use corrective lenses. Concave lenses are used to correct myopia (short-sightedness) and convex lenses are used to correct hypermetropia (long-sightedness).

Based on the above information, answer the following questions:

(a) What type of lens is present in the human eye? (1 mark)

(b) Where is the image formed in a healthy human eye? (1 mark)

(c) Which type of lens is used to correct myopia? (1 mark)

(d) Why do we see objects erect even though the image on retina is inverted? (1 mark)

DETAILED ANSWER KEY - PAPER 02

SECTION A - Answers to MCQs

1. (b) At the center of curvature

When an object is placed at the center of curvature (C) of a concave mirror, the image is formed at the same point, i.e., at C itself. The image is real, inverted, and of the same size as the object.

2. (a) Concave mirror as well as convex lens

Both a concave mirror and a convex lens can convert diverging rays from a point source into a parallel beam of light when the point source is placed at their respective principal focus.

3. (c) 0.4 m, concave

Power P = -2.5 D (negative sign indicates concave lens)
Using P = 1/f
-2.5 = 1/f
f = -1/2.5 = -0.4 m
The focal length is 0.4 m and the lens is concave (diverging).

4. (b) Speed of light in vacuum is 2.42 times the speed in diamond

Refractive index n = speed of light in vacuum / speed of light in medium
n = 2.42 means light travels 2.42 times slower in diamond than in vacuum, or equivalently, light in vacuum travels 2.42 times faster than in diamond.

5. (d) Both concave mirror and convex lens

A virtual and magnified image can be produced by:
- Concave mirror when object is placed between pole and focus
- Convex lens when object is placed between optical center and focus
Both can produce virtual, erect, and enlarged images.

6. (c) Slow down and bend towards normal

When light travels from air (rarer medium) to water (denser medium):
- It slows down because the speed of light is less in water
- It bends towards the normal due to the change in medium density

7. (b) Virtual and diminished

A convex mirror always forms a virtual, erect, and diminished (smaller) image regardless of the position of the object. This is why they are used as rear-view mirrors.

8. (b) Image is real and half the size of object

Magnification m = -0.5
The negative sign indicates the image is real and inverted.
The magnitude 0.5 indicates the image is half the size of the object (diminished).

9. (b) Refraction of light

Stars twinkle due to atmospheric refraction. Light from stars passes through different layers of atmosphere having varying densities and temperatures, causing continuous refraction and apparent change in position and brightness.

10. (b) Concave mirror

Dentists use concave mirrors to examine teeth because when the teeth are within the focal length of the mirror, it produces an enlarged, erect, and virtual image, making it easier to examine small cavities and details.

SECTION B - Answers to Short Answer Questions

11. Aperture of a Mirror

Aperture: The aperture of a mirror is the effective diameter of the light-reflecting area of the mirror. It is the diameter of the circular boundary of the mirror.

Why small aperture is used in laboratories:
Mirrors of small aperture are used in laboratories because:
1. They follow mirror formulas accurately (formulas are derived for mirrors with small aperture)
2. They minimize spherical aberration (distortion of images)
3. The focal length of such mirrors is approximately equal to half the radius of curvature

12. Light Ray Through Glass Slab

Diagram should show:
- Rectangular glass slab ABCD
- Incident ray striking surface AB at point O
- Normal at O
- Refracted ray bending towards normal inside glass
- Emergent ray at surface CD bending away from normal
- Normal at point of emergence

- Labels: Incident ray, Refracted ray, Emergent ray, Air, Glass

Observation:

The emergent ray is parallel to the incident ray but laterally displaced. This happens because refraction at the two parallel surfaces is equal and opposite.

13. Principal Focus of Lenses

Principal Focus of Convex Lens:

The principal focus of a convex lens is the point on the principal axis where light rays parallel to the principal axis actually converge after refraction through the lens.

Principal Focus of Concave Lens:

The principal focus of a concave lens is the point on the principal axis from where light rays parallel to the principal axis appear to diverge after refraction through the lens.

Difference:

- In convex lens, rays actually meet at focus (real focus)
- In concave lens, rays appear to come from focus (virtual focus)
- Convex lens converges light; concave lens diverges light

14. Swimming Pool Appearing Raised

The bottom of a swimming pool appears raised when viewed from above due to **refraction of light**.

Explanation:

- Light rays coming from the bottom of the pool travel from water (denser medium) to air (rarer medium)
- These rays bend away from the normal when they emerge from water
- When these refracted rays reach our eyes, we trace them backward in straight lines
- The apparent position appears higher than the actual position
- This makes the pool appear shallower than it actually is

SECTION C - Answers to Short Answer Questions

15. Finding Position and Size of Image

Given:

Object height, h = 5 cm

Object distance, u = -20 cm

Focal length, f = +10 cm (convex lens)

Step 1: Find image distance (v)

Using lens formula: $1/v - 1/u = 1/f$

$1/v - 1/(-20) = 1/10$

$1/v + 1/20 = 1/10$

$1/v = 1/10 - 1/20$

$1/v = (2-1)/20 = 1/20$

v = +20 cm

The image is formed at 20 cm on the opposite side of the lens.

Step 2: Find image height (h')

Using magnification formula: $m = h'/h = v/u$

$h'/5 = 20/(-20)$

$h'/5 = -1$

h' = -5 cm

The negative sign indicates the image is inverted.

The image is 5 cm in height, same size as object, real and inverted.

16. Concave Mirror Converging Light

Diagram should show:

- Concave mirror with principal axis
- Parallel rays coming from left (from infinity)
- All rays reflecting and converging at focus F
- Labels: Pole (P), Focus (F), Center of curvature (C), Incident parallel rays, Reflected rays

Explanation:

When a beam of light parallel to the principal axis falls on a concave mirror, all rays reflect and converge at the principal focus. This is the converging property of concave mirrors.

Practical Application:

This property is used in:

- Solar furnaces/solar cookers to concentrate sunlight
- Searchlights and headlights of vehicles (used in reverse - point source at focus gives parallel beam)
- Telescopes to collect light from distant objects

17. Speed of Light in Glass

Given:

Refractive index of glass, $n = 1.50$

Speed of light in vacuum/air, $c = 3 \times 10^8$ m/s

Speed of light in glass, v = ?

Using formula:

Refractive index, n = c/v

$1.50 = (3 \times 10^8)/v$

$v = (3 \times 10^8)/1.50$

$v = 2 \times 10^8$ m/s

The speed of light in glass is 2×10^8 m/s.

This shows that light travels slower in glass compared to air/vacuum.

SECTION D - Answer to Long Answer Question

18. Spherical Mirror Problem

(a) Relationship between R and f:

For a spherical mirror of small aperture, the radius of curvature (R) is twice the focal length (f).

R = 2f or **f = R/2**

This means the principal focus lies midway between the pole and the center of curvature.

(b) Numerical Problem:

Given:

Object height, h = 2 cm

Object distance, u = -15 cm

Focal length, f = -10 cm (concave mirror)

Image distance, v = ?

Image height, h' = ?

Step 1: Find image distance

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

1/v = 1/f - 1/u

1/v = 1/(-10) - 1/(-15)

1/v = -1/10 + 1/15

1/v = (-3 + 2)/30

1/v = -1/30

v = -30 cm

The screen should be placed at 30 cm in front of the mirror.

Step 2: Find image height

Using magnification: m = -v/u = h'/h

m = -(-30)/(-15) = -30/15 = -2

h'/2 = -2

h' = -4 cm

Answer:

- Screen distance: 30 cm in front of mirror
- Image height: 4 cm
- Nature: Real, inverted (indicated by negative signs), and magnified (twice the size)

SECTION E - Answers to Case Study Based Questions

19. Case Study 1: Rear-View Mirror in Vehicles

(a) Why convex mirrors are preferred over plane mirrors:

Convex mirrors are preferred over plane mirrors for rear-view purposes because they provide a much wider field of view. Due to their outward curved surface, they can show a larger area of traffic behind the vehicle in the same size mirror, helping drivers see more vehicles and make safer decisions.

(b) Meaning of "Objects in the mirror are closer than they appear":

This statement means that the actual distance of the objects (vehicles behind) is less than what it appears to be in the convex mirror. Since convex mirrors form diminished images, objects appear smaller and farther away than their actual position. This warning alerts drivers to judge distances carefully.

(c) Nature of image formed by convex mirror:

The image formed by a convex mirror is always:

- Virtual (cannot be obtained on screen)
- Erect (upright, same orientation as object)
- Diminished (smaller than the object)

(d) Can convex mirror form a real image?

No, a convex mirror can never form a real image. This is because the reflected rays from a convex mirror always diverge and never actually meet. They only appear to meet when extended backward, forming a virtual image behind the mirror. Real images require actual convergence of light rays, which is not possible with a convex mirror.

20. Case Study 2: The Human Eye and Lenses

(a) Type of lens in human eye:

The human eye contains a convex lens (converging lens) called the eye lens or crystalline lens. This natural lens helps focus light onto the retina.

(b) Where is the image formed in a healthy eye:

In a healthy human eye, the image is formed exactly on the retina, which is located at the back of the eyeball. The retina contains light-sensitive cells that convert the image into electrical signals sent to the brain.

(c) Lens used to correct myopia:

A concave lens (diverging lens) is used to correct myopia (short-sightedness). In myopia, the image forms before the retina. The concave lens diverges the light rays slightly so that they focus correctly on the retina.

(d) Why we see objects erect despite inverted image on retina:

Although the image formed on the retina is real and inverted, we see objects erect because our brain processes and interprets the visual information. The brain has learned from experience to correct this inversion, so we perceive objects in their actual upright orientation. This is a result of neural processing in the visual cortex of the brain.
