Class: 10th

Subject: Physics

Unit 12: GEOMETRICAL OPTICS

Exercise MCQs:

1. Which of the following quantities is not changed during the refraction of light?

(a) Its direction

(b) Its speed

(c) Its frequency ✅

(d) Its wavelength

2. A converging mirror with a radius of 20 cm creates a real image 30 cm from the mirror. What is the object distance?

(a) -5.0 cm

(b) -7.5 cm

(c) -15 cm ✅

(d) -20 cm

3. An object is placed at the centre of curvature of a concave mirror. The image produced by the mirror is located:

(a) Out beyond the centre of curvature

(**b**) At the centre of curvature ✅

(c) Between the centre of curvature and the focal point

(d) At the focal point

4. An object is 14 cm in front of a convex mirror. The image is 5.8 cm behind the mirror. What is the focal length of the mirror?

(**a**) -4.1 cm ✅

(b) -8.2 cm

(c) -9.9 cm

(d) -20 cm

5. The index of refraction depends on:

(a) The focal length

(**b**) The speed of light ✅

(c) The image distance

(d) The object distance

6. Which type of image is formed by a concave lens on a screen?

(a) Inverted and real

(b) Inverted and virtual

(c) Upright and real

(d) Upright and virtual ✅

7. Which type of image is produced by the converging lens of the human eye when it views a distant object?

(a) Real, erect, same size

(b) Real, inverted, diminished ✅

(c) Virtual, erect, diminished

(d) Virtual, inverted, magnified

8. Image formed by a camera is:

(a) Real, inverted, and diminished ✅

(b) Virtual, upright, and diminished

(c) Virtual, upright, and magnified

(d) Real, inverted, and magnified

9. If a ray of light in glass is incident on an air surface at an angle greater than the critical angle, the ray will:

(a) Refract only

(**b**) Reflect only ✅

(c) Partially refract and partially reflect

(d) Diffract only

10. The critical angle for a beam of light passing from water into air is 48.8°. This means that all light rays with an angle of incidence greater than this angle will be:

(a) Absorbed

(**b**) Totally reflected ✅

(c) Partially reflected and partially transmitted

(d) Totally transmitted

Important MCQs:

1. What is the name of the ray that bounces back after striking a mirror?

(a) Refracted ray

(b) Emergent ray

(c) Reflected ray ✅

(d) Absorbed ray

2. What is the relationship between the angle of incidence (i) and the angle of reflection (r)?

(a) $i > r$

(b) $i < r$

(c) $i = r$ ✅

(d) No relation

3. According to the laws of reflection, the incident ray, reflected ray and normal:

(a) Lie in different planes

(b) Lie in the same plane ✅

(c) Lie at right angles

(d) Do not intersect

4. Which type of surface causes regular reflection of light?

(a) Rough wall

(b) Wooden table

(**c**) Polished silver plate ✅

(d) Paper sheet

5. What kind of reflection occurs on a rough surface?

(a) Regular reflection

(**b**) Irregular reflection ✅

(c) Mirror reflection

(d) Total internal reflection

6. What is a spherical mirror?

(a) A flat mirror

(**b**) A part of a hollow sphere with a reflecting surface ✅

(c) A transparent glass

(d) A mirror with plane surface

7. Which mirror has its inner curved surface as reflecting?

(a) Convex mirror

(b) Concave mirror ✅

(c) Plane mirror

(d) Transparent mirror

8. Which mirror always forms a virtual and erect image?

(a) Concave mirror

(b) Plane mirror

(c) Convex mirror ✅

(d) Silver mirror

9. Which mirror can produce both real and virtual images?

(a) Convex mirror

(b) Plane mirror

(c) Concave mirror ✅

(d) None of these

10. What is the midpoint of the spherical mirror's surface called?

(a) Focus

(b) Centre of curvature

(**c**) Pole ✅

(d) Radius

11. What is the distance between the pole and the principal focus called?

(a) Diameter

(b) Radius of curvature

(c) Principal axis

(**d**) Focal length ✅

12. What is the formula relating focal length (f) and radius of curvature (R)?

(a) $f = R \times 2$

(**b**) $f = R/2$ ✅

(c) $f = R + 2$

(d) f = 2/R

13. What is the centre of the sphere from which the mirror is taken called?

(a) Pole

(b) Vertex

(c) Centre of curvature ✅

(d) Principal axis

14. Where does the focus of a convex mirror lie?

(a) In front of the mirror

(b) On the mirror surface

(c) Behind the mirror ✅

(d) No focus exists

15. Why is a concave mirror called a converging mirror?

(a) It spreads light rays

(b) It absorbs light

(c) It converges parallel rays to a point ✅

(d) It produces only virtual images

16 The mirror formula shows the relationship between:

(a) Object height, image height, and distance

(**b**) Object distance, image distance, and focal length ✅

(c) Mirror size, image position, and curvature

(d) Radius, image size, and mirror type

17. What is the standard mirror formula?

(a) 1/f = p + q

(b) 1/f = q – p

(c) 1/f = 1/p – 1/q

(**d**) 1/f = 1/p + 1/q ✅

18. In the mirror formula, what does 'p' represent?

(a) Image height

(**b**) Object distance ✅

(c) Radius of curvature

(d) Principal axis

19. What is the bending of light as it moves from

one transparent medium to another called?

(a) Reflection

(b) Scattering

(**c**) Refraction ✅

(d) Dispersion

20. When a ray of light enters from air into glass, it bends:

(a) Away from the normal

(**b**) Toward the normal ✅

(c) Straight

(d) Randomly

21. Which one is the correct expression for Snell's Law?

(a) sin i = sin r

(b) sin r/sin i = n

(**c**) sin i / sin r = n ✅

(d) sin i × sin r = n

22. What is the refractive index (n) defined as?

(a) n = c / v ✅

(b) n = v / c

(c) n = r / i

(d) n = i × r

23. What causes the refraction of light?

(a) Difference in wavelength

(b) Difference in frequency

(c) Difference in speed in different media ✅

(d) Difference in intensity

24. What happens to the speed of light when it enters water from air?

(a) Increases

(b) Remains the same

(c) Decreases ✅

(d) Disappears

25. What is the speed of light in air approximately?

(a) 2×10^8 m/s

(b) 1.5×10^6 m/s

(c) 3×10^8 m/s ✅

(d) 2.3×10^6 m/s

26. What is the critical angle?

(a) The angle of refraction when light bends 45°

(b) The angle of incidence when the refracted ray bends 90° ✅

(c) The angle when total reflection occurs

(d) The angle of deviation between rays

27. Total internal reflection occurs when:

(a) Light travels from a rarer to a denser medium

(b) Angle of incidence is less than critical angle

(c) Light reflects at the boundary of two opaque materials

(d) Light travels from a denser to a rarer medium with angle greater than critical angle ✅

28. Which optical device works on the principle of total internal reflection?

(a) Microscope

(b) Optical fibre ✅

(c) Magnifying glass

(d) Thermometer

29. What is the main function of cladding in optical fibres?

(a) To absorb light

(b) To increase speed

(c) To reflect light back into the core ✅

(d) To transmit sound waves

30. What is an endoscope used for?

(a) Examining stars

(b) Measuring temperature

(c) Viewing inside the human body ✅

(d) Measuring light speed

31. A prism is a transparent object made of:

(a) Metal

(b) Plastic

(c) Optical glass ✅

(d) Wood

32. What is the shape of a basic prism discussed in the syllabus?

(a) Circular

(b) Rectangular

(c) Triangular ✅

(d) Cubical

33. In refraction through a prism, the emergent ray:

(a) Is parallel to the incident ray

(b) Is reflected back

(c) Deviates from the incident path ✅

(d) Is absorbed completely

34. The angle by which the light is bent by the prism is called:

(a) Angle of incidence

(b) Critical angle

(c) Angle of emergence

(d) Angle of deviation ✅

35. A convex lens is also known as:

(a) Diverging lens

(b) Reflecting lens

(**c**) Converging lens ✅

(d) Deflecting lens

36. What is the shape of a convex lens?

(a) Thick at edges, thin at centre

(b) Uniform throughout

(**c**) Thick at centre, thin at edges ✅

(d) Flat surface on both sides

37. In a concave lens, parallel rays after refraction:

(a) Meet at a real focus

(**b**) Diverge from a virtual focus ✅

(c) Go straight

(d) Reflect back

38. The distance between the optical centre and principal focus is called:

(a) Principal axis

(b) Radius

(**c**) Focal length ✅

(d) Lens width

39. Power of a lens is defined as:

(a) P = focal length

(b) P = focal length × radius

(**c**) P = 1 / focal length in metres ✅

(d) P = radius / distance

40. The SI unit of the power of a lens is:

(a) Metre

(b) Watt

(**c**) Dioptre ✅

(d) Hertz

41. In a convex lens, the image is formed due to:

(a) Reflection of light

(**b**) Refraction of light ✅

(c) Diffraction of light

(d) Absorption of light

42. Which of the following rays passes straight through the lens without deviation?

(a) Ray passing through focal point

(b) Ray parallel to principal axis

(c) Ray passing through optical centre ✅

(d) Emergent ray

43. The ray that enters the lens parallel to the principal axis passes through:

(a) Optical centre

(b) Apex

(c) Principal focus ✅

(d) Any point

44. Which formula gives the relationship between object distance, image distance and focal length of a lens?

(a) v = u + f

(b) m = hi / ho

(c) 1/f = 1/p + 1/q ✅

(d) f = m × u

45. What is the sign of focal length (f) for a convex lens?

(a) Negative

(b) Zero

(**c**) Positive ✅

(d) Depends on object

46. In a simple camera, the object is placed:

(a) At focal point

(b) Between F and 2F

(**c**) Beyond 2F ✅

(d) At 2F

47. A slide projector forms a:

(a) Virtual and erect image

(**b**) Real and inverted image ✅

(c) Real and erect image

(d) Virtual and inverted image

48. In a photograph enlarger, the object (film) is

placed:

(a) At F

(b) Between F and 2F ✅

(c) At 2F

(d) Beyond 2F

49. The image formed by a simple microscope is:

(a) Real, inverted, and reduced

(b) Real and magnified

(c) Virtual, erect, and magnified ✅

(d) Virtual and diminished

50. The magnifying power of a convex lens used in a simple microscope increases if:

(a) Focal length increases

(b) Object distance increases

(c) Focal length decreases ✅

(d) Image distance decreases

51. A compound microscope uses how many lenses for magnification?

(a) One concave and one convex

(b) Two convex lenses ✅

(c) One convex and one plane lens

(d) Two concave lenses

52. The objective lens of a compound microscope has:

(a) Long focal length

(b) Variable focal length

(c) Short focal length ✅

(d) No focal length

53. What is the magnification formula for a compound microscope?

(a) $M = f_o / f_e$

(b) $M = f_e / f_o$

(c) $M = L/f_o \times (1 + d/f_e)$ ✅

(d) $M = L \times f_o/f_e$

54. What is the use of a compound microscope?

(a) To see stars

(b) To measure temperature

(**c**) To study micro-organisms ✅

(d) To focus sunlight

55. Which instrument uses lenses or mirrors to observe distant objects?

(a) Microscope

(b) Spectrometer

(c) Periscope

(**d**) Telescope ✅

56. In a refracting telescope, the real image formed by objective acts as:

(a) Final image

(**b**) Object for eyepiece ✅

(c) Source of light

(d) Virtual image

57. The human eye forms an image on which part?

(a) Cornea

(b) Iris

(c) Retina ✅

(d) Pupil

58. What controls the size of the pupil in human eye?

(a) Lens

(b) Iris ✅

(c) Retina

(d) Ciliary muscles

59. The process of changing the focal length of eye lens to focus objects is called:

(a) Refraction

(b) Accommodation ✅

(c) Adjustment

(d) Adaptation

60. The minimum distance from the eye to see a clear image is called:

(a) Far point

(b) Focal point

(c) Near point ✅

(d) Image point

Important Short Questions:

1. What is meant by the reflection of light?

Answer:

When light travelling in a certain medium strikes the surface of another medium and turns back into the same medium, it is called reflection of light.

2. Define the incident ray and reflected ray.

Answer:

- **Incident ray:** The ray of light that falls on the mirror.
- **Reflected ray**: The ray of light that bounces back from the mirror.

4. State the first law of reflection.

Answer:

The incident ray, the normal, and the reflected ray all lie in the same plane.

5. State the second law of reflection.

Answer:

The angle of incidence is equal to the angle of reflection (i = r).

6. What is regular reflection?

Answer:

When light reflects from a smooth surface in one direction, it is called regular reflection.

7. What is irregular reflection?

Answer:

When light reflects from a rough surface in many directions, it is called irregular reflection.

8. What is a spherical mirror?

Answer:

A mirror whose reflecting surface is a part of a hollow sphere is called a spherical mirror.

9. What is the difference between a concave and a convex mirror?

Answer:

- **Concave mirror:** Inner curved surface is reflecting; forms real or virtual images.
- **Convex mirror:** Outer curved surface is reflecting; forms only virtual and erect images.

10. Define pole and centre of curvature of a spherical mirror.

Answer:

- **Pole:** The midpoint of the curved surface of a spherical mirror.
- **Centre of Curvature:** The centre of the imaginary sphere of which the mirror is a part.

11. What is mirror formula?

Answer:

Mirror formula is the relationship between object distance (p), image distance (q), and focal length (f) of a spherical mirror. **It is written as:**

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

12. Is the mirror formula valid for both concave and convex mirrors?

Answer:

Yes, the mirror formula is valid for both concave and convex mirrors by using proper sign conventions.

13. What is refraction of light?

Answer:

Refraction is the bending of light when it passes from one transparent medium into another due to change in its speed.

14. What causes refraction of light?

Answer:

Refraction occurs due to the change in the speed of light in different media.

15. What is meant by angle of incidence and angle of refraction?

Answer:

- **Angle of incidence (i):** The angle between the incident ray and the normal.

- **Angle of refraction (r):** The angle between the refracted ray and the normal.

16. State the first law of refraction.

Answer:

The incident ray, the refracted ray, and the normal all lie in the same plane.

17. What is Snell's Law?

Answer:

Snell's Law states that the ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant for a given pair of media.

Formula:

sin r/ sin i = n

17. Define refractive index.

Answer:

Refractive index is the ratio of the speed of light in air to the speed of light in a medium:

n = c/v

18. What is total internal reflection?

Answer:

When light travels from a denser to a rarer medium and the angle of incidence exceeds the critical angle, it is completely reflected back into the denser medium. This is called total internal reflection.

19. What is critical angle?

Answer:

The critical angle is the angle of incidence in the denser medium for which the angle of refraction in the rarer medium is 90°.

20. What is the role of total internal reflection in a right-angled prism?

Answer:

It reflects light through 90° or 180° using total internal reflection, commonly used in binoculars, periscopes, and cameras.

21. Why does a prism totally reflect light when it strikes at 45°?

Answer:

Because 45° is greater than the critical angle of glass (42°), so total internal reflection occurs.

22. What is an optical fibre?

Answer:

An optical fibre is a thin thread of glass or plastic that transmits light using total internal reflection.

23. What are the two parts of an optical fibre?

Answer:

- **Core**: Inner part with high refractive index
- **Cladding**: Outer layer with low refractive index

24. Mention one advantage of using optical fibre in telecommunication.

Answer:

It allows transmission of thousands of phone calls with minimal energy loss and no disturbance.

25. What is a light pipe?

Answer:

A bundle of optical fibres used to illuminate or view hard-to-reach places, such as inside the human body.

26. What is an endoscope?

Answer:

A medical instrument that uses optical fibres to view internal organs without surgery.

27. Name three types of endoscopes and their uses.

Answer:

- **Gastroscope**: For stomach
- **Cystoscope**: For bladder
- **Bronchoscope**: For throat

28. What is meant by angle of deviation in a prism?

Answer:

It is the angle by which the emergent ray deviates from the direction of the incident ray.

29.What is the formula for the power of a lens and its unit?

Answer:

$$P = \frac{1}{f(\text{in meters})}$$

30. What is the difference between image formation in mirrors and lenses.

Answer:

Mirrors form images by reflection, while lenses form images by refraction.

31. Which three principal rays are used to form images in a convex lens.

Answer:

- A ray parallel to principal axis passes through focus after refraction.
- A ray through optical center goes undeviated.
- A ray through focus becomes parallel to principal axis.

32. What is meant by lens formula and what is its mathematical form

Answer:

It is the relation between object distance, image distance, and focal length of a lens. Its formula is:

$1/f = 1/p + 1/q$

33. What does a positive focal length of a lens indicate.

Answer:

A positive focal length indicates a converging (convex) lens.

24. What is the sign of image distance for a virtual image formed by a real object.

Answer:

It is negative, as the virtual image is formed on the left side of the lens.

25. What type of image is formed in a camera using a convex lens?

Answer:

A real, inverted and diminished image is formed.

26. What are the functions of objective and

eyepiece in a compound microscope.

Answer:

- Objective forms a small real image
- Eyepiece magnifies this image to form a large virtual image

27. What is a telescope?

Answer:

A telescope is an optical instrument used to observe distant objects using lenses or mirrors.

28. What is a refracting telescope?

Answer:

A refracting telescope uses two converging lenses — an objective and an eyepiece — to form images.

29. What is the function of the objective lens in a telescope?

Answer:

It forms a real image of a distant object.

30. What is the function of the eyepiece in a refracting telescope?

Answer:

It forms a virtual image that can be seen by the eye.

31. What is meant by accommodation of the eye?

Answer:

The ability of the eye lens to change its focal length to form a sharp image on the retina.

32. What is the function of the ciliary muscles in the eye?

Answer:

They control the curvature of the eye lens to adjust its focal length.

33. What is the near point of the human eye?

Answer:

It is the minimum distance at which an object can be clearly seen, normally 25 cm.

34. What is the far point of the human eye?

Answer:

It is the maximum distance up to which the eye can see clearly, normally at infinity.

35. What is myopia?

Answer:

Myopia or nearsightedness is a defect in which distant objects appear blurred.

36. How can hypermetropia be corrected?

Answer:

It can be corrected using a converging (convex) lens.

Important Long Questions:

🌟 **Q1: Define reflection of light. Explain with the help of a labeled diagram.**

❖ **Definition of Reflection of Light:**

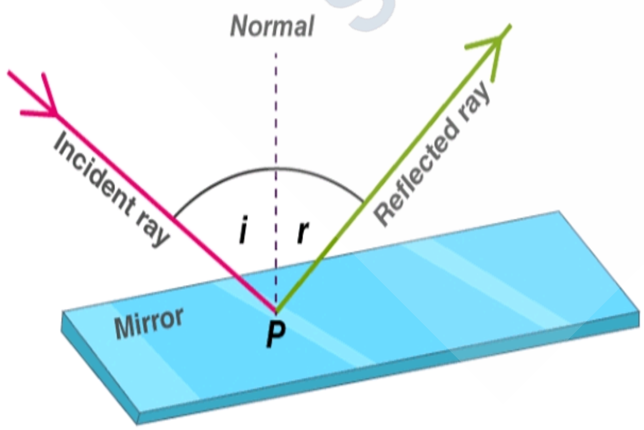
- When light travelling in a certain medium strikes the surface of another medium and bounces back into the same medium, this phenomenon is called reflection of light.

- "Reflection is the turning back of light into the same medium after striking a surface."

◆ Important Terms:

- Incident Ray: The ray of light that strikes the surface (AO).
- Reflected Ray: The ray of light that bounces back from the surface (OB).
- Normal: A line perpendicular to the surface at the point of incidence (ON).
- Angle of Incidence (i): The angle between the incident ray and the normal.
- Angle of Reflection (r): The angle between the reflected ray and the normal.

◆ Labeled Diagram:



🔹 **Real-life Example:**

- When we look into a plane mirror, the light from our face strikes the mirror and reflects back to our eyes, allowing us to see ourselves.
- **Example**: Mirrors in bathrooms, shops, and vehicles.

🌟 **Q2: State and explain the laws of reflection with the help of a diagram.**

❖ **Answer:**

🔹 **Laws of Reflection:**

1. First Law:

The incident ray, the reflected ray, and the normal at the point of incidence all lie in the same plane.

2. Second Law:

The angle of incidence (i) is equal to the angle of reflection (r).

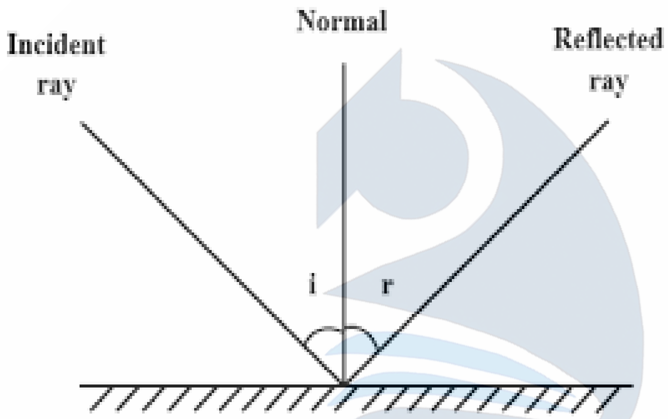
$i = r$

🔹 **Explanation of Laws:**

- When a light ray hits a plane surface like a mirror, it reflects off such that its path obeys the above two laws.

- These laws are true for both smooth and rough surfaces (at micro level, rough surfaces have tiny mirrors).

◆ Labeled Diagram:



◆ Real-life Applications:

- Plane Mirrors for grooming and decoration
- Periscopes used in submarines (reflect light to see above water)
- Solar Cookers reflect sunlight for heating
- Reflectors in vehicles use reflection to improve visibility

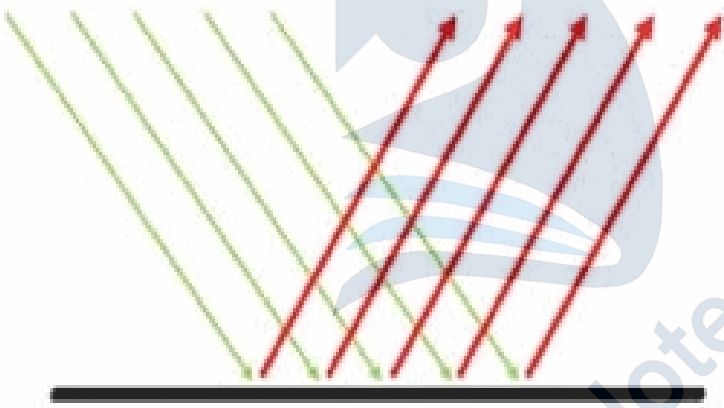
🌟 Q3: What are the types of reflection? Explain regular and irregular reflection with diagrams.

❖ Answer:

🔹 Types of Reflection:

There are two main types of reflection based on the surface:

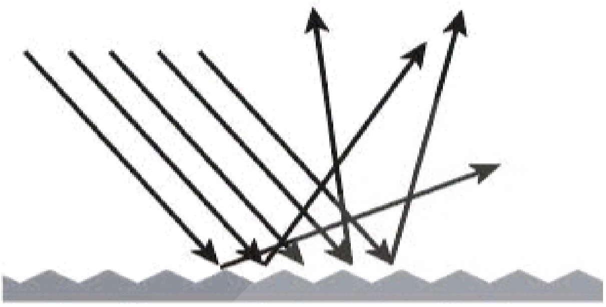
1. Regular Reflection (Specular Reflection):



- Occurs on smooth and shiny surfaces like mirrors or polished metals.
- Light rays reflect in one direction.
- Forms clear images.

Example: Plane mirror, calm water surface, polished metal.

2. Irregular Reflection (Diffuse Reflection):



- Occurs on rough or uneven surfaces like paper or wood.
- Light rays reflect in many directions.
- Does not form clear images.
- **Example**: Wall, book, unpolished surface.

🔹 Practical Examples:

Regular: Used in mirrors, solar panels, optical instruments.

Irregular: Used in room lighting, diffusing sunlight through curtains.

🌟 Q4: Discuss the importance of reflection of light in daily life.

❖ Answer:

Reflection of light plays a vital role in our daily lives.

Many devices and tools work on the principle of reflection.

◆ Uses of Reflection in Daily Life:

1. Mirrors (Personal Grooming):

Used to see ourselves in bathrooms, cars, shops, and homes.

2. Periscopes and Telescopes:

Used in submarines and astronomy to observe objects by reflecting light.

3. Road Safety Reflectors:

Used in vehicles, road signs, and bicycles to reflect headlights at night for safety.

4. Solar Cookers:

Use mirrors to focus sunlight on a cooking pot using reflection for heating.

◆ Other Applications:

Security systems (e.g., mirror domes in stores)

Lighting design in buildings

Optical fibers for internet and communication

🔍 **Summary:**

Reflection is not just a scientific concept but an essential part of technology and our everyday life.

🌟 **Q5: Define Refraction of Light. Explain the phenomenon with a labeled diagram and real-life example.**

❖ **Definition:**

Refraction of light is the bending of light when it passes from one transparent medium into another of different density.

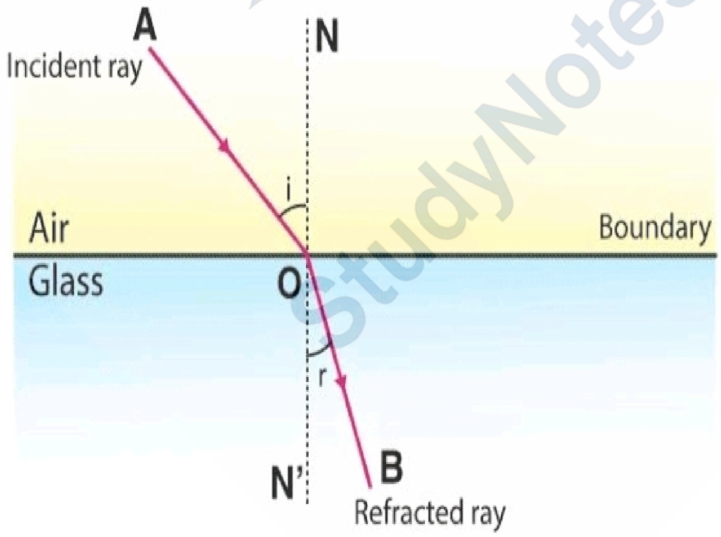
🔷 **Explanation:**

- When light travels from a rarer medium (like air) to a denser medium (like glass), it bends towards the normal.
- When light travels from a denser medium to a rarer medium, it bends away from the normal.
- This change in direction is due to a change in the speed of light in different media.

🔷 **Important Terms:**

- **Incident Ray (IO):** The ray that strikes the surface.
- **Refracted Ray (OR):** The ray that bends and travels in the second medium.
- **Normal Line (ON):** A perpendicular line drawn at the point of incidence.
- **Angle of Incidence (i):** Angle between the incident ray and the normal.
- **Angle of Refraction (r):** Angle between the refracted ray and the normal.

🔷 **Labeled Diagram:**



🔷 **Real-Life Example:**

- When a pencil is partially dipped in water, it appears bent at the surface.
- This is because light rays from the submerged part bend as they move from water to air, creating a shifted image.

🌟 **Q6: State and explain the laws of refraction of light with the help of a diagram.**

❖ **Answer:**

🔷 **Laws of Refraction:**

- (i) The incident ray, the refracted ray, and the normal all lie in the same plane.
- (ii) The ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant.

This is called Snell's Law:

sin i/sin r = n

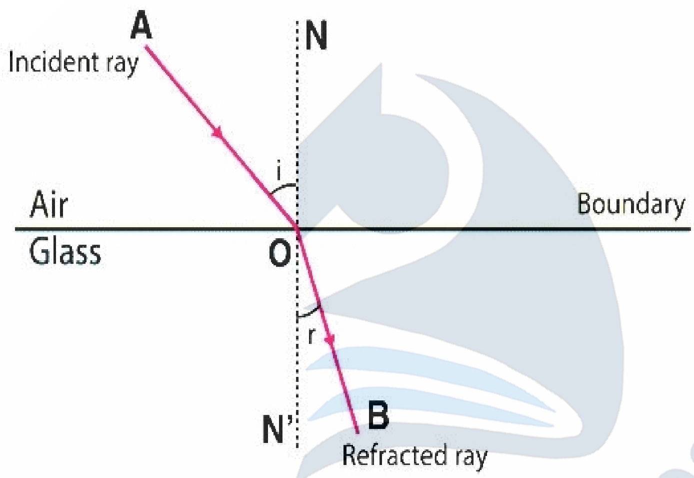
Where n is the refractive index of the second medium with respect to the first.

🔷 Explanation of Each Law:

The first law ensures geometric consistency and defines the orientation of rays.

The second law shows the quantitative relationship using Snell's Law. It explains how much the light will bend depending on the medium.

🔷 Labeled Diagram:



🔷 Real-Life Applications:

- Lenses in glasses, cameras, and microscopes.
- Prisms and optical fibers for data transmission.
- Mirages formed due to temperature-based refraction in deserts.

🌟 Q7: What is a Lens? Explain Different Types of Lenses with Labeled Diagrams.

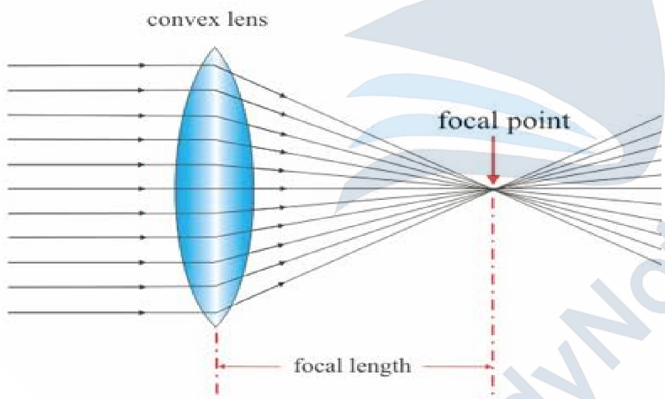
❖ **Definition:**

A lens is a transparent optical device made of glass or plastic that has two refracting surfaces, at least one of which is curved. It bends (refracts) light rays in such a way that an image of an object is formed.

🔷 Classification of Lenses

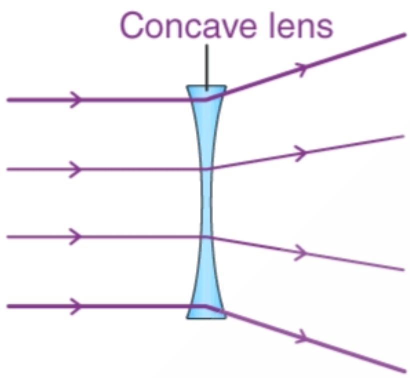
Lenses are mainly classified into two types based on how they refract light:

1. Convex Lens (Converging Lens):



- It is thicker at the center and thinner at the edges.
- It converges parallel rays of light towards a single point called the principal focus.
- Used in magnifying glasses, cameras, and microscopes.

2. Concave Lens (Diverging Lens):



- It is thinner at the center and thicker at the edges.
- It diverges parallel rays of light so that they appear to come from a virtual point behind the lens.
- Used in spectacles for myopia (short-sightedness).

🔷 Types of Lenses

1. Double Convex Lens:

- Both surfaces are outwardly curved (convex).
- Most commonly used in optical instruments.

2. Plano Convex Lens:

- One surface is flat, and the other is convex.

- Used in focusing systems and lasers.

3. Concavo-Convex Lens:

- One surface is concave, and the other is convex.
- Forms a weaker converging or diverging lens depending on curvature.

🔷 Real-Life Examples of Lenses

Convex Lens:

- Used in microscopes, magnifying glasses, projectors, and cameras.
- Used in correcting hypermetropia (long-sightedness).
- Concave Lens:
- Used in spectacles to correct myopia (short-sightedness).
- Used in peepholes and laser beam expanders.

🔍 Summary:

Lenses play a vital role in optics by refracting light to form images. Understanding their types and properties helps in designing a variety of optical devices used in science, medicine, photography, and daily life.

Exercise Long Questions:

REVIEW QUESTIONS:

🌟Q.12.1. What do you understand by reflection of light? Draw a diagram to illustrate reflection at a plane surface.

❖ Definition of Reflection of Light:

- Reflection of light is the bouncing back of light rays when they strike a smooth and shiny surface like a mirror.
- This occurs in such a way that the angle of incidence equals the angle of reflection.

🔷 Explanation:

- When a light ray hits a plane (flat) surface such as a mirror, it bounces back into the same medium following certain laws.

- This phenomenon allows us to see images in mirrors and shiny surfaces.

🔷 Key Terms

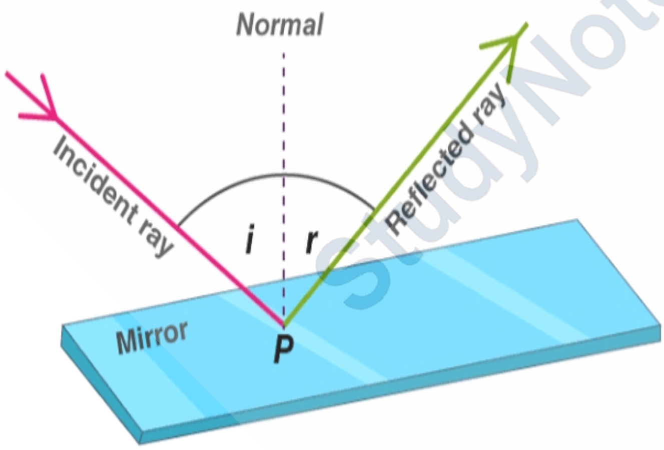
Incident Ray: The ray that strikes the surface.

Reflected Ray: The ray that bounces back.

Normal: The imaginary perpendicular line drawn at the point where the ray strikes.

Point of Incidence: The exact point where the incident ray meets the surface.

📷 Labeled Diagram of Reflection at Plane Surface



🔷 Real-Life Example

- Seeing your image in a bathroom mirror.

- Car headlights reflecting off road signs at night.

🌟 **Q.12.2. Describe the following terms used in reflection:**

❖ **Answer:**

(i) Normal

- A normal is an imaginary line drawn perpendicular to the surface at the point of incidence.
- It helps in measuring angles of incidence and reflection.

(ii) Angle of Incidence (i)

- The angle between the incident ray and the normal is called the angle of incidence.
- It is denoted by i.

(iii) Angle of Reflection (r)

- The angle between the reflected ray and the normal is called the angle of reflection.
- It is denoted by r.

🔷 **Important Point**

According to the laws of reflection, angle of incidence = angle of reflection.

🌟 **Q.12.3. State Laws of Reflection. Describe how they can be verified graphically.**

❖ **Answer:**

🔷 Laws of Reflection

1. First Law:

- The incident ray, the reflected ray, and the normal at the point of incidence all lie in the same plane.

2. Second Law:

- The angle of incidence (i) is equal to the angle of reflection (r).

sin i/sin r= n

🔷 Graphical Verification (Lab Method)

Apparatus Required:

- A plain sheet of paper
- Plane mirror
- Protractor

- Pins or pencil

Procedure:

1. Place a plane mirror on the paper.
2. Fix two pins to mark the incident ray.
3. Draw the normal at the point where the ray strikes.
4. Fix two more pins to mark the reflected ray.
5. Measure both $\angle i$ and $\angle r$ using a protractor.

Observation:

$\angle i = \angle r \Rightarrow$ This verifies the second law.

All rays lie on the paper (same plane) $\Rightarrow$ This verifies the first law.

🔍 **Summary:**

The laws of reflection are universally true for smooth surfaces. They are easily verifiable through simple graphical experiments, confirming the predictable behavior of light upon reflection.

🌟 **Q12.4: Define Refraction of Light. Describe the Passage of Light through Parallel-Sided**

Transparent Material.

❖ Definition of Refraction of Light:

- Refraction is the bending of light when it passes from one transparent medium to another due to a change in its speed.
- When light enters a denser medium (like air to glass), it slows down and bends towards the normal.
- When it enters a rarer medium (like glass to air), it speeds up and bends away from the normal.

📌 **Explanation**: Passage through Parallel-Sided Material

A parallel-sided transparent material like a glass slab has two flat and parallel surfaces.

🔹 When a ray of light travels through it:

1. At First Surface (Air to Glass):

- Light slows down.
- It bends towards the normal.

2. Inside the Glass Slab:

- The light ray travels in a straight line but at a reduced speed.

3. At Second Surface (Glass to Air):

- Light speeds up.
- It bends away from the normal.

4. Result:

- The emergent ray is parallel to the incident ray, but there is a lateral shift (displacement) in its path.
- Real-Life Examples of Refraction
- A pencil appears bent or broken in a glass of water.
- Eyeglasses and contact lenses.
- Magnifying glasses and microscopes.
- Camera and projector lenses.

🌟 **Q.12.5: Define the Following Terms Used in Refraction:**

❖ **Answer:**

(i) Angle of Incidence (i):

- It is the angle between the incident ray and the normal at the point where the light ray enters a new medium.

(ii) Angle of Refraction (r):

- It is the angle between the refracted ray and the normal at the point where the light ray passes into the new medium.

Key Point

- The amount of bending depends on the optical density of the material and the angle of incidence.

🌟 Q.12.6: What is Meant by Refractive Index of a Material? How Would You Determine the Refractive Index of a Rectangular Glass Slab?

❖ Definition of Refractive Index:

The refractive index (n) of a material is a number that tells how much the speed of light decreases in that medium compared to air or vacuum.

n = speed of light in air (c) / speed of light in medium (v)

Or, using angles:

n = sin i/ sin r

📌 **Determining Refractive Index Using Glass Slab**

🔹 **Apparatus Needed:**

- Rectangular glass slab
- White paper
- Pins
- Ruler and pencil
- Protractor

🔹 **Procedure:**

1. Place the glass slab on paper and mark its boundary.

2. Draw a normal line and an incident ray at a known angle.

3. Place pins on the incident ray and observe the refracted and emergent rays.

4. Trace the paths and draw normal lines at entry and exit points.

5. Measure the angle of incidence (i) and angle of refraction (r).

6. Use the formula:

$n = \sin i / \sin r$

🔍 **Summary:**

- The refractive index gives us the optical density of a material.
- It is important in designing lenses, spectacles, microscopes, and optical fibers.

🌟 **Q.12.10. What is Critical Angle? Derive a relationship between the critical angle and the refractive index of a substance.**

❖ **Definition of Critical Angle:**

The critical angle is the minimum angle of incidence in a denser medium for which the angle of refraction in the rarer medium becomes 90°.

At this angle, the refracted ray just grazes along the surface separating the two media.

✅ Derivation of Relationship between Critical

Angle and Refractive Index

Let:

- n_1 = refractive index of denser medium
- n_2 = refractive index of rarer medium
- C = critical angle
- According to Snell's Law:

$$n_1 \sin C = n_2 \sin 90^\circ$$

$$n_1 \sin C = n_2(1)$$

$$\sin C = \frac{n_2}{n_1}$$

If the rarer medium is air, then $n_2 = 1$, and we get:

$$\sin C = \frac{1}{n} \quad \text{or} \quad n = \frac{1}{\sin C}$$

🔍 **Summary:**

The refractive index of a medium is equal to the reciprocal of sine of its critical angle.

🌟 **Q.12.11. What are Optical Fibres? Describe how total internal reflection is used in light propagating through optical fibres.**

❖ **Definition of Optical Fibres:**

Optical fibres are very thin, flexible strands of glass or plastic that transmit light signals from one end to another using total internal reflection.

Each fibre consists of:

- Core (denser medium)
- Cladding (rarer medium with lower refractive index)

✅ Working Principle – Total Internal Reflection

When light enters the core at a certain angle:

1. It hits the core-cladding boundary.
2. If angle of incidence > critical angle, the light reflects internally.
3. This reflection continues along the length of the fibre without escaping.

Thus, the light signal travels long distances with minimal loss.

🔹 **Uses of Optical Fibres**

- Telecommunications (high-speed internet and calls)

- Medical endoscopy
- Lighting and decoration
- Networking in computers

🌟 **12.12. Define the following terms applied to a lens:**

❖ **Answer:**

(i) Principal Axis

- The principal axis of a lens is the imaginary straight line that passes through the centres of curvature of both spherical surfaces of the lens.
- It passes through the optical centre and is perpendicular to the surfaces.

(ii) Optical Centre

- The optical centre of a lens is the geometrical centre of the lens.
- A ray of light passing through the optical centre does not change its path (passes undeviated).

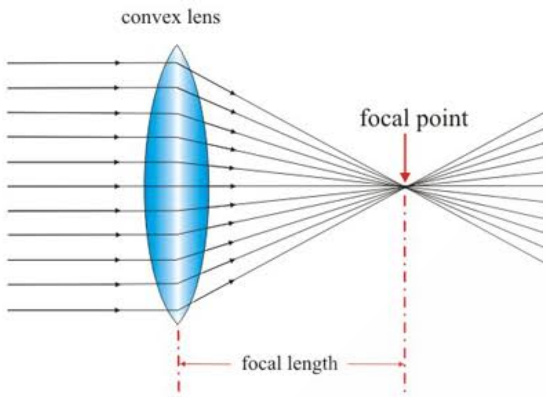
(iii) Focal Length

- The focal length (f) of a lens is the distance between the optical centre and the principal focus (F).
- For a convex lens, the focus is real and positive.
- For a concave lens, the focus is virtual and negative.

🌟 **12.13. What is meant by the principal focus of a (a) convex lens? Illustrate your answer with ray diagrams.**

❖ **Definition: Principal Focus of a Convex Lens**

- The **principal focus** (F) of a convex lens is the point on the principal axis where parallel rays of light, after passing through the lens, converge (meet) after refraction.
- For a **convex lens** (also called converging lens), the principal focus is real and on the opposite side of the incident rays.
- Every **convex lens** has two principal foci, one on each side of the lens, at equal distances from the optical centre.



✅ Conceptual Explanation:

When a beam of parallel rays (like sunlight) enters a convex lens:

- These rays bend towards the principal axis.
- After passing through the lens, they all meet at a common point = Principal Focus.
- This is why a convex lens can focus sunlight to a point and even burn paper.

🌟 12.14. Describe how light is refracted through a convex lens.

❖ Answer:

🔹 Refraction Through a Convex Lens

- A convex lens is thicker at the center and thinner at the edges. It bends light inward (converging) due to refraction.

- When light passes from air into glass, and then back from glass into air, the speed of light changes at both surfaces, causing the light rays to bend twice:

✅ Steps of Refraction in Convex Lens:

1. At First Surface (Air Glass):

Light slows down and bends towards the normal.

2. At Second Surface (Glass ⇒ Air):

Light speeds up and bends away from the normal.

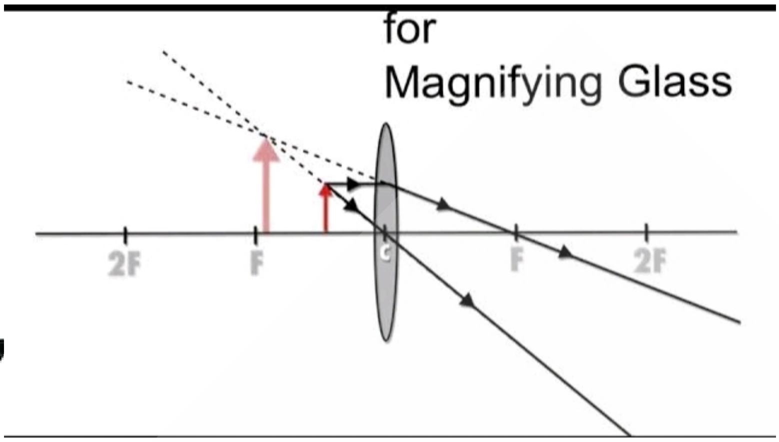
3. Due to the curved surfaces, the rays are refracted inward, and they converge at a point called the principal focus.

➤ **Result:**

- Parallel rays of light are brought to a point after refraction.
- This property is why convex lenses are called converging lenses.

🌟Q.12.15. With the help of a ray diagram, how can you show the use of a thin converging lens as a

magnifying glass?



✅ Use of Converging Lens as a Magnifying Glass

A thin convex lens can be used as a magnifying glass when the object is placed closer to the lens than its focal length (i.e., object distance < focal length).

✅ How It Works:

1. The object is placed between the lens and its principal focus.

2. Light rays from the object diverge after passing through the lens.

3. When these diverging rays are extended backward, they appear to come from a larger, upright image.

4. The image is:

- Virtual (not real)
- Upright (not inverted)
- Magnified (larger than the object)**

🔍 **Summary:**

- This setup is used in magnifying glasses, reading lenses, and jewellers' lenses.
- It allows us to see tiny objects enlarged and clearly.

🌟 **Q.12.16. A coin is placed at a focal point of a converging lens. Is an image formed? What is its nature?**

❖ **Definition:**

A converging lens (convex lens) is a lens that bends parallel rays of light to meet at a point called the principal focus.

🔸 **Explanation:**

- When a coin or any object is placed exactly at the focal point of a convex lens:

- The rays of light after refraction become parallel to each other.
- These parallel rays never converge on the other side.
- As a result, no real image is formed.

🔹 **Nature of the image:**

- Image is formed at infinity.
- Image is real, highly magnified, and inverted (in theory).
- In practical use, the image cannot be seen or captured on a screen.

🌟 12.17. What are the differences between real and virtual images?

❖ **Definition:**

Real and virtual images are formed by mirrors or lenses, but they differ in various aspects. Below are the key differences:

1. Formation of Image

- **Real Image:** Formed when light rays actually converge after reflection or refraction.

- **Virtual Image**: Formed when light rays appear to diverge from a point behind the mirror or lens (no actual convergence).

2. Projection on Screen

- **Real Image**: Can be projected on a screen because light rays actually meet at a point.
- **Virtual Image**: Cannot be projected on a screen because rays only appear to meet.

3. Orientation

- Real Image: Always inverted (upside down).
- Virtual Image: Always upright (erect).

4. Formation by Mirrors

- **Real Image**: Formed by concave mirrors, when the object is placed beyond the focal point.
- **Virtual Image**: Formed by plane mirrors or convex mirrors, or by concave mirrors if the object is within the focal point.

5. Formation by Lenses

- **Real Image**: Formed by convex (converging) lenses when the object is beyond the focal length.
- **Virtual Image**: Formed by concave (diverging) lenses, or convex lenses when the object is within the focal length.

6. Size of Image

- **Real Image**: May be diminished, same size, or magnified depending on object distance.
- **Virtual Image**: Usually magnified or diminished, but never same size and real.

🔍 Summary:

Real images are formed by actual convergence of light rays and can be displayed on screens. Virtual images, on the other hand, are only seen through mirrors or lenses and cannot be projected.

🌟 12.18. How does a converging lens form a virtual image of a real object? How can a diverging lens form a real image of a real object?

❖ Definition:

- A converging lens forms a virtual image when the object is placed between the lens and its focus (F).
- A diverging lens generally forms only virtual images, but in special conditions, it may form real images when used in optical systems.

🔸 Converging Lens (Convex):

- When a real object is placed closer than the focal length, the rays diverge after refraction.
- The brain traces them back and sees a virtual image behind the lens.

🔹 Nature of image:

- Virtual
- Upright
- Magnified

📚 **Example**: Magnifying glass

🔸 Diverging Lens (Concave):

- Normally forms only virtual and diminished images.

- However, if converging rays are directed toward a diverging lens (e.g., from another lens), a real image can be formed.
- In normal cases, it does not form real images from real objects.

🌟 **12.19. Define power of a lens and its units.**

❖ **Answer:**

Definition:

The power of a lens is the ability of a lens to bend (refract) light rays. It is defined as the reciprocal of the focal length (in meters).

$$\text{Power (P)} = \frac{1}{\text{Focal length (f in meters)}}$$

🔸 **Unit:**

- The **SI unit** of lens power is Dioptre (D).
- **1 Dioptre** = Power of a lens with focal length = 1 meter.

🔸 **Types:**

- Convex lens (converging) ⇒ Positive power

- Concave lens (diverging) ⇒ Negative power

📚 **Example**: A lens with focal length +0.5 m

P = 1/0.5 = +2D

🌟 **12.20. Describe the passage of light through a glass prism and measure the angle of deviation.**

❖ **Answer:**

Definition:

A glass prism is a transparent optical object with two plane surfaces inclined at an angle. It refracts light passing through it.

🔸 **Passage of light through prism:**

- When a light ray enters the prism, it bends toward the normal due to change in medium (air to glass).
- Inside the prism, it travels straight.
- On emerging out, the light ray bends away from the normal (glass to air).
- The final direction of light is shifted from the original path.

🔸 Angle of Deviation (δ):

The angle between the original path of the incident ray and the emergent ray.

It depends on:

- Angle of the prism
- Material of the prism (refractive index)
- Angle of incidence

📚 Use:

Used in optical instruments, spectrometers, and dispersion of light.

🌟 12.21. Define the terms resolving power and magnifying power.

❖ Answer:

🔹 (i) Resolving Power:

- It is the ability of an optical instrument (like a microscope or telescope) to distinguish between two closely spaced objects.
- A high resolving power means the device can see fine details.

- Important in microscopes and astronomy.

🔹 (ii) Magnifying Power:

- It refers to the ability of a lens or optical instrument to enlarge the appearance of an object.

- It is defined as:

$$\text{Magnifying Power (M)} = \frac{\text{Size of image}}{\text{Size of object}}$$

- More magnifying power means the object appears larger than its actual size.

📚 Example:

- A magnifying glass increases the size of small objects.
- A telescope magnifies distant objects.

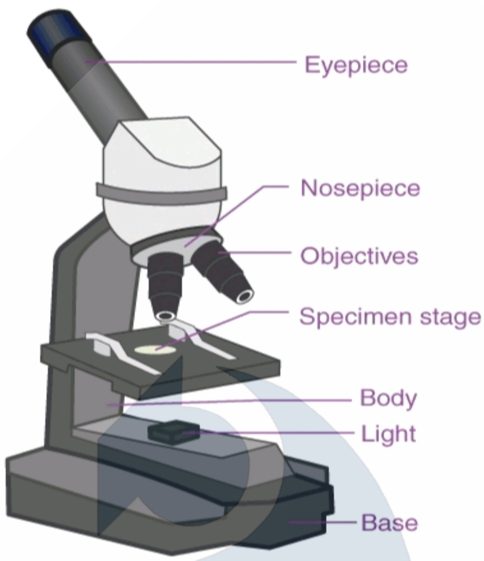
🌟 12.22. Draw the ray diagrams of:

❖ Answer:

(i) Simple Microscope

🔹 **Definition:**

A simple microscope is a single convex lens used to obtain a magnified view of small objects placed close to the eye.

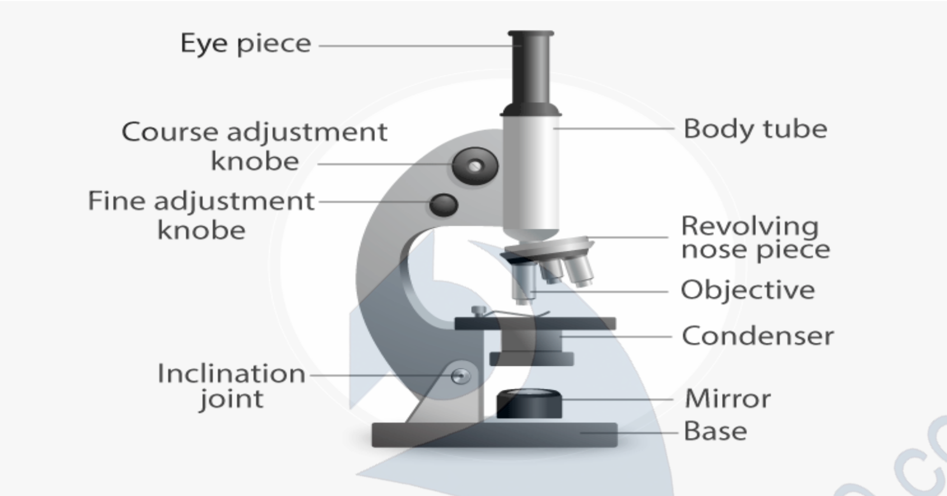


Simple Microscope

- **Working Principle (in points):**
  - A convex lens is used.
  - The object is placed between the lens and its focal point.
  - The lens forms a virtual, erect, and magnified image.
  - The image is seen on the same side as the object.
- **Uses:**

- Reading small text
- Observing small objects
- Used by watchmakers and jewelers

(ii) Compound Microscope



- **Definition:**

A compound microscope is an optical instrument that uses two convex lenses to produce a highly magnified image of tiny objects.

- **Working Principle (in points):**

Consists of two lenses: Objective lens (near object) and Eyepiece lens (near eye).

- The objective forms a real, inverted, and magnified image.

- The eyepiece magnifies this image further, producing a virtual, inverted, and magnified final image.

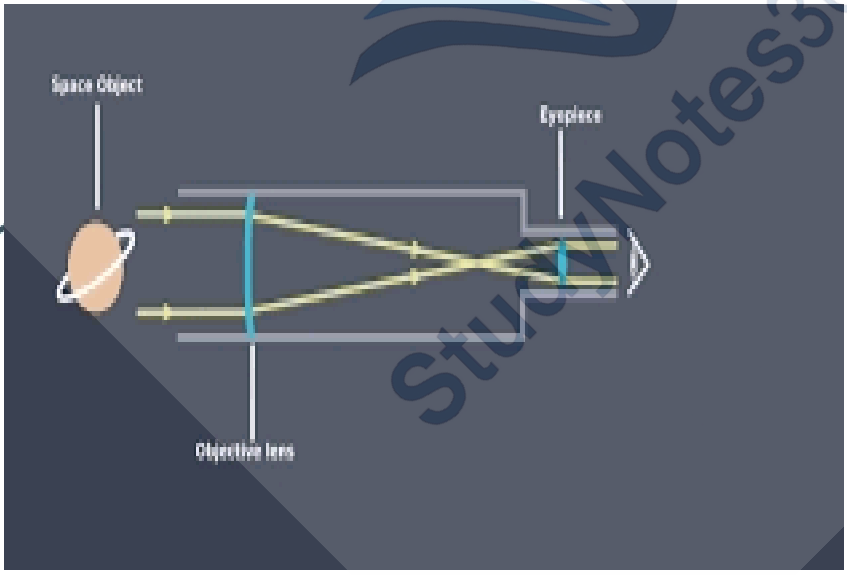
◆ **Uses:**

- In biology and medical labs
- Viewing microorganisms and cells

(iii) Refracting Telescope

◆ **Definition:**

A refracting telescope uses lenses to collect and focus light from distant objects like stars or planets.



◆ **Working Principle (in points):**

- It uses a large objective lens to gather light and form a real image.
- The eyepiece lens magnifies this image.
- The final image is virtual, magnified, and inverted.

🔹 **Uses**:

- In astronomy
- Observing distant planets and celestial objects

🌟 **12.23. Mention the magnifying powers of the following optical instruments:**

❖ **Answer:**

(i) Simple Microscope

🔹 **Magnifying Power (M):**

- M = 1 + D/f
- D = Least distance of distinct vision (usually 25 cm)
- f = Focal length of the convex lens

(ii) Compound Microscope

- **Magnifying Power (M):**

$$M = M_o \times M_e$$

- M_o = Magnifying power of objective
- M_e = Magnifying power of eyepiece

Detailed formula:

$$M = \frac{L}{f_o} \times \left(1 + \frac{D}{f_e}\right)$$

- L = Tube length
- f_o = Focal length of objective
- f_e = Focal length of eyepiece
- D = Least distance of distinct vision

(iii) Refracting Telescope

- **Magnifying Power (M):**

$$M = \frac{f_0}{f_e}$$

- f_0 = Focal length of objective lens
- f_e = Focal length of eyepiece lens

🌟 **12.24. Draw ray diagrams to show the formation of images in the normal human eye.**

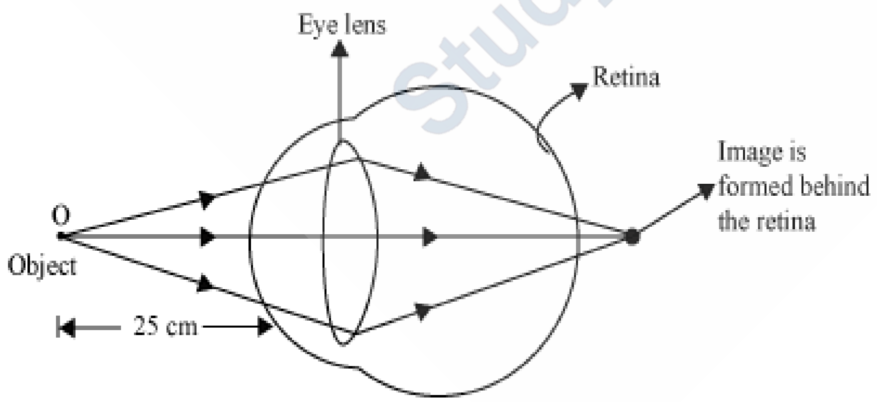
◆ **Definition:**

A normal eye is the eye that can focus light rays from both near and distant objects directly on the retina, forming a clear, sharp image without any visual defect.

◆ **Ray Diagram of Normal Eye:**

- Formation of image in normal eye:
- Light rays from a distant object enter the eye.
- The cornea and eye lens bend (refract) the light rays.
- Rays converge exactly on the retina, forming a real, inverted, and sharp image.

📷 **Diagram Illustration:**



Key Points:

🔍 **Retina**: Acts as the screen for image formation.

🔍 **Eye lens:** A natural convex lens that focuses light rays.

🔍 **Image Formed**: Real, inverted, and small (focused on retina).

🔍 **Accommodation**: The ability of eye lens to adjust its shape to focus near or distant objects.

🌟 **12.25. What is meant by the terms nearsightedness and farsightedness? How can these defects be corrected?**

🔹 **(A) Nearsightedness (Myopia):**

❖ **Definition:**

Myopia is a defect in which a person can see near objects clearly but distant objects appear blurred.

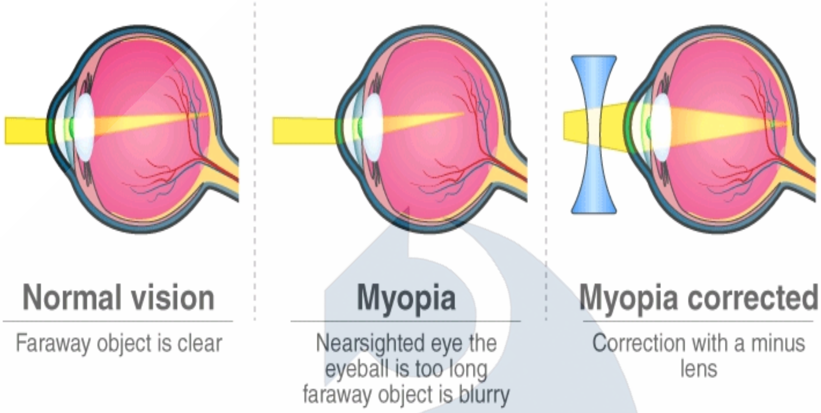
🔹 **Causes:**

- Eyeball is too long
- Eye lens is too curved
- Light rays converge before the retina

🛠️ **Correction:**

- Use a concave (diverging) lens
- It spreads out light rays so that they focus on the retina

📷 **Myopia Correction Diagram:**



🔹 (B) Farsightedness (Hypermetropia):

Definition:

Hypermetropia is a defect in which a person can see distant objects clearly but nearby objects appear blurred.

Causes:

- Eyeball is too short
- Eye lens is too flat
- Light rays focus behind the retina

◆ **Correction:**

- Use a convex (converging) lens
- It converges light rays so they focus on the retina

◆ **Real-Life Importance:**

- These corrections allow people to read, drive, and see distant/close objects properly.
- Use of corrective lenses or laser surgeries can improve vision.

CONCEPTUAL QUESTIONS

🌟 **12.1. A man raises his left hand in a plane mirror, the image facing him is raising his right hand. Explain why.**

❖ **Explanation:**

This phenomenon is due to lateral inversion, which is a characteristic of plane mirrors.

◆ **Key Points:**

When you stand in front of a plane mirror, the image formed is virtual, laterally inverted, and of the same size.

Lateral inversion means:

- 👉 Left and right sides are reversed in the mirror image.
- So, if a man raises his left hand, the image appears to raise its right hand, because:
- The mirror does not change up/down direction — only left and right are interchanged.

Reason in simple words:

The mirror flips the horizontal orientation. That's why our image seems to do the opposite (left ″ right) when we move.

🌟 **12.2. In your own words, explain why light waves are refracted at a boundary between two materials.**

❖ Explanation:

Refraction happens when light travels from one medium to another (e.g., air to water) and changes speed, which causes the light to bend.

Key Points:

- Light travels at different speeds in different materials.
- When light enters a denser medium (e.g., air ’n glass), it slows down and bends towards the normal.
- When light enters a rarer medium (e.g., glass ’n air), it speeds up and bends away from the normal.
- This change in speed at the boundary causes the light ray to change direction, which is called refraction.

🔹 **Real-life examples:**

- A straw in water looks bent due to refraction.
- Lenses focus light using refraction.
- Rainbow formation and prism dispersion are based on refraction.

🔍 **Summary:**

Refraction occurs because light changes speed when moving between materials with different optical densities, and this causes the bending of its path.

🌟 **12.3. Explain why a fish under water appears to be at a different depth below the surface than it actually is. Does it appear deeper or shallower?**

❖ **Answer:**

When we look at a fish under water, it appears to be at a different position than it actually is. This happens due to refraction of light.

📘 **Explanation:**

- Light travels from water (denser medium) to air (rarer medium).
- As it passes the boundary, it bends away from the normal (according to the laws of refraction).
- However, our brain assumes that light travels in a straight line.
- Because of this assumption, the refracted light appears to come from a point higher than the

actual fish.

🔍 **Summary:**

The fish appears to be at a shallower depth than it actually is.

🌟 12.4. Why or why not concave mirrors are suitable for makeup?

❖ **Answer:**

Yes, concave mirrors are suitable for makeup purposes, especially close-up makeup.

📘 **Explanation:**

- A concave mirror is a converging mirror, which can form a magnified and upright image of an object placed close to it (i.e., between the mirror and its focal point).

When the face is within the focal length of the mirror:

- It produces a virtual, erect, and magnified image.
- This helps to see facial details clearly, making

it ideal for applying makeup, shaving, or tweezing.

🔍 **Summary:**

Concave mirrors are suitable for makeup because they allow the user to see an enlarged and clear view of the face at a close distance.

🌟 **12.5. Why is the driver's side mirror in many cars convex rather than plane or concave?**

❖ **Answer:**

The driver's side mirror in many cars is convex to provide a wider field of view and enhance road safety.

📘 **Explanation:**

- A convex mirror curves outward, allowing it to capture more area than a plane or concave mirror.
- It helps drivers see vehicles, pedestrians, or objects in their blind spots.
- Although the image is smaller and virtual, it gives a clearer and wider rear view.

- The phrase "objects in mirror are closer than they appear" is often written to warn that images are reduced in size.

🔍 **Summary:**

Convex mirrors are used in cars because they provide a wide-angle view, making driving safer and more convenient.

🌟 **12.6. When an optician's testing room is small, he uses a mirror to help him test the eyesight of his patients. Explain why.**

❖ **Answer:**

An optician uses a mirror in small rooms to create an optical illusion of distance, allowing proper eyesight testing.

📘 **Explanation:**

- The eye test chart needs to be at a specific distance (usually 6 meters) for accurate vision testing.
- In small rooms, this distance cannot be physically achieved.

- By placing a plane mirror behind the chart, the image appears to be farther away.
- This setup doubles the visual path, simulating the correct testing distance.

🔍 **Summary:**

Mirrors help opticians in small rooms by creating a virtual long-distance setup, allowing proper eyesight testing without needing a large space.

🌟 12.7. How does the thickness of a lens affect its focal length?

❖ **Answer:**

The thickness of a lens, especially at its center, directly affects its focal length — the distance from the lens where parallel rays converge or appear to diverge.

📘 **Explanation:**

- A thicker lens (more curved surfaces) bends light more strongly, so the focal length becomes shorter.
- A thinner lens (less curved surfaces) bends

light less, so it has a longer focal length.

The focal length depends on:

- Curvature of lens surfaces
- Refractive index of lens material
- Lens thickness (optical power)

🔍 **Summary:**

- Greater thickness ⇒ Shorter focal length
- Less thickness ⇒ Longer focal length
- This is why high-power lenses (like magnifying glasses) are often thicker in the middle.

🌟 12.8. Under what conditions will a converging lens form a virtual image?

❖ Answer:

A converging lens (convex lens) forms a virtual image when the object is placed between the lens and its focal point.

📘 Conditions for Virtual Image Formation:

- Object is closer to the lens than the focal length (i.e., within the focus).

- The rays diverge after passing through the lens.
- The eye or device traces them back to a virtual point behind the lens.

✨ **Characteristics of Virtual Image:**

- Upright
- Enlarged
- Formed on the same side of the object
- Cannot be projected on a screen

🔹 **Examples:**

- Magnifying glass used for reading or viewing small objects.
- Optical instruments like simple microscope.

🌟 **12.9. Under what conditions will a converging lens form a real image that is the same size as the object?**

❖ **Answer:**

A converging lens (convex lens) forms a real image of the same size as the object when the object is placed at twice the focal length (2F) from the lens.

📘 **Explanation:**

Let F be the focal point and 2F be twice the focal distance.

When the object is placed at 2F, the image is:

- Real
- Inverted
- Same size as the object
- Formed at 2F on the other side of the lens

🔍 **Summary:**

- Object position: At 2F ⇒ Image position: At 2F, real, inverted, same size

🌟 **12.10. Why do we use refracting telescope with large objective lens of large focal length?**

❖ **Answer:**

A refracting telescope is designed with a large objective lens of long focal length to improve image quality and magnification.

📘 **Reasons for Using Large Objective Lens with Long Focal Length:**

1. Collects More Light:

- A larger lens collects more light from distant objects (stars, planets), making dim objects brighter and clearer.

2. Increases Resolution:

- Improves the resolving power (ability to distinguish fine details).

3. Greater Magnification:

- A long focal length objective, combined with a short focal length eyepiece, results in high magnification.

4. Minimizes Optical Aberrations:

- Long focal lengths reduce spherical and chromatic aberrations, resulting in sharper images.

🔍 Summary:

A large objective lens with long focal length allows refracting telescopes to produce bright, magnified, and high-quality images of distant celestial objects.

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

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Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.