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CHAPTER NOTES

Light Reflection and Refraction Class 10 Notes | CBSE Chapter 9 Science

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Light Reflection and Refraction Class 10 Notes | CBSE Chapter 9 Science

Light — Reflection and Refraction is Chapter 9 of CBSE Class 10 Science. Light is a form of energy that enables us to see objects. This chapter covers how light reflects from surfaces (mirrors) and how it bends when passing through different media (lenses). You will learn the laws of reflection and refraction, image formation by mirrors and lenses, and the mirror and lens formulas.

This is one of the highest-weightage chapters in the Physics section — expect 8–10 marks. Ray diagrams, mirror/lens formula numericals, and sign conventions are the most frequently tested topics.

Key Concepts

1. Reflection of Light

Reflection is the bouncing back of light when it strikes a smooth surface (like a mirror).

Laws of Reflection

1. The angle of incidence ($\angle i$) is equal to the angle of reflection ($\angle r$): $\angle i = \angle r$
2. The incident ray, the reflected ray, and the normal to the mirror at the point of incidence all lie in the **same plane**

Key Terms

Term	Definition
Incident ray	Ray of light falling on the mirror surface
Reflected ray	Ray of light bouncing back from the mirror
Normal	Line perpendicular to the mirror surface at the point of incidence
Angle of incidence ($\angle i$)	Angle between the incident ray and the normal
Angle of reflection ($\angle r$)	Angle between the reflected ray and the normal

2. Spherical Mirrors

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

Types

Type	Reflecting Surface	Also Called
Concave mirror	Inner (caved-in) surface	Converging mirror (converges light)
Convex mirror	Outer (bulging) surface	Diverging mirror (spreads light)

Important Terms for Spherical Mirrors

Term	Symbol	Definition
Centre of curvature	C	Centre of the sphere of which the mirror is a part
Radius of curvature	R	Radius of the sphere (distance from pole to centre of curvature)
Pole	P	Centre point of the mirror surface
Principal axis	—	Straight line passing through P and C
Focus (Focal point)	F	Point on principal axis where parallel rays converge (concave) or appear to diverge from (convex)
Focal length	f	Distance from pole to focus. $f = R/2$
Aperture	—	Diameter of the reflecting surface of the mirror

Relationship: $f = R/2$ (focal length is half the radius of curvature)

3. Image Formation by Concave Mirror

Position of Object	Position of Image	Size of Image	Nature of Image
At infinity	At F	Highly diminished (point-sized)	Real, inverted
Beyond C	Between F and C	Diminished (smaller)	Real, inverted
At C	At C	Same size	Real, inverted
Between C and F	Beyond C	Enlarged (larger)	Real, inverted
At F	At infinity	Highly enlarged	Real, inverted
Between F and P	Behind the mirror	Enlarged	Virtual, erect

Uses of concave mirrors: Shaving/makeup mirrors (between F and P), torch/headlight reflectors (object at F), dentist's mirror, solar concentrators

Image Formation by Convex Mirror

Position of Object	Position of Image	Size of Image	Nature of Image
At infinity	At F (behind mirror)	Highly diminished (point-sized)	Virtual, erect
Anywhere in front	Between P and F (behind mirror)	Diminished (smaller)	Virtual, erect

Convex mirror always forms: Virtual, erect, and diminished images.

Uses of convex mirrors: Rear-view mirrors in vehicles (wider field of view), security mirrors in shops.

4. Sign Convention (New Cartesian Sign Convention)

Used for mirrors AND lenses. The **pole (P)** of the mirror or **optical centre (O)** of the lens is the origin.

- All distances are measured from P (or O)
- Distances in the **direction of incident light** are **positive**
- Distances **against** the direction of incident light are **negative**
- Heights **above** the principal axis are **positive**
- Heights **below** the principal axis are **negative**

For concave mirror: f is negative (focus is in front); **For convex mirror:** f is positive (focus is behind)

5. Mirror Formula and Magnification

Mirror Formula

$$1/v + 1/u = 1/f$$

Where:

- v = image distance (from mirror)
- u = object distance (from mirror) — always negative (object is in front)
- f = focal length

Magnification (m)

$$m = h'/h = -v/u$$

Where:

- h' = height of image

- h = height of object
 - If m is **negative** → image is **real and inverted**
 - If m is **positive** → image is **virtual and erect**
 - If $|m| > 1$ → image is enlarged; $|m| < 1$ → diminished; $|m| = 1$ → same size
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6. Refraction of Light

Refraction is the change in direction (bending) of light when it passes from one transparent medium to another.

Why does refraction happen? Because the speed of light is different in different media. Light travels fastest in vacuum/air and slower in denser media (glass, water).

Laws of Refraction (Snell's Law)

1. The incident ray, refracted ray, and normal all lie in the **same plane**
2. 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: **$\sin i / \sin r = \text{constant } (n)$**

This constant n is called the **refractive index**.

Refractive Index

The **refractive index** of a medium measures how much light slows down in that medium compared to vacuum.

$$n = \text{Speed of light in vacuum} / \text{Speed of light in medium} = c/v$$

Medium	Refractive Index (n)
Air/Vacuum	1.0
Water	1.33
Glass	1.5
Diamond	2.42

Key rules of refraction:

- Light going from **rarer** → **denser medium** (air → glass): bends **towards** the normal ($\angle i > \angle r$)
 - Light going from **denser** → **rarer medium** (glass → air): bends **away** from the normal ($\angle i < \angle r$)
 - Light hitting the surface perpendicularly (along the normal): passes straight through without bending
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7. Spherical Lenses

A **lens** is a transparent material (usually glass) with at least one curved surface that refracts light.

Type	Shape	Also Called	Action
Convex lens	Thicker in the middle, thinner at edges	Converging lens	Converges (focuses) light
Concave lens	Thinner in the middle, thicker at edges	Diverging lens	Diverges (spreads) light

Important Terms for Lenses

Term	Symbol	Definition
Optical centre	O	Centre of the lens; light passing through O goes undeviated
Principal focus	F	Point where parallel rays converge (convex) or appear to diverge from (concave)
Focal length	f	Distance from optical centre to principal focus
2F	2F	Point at twice the focal length from optical centre

Note: A lens has two foci — one on each side (F_1 and F_2).

8. Image Formation by Convex Lens

Position of Object	Position of Image	Size of Image	Nature of Image
At infinity	At F_2	Highly diminished (point-sized)	Real, inverted
Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real, inverted
At $2F_1$	At $2F_2$	Same size	Real, inverted
Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real, inverted
At F_1	At infinity	Highly enlarged	Real, inverted
Between F_1 and O	Same side as object	Enlarged	Virtual, erect

Uses of convex lens: Magnifying glass, spectacles for hypermetropia (farsightedness), camera lens, projector

Image Formation by Concave Lens

Position of Object	Position of Image	Size of Image	Nature of Image
At infinity	At F_1	Highly diminished (point-sized)	Virtual, erect
Anywhere	Between F_1 and O (same side as object)	Diminished	Virtual, erect

Concave lens always forms: Virtual, erect, and diminished images.

Uses of concave lens: Spectacles for myopia (short-sightedness), peepholes in doors

9. Lens Formula, Magnification, and Power

Lens Formula

$$1/v - 1/u = 1/f$$

Sign Convention for Lenses

- Object distance (u) is always **negative** (object on left side)
- For convex lens: f is **positive**
- For concave lens: f is **negative**

Magnification

$$m = h'/h = v/u$$

(Note: For lenses, $m = v/u$, NOT $-v/u$ like mirrors)

Power of a Lens

$$P = 1/f \text{ (where } f \text{ is in metres)}$$

Unit: **Diopetre (D)**

- Convex lens: positive power (+D)
- Concave lens: negative power (−D)

Power of a combination of lenses: $P = P_1 + P_2 + P_3 + \dots$

Important Definitions

Term	Definition
Reflection	Bouncing back of light from a smooth surface
Refraction	Bending of light when it passes from one medium to another
Focal length	Distance between the pole/optical centre and the principal focus
Refractive index	Ratio of speed of light in vacuum to speed of light in a medium ($n = c/v$)
Real image	Image formed by actual convergence of light rays; can be obtained on a screen
Virtual image	Image formed by apparent divergence of light rays; cannot be obtained on a screen
Power of a lens	Reciprocal of focal length in metres; measures the converging/diverging ability of a lens
Dioptre	SI unit of power of a lens; 1 D = power of a lens with focal length 1 m

Solved Examples (NCERT-Based)

Example 1

An object is placed 30 cm from a concave mirror of focal length 15 cm. Find the position and nature of the image.

Answer: Using sign convention: $u = -30$ cm, $f = -15$ cm

Mirror formula: $1/v + 1/u = 1/f$

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

$$1/v = -1/15 + 1/30 = (-2 + 1)/30 = -1/30$$

$$v = -30 \text{ cm}$$

The image is formed at 30 cm in front of the mirror (at C). Since v is negative, the image is **real and inverted**.

Magnification: $m = -v/u = -(-30)/(-30) = -1$. The image is **same size** as the object and inverted.

Example 2

A convex lens has a focal length of 20 cm. An object is placed 30 cm from the lens. Find the image position and magnification.

Answer: $u = -30$ cm, $f = +20$ cm

Lens formula: $1/v - 1/u = 1/f$

$$1/v - 1/(-30) = 1/20$$

$$1/v + 1/30 = 1/20$$

$$1/v = 1/20 - 1/30 = (3 - 2)/60 = 1/60$$

$v = +60$ cm (positive $\rightarrow$ image on other side $\rightarrow$ real)

Magnification: $m = v/u = 60/(-30) = -2$. Image is **real, inverted, and twice the size**.

Example 3

Find the power of a concave lens of focal length 50 cm.

Answer: $f = -50$ cm $= -0.5$ m (negative for concave lens)

$$P = 1/f = 1/(-0.5) = -2 \text{ D}$$

Example 4

The refractive index of glass is 1.5. What is the speed of light in glass? (Speed of light in vacuum $= 3 \times 10^8$ m/s)

Answer: $n = c/v$, so $v = c/n = (3 \times 10^8)/1.5 = 2 \times 10^8$ m/s

Important Questions for Board Exams

1-Mark Questions

1. What type of mirror is used as a rear-view mirror in vehicles? Why?
2. State the relationship between focal length and radius of curvature.
3. What is the SI unit of power of a lens?
4. Define refractive index of a medium.
5. A concave lens always forms what type of image?

2-Mark Questions

1. State the laws of reflection.
2. Distinguish between real and virtual images.
3. An object is placed at the focus of a concave mirror. Where is the image formed? What is its nature?
4. Why does a pencil appear bent when partly immersed in water?
5. Find the power of a convex lens of focal length 25 cm.

3-Mark Questions

1. Draw ray diagrams to show image formation when an object is placed (a) between F and C, (b) at C, of a concave mirror.
2. State the laws of refraction. Define refractive index.
3. An object is placed 20 cm from a convex lens of focal length 10 cm. Find the position, nature, and magnification of the image.
4. Compare a convex mirror and a concave mirror in terms of image formation and uses.
5. Draw a ray diagram for image formation by a convex lens when the object is between F and 2F.

5-Mark Questions

1. State the new Cartesian sign convention for mirrors. Derive the mirror formula ($1/v + 1/u = 1/f$) for a concave mirror.
 2. What is refraction? State its laws. An object is placed 15 cm from a concave lens of focal length 15 cm. Find the image position, nature, and magnification using the lens formula.
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Quick Revision Points

- Reflection: $\angle i = \angle r$; incident ray, reflected ray, normal all in same plane
 - Concave mirror: converging; Convex mirror: diverging
 - $f = R/2$ for spherical mirrors
 - Concave mirror images: varies from real-inverted to virtual-erect (object between F and P)
 - Convex mirror: always virtual, erect, diminished — used in rear-view mirrors
 - Mirror formula: $1/v + 1/u = 1/f$; Magnification: $m = -v/u$
 - Refraction: light bends towards normal when entering denser medium, away when entering rarer
 - Snell's law: $n_1 \sin i = n_2 \sin r$; Refractive index $n = c/v$
 - Convex lens: converging; Concave lens: diverging
 - Lens formula: $1/v - 1/u = 1/f$; Magnification: $m = v/u$
 - Power of lens: $P = 1/f$ (in metres); Unit: Dioptre (D)
 - Convex lens: $+f$, $+P$; Concave lens: $-f$, $-P$
 - Combined power: $P = P_1 + P_2 + \dots$
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Previous Chapter: Chapter 8 — Heredity

Next Chapter: Chapter 10 — The Human Eye and the Colourful World



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