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## Spherical Mirrors

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### Definition and Types

Mirrors with reflecting surfaces that are parts of a sphere are called spherical mirrors. They can be of two types based on the curvature of their reflecting surface:

- **Concave Mirror:** The reflecting surface curves inward, like the inside of a bowl.
- **Convex Mirror:** The reflecting surface curves outward, like the back of a spoon.

### Structure and Properties

A spherical mirror is considered as a part of an imaginary hollow glass sphere. The reflective coating is applied on the back of the glass for convex mirrors and on the outer curved surface for concave mirrors so that the inner surface acts as the reflecting surface.

Concave mirrors converge light rays, focusing them to a point, while convex mirrors diverge light rays, spreading them out.

## Examples in Daily Life

A spoon demonstrates both types of spherical mirrors: its inner surface acts as a concave mirror and the outer surface as a convex mirror.

## Solved Examples

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**Example 1:** Describe the difference in image formation by concave and convex mirrors when an object is placed close to them.

*Solution:* When an object is placed close to a concave mirror, it forms an erect and enlarged image. In contrast, a convex mirror forms an erect and diminished image of the object.

**Example 2:** Explain why a concave mirror can be used to focus sunlight to ignite a paper.

*Solution:* A concave mirror converges parallel rays of sunlight to a focal point. When a piece of paper is placed at this focal point, the concentrated light produces enough heat to ignite the paper.

## Practice Set

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- **Level 1:** What is the shape of the reflecting surface of a concave mirror?
- **Level 2:** How does the image formed by a convex mirror differ from that formed by a concave mirror when the object is far away?
- **Level 3:** Explain the use of concave mirrors in solar concentrators.

## Answer Key

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- **Level 1:** The reflecting surface of a concave mirror is curved inward.
- **Level 2:** A convex mirror forms a smaller, erect image regardless of the object's distance, while a concave mirror forms an inverted image that changes size depending on the object's distance.
- **Level 3:** Concave mirrors in solar concentrators focus sunlight onto a small area to produce heat, which can be used to generate steam and electricity or for cooking.

## Image Formation

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### By Spherical Mirrors

The image formed by spherical mirrors depends on the type of mirror and the position of the object:

- **Concave Mirror:** Can form both erect and inverted images. When the object is close, the image is erect and enlarged; when far, the image is inverted and varies in size.
- **Convex Mirror:** Always forms erect, diminished images regardless of object distance.

### Lateral Inversion

Both concave and convex mirrors exhibit lateral inversion when the image formed is virtual.

## Solved Examples

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**Example 1:** What type of image is formed by a convex mirror when an object is placed in front of it?

*Solution:* A convex mirror always forms a virtual, erect, and diminished image of the object.

**Example 2:** Describe the change in image size formed by a concave mirror as the object moves away from the mirror.

*Solution:* As the object moves away from a concave mirror, the image changes from erect and enlarged to inverted and diminished in size.

## Practice Set

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- **Level 1:** What kind of image does a convex mirror form?
- **Level 2:** How does the image formed by a concave mirror change with object distance?
- **Level 3:** Why does a concave mirror produce a magnified image when the object is close?

## Answer Key

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- **Level 1:** A convex mirror forms a virtual, erect, and diminished image.
- **Level 2:** The image changes from erect and enlarged to inverted and diminished as the object moves away.
- **Level 3:** When the object is close, the reflected rays diverge, and the brain perceives a magnified virtual image behind the mirror.

## Lenses

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### Definition and Types

A lens is a transparent material bounded by two curved surfaces. There are two main types:

- **Convex Lens:** Thicker at the middle than at the edges; converges light rays.
- **Concave Lens:** Thicker at the edges than at the middle; diverges light rays.

## Image Formation by Lenses

Convex lenses can form both erect and inverted images depending on the object's distance. Concave lenses always form erect, diminished images.

## Uses of Lenses

- Convex lenses are used in eyeglasses for farsightedness, cameras, microscopes, telescopes, and magnifying glasses.
- Concave lenses are used in eyeglasses for nearsightedness, peepholes, and some optical instruments.

## Solved Examples

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**Example 1:** What type of image is formed by a convex lens when the object is close to it?

*Solution:* The convex lens forms an erect and magnified image when the object is close.

**Example 2:** Explain why a convex lens can ignite paper when focused on sunlight.

*Solution:* A convex lens converges parallel rays of sunlight to a focal point, concentrating heat enough to ignite paper placed at that point.

## Practice Set

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- **Level 1:** What is the shape of a concave lens?
- **Level 2:** How does the image formed by a convex lens change as the object moves away?
- **Level 3:** Describe the use of convex lenses in optical instruments.

# Answer Key

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- **Level 1:** A concave lens is thinner in the middle and thicker at the edges.
- **Level 2:** The image changes from erect and magnified to inverted and diminished as the object moves away.
- **Level 3:** Convex lenses are used to focus light and magnify images in instruments like cameras, microscopes, and telescopes.

## Reflection

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### Basic Concepts

Reflection is the change in direction of light when it strikes a surface and bounces back.

The ray of light striking the surface is called the **incident ray**, and the ray bouncing back is the **reflected ray**. The line perpendicular to the surface at the point of incidence is called the **normal**.

### Laws of Reflection

- The angle of incidence is equal to the angle of reflection.
- The incident ray, reflected ray, and normal all lie in the same plane.

### Reflection in Spherical Mirrors

Spherical mirrors follow the same laws of reflection. However, due to their curved surfaces, the reflected rays may converge or diverge, forming different types of images.

### Solved Examples

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**Example 1:** State the laws of reflection.

*Solution:* The angle of incidence equals the angle of reflection, and the incident ray, reflected ray, and normal lie in the same plane.

**Example 2:** Explain why a concave mirror can focus sunlight to a point.

*Solution:* The concave mirror's curved surface causes parallel rays of sunlight to reflect and converge at a focal point, concentrating light and heat.

## Practice Set

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- **Level 1:** What is the normal in reflection?
- **Level 2:** Why do reflected rays from a concave mirror converge?
- **Level 3:** Describe the path of light rays when they strike two mirrors placed at right angles.

## Answer Key

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- **Level 1:** The normal is a line perpendicular to the reflecting surface at the point of incidence.
- **Level 2:** Because the concave mirror's surface curves inward, the reflected rays converge at a focal point.
- **Level 3:** Light rays incident on two mirrors at right angles reflect off both mirrors, splitting into different directions according to the laws of reflection.

## Quick Reference Table

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## Common Mistakes and Misconceptions

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