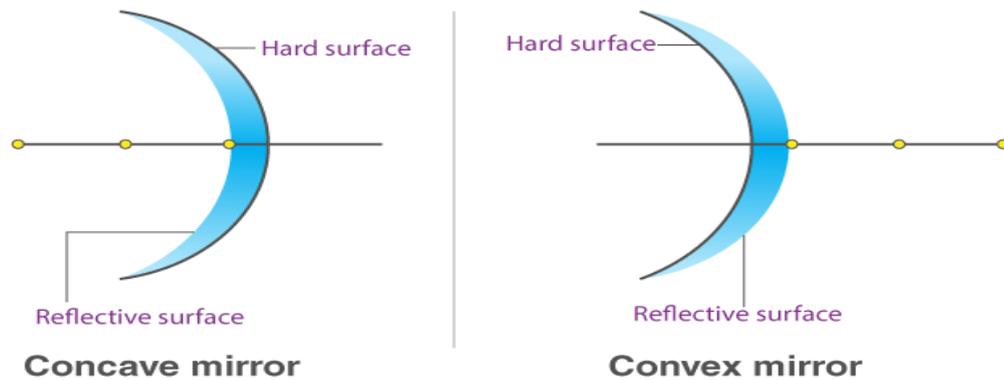


CONCAVE MIRRORS AND CONVEX MIRRORS



A mirror is a surface that reflects almost all incident light. Mirrors come in two types: those with a flat surface, known as plane mirrors, and those with a curved surface, called spherical mirrors. In this article, we will explore two specific types of spherical mirrors: convex mirrors and concave mirrors. We will also delve into the concept of ray diagrams, which help us understand how light behaves when it interacts with these mirrors. By examining the ray diagram of a spherical mirror, we can gain insights into the fascinating phenomena of reflection and image formation.

What is a Mirror?

A mirror plays a fascinating role in reflecting light, resulting in the formation of images. When an object is placed in front of a mirror, we observe its reflection. Incident rays originate from the object, and the reflected rays converge or appear to diverge to create the image. Images formed by mirrors can be classified as real image or virtual image. Real images are produced when light rays converge and intersect, while virtual images are formed when light rays appear to diverge from a point.

Ray diagrams are employed to comprehend the behaviour of light and better understand image formation. These diagrams use lines with arrows to represent incident and reflected rays, allowing us to trace their paths and interactions with the mirror. By interpreting ray diagrams, we gain valuable insights into how images are formed and a deeper understanding of how our eyes perceive objects through reflection.

Plane Mirror vs Spherical Mirror

A plane mirror is a flat, smooth reflective surface with a clear, undistorted reflection. When an object is reflected in a plane mirror, it always forms a virtual image that is upright, of the same shape and size as the object.

On the other hand, a spherical mirror exhibits a consistent curvature. It possesses a constant radius of curvature (In the context of spherical mirrors, the radius of curvature refers to the distance between the centre of the spherical mirror and its curved surface.). Spherical mirrors can create both real and virtual images, depending on the position of the object and the mirror. Spherical mirrors are further categorized into concave and convex mirrors, each with distinct properties and image formation characteristics.

In the upcoming sections, we will detail the characteristics of convex and concave mirrors, along with a comprehensive understanding of the images formed by these mirrors when the object is placed at various positions with the help of ray diagrams.

Characteristics of Concave and Convex Mirrors

Concave Mirror Definition

A concave mirror is a curved mirror where the reflecting surface is on the inner side of the curved shape. It has a surface that curves inward, resembling the shape of the inner surface of a hollow sphere. Concave mirrors are also converging mirrors because they cause light rays to converge or come together after reflection. Depending on the position of the object and the mirror, concave mirrors can form both real and virtual images.

Characteristics of Concave Mirrors

1. **Converging Mirror:** A concave mirror is often referred to as a converging mirror because when light rays strike and reflect from its reflecting surface, they converge or come together at a specific point known as the focal point. This property of concave mirrors allows them to focus light to a point.
2. **Magnification and Image Formation:** When a concave mirror is placed very close to the object, it forms a magnified, erect, and virtual image. The image appears larger than the actual object and is upright. The virtual image is formed as the reflected rays appear to diverge from a point behind the mirror.
3. **Changing Distance and Image Properties:** As the distance between the object and the concave mirror increases, the size of the image decreases. Eventually, at a certain distance, the image transitions from virtual to real. In this case, a real and inverted image is formed on the opposite side of the mirror.
4. **Versatile Image Formation:** Concave mirrors have the ability to create images that can vary in size, from small to large, and in nature, from real to virtual. These characteristics make concave mirrors useful in various applications such as telescopes, shaving mirrors, and reflecting headlights.

Convex Mirror Definition

A convex mirror is a curved mirror with the reflecting surface on the curved shape's outer side. It has a surface that curves outward, resembling the shape of the outer surface of a sphere. Convex mirrors are also known as diverging mirrors because they cause light rays to diverge or spread out after reflection. Convex mirrors always form virtual, erect, and diminished images, regardless of the object's position. They are commonly used in applications requiring a wide field of view, such as rear-view mirrors and security mirrors.

Characteristics of Convex Mirrors

1. **Diverging Mirror:** A convex mirror is commonly referred to as a diverging mirror because when light rays strike its reflecting surface, they diverge or spread out. Unlike concave mirrors, convex mirrors cause light rays to diverge from a specific focal point.
2. **Virtual, Erect, and Diminished Images:** Regardless of the distance between the object and the convex mirror, the images formed are always virtual, erect, and diminished. The image appears upright, smaller than the actual object, and behind the mirror. When traced backwards, the virtual image is formed by the apparent intersection of diverging rays.
3. **Wide Field of View:** One of the significant characteristics of convex mirrors is their ability to provide a wide field of view. Due to the outwardly curved shape, convex mirrors can reflect a broader area compared to flat or concave mirrors. This property makes them useful when a larger perspective is required, such as in parking lots, intersections, or surveillance systems.

4. **Image Distance and Size:** Convex mirrors always produce virtual images closer to the mirror than the object. The image formed by a convex mirror appears diminished or smaller than the object. This reduction in image size allows a greater expanse of the reflected scene to be captured within the mirror's field of view.

Image Formation by Spherical Mirrors

By understanding some crucial guidelines for ray incidence on concave and convex mirrors, we can predict and analyze the behaviour of light rays, aiding in constructing accurate ray diagrams and comprehending image formation processes.

Guidelines for Rays Falling on the Concave and Convex Mirrors

Oblique Incidence: When a ray strikes a concave or convex mirror at its pole, it is reflected obliquely, making the same angle as the principal axis. This principle of reflection ensures that the angle of incidence is equal to the angle of reflection, maintaining the symmetry of the reflected rays.

Parallel Incidence: When a ray parallel to the principal axis strikes a concave or convex mirror, the reflected ray follows a specific path. In the case of a concave mirror, the reflected ray passes through the focus on the principal axis. Similarly, for a convex mirror, the reflected ray originates from the focus on the same side as the incident ray.

Focus Incidence: When a ray passes through the focus and strikes a concave or convex mirror, the reflected ray will be parallel to the principal axis. This characteristic holds for concave and convex mirrors and is crucial in determining the path of reflected rays.

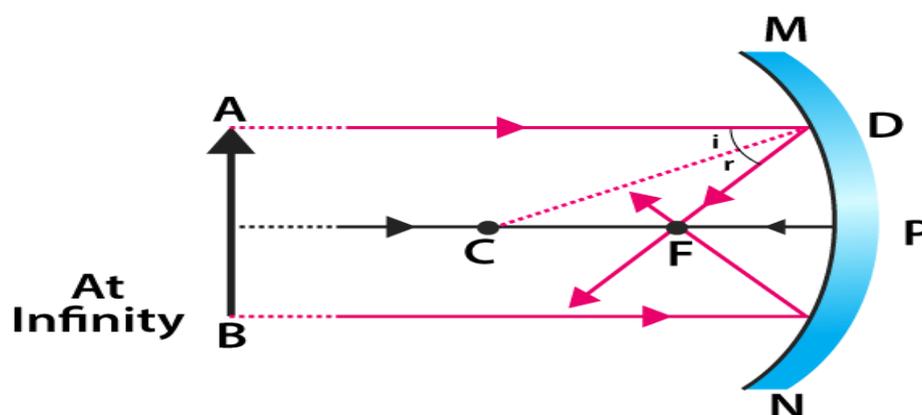
Centre of Curvature Incidence: A ray passing through the centre of curvature of a spherical mirror will retrace its path after reflection. This principle illustrates that when a ray hits the mirror's centre of curvature, it undergoes reflection and follows the exact same path in the opposite direction.

Image Formation by Concave Mirror

The object's position in relation to a concave mirror affects the type and characteristics of the image formed. Different scenarios result in different types of images:

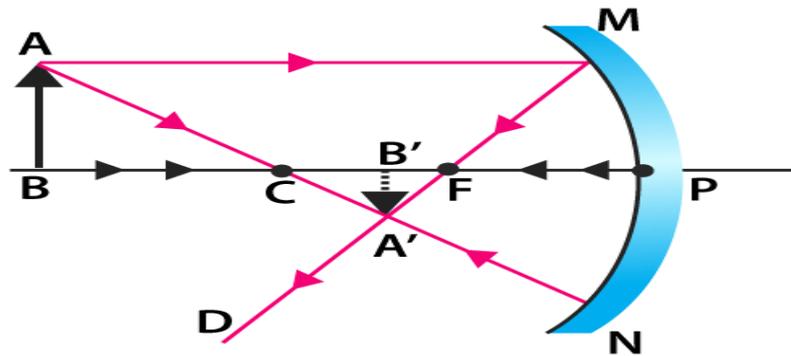
Object at Infinity

A real and inverted image is formed at the focus when the object is placed at infinity. The size of the image is significantly smaller than that of the object.



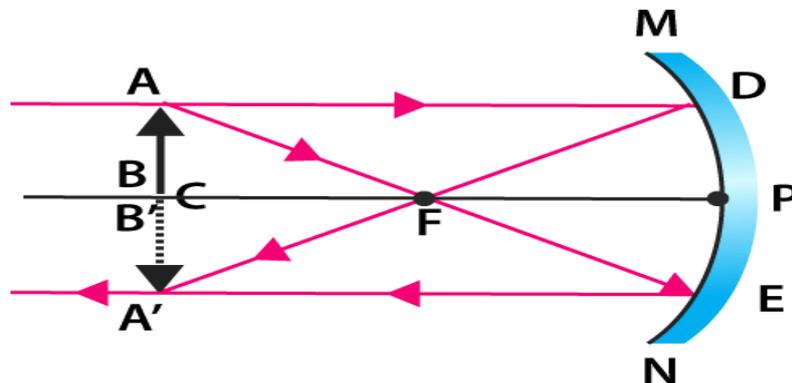
Object Beyond the Centre of Curvature

When the object is positioned beyond the centre of curvature, a real image is formed between the centre of curvature and the focus. The size of the image is smaller compared to that of the object.



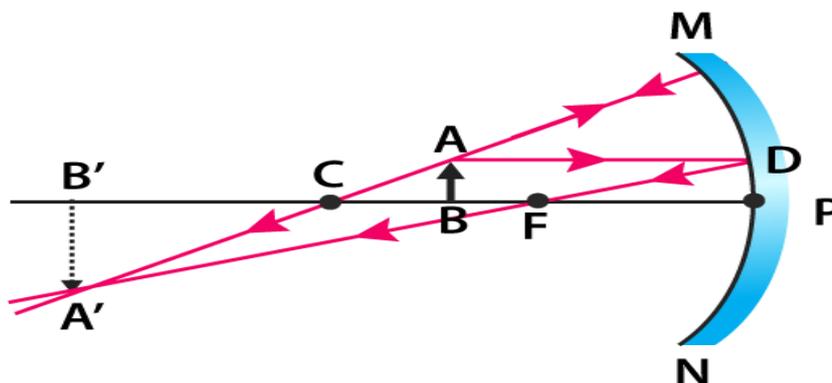
Object at the Centre of Curvature or Focus

When the object is placed at the centre of curvature, or the focus, a real image is formed at the centre of curvature. The size of the image remains the same as that of the object.



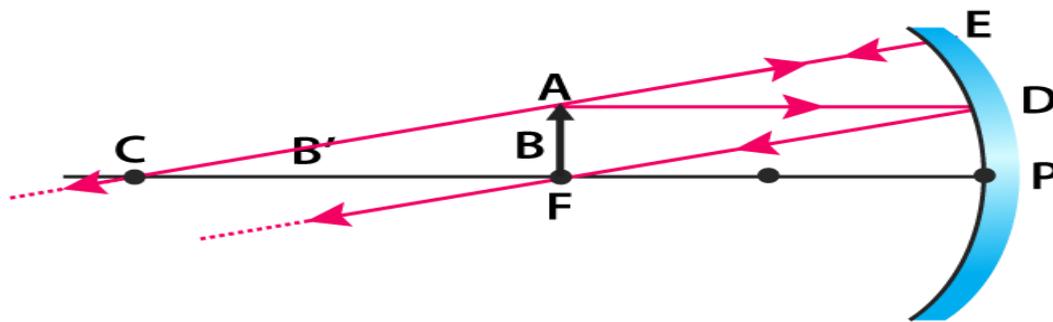
Object Between the Centre of Curvature and Focus

If the object is located between the centre of curvature and the focus, a real image is formed behind the centre of curvature. The size of the image is larger compared to that of the object.



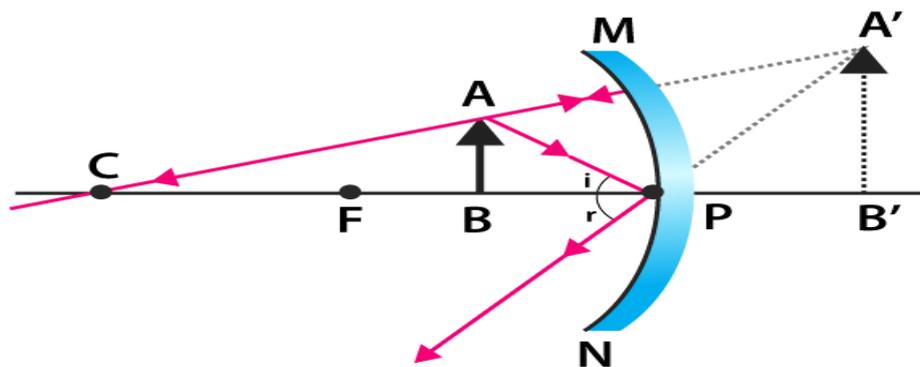
Object at the Focus-

When the object is positioned exactly at the focus, a real image is formed at infinity. The size of the image is much larger than that of the object.



Object Between the Focus and the Pole

Placing the object between the focus and the pole results in the formation of a virtual and erect image. The size of the image is larger compared to that of the object.



Concave Mirror Image Formation Summary

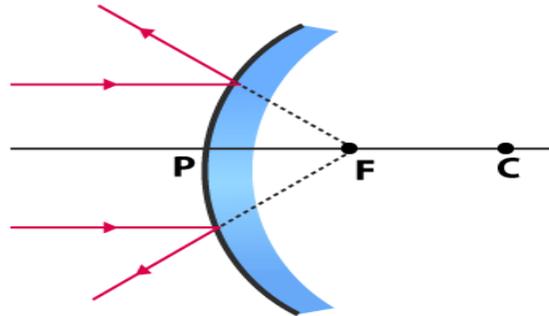
S. No	Position of Object	Position of Image	Size of Image	Nature of Image
1	Object at Infinity	At the Focus	Highly Diminished	Real and Inverted
2	Object Beyond the Centre of Curvature	Between the Centre of Curvature and Focus	Diminished	Real and Inverted
3	Object at the Centre of Curvature or Focus	At the Centre of Curvature	Same Size	Real and Inverted
4	Object Between the Centre of Curvature and Focus	Behind the Centre of Curvature	Enlarged	Real and Inverted
5	Object at the Focus	At Infinity	Highly Enlarged	Real and Inverted
6	Object Between the Focus and the Pole	Behind the Mirror	Enlarged	Virtual and Erect

Image Formation by Convex Mirror

A convex mirror produces specific characteristics in the images formed. Let's explore the types of images formed by a convex mirror.

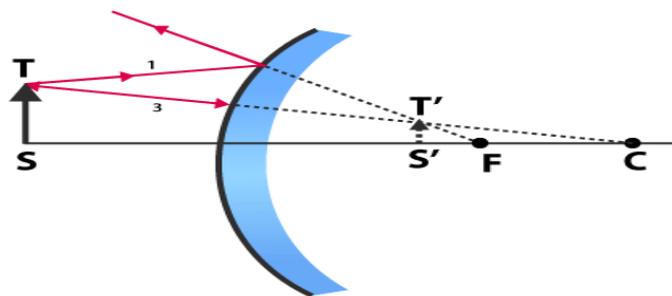
Object at Infinity

When the object is positioned at infinity, a virtual image is formed at the focus of the convex mirror. The size of the image is significantly smaller than that of the object.



Object at a Finite Distance

When an object is placed at a finite distance from the mirror, a virtual image is formed between the pole and the focus of the convex mirror. The size of the image is smaller than compared to that of the object.



It's important to note that in both cases, the images formed by a convex mirror are always virtual and erect. The nature of a convex mirror causes light rays to diverge upon reflection, creating virtual images with reduced sizes. Understanding these principles helps us accurately predict the characteristics of images formed by convex mirrors.

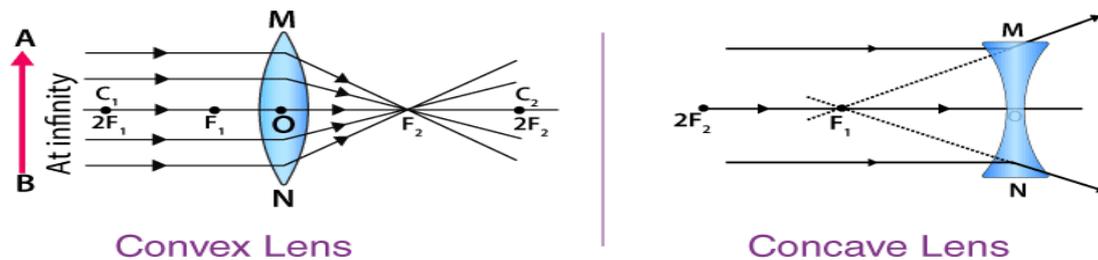
Concave Mirror Image Formation Summary

S. No	Position Of Object	Position of Image	Size of Image	Nature of Image
1	At Infinity	At the focus F, behind the mirror	Highly diminished	Virtual and Erect
2	Between Infinity and the Pole	Between P and F, behind the mirror	Diminished	Virtual and Erect

CONVEX AND CONCAVE LENS-

Spherical lenses are lenses formed by connecting two spherical transparent surfaces. In general, there are two types of spherical lenses. So, lenses formed by binding two spherical surfaces bulging outward are known as convex lenses, while the lenses formed by binding two spherical surfaces such that they are curved inward are known as concave lenses. This is one of the basic differences between concave and convex lenses.

Convex lenses are also known as converging lenses since the rays converge after falling on the convex lens. The concave lens are known as diverging lenses, as the rays diverge after falling on the concave lens. In this article, we will learn about image formation by concave and convex lenses.



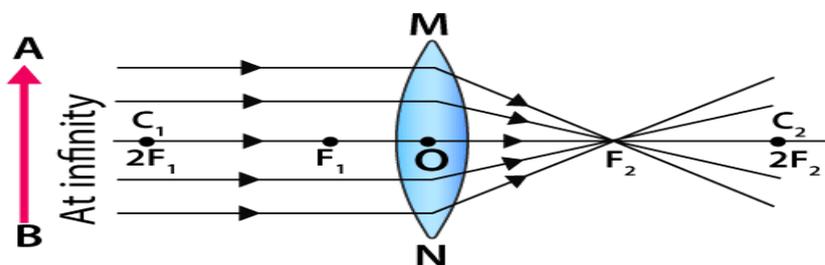
Guidelines for rays falling on the concave and convex lenses

1. When a ray strikes concave or convex lenses obliquely at its optical centre, it continues to follow its path.
2. When a ray, parallel to the principal axis strikes concave or convex lenses, the reflected ray passes through a focus on the principal axis.
3. When a ray, passing through focus strikes concave or convex lenses, the reflected ray will pass parallel to the principal axis.

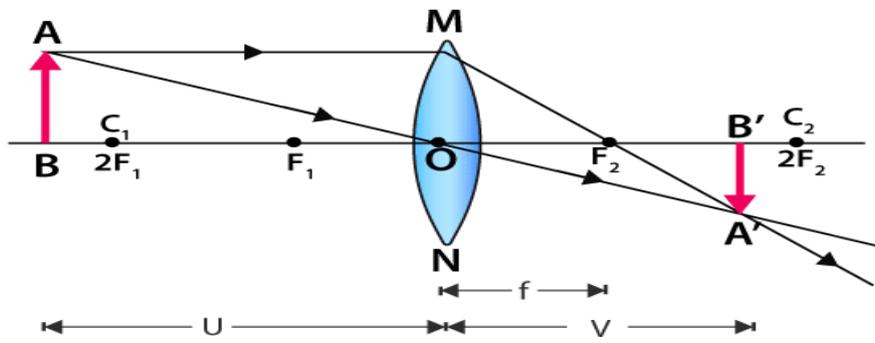
Image Formation by Concave and Convex Lenses:

Convex Lenses

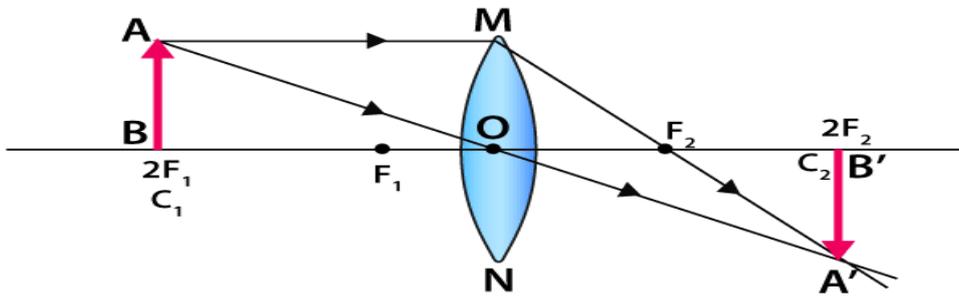
- When an object is placed at infinity, the real image is formed at the focus. The size of the image is highly diminished and point size.



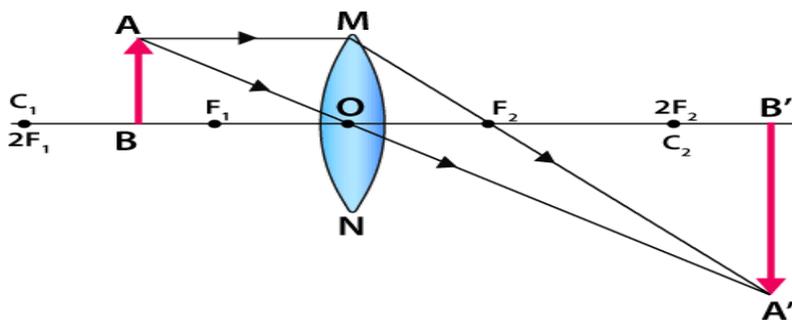
- When an object is placed beyond the centre of curvature, the real image is formed between the centre of curvature and focus. The image size will not be the same as the object. It will be diminished in size.



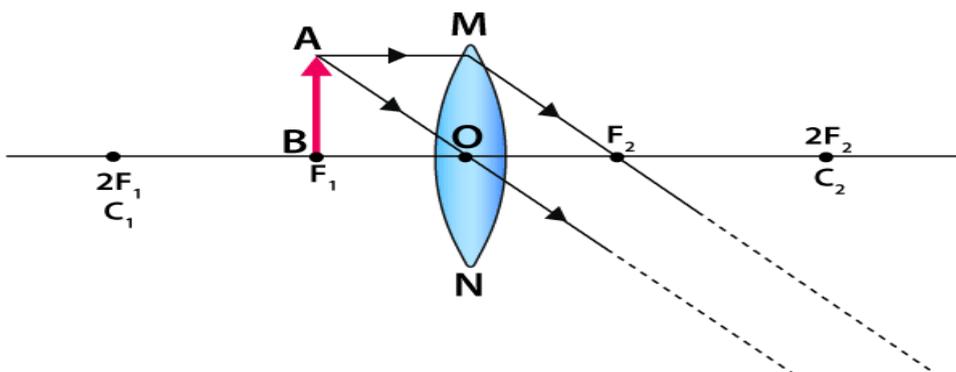
- When an object is at the centre of curvature, the real image is formed at the other centre of curvature. The size of the image is the same as compared to that of the object.



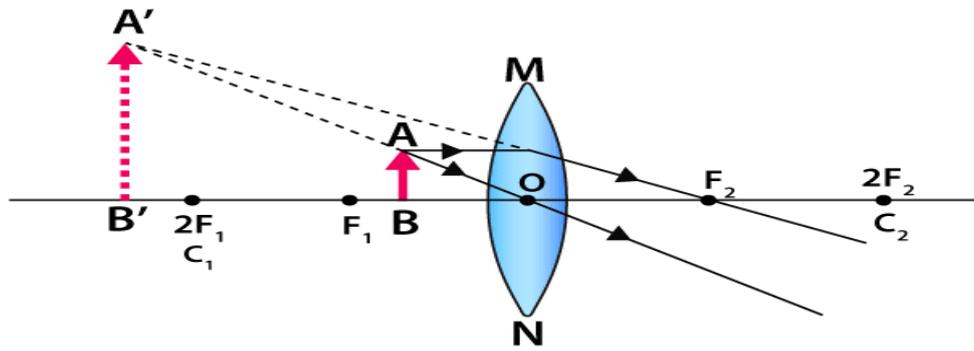
- When an object is placed in between the centre of curvature and focus, the real image is formed behind the centre of curvature. The size of the image is larger than that of the object.



- When an object is placed at the focus, a real image is formed at infinity. The size of the image is much larger than that of the object.

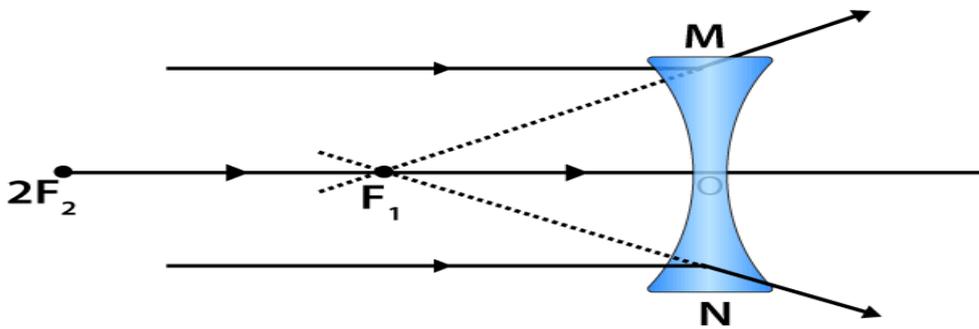


- When an object is placed in between focus and optical centre, a virtual image is formed. The size of the image is larger than that of the object.

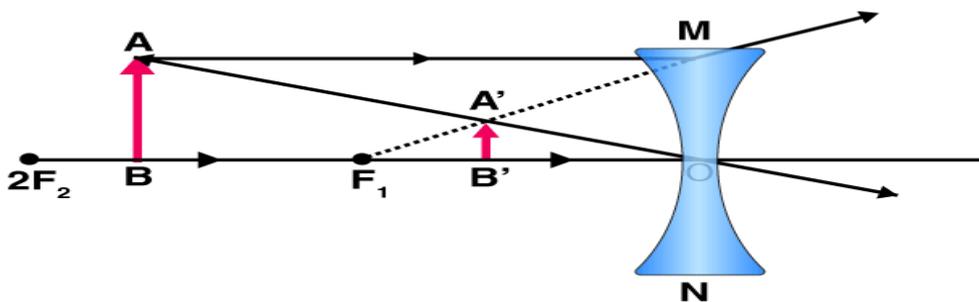


Concave Lenses

- When an object is placed at infinity, a virtual image is formed at the focus. The size of the image is highly diminished and point size.



- When an object is placed at a finite distance from the lens, a virtual image is formed between the optical centre and the focus of the concave lens. The size of the image is smaller than that of the object.



Summary of Image Formation by Concave and Convex Lens

Image formation by Concave Lens

Object Location	Image Location	Image Nature	Image Size
Infinity	At F_1	Virtual and Erect	Highly diminished, point-sized
Beyond Infinity and Optical Centre	Between Focus (F_1) and Optical center (O)	Virtual and Erect	Diminished

Image formation by Convex Lens

Object location	Image location	Image nature	Image size
Infinity	At F_2	Real and Inverted	Diminished, point sized
Beyond $2F_1$	Between $2F_2$ and F_2	Real and Inverted	Diminished
Between $2F_1$ and F_1	Beyond $2F_2$	Real and Inverted	Enlarged
At F_1	At infinity	Real and Inverted	Infinitely large or highly enlarged
At $2F_1$	At $2F_2$	Real and Inverted	Same size
Between F_1 and 0	On the same side as the object	Virtual and Erect	Enlarged