NCERT Class 10 Science Notes

Chapter 10 Light Reflection and Refraction

Important Terms

Light is a type of energy that can be converted into other types of energy.

Light does not require a physical medium to propagate.

Light's velocity in air or vacuum is $3 \times 10^8 \text{ m/s}$.

Rectilinear Propagation of Light

Light travels in a straight line in a homogeneous transparent medium, which is known as rectilinear propagation of light.

Reflection of Light

Reflection of light describes the phenomenon by which a ray of light changes its propagation direction when it encounters a boundary between different media through which it cannot pass.

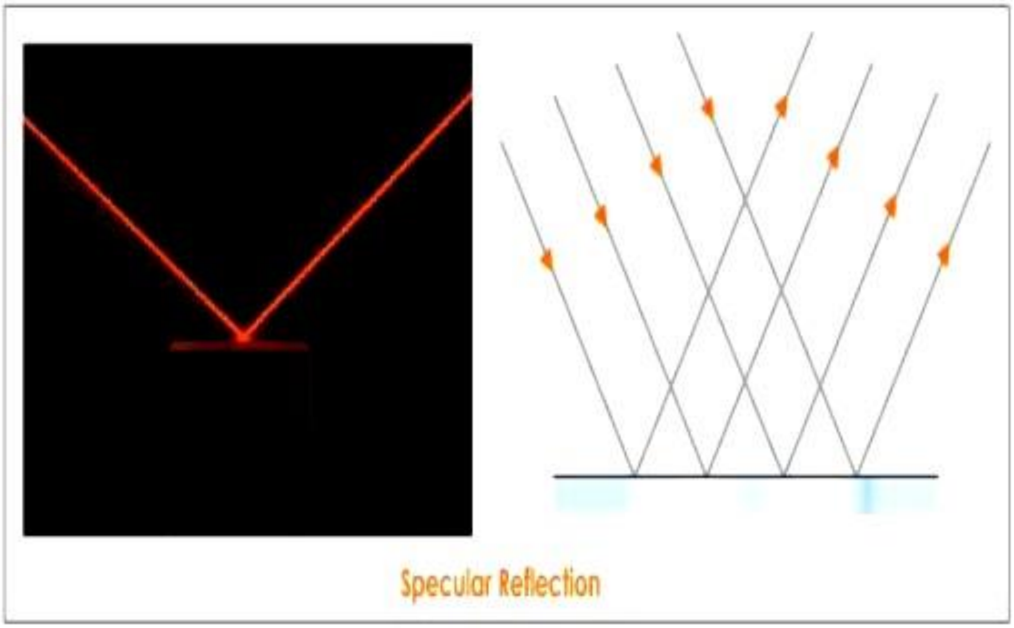
There are two types of reflection of light:

➢ Regular reflection or specular reflection

➢ Irregular reflection or diffused reflection

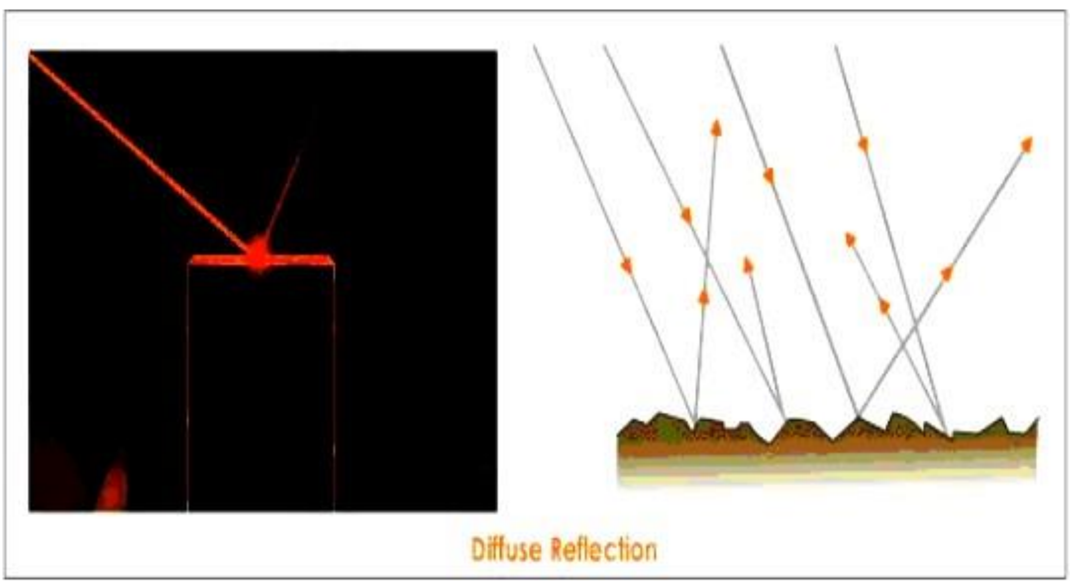
Regular Reflection

The perfect, mirror-like reflection of light is known as specular or regular reflection. Regular reflections include reflections in mirrors, water surfaces, and highly polished floors.



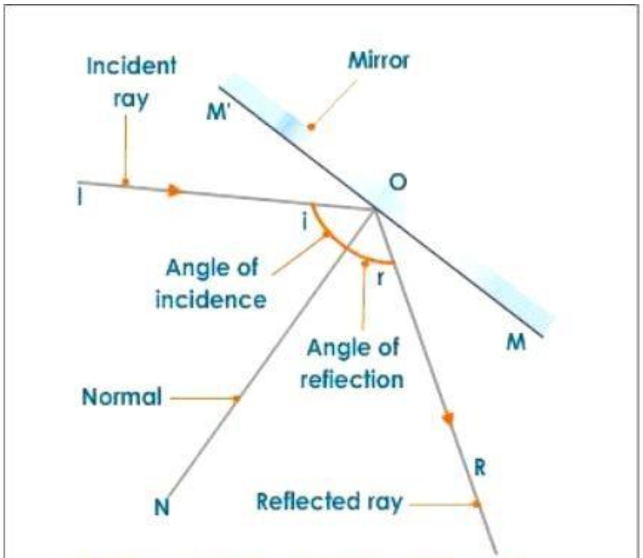
Irregular Reflection:

Irregular reflection, also known as diffused reflection, occurs when a ray of light strikes a rough or unpolished wall or wood. In this case, the incident light is reflected in different directions by different parts of the surface. There is no definite image formed in such cases, but the surface becomes visible. It is commonly referred to as light scattering. As a result of the diffused reflection, non-luminous objects become visible.



Reflection of Light by a Plane Surface:

The diagram depicts how a light ray is reflected by a plane surface. Assume MM' is a reflecting surface. When a light ray strikes MM' in the direction IO, it is reflected along the direction OR. The incident ray is denoted by IO, the point of incidence by O, and the reflected ray by OR.



Reflection of a Ray of Light by a Plane Mirror

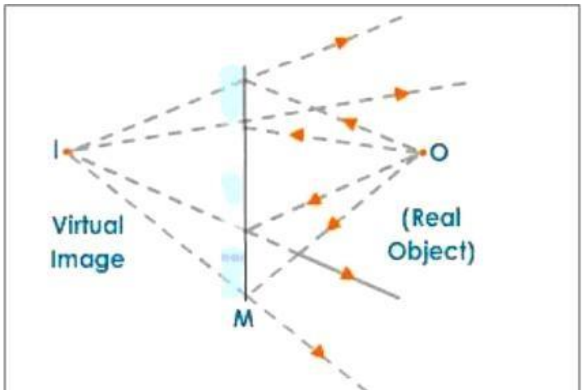
Let ON be the perpendicular normal to the surface MM' at the point of incidence. The angle of incidence, denoted by the letter I is the angle formed by the incident ray with the normal at the point of incidence. The angle of reflection 'r' is the angle formed by the reflected ray and the normal at the point of incidence. A reflecting surface is something like a mirror.

Laws of Reflection:

The laws of reflection are observed to apply to any plane surface's reflection. The incident ray, reflected ray, and normal at the point of incidence all lie in the same plane, according to the laws of reflection. The angle of incidence equals the angle of reflection.

Nature of Image Formed by a Plane Reflecting Surface:

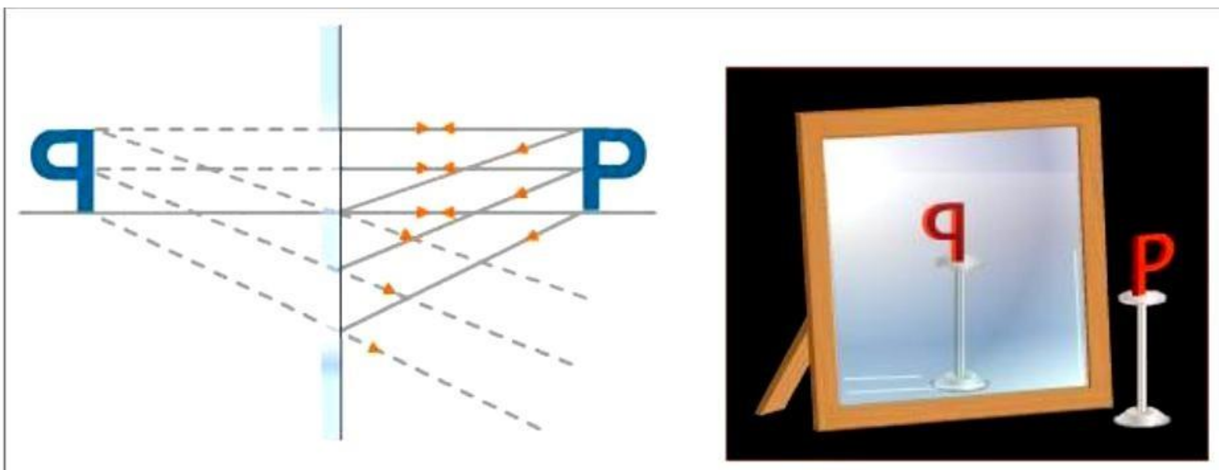
An image can be both real and virtual. When light rays intersect after reflection, a true image is formed. When the light rays after reflection do not actually intersect but appear to diverge from it, a virtual image is formed (these rays of light intersect when produced backwards).



(i)
Virtual Image Formed by a Plane Mirror

Ray Diagrams of Plane Mirrors:

When drawing ray diagrams, the following rays are usually taken into account: A ray of light incident at 90 degrees on a plane mirror is reflected from the mirror along the same path. A ray of light falling at any angle on a plane mirror is reflected from it in such a way that the angle of incidence equals the angle of reflection. The image is formed when the reflected rays appear to collide.



Formation of Image by a Plane Mirror

Spherical Mirrors:

A spherical mirror is a mirror with a polished, reflecting surface that is part of a hollow sphere of glass or plastic. One of the two curved surfaces of a spherical mirror is coated with a thin layer of silver, followed by a coat of red lead oxide paint. As a result, one side of the spherical mirror is opaque, while the other is a highly polished reflecting surface. The opaque side of a mirror is always shaded in a diagram.

Please keep in mind that the opaque, non-reflecting side is shaded blue in the diagrams below, while the reflecting side is shaded red.

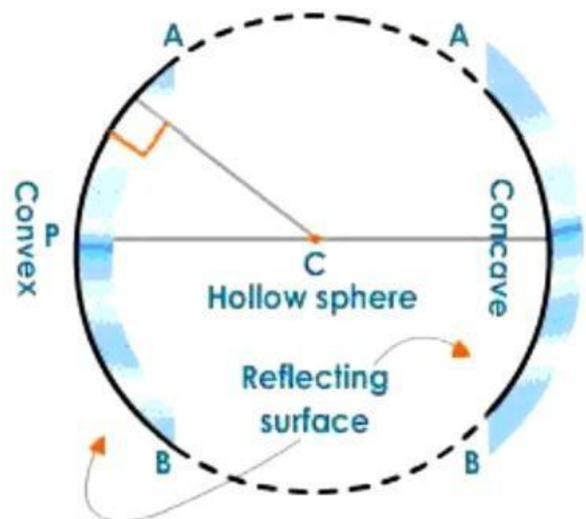
The spherical mirror is classified as follows based on the nature of its reflecting surface:

Concave mirror

A concave mirror is a spherical mirror with its reflecting surface oriented toward the center of the sphere of which it is a part.

Convex mirror

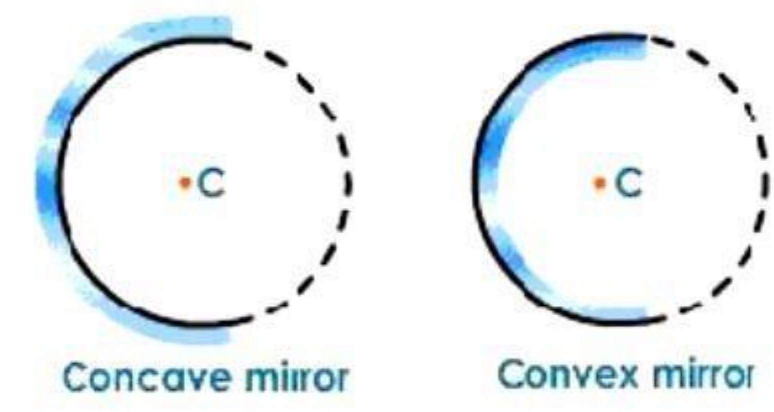
A convex mirror is a spherical mirror with a reflecting surface that is angled away from the center of the sphere of which it is a part.



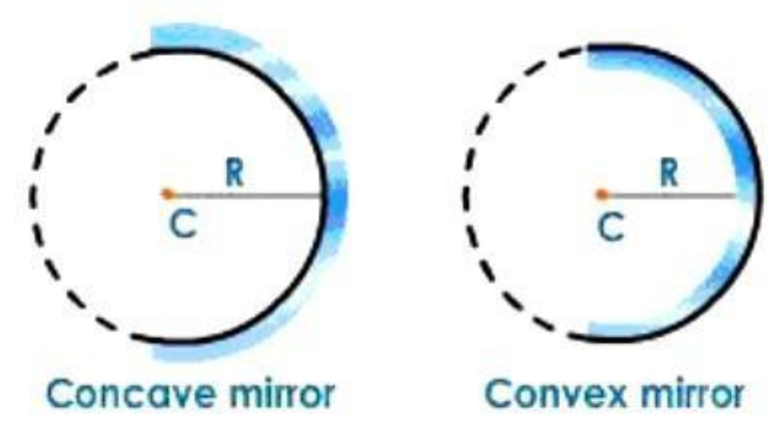
Concave and Convex Mirror

Centre of curvature:

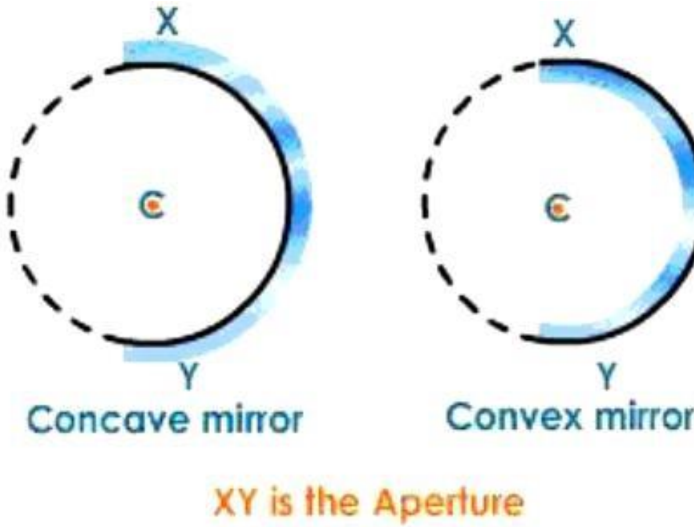
The centre of curvature is the center of the sphere, of which the spherical mirror is a part. It is represented by the letter C.



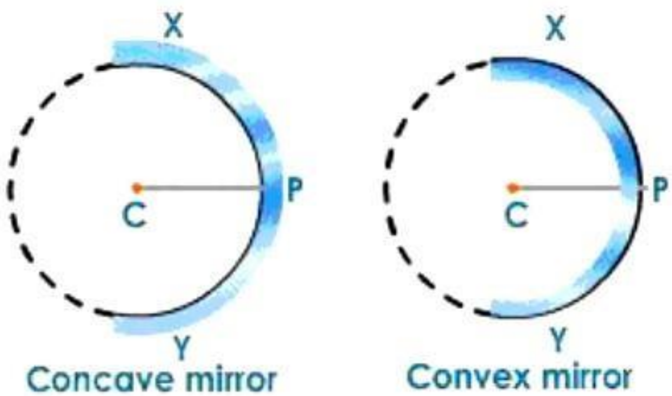
Radius of Curvature: The radius of the sphere, of which the mirror is a part, is defined as the radius of curvature. It is denoted by the letter R.



Linear Aperture: The distance between the extreme points (X and Y) on the mirror's periphery is defined as the linear aperture.

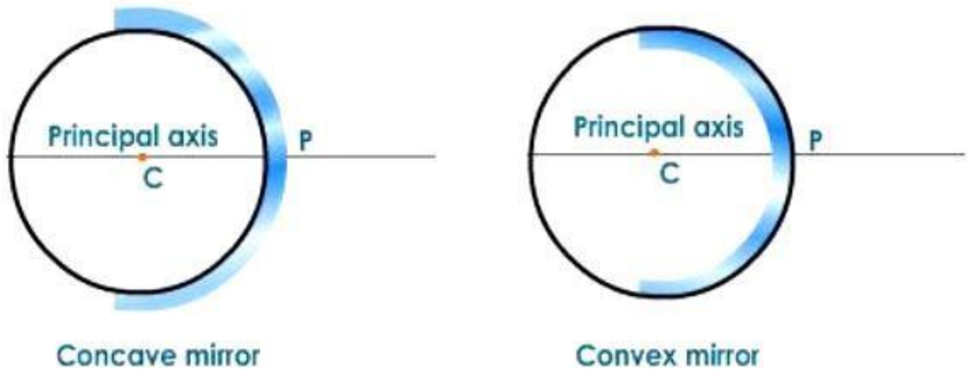


Pole: The pole is the spherical mirror's aperture's midpoint. It is denoted by the letter P.

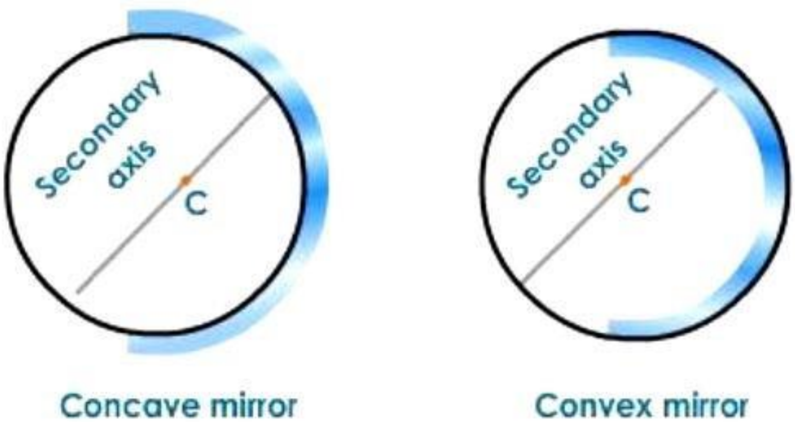


Principal axis

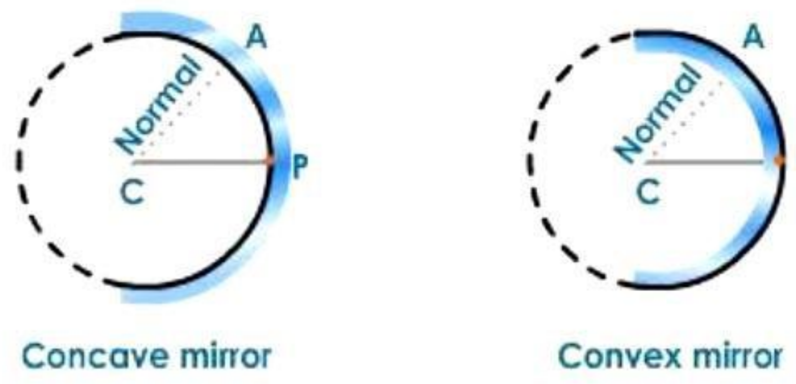
The principal axis of a spherical mirror is the straight line that passes through the pole and the center of curvature.



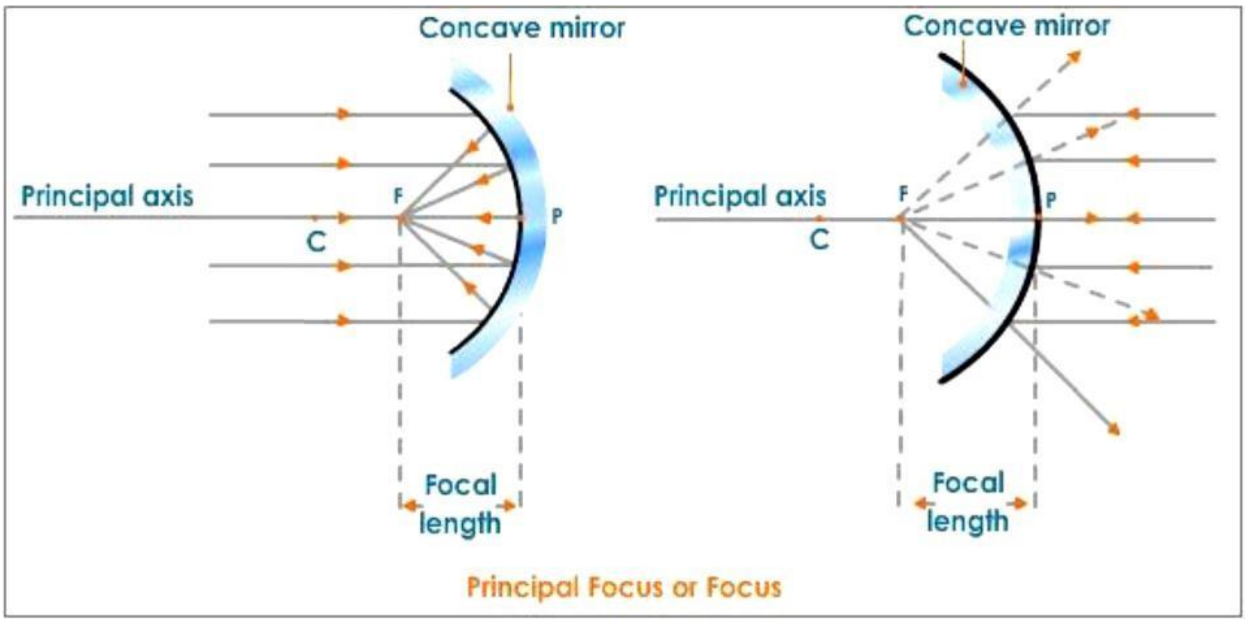
Secondary Axis: A secondary axis is any radial line other than the principal axis that passes through the center of curvature.



Normal: The normal at any point on the spherical mirror is the straight line formed by connecting that point to the mirror's center. The normal at point A on the mirror is the line AC obtained by connecting A to the mirror's center of curvature. The radius of the sphere of which the mirror is a part is equal to the normal at any point on a spherical mirror.



Principal Focus or Focus:



After reflection, light rays parallel to the principal axis of a mirror either pass through a point (in the case of a concave mirror) or appear to diverge from a point (in the case of a convex mirror), and this point is referred to as the mirror's principal focus or focal point.

Focal Length: The focal length of a mirror is the distance between the pole and the focus. It is symbolized by the letter f.

Characteristics of Focus of a Concave Mirror and a Convex Mirror

Convex mirror	Concave mirror
The focal point is hidden behind the mirror.	The focus is on the mirror.
Because the rays of light after reflection appear to come from the focus, the focus is virtual.	The focus exists because light rays converge at the focus after reflection.

Sign Convention for Spherical Mirrors

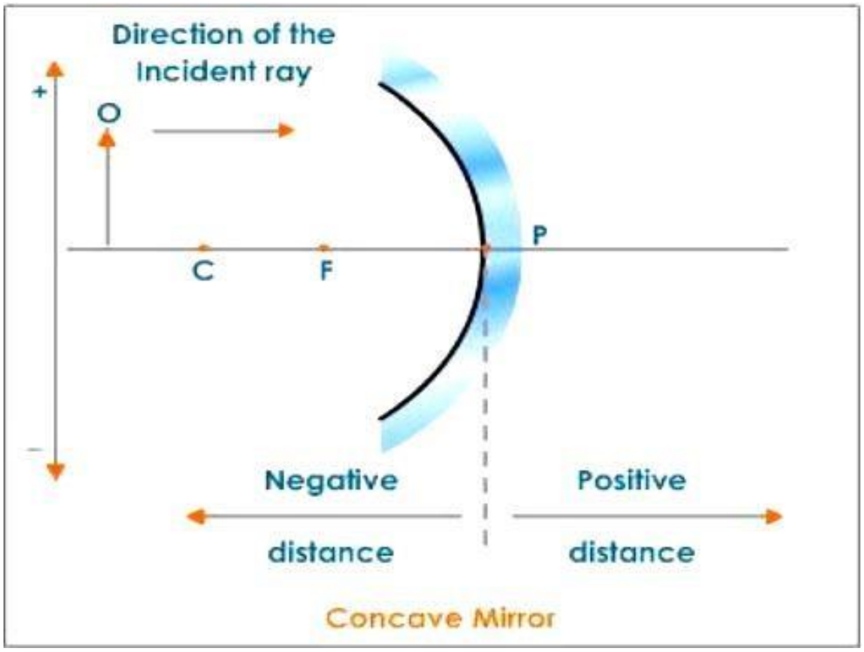
In the ray diagrams of spherical mirrors, the following sign convention is used to measure various distances:

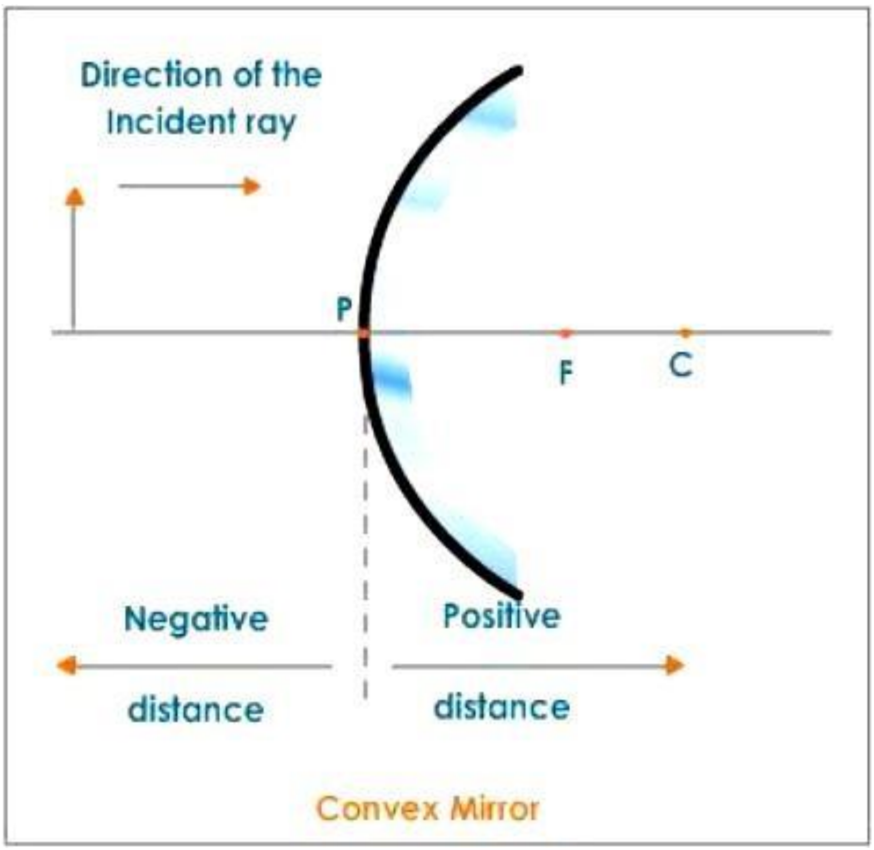
The object is always positioned to the left of the mirror.

All distances are measured from the mirror's pole.

Distances measured in the direction of the incident ray are positive, while distances measured in the opposite direction are negative.

Distances measured above the principal axis are positive, while distances measured below the principal axis are negative.

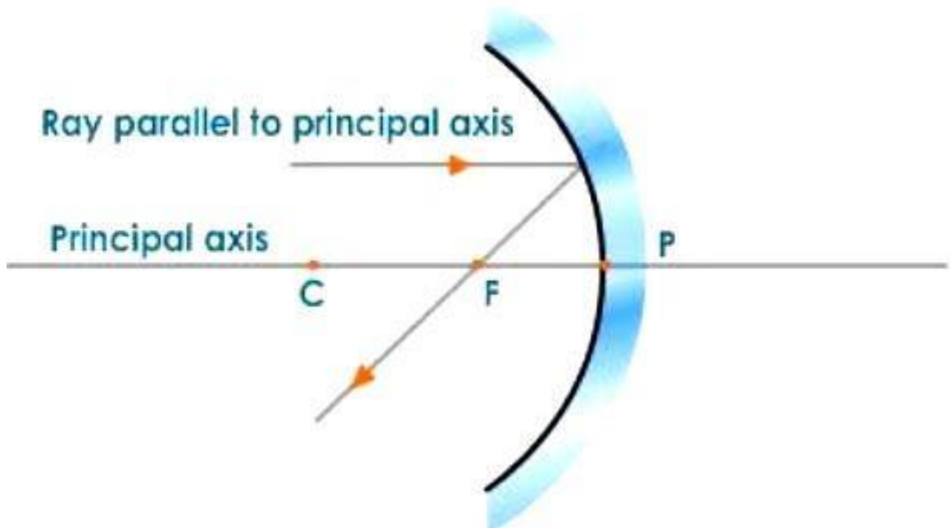




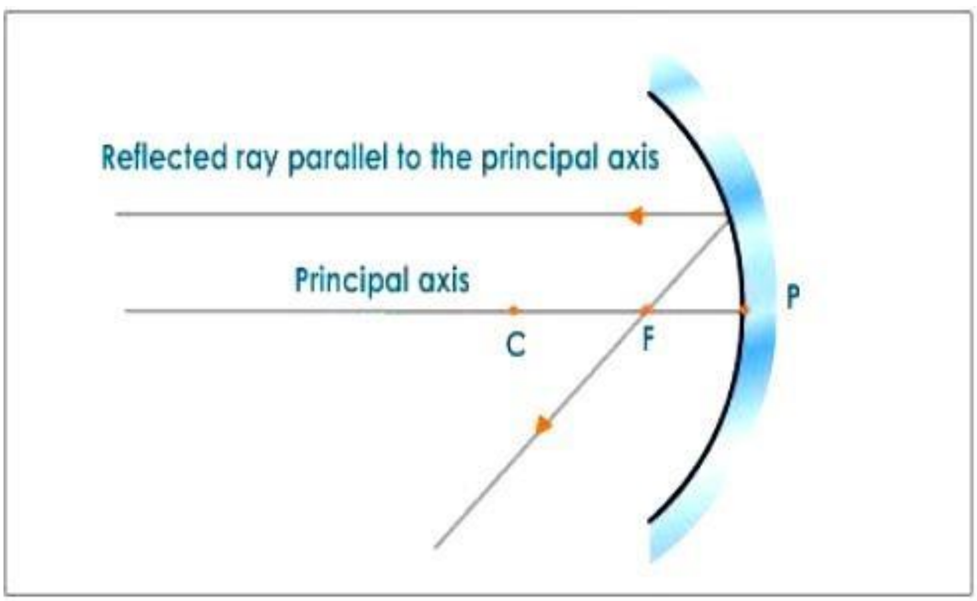
Concave Mirror

When an object is placed in front of a concave mirror, light rays from the object are reflected on the mirror. At the point where the reflected rays intersect or appear to intersect, an image is formed. The formation of an image by mirrors is typically depicted by drawing ray diagrams. To create a ray diagram, we need at least two rays with known paths after reflection from the mirror. These rays must be chosen based on our needs. To obtain the image, any two of the following rays can be considered.

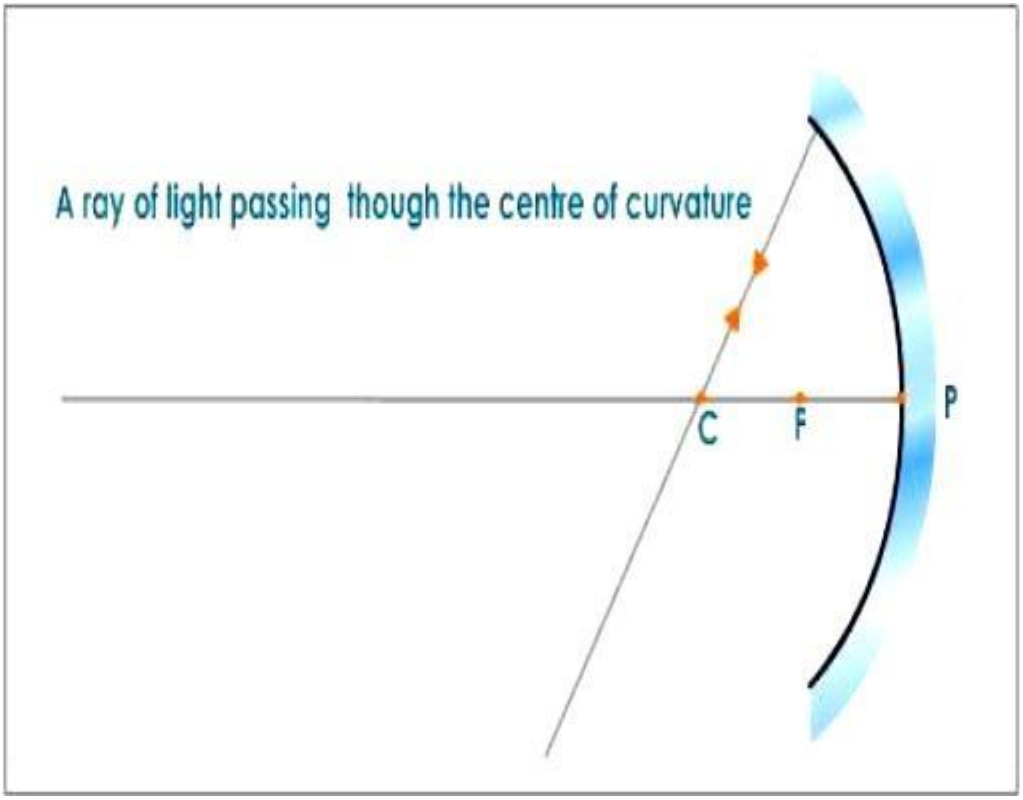
After reflection from a concave mirror, a ray of light parallel to the principal axis passes through its focus.



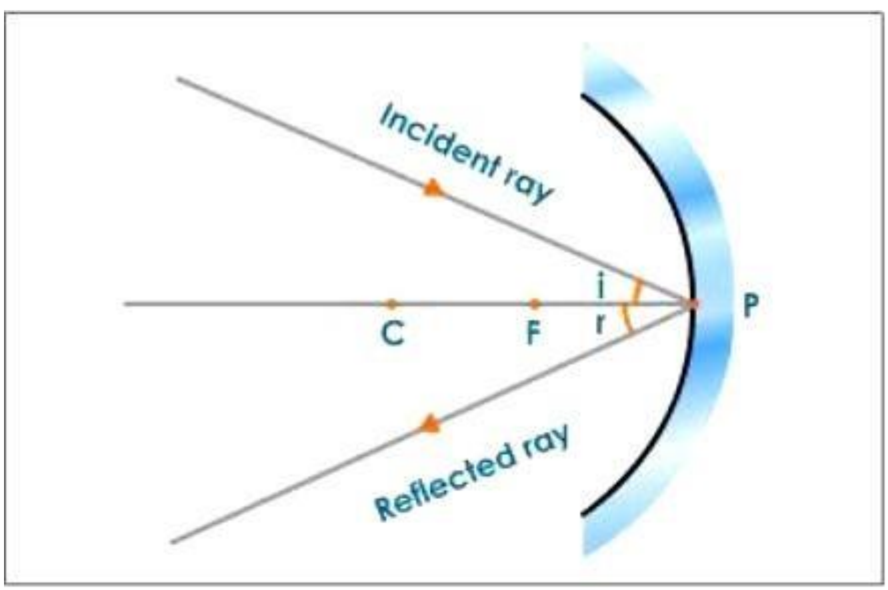
After reflection, a ray of light passing through the focus of a concave mirror emerges parallel to the principal axis.



As the ray passing through the center of curvature acts as a normal to the spherical mirror, a ray passing through the center of curvature retraces its path after reflection.



According to the law of reflection, a ray of light striking the mirror at its pole is reflected.



Formation of Image by a Concave Mirror

When the Object Is at Infinity

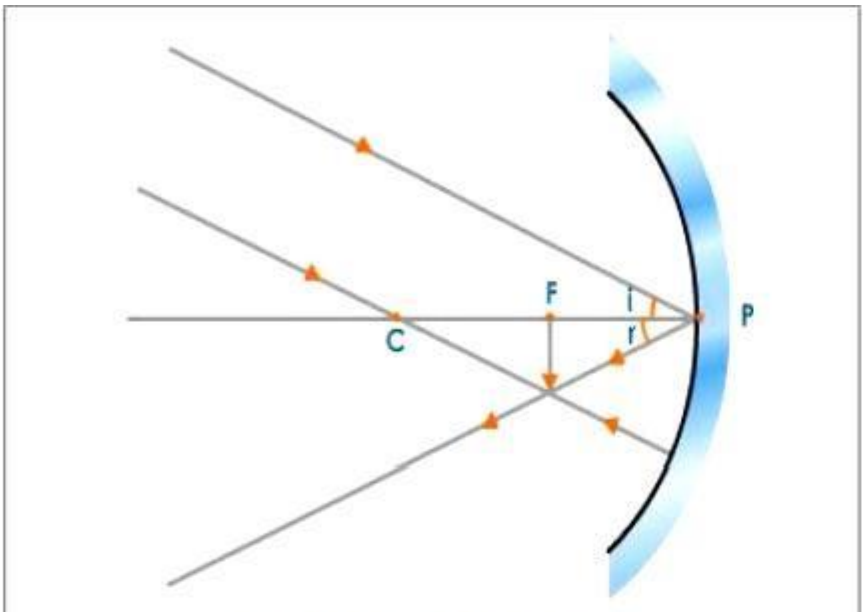
When an object is placed at infinity, its rays are parallel to each other. Consider two rays, one striking the pole of the mirror and the other passing through the center of curvature. The incident ray at the pole is reflected according to the law of reflection, and the second ray that passes through the mirror's center of curvature retraces its path. After reflection, these rays form an image at the focus. The resulting image is accurate, inverted, and scaled down.

The image is at F

Real

Inverted

Diminished



When the Object is at Infinity

When the Object Is Placed Beyond C

The two rays considered in order to obtain the image are:

A ray that passes through the center of the curvature.

A ray that runs parallel to the principal axis.

After reflection, the ray passing through the center of curvature retraces its path, and the ray parallel to the principal axis passes through the focus. After reflection, these rays intersect at a point between C and F.

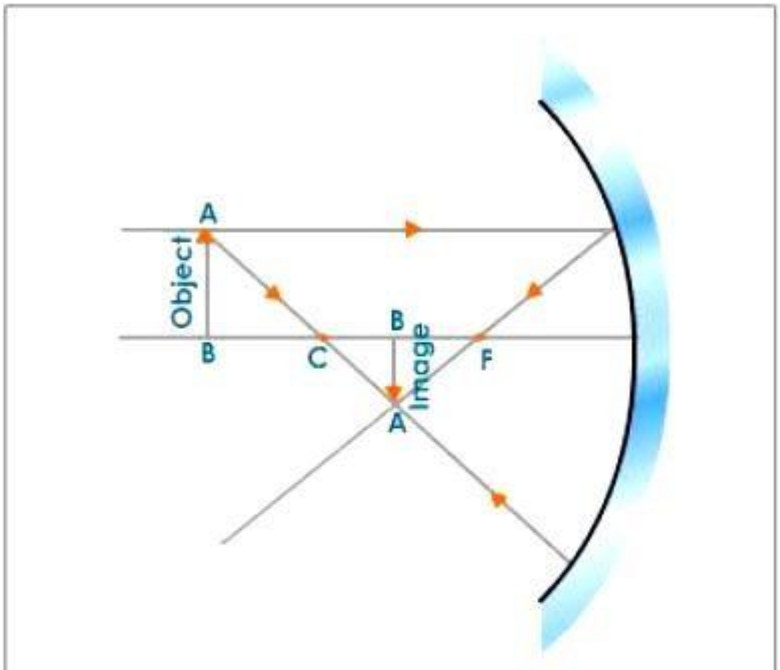
The image is inverted, real, and shrunk. The image is:

Between C and F

Real

Inverted

Diminished



When the Object is Placed Beyond C

When the Object Is Placed at the Centre of Curvature

In this section, we will look at two rays, one parallel to the principal axis and the other passing through the focus. After reflection, the ray of light parallel to the principal axis passes through the focus. After reflection, the other ray that passes through the focus emerges parallel to the axis. Following reflection, these rays collide at the center of curvature to form an inverted image that is real and the same size as the object.

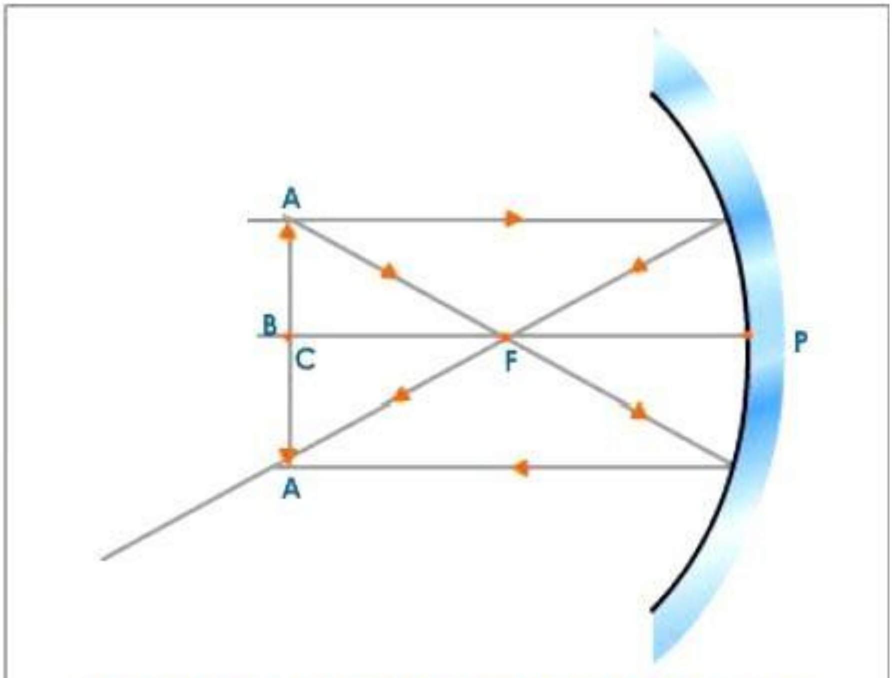
The image is:

At C

Real

Inverted

Same size as object



When the Object is Placed at the Centre of Curvature

When the Object Is Between C and F

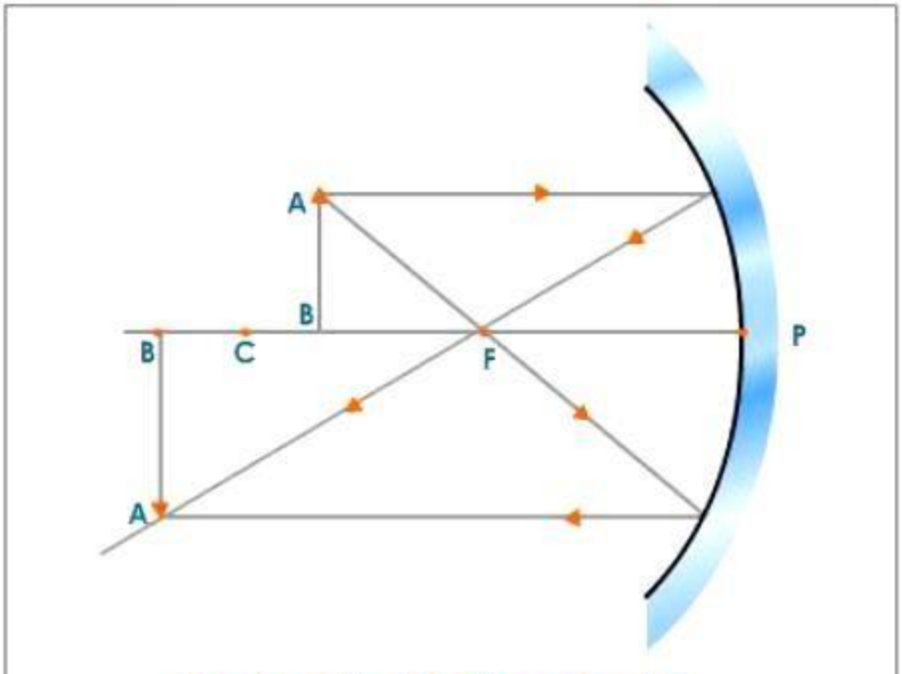
Consider a light ray parallel to the principal axis and another ray passing through the focus. The ray that is parallel to the principal axis passes through the principal focus, and the ray that emerges parallel to the principal axis after reflection. The reflected rays collide at a point beyond C, resulting in a real, inverted, and magnified image. The image is:

Beyond C

Real

Inverted

Magnified



When the Object is Between C and F

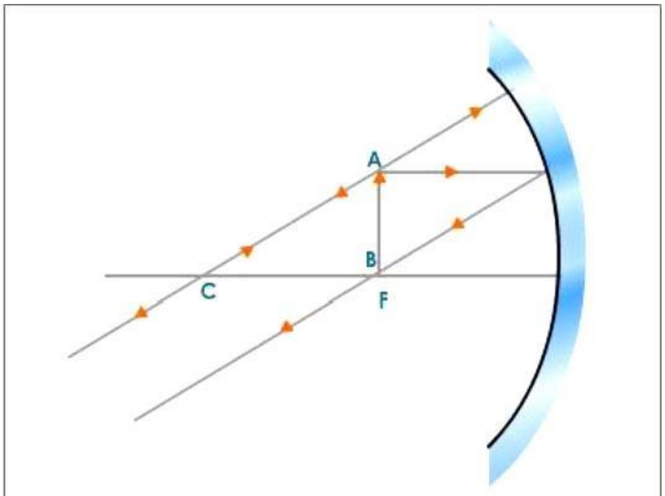
When the Object Is at the Focus

Consider a light ray parallel to the principal axis and another ray passing through the center of curvature. The ray parallel to the principal axis passes through the focus, while the ray through the center of curvature retraces its path. The reflected rays are parallel to each other and would only meet at infinity, implying that the image is formed at infinity and is a true, inverted, and enlarged image. The image is at infinity:

Real

Inverted

Magnified



When the Object is at the Focus

When the Object Is Between the Pole and the Focus

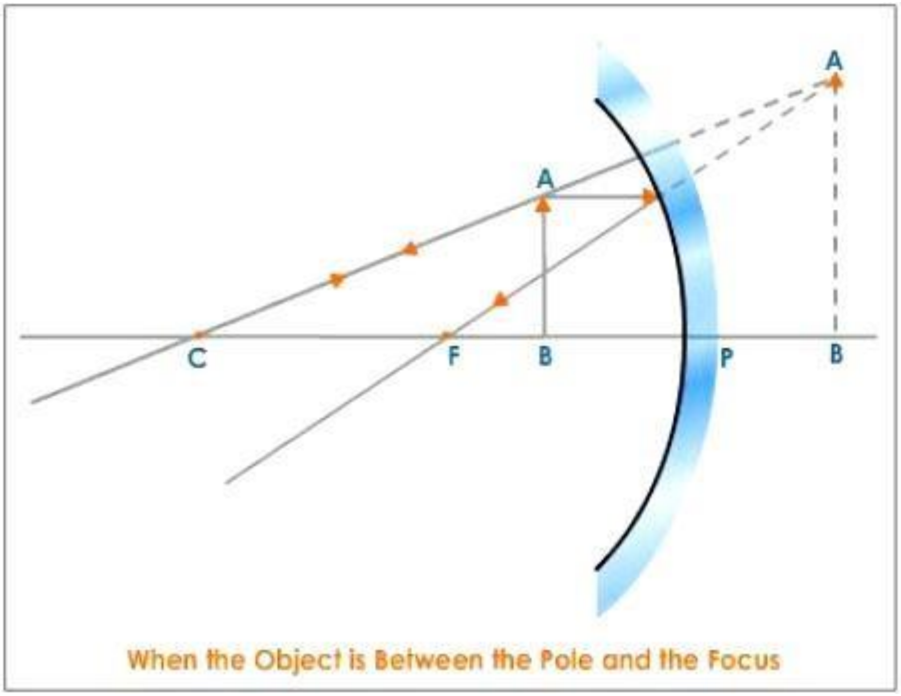
Consider a ray of light parallel to the principal axis and another ray passing through the center of curvature. After reflection, the ray that passes through the center of curvature retraces its path, and the other ray that is parallel to the principal axis passes through the focus. When the reflected rays are extended backwards, these rays appear to meet behind the mirror. The image is erect, virtual, and magnified. The image is:

Behind the mirror

Virtual

Erect

Magnified



Uses of Concave Mirrors

Concave mirrors are used to obtain a parallel beam of light in the following applications: as reflectors in car headlights, search lights in torches, and so on. The light source is positioned at the concave reflector's focus for this purpose.

Fig. Headlight of Car

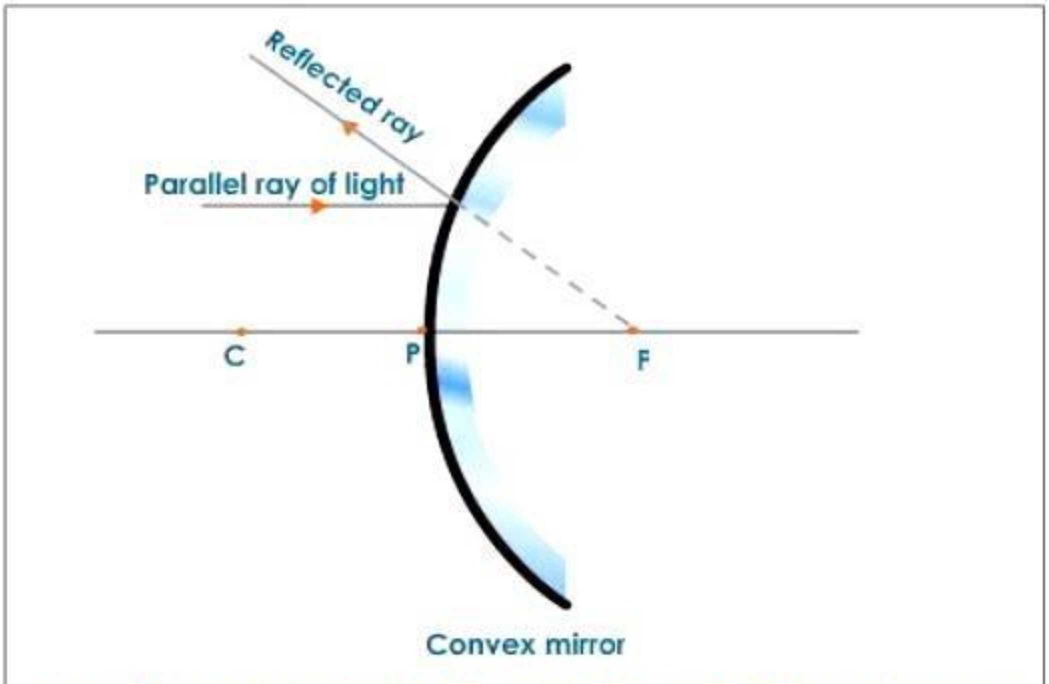
Light is focused on the tooth to be examined by the dentist.

As shaving and make-up mirrors to obtain an enlarged erect image of the face

Solar radiations are concentrated in solar heating devices. The food or substance to be heated is placed in the center of a large concave reflector for this purpose. Sunlight converges on the substance after reflection and heats it.

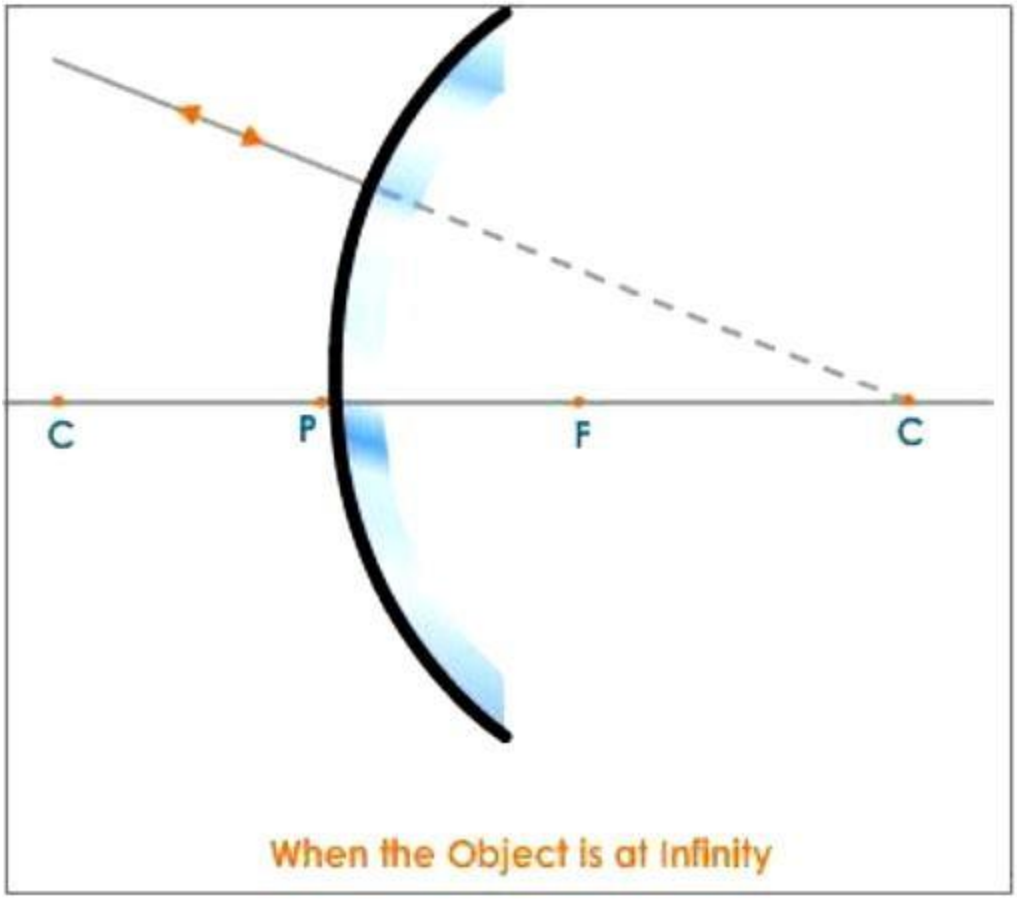
Convex Mirror

When creating ray diagrams, the following rays are taken into account. After reflection from a convex mirror, a ray of light traveling parallel to the principal axis appears to come from its focus behind the mirror.



When the Object is Placed Between Infinity and the Pole of the Mirror

A ray of light traveling towards the mirror's center of curvature hits the mirror at 90° and is reflected along its path.



A ray of light directed towards the principal focus of a convex mirror will emerge parallel to the principal axis after reflection.

According to the laws of reflection, a ray of light incident obliquely to the principal axis and directed towards the pole of the mirror is reflected.

Regardless of the position, a convex mirror always produces a virtual image.

Formation of Image in a Convex Mirror

When the Object Is Placed Between Infinity and the Pole of the Mirror

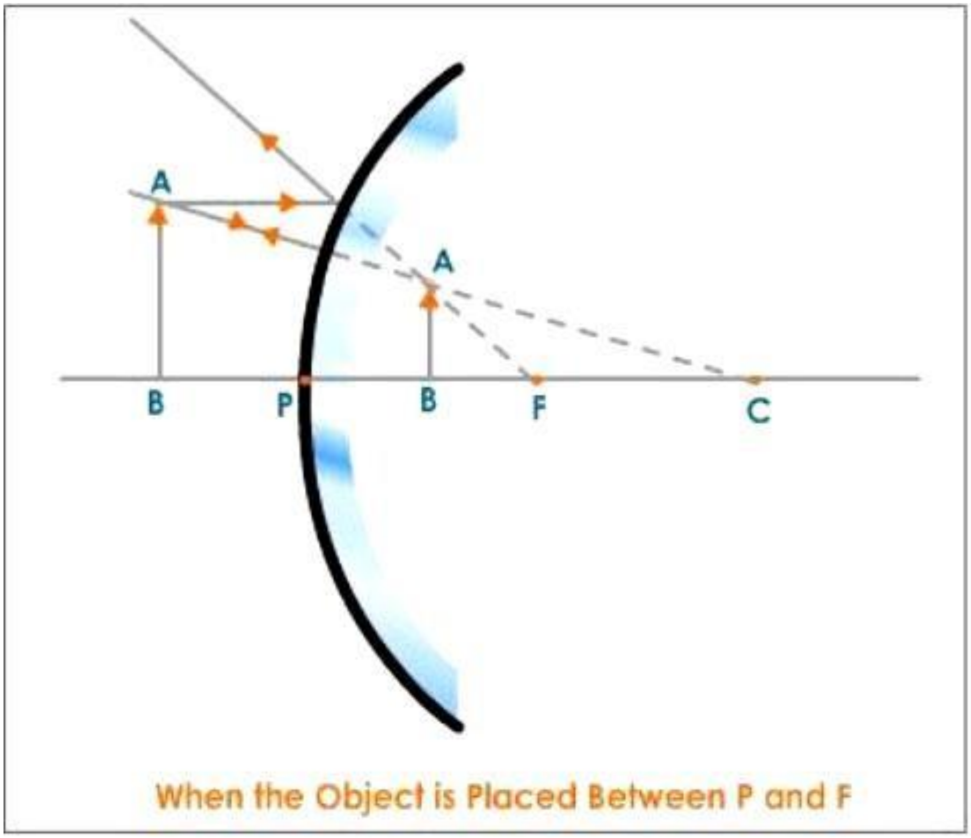
The image is:

Formed between the pole and the focus

Erect

Diminished

Virtual



When the Object Is at Infinity

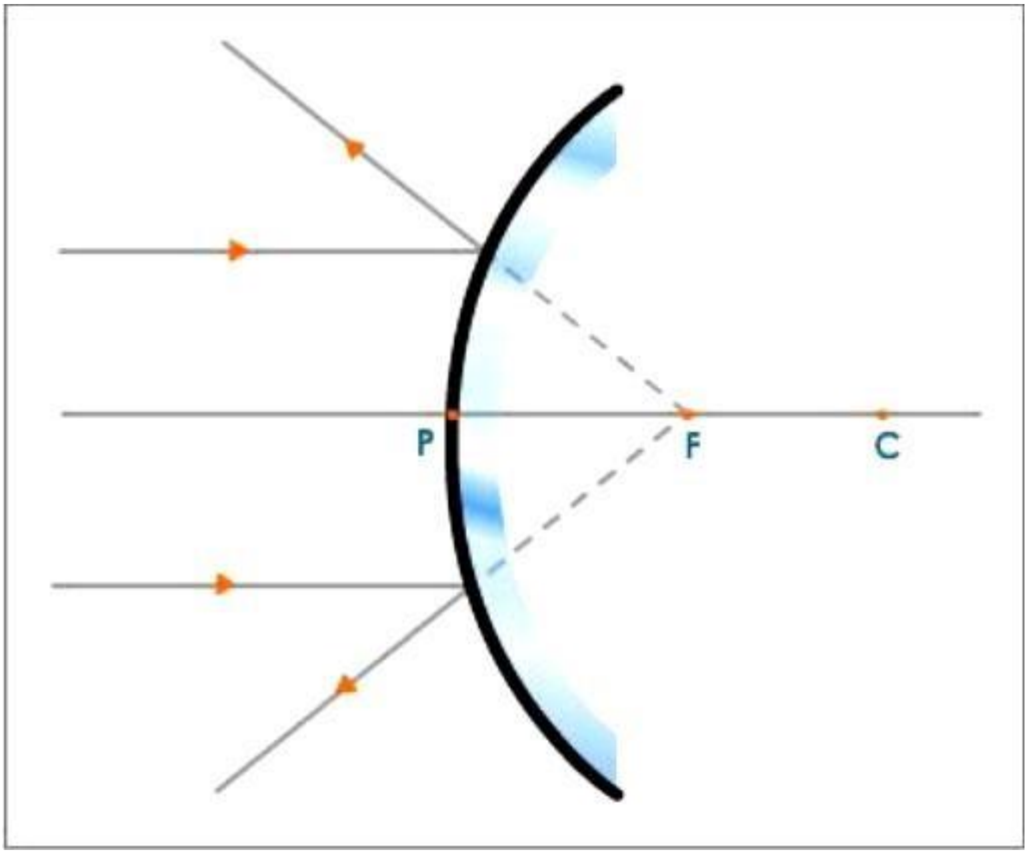
The image is:

Formed at the focus

Extremely diminished

Virtual

Erect



Uses of Convex Mirror

A rear-view mirror in a car. This convex mirror provides the driver with a clear view of approaching traffic from behind because convex mirrors are curved outwards, providing a wider field of view.

In department stores, there is a vigilance mirror.

Reflectors are used in street lamps to divert light over a large area.

Position of object	**Position of image**	**Size of the image**	**Nature of the image**
At infinity	At focus	Extremely diminished	Virtual and erect
Between infinity and pole of the mirror	Between the focus and pole	Diminished	Virtual and erect

Mirror formula

$$\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$$

Here, u is the object distance, v is the image distance and f is the focal length.

Magnification

The magnification produced by a spherical mirror indicates the extent to which an object's image is magnified in relation to the object size.

Magnification is defined as the ratio of the image's height to the object's height. The letter m is commonly used to represent it.

If h is the object's height and h' is the image's height, then the magnification m produced by a spherical mirror can be written as

$$m = \frac{h'}{h}$$

The magnification 'm' is also related to object distance (u) and image distance (v). It can be expressed as:

$$m = \frac{h'}{h} = -\frac{v}{u}$$

The negative sign in the value of the magnification indicates that the image is real. A positive sign in the value of the magnification indicates that the image is virtual.

Refraction The deviation in the path of light when it passes from one medium to another medium of different density is called refraction.

The twinkling of stars is due to atmospheric refraction of starlight. Since light bends towards the normal the apparent position of the star is slightly different from its actual position as it passes through the atmosphere. Hence the star appears slightly higher than its actual position. Due to changing condition of earth's atmosphere the apparent position of the star changes slightly and the intensity of light reaching the eye also fluctuates. This gives rise to the twinkling effect of the star.

Incident Ray (IO)

The ray of light striking the surface of separation of the media through which it is traveling is known as the incident ray.

Point of Incidence (O)

The point at which the incident ray strikes the surface of separation of the two media is called the point of incidence.

Normal (N)

The perpendicular drawn to the surface of separation at the point of incidence is called the normal.

Refracted Ray (OR)

The ray of light which travels into the second medium, when the incident ray strikes the surface of separation between the media 1 and 2, is called the refracted ray.

Angle of Incidence (i)

The angle which the incident ray makes with the normal at the point of incidence, is called angle of incidence.

Angle of Refraction (r)

The angle which the refracted ray makes with the normal at the point of incidence, is called angle of refraction. A ray of light refracts or deviates from its original path as it passes from one optical medium to another because the speed of light changes.

Laws of Refraction

The incident ray, the refracted ray and the normal to the surface at the point of incidence all lie in one plane. For any two given pair of media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant. The above law is called Snell's law after the scientist Willebrod Snellius who first formulated it

Thus,

$$\frac{\sin i}{\sin r} = \text{ a constant } = \mu$$

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

The refractive index of glass with respect to air is given by the relation.

In general, if a ray of light is passing from medium 1 to medium 2, then

If the medium 1 is air or vacuum, the refractive index of medium 2 is referred to as the absolute refractive index. The refractive index of a medium depends on the following factors: The nature of the medium. The colour or wavelength of the incident light.

Refraction of Light through a Glass Slab

When a ray light is passing from air to glass, that is, from a rarer medium to a denser medium, the refracted ray bends towards the normal drawn at the point of incidence. In this case angle of i > angle of r. But when the ray of light is passing from glass to air, that is, from a denser medium to a rarer medium the refracted ray bends away from the normal. In this case angle of r > angle of i. The emergent ray, O1E which is nothing but the refracted ray emerging out of the glass slab is parallel to the incident ray. This means that the refracted ray (emergent ray) has been displaced from its original path by a distance XY. This displacement is referred to as lateral displacement.

Lenses

A lens is a portion of a transparent refracting medium bounded by two generally spherical or cylindrical surfaces, or one curved and one plane surface. Convex lenses and converging lenses are the two types of lenses.

Convex Lens

A convex lens is one that is thicker in the center and thinner at the edges. A convex lens has at least one surface that bulges out in the middle. Convex lenses are classified as bi-convex or double-convex, Plano - convex lens and concavo - convex lens based on their shape.

Concave Lens

A concave lens is one that is thinner in the center and thicker at the edges. These lenses, like convex lenses, are classified as:

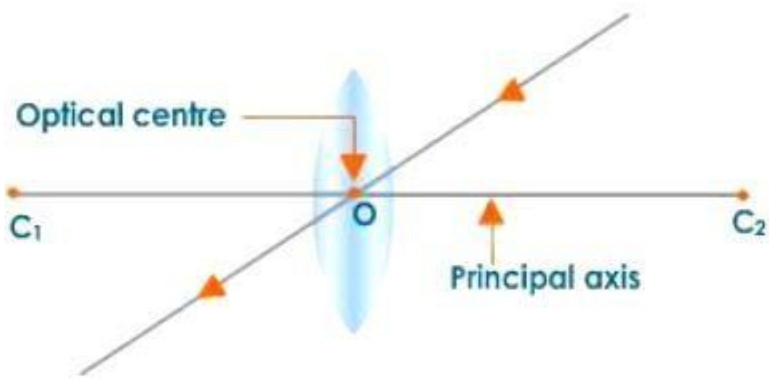
bi-concave

Plano - concave

convexo - concave

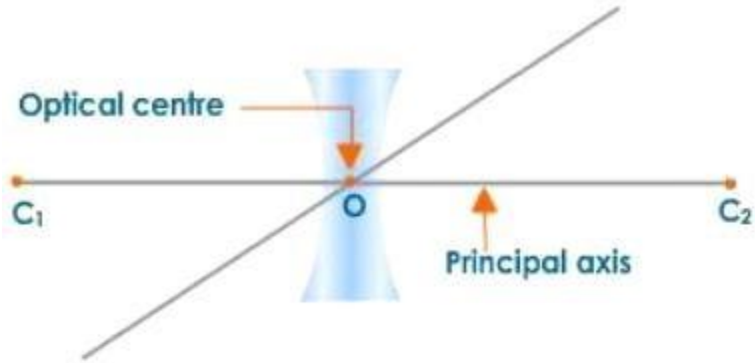
Terminology Used in Optics

Optical Centre



It is the focal point of a lens. It is represented by the letter O. A ray of light passing through the optical center of a lens does not deviate in any way. It is also known as an optic center.

Principal Axis



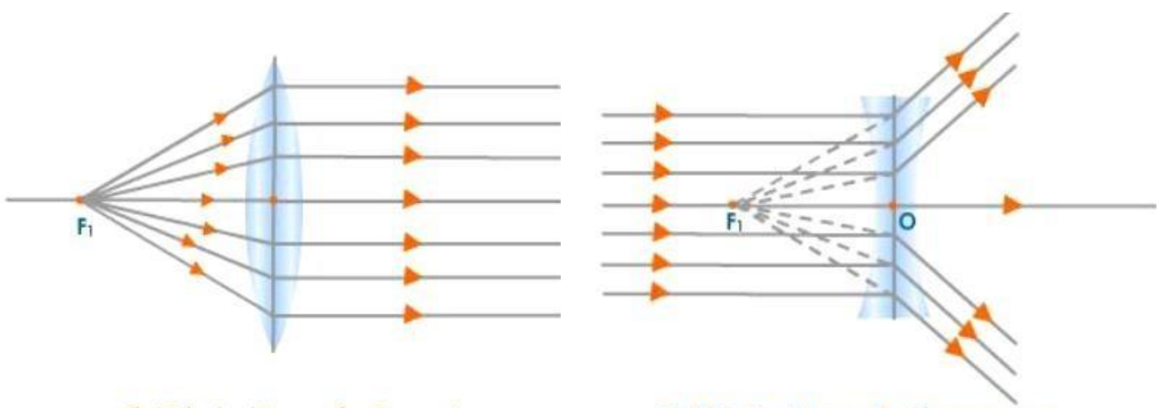
The principal axis is the straight line that connects the centers of curvature of a lens's two curved surfaces.

Principal Foci

Rays of light can pass through the lens in any direction, so there will be two principal foci on either side of the lens, which are referred to as the first and second principal foci of a lens, respectively.

First Principal Focus (F_1)

It is a point on the lens's principal axis where light rays starting from it (convex lens) or appearing to meet at the point (concave lens) become parallel to the lens's principal axis after refraction from the two surfaces of the lens.



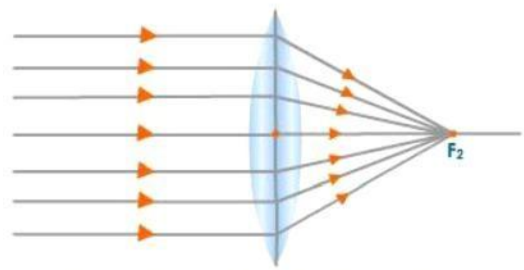
First Principal Focus of a Convex Lens

First Principal Focus of a Concave Lens

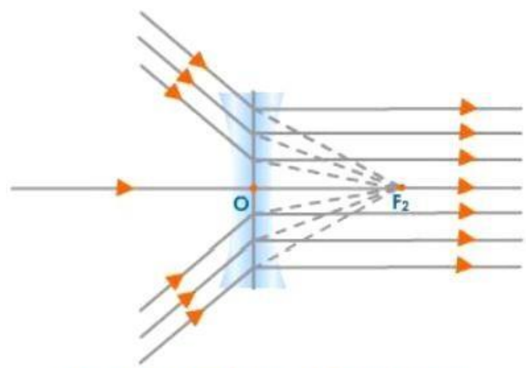
The distance between the optic center and the first focus is referred to as the lens's first focal length (f_1).

Second Principal Focus (F_2)

It is a point on the lens's principal axis at which light rays parallel to the lens's principal axis after refraction from both surfaces of the lens pass through (convex lens) or appear to come from this point (concave lens).



Second Principal Focus of a Convex Lens



Second Principal Focus of a Concave Lens

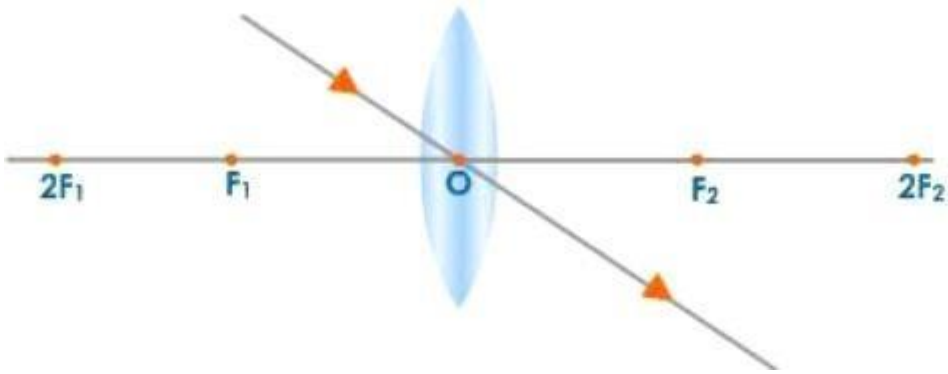
The distance between the optic center and the second principal focus is referred to as the lens's second focal length (f_2). The first and second focal lengths will be equal if the medium on both sides of the lens is the same. The focus of a convex lens is physical, whereas the focus of a concave lens is virtual.

Sign Convention for Spherical Lenses

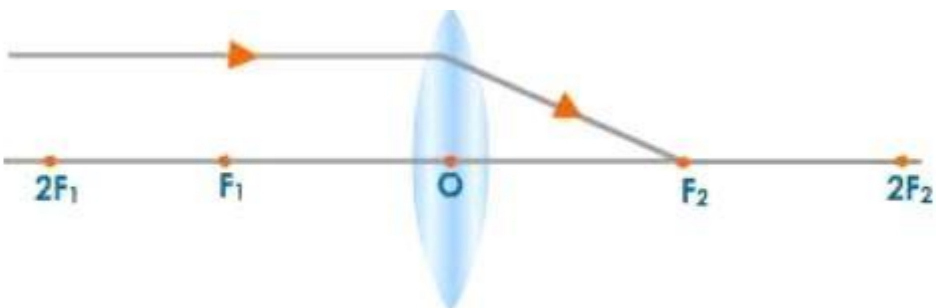
All distances are measured from the lens's optical center. Distances measured in the direction of the incident light are considered positive, while distances measured in the opposite direction of the incident light are considered negative. All measurements taken above the principal axis are considered positive, while measurements taken below the principal axis are considered negative, i.e., object height is always considered positive, while image height is only considered positive for virtual images.

Formation of Image by a Convex Lens

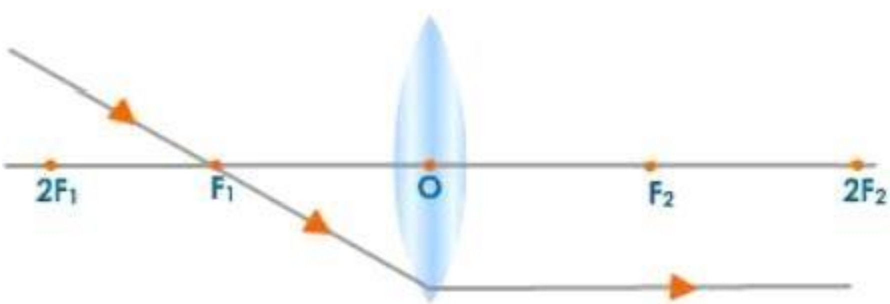
A ray of light passing through the lens's optical center travels straight and without deviation. Only in the case of a thin lens does this hold true.



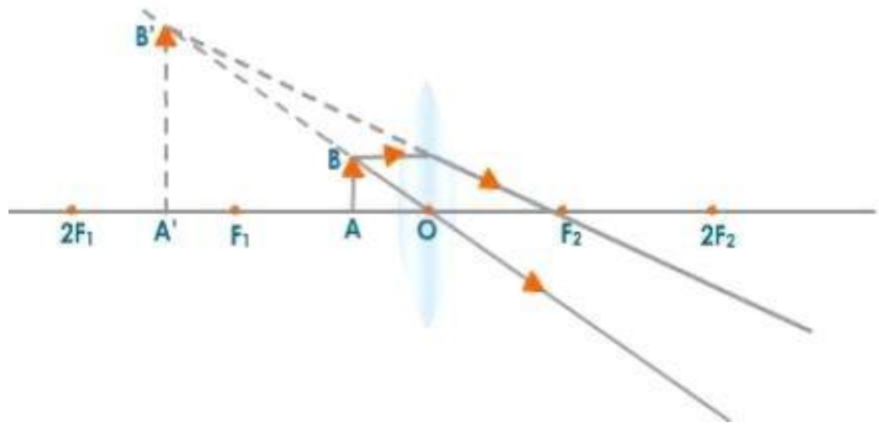
After refraction, an incident ray parallel to the principal axis passes through the focus.



After refraction, an incident ray passing through the focus of a lens emerges parallel to the principal axis.



When the Object is Placed between F_1 and O



The image is:

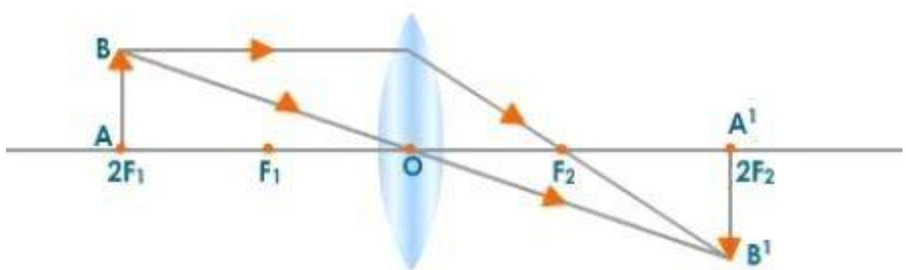
Formed behind the object

Virtual

Erect

Magnified

When the Object is placed at $2F_1$



The image is:

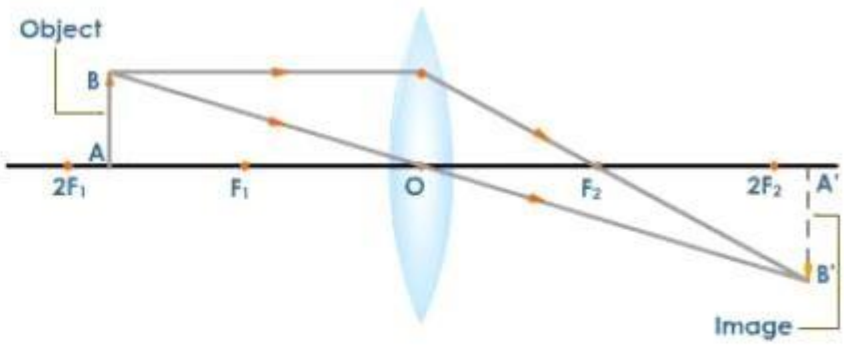
Formed at $2F_2$

Real

Inverted

Same size as the object

When the Object is placed Between F_1 and $2F_1$



The image is:

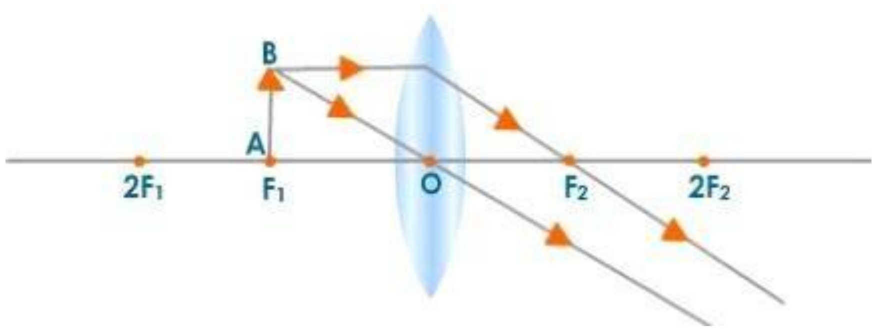
Formed beyond $2F_2$

Real

Inverted

Magnified

When the Object is placed at F_1



The image is:

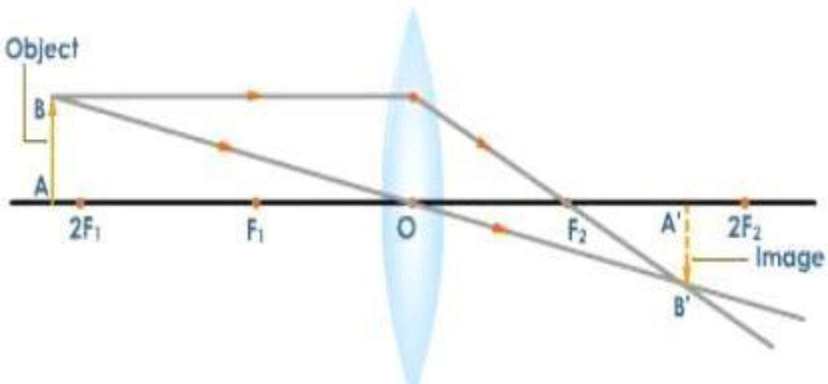
formed at infinity

real

inverted

magnified

When the Object is placed beyond $2F_1$



The image is: formed between F_2 and $2F_2$ real inverted diminished.

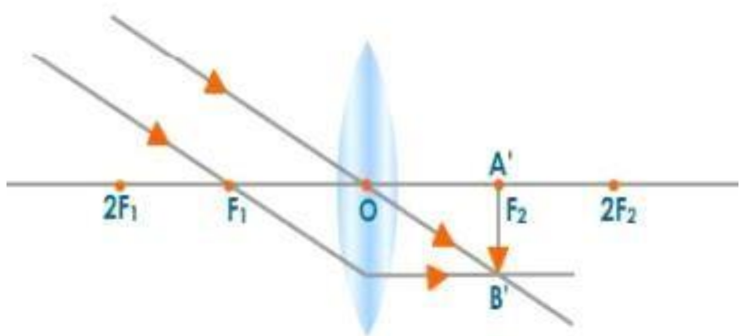
When the Object is placed at Infinity

When the object is at infinity, the rays coming from it are parallel to each other. The image is:

formed at F_2 inverted

real

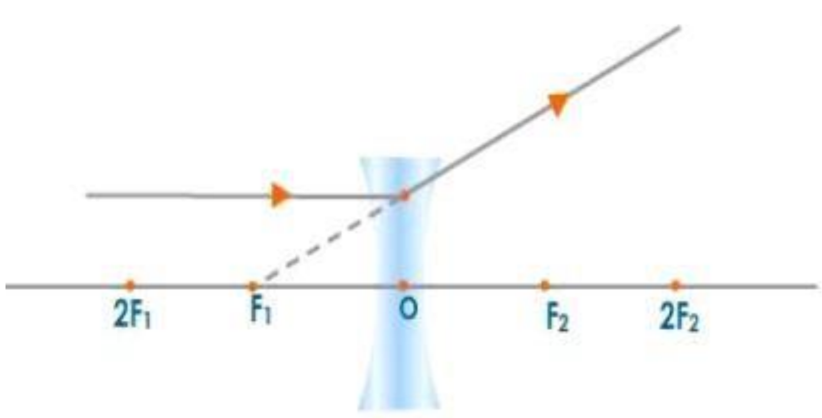
highly diminished



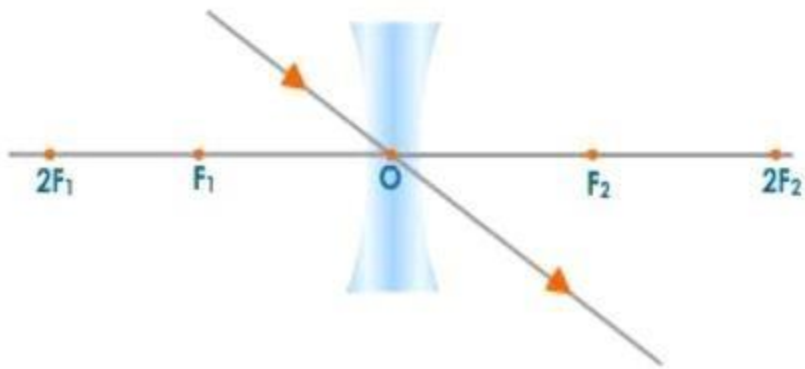
Convex lenses are also used in spectacles to correct the vision problem hypermetropia.

Formation of Image by a Concave Lens

After refraction, an incident ray of light from an object parallel to the principal axis of a concave lens appears to come from its focus.

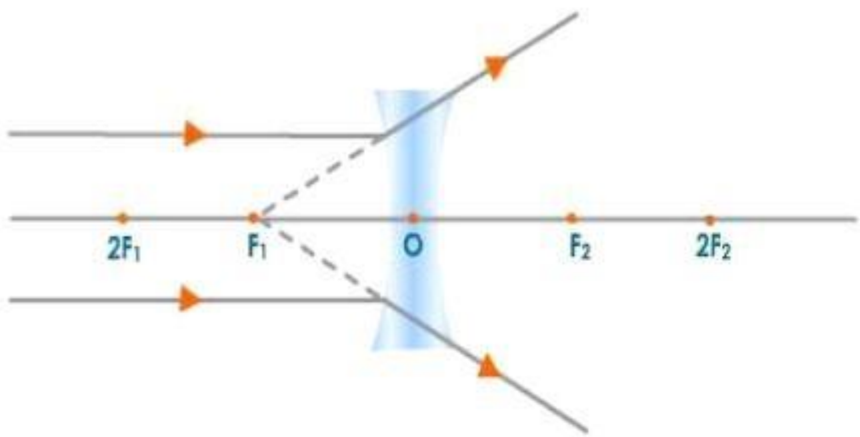


An incident ray of light that passes through the optical center exits the lens with no deviation.



Whatever the object's position, a concave lens always produces a virtual, erect, and diminished image. Let us now draw ray diagrams to show where the images are when the object is placed - at infinity, between O and F1, and anywhere between infinity and O.

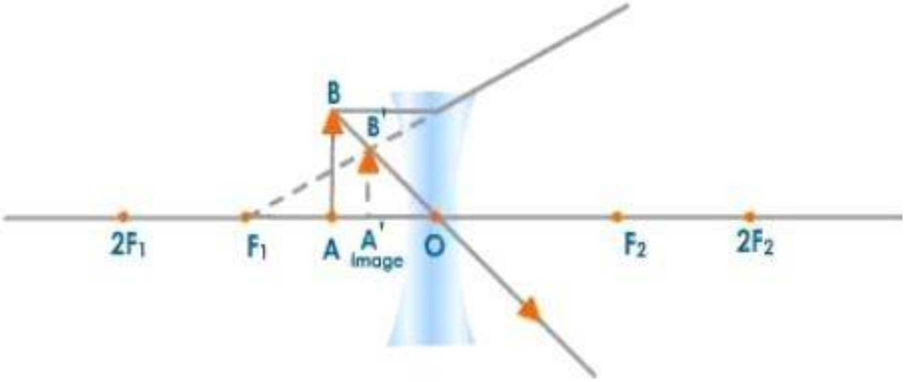
When the Object is at Infinity



The image is: formed at F_1 erect virtual diminished.

When the Object is placed at any Position between O and infinity

The image is: formed between O and F1 erect virtual diminished

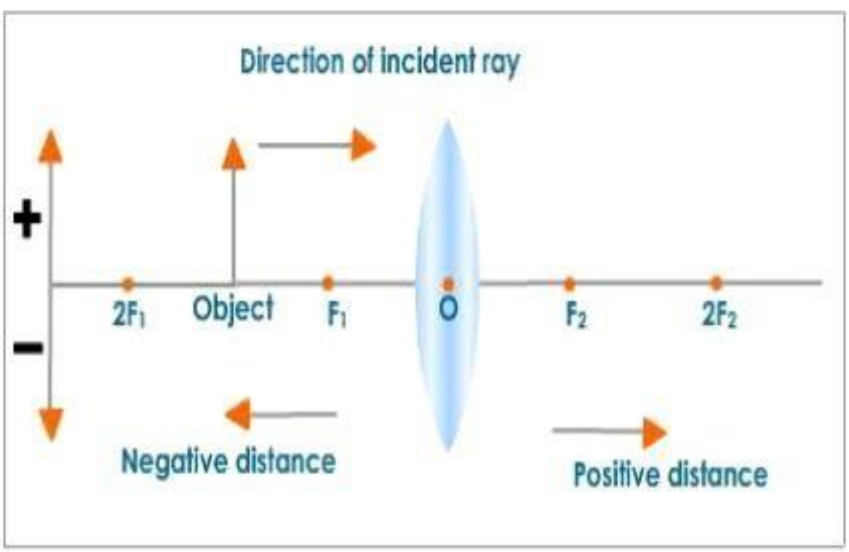


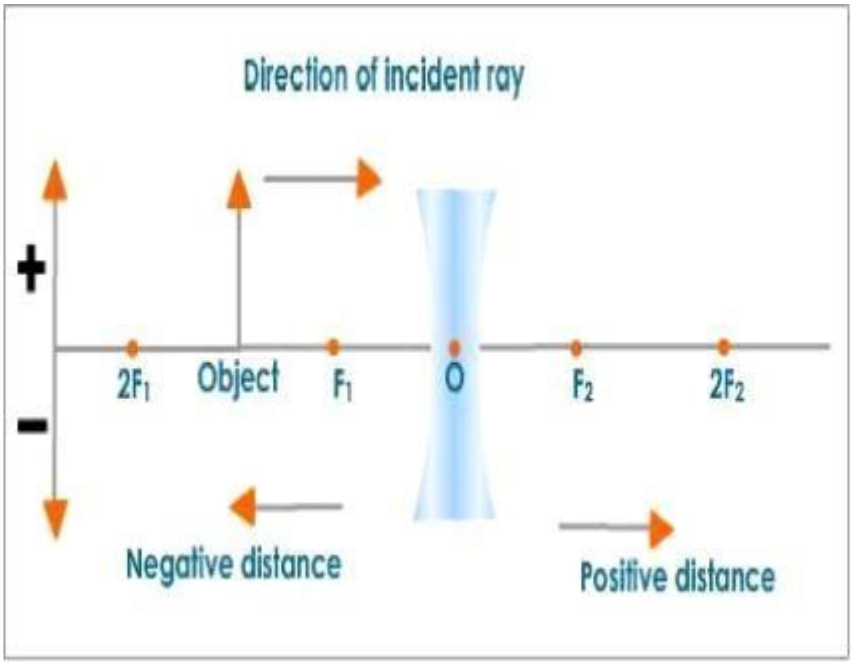
Uses of concave lens

- It is used to correct myopia in spectacles.
- It is used in conjunction with a convex lens to correct flaws such as chromatic and spherical aberration (the failure of rays to converge at one focus because of a defect in a lens or mirror).

Sign Convention for Lenses

For measuring various distances, the following sign convention is used:





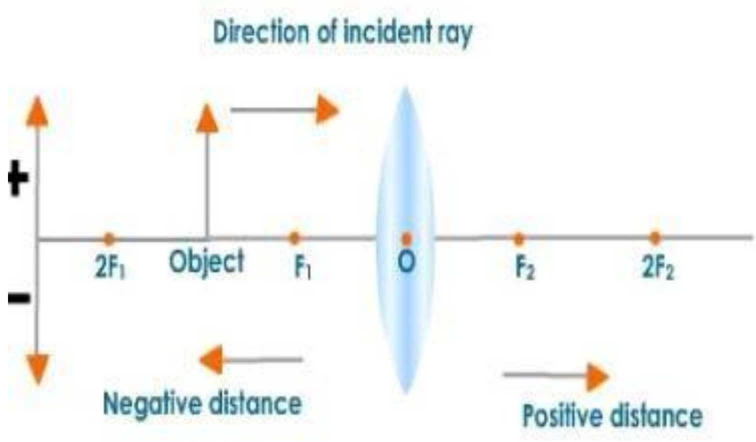
- All distances on the principal axis are measured from the optical center.
- Distances measured in the direction of incident rays are positive, while distances measured in the opposite direction of incident rays are negative.
- All measurements taken above the principal axis are positive. As a result, the height of an object and the height of an erect image are both positive, while all distances measured below the principal axis are negative.

Note:

The rules are the same as for spherical mirrors.

The sign convention for lenses is shown in the table below:

For measuring various distances, the following sign convention is used:



The optical center is used to measure all distances along the principal axis. Distances measured in the direction of incident rays are positive, while distances measured in the opposite direction of incident rays are negative. All measurements taken above the principal axis are positive. As a result, the height of an object and the height of an erect image are both positive, while all distances measured below the principal axis are negative.

Lens Formula

The lens formula or lens equation describes the relationship between the object's distance (u), the image's distance (v), and the focal length (f) of the lens.

$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$$

This lens formula works for both convex and concave lenses.

Note: Things to keep in mind when using the lens formula. The known parameter values should be used with their proper sign according to the sign convention. During calculations, the unknown parameter should not be given a sign.

Magnification

Magnification is defined as the ratio of image size (h_I) to object size (h_o).

Depending on the size and nature of the image, the magnification produced by a lens can be equal to one, greater than one, or less than one.

Case I

When the image's height (h_I) equals the object's height (h_o).

$$m = \frac{h_I}{h_o} = 1$$

As a result, when the magnification is set to one, the size of the image is the same as the size of the object.

Case II

When the image height (h_1) is greater than the object's height.

$$m = \frac{h_I}{h_o} > 1$$

The image is magnified

Case III

When the image's height is lesser than the object's height.

$$m = \frac{h_I}{h_o} < 1$$

The image is diminished.

The height of the object is always positive for both types of lenses, whereas the height of the image can be + or - depending on its nature. The height of an inverted and real image is negative according to lens sign convention, and thus the magnification of a lens is negative when it produces an inverted and real image. The image's height is positive for an erect and virtual image. When an erect and virtual image is formed, the magnification is positive.

Power of a Lens

A ray of light bends whenever it passes through a lens (except when it passes through the optical center). Convergence is the bending of light rays towards the principal axis, and divergence is the bending of light rays away from the principal axis. The power of a lens expresses its degree of convergence or divergence. A lens with a short focal length deviates the rays more than a lens with a long focal length. As a result, a lens's power is defined as the reciprocal of its focal length in meters.

$$\text{Power of a lens} = \frac{1}{\text{Focal length in metres}}$$

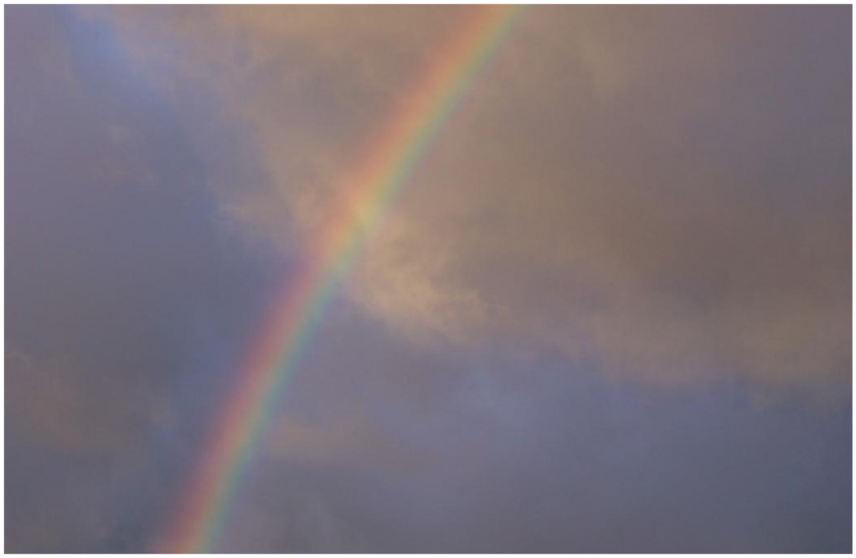
The unit of power is dioptre.

If a convex lens has a power of one D, its focal length is one meter.

Dispersion and scattering of light

Newton's Experiment - Dispersion of Light

Sir Isaac Newton discovered that the images of heavenly bodies formed by a lens were colored at the edges while studying them. In order to investigate this, he conducted an experiment with a prism in 1665. Newton's room at Trinity College, Cambridge, was darkened, and a beam of sunlight passed through a small circular hole in the shutter, forming a white circular patch on the opposite wall. He then placed a triangular prism in the path of the light beam and observed that the white light was split into seven colors, which resembled the colors of a rainbow, namely violet, indigo, blue, green, yellow, orange, and red (VIBGYOR).



Dispersion is the splitting of white light into its constituent colors when it passes through a transparent medium. A spectrum is a band of colors that results from the dispersion of white light.

Newton deduced from the preceding experiment that white light is a mixture of seven different colors.

Tracing the Path of Light through a Prism

Let us now trace light's path through a prism. Trace the ABC boundary of a prism on a white sheet of paper with the triangular face on the sheet.

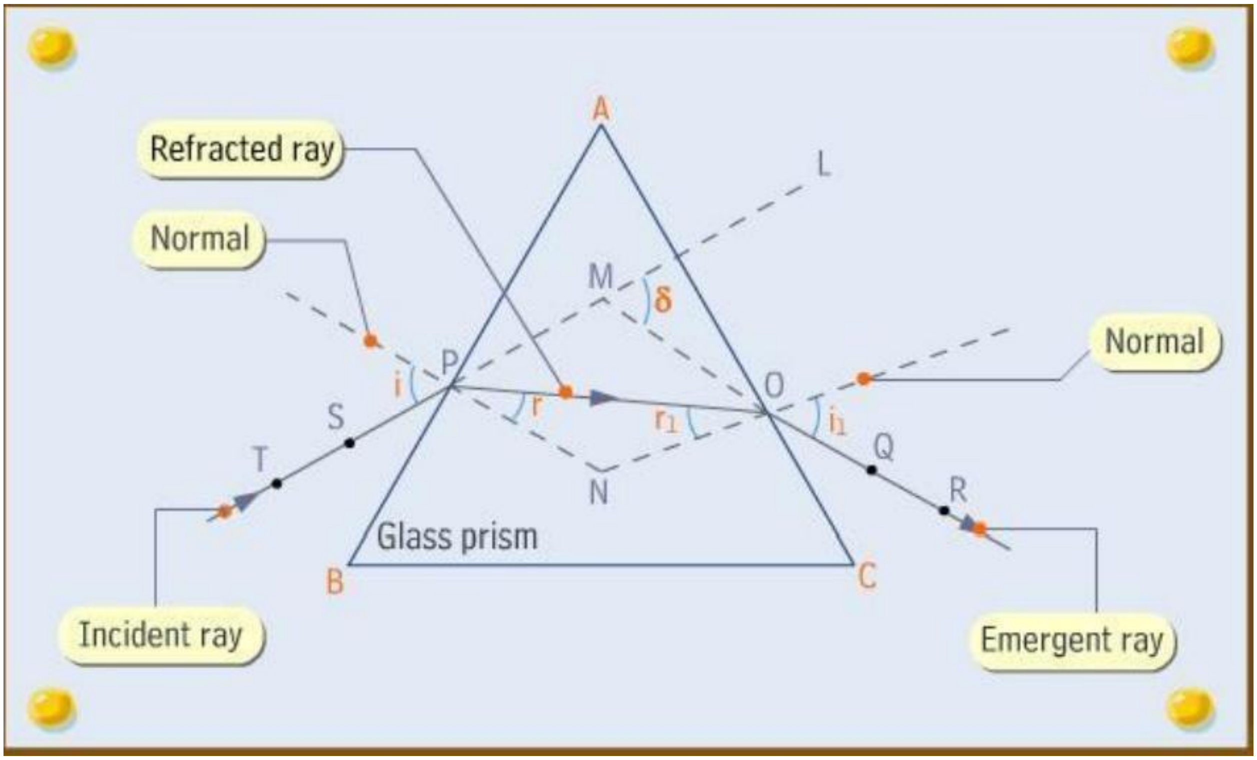
Attach two T and S pins to one side.

Place the prism on the ABC boundary.

Fix two more pins Q and R through the other side so that all four pins appear to be in the same line.

Remove the pins and make a note of where they are.

Connect TS and RQ and extend them to meet the prism faces at P and O, respectively. Participate in PO.



The incident ray is represented by TP.

The refracted ray is represented by PO.

And OR denotes the emergent ray that is bent towards the bottom.

Let PN and ON represent the normals at P and O, respectively.

Let I be the incidence angle and r be the refraction angle.

If the incident ray TP is extended forward and the emergent ray RO is extended backwards, they will intersect at M, forming the angle OML.

OML is the angle measured. This angle is referred to as the angle of deviation.

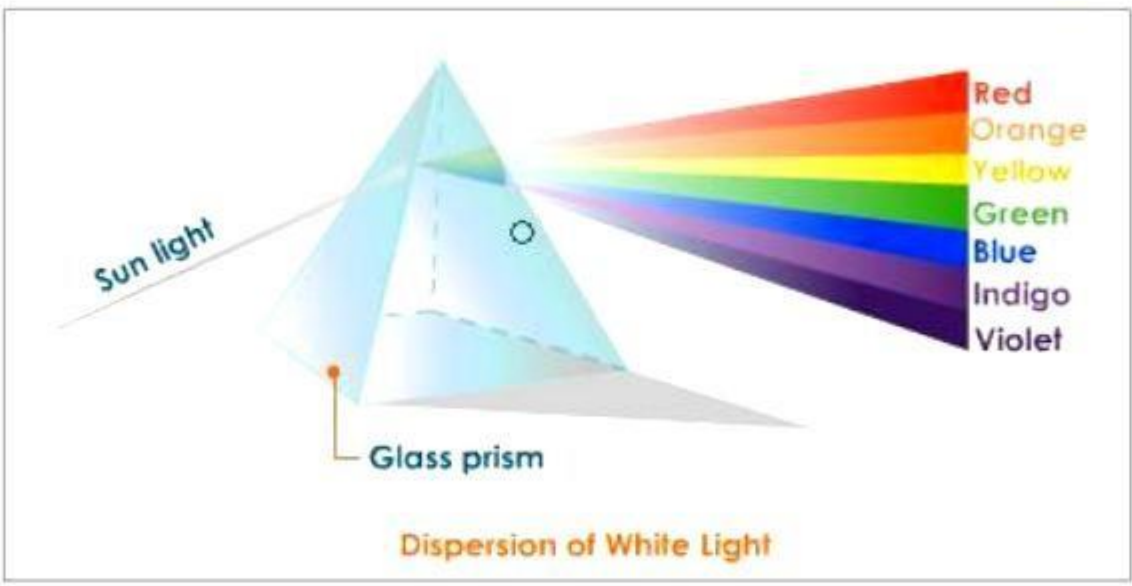
The angle of deviation of an incident ray is the angle through which it deviates. This should be repeated for different angles of incidence.

Dispersion of White Light by a Glass Prism

Even though all colors of the visible spectrum travel at the same speed in vacuum, their speed varies when they pass through a transparent medium such as glass or water. That is, the refractive index of glass varies depending on the color.

When a polychromatic light (multicolored or light with more than one wavelength), such as white light, strikes the first surface of the prism, it is refracted. However, each constituent of white light is refracted through a different angle, causing white light to be dispersed. When these colors strike the prism's second surface, they undergo refraction (being refracted from a denser to a rarer medium) and are further separated. A white light beam incident on a prism split into its constituent colors, forming a spectrum.

Each component of the white light is deviated towards the prism's base. Violet has the greatest deviation, while red has the least. The obtained spectrum is impure because the colors in the spectrum lack sharp boundaries, i.e., each color merges gradually into the next.

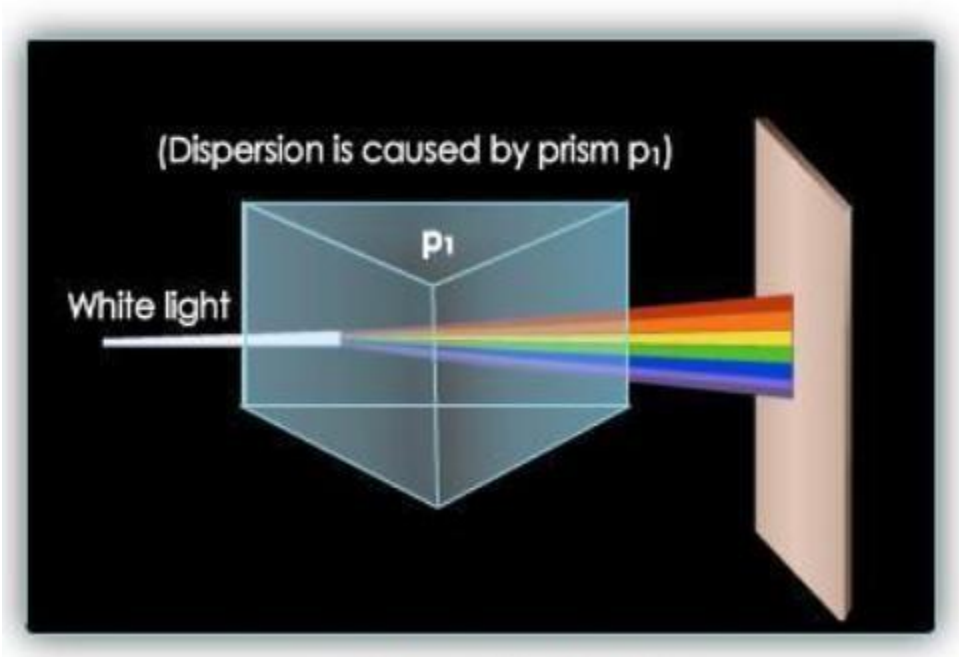


Recomposition of White Light

The prisms are arranged as shown in the diagram to produce white light from dispersed light. Recomposition of white light is the recombination of the seven colors of dispersed white light to produce white light.

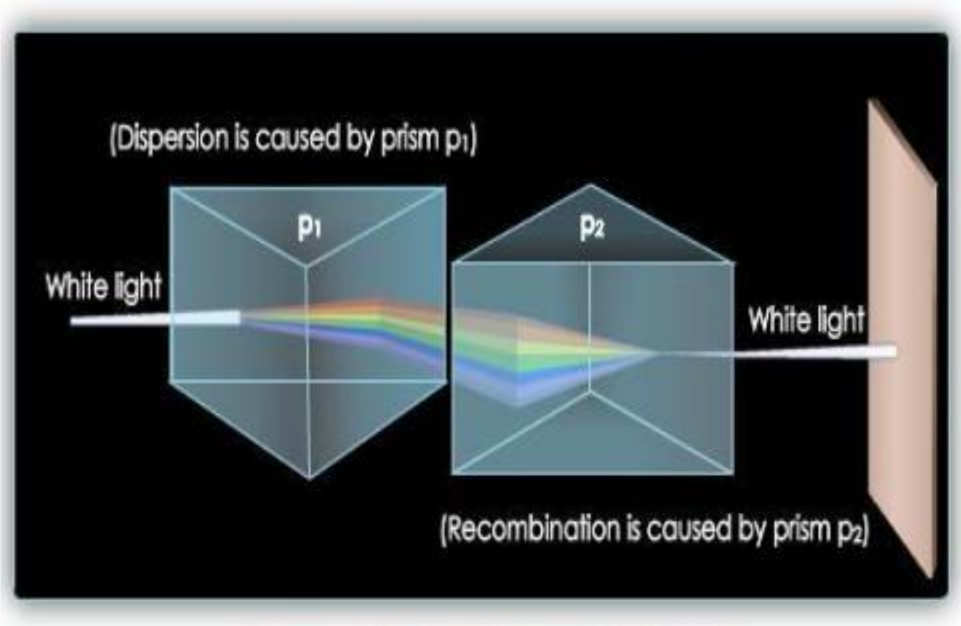
Experiment to Show the Recomposition of White Light

Set up a prism (P_1) on a table with a screen behind it. Allow a narrow beam of light to strike the prism (P_1). The white light is dispersed, resulting in a seven-color band on the screen.



Dispersed White Light

Remove the screen and replace it with another prism P2 of the same material oriented in the opposite direction. Put a white screen in front of P2. A white light spot appears on the screen. As a result, the dispersed light has been recombined by the second prism.



Recomposition of the Dispersed White Light

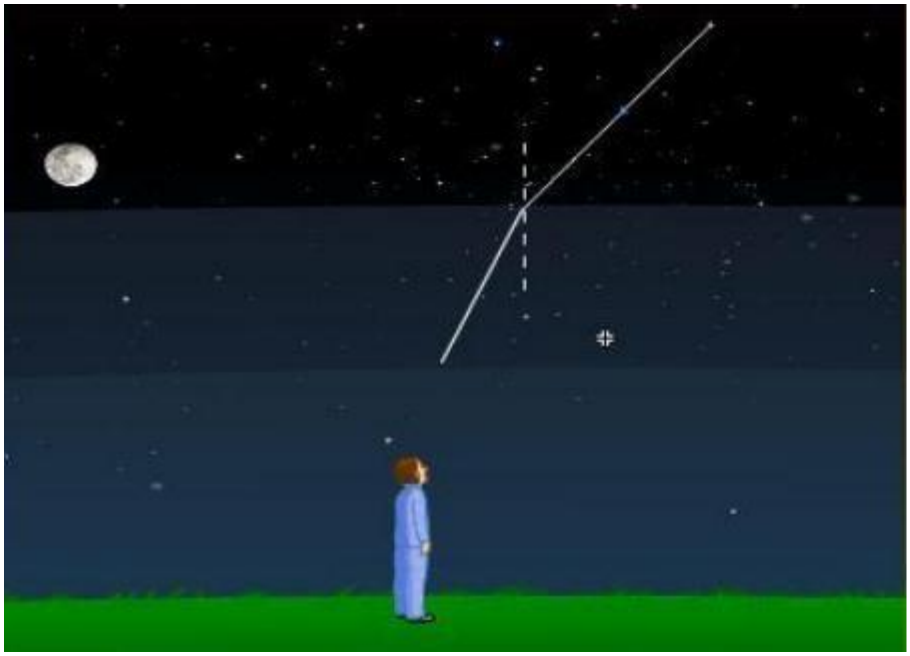
Formation of a Rainbow

The small raindrops that remain suspended in the air after the rain act as a prism. When sunlight passes through these raindrops, it disperses and we see the rainbow's seven colors.

Atmospheric Refraction

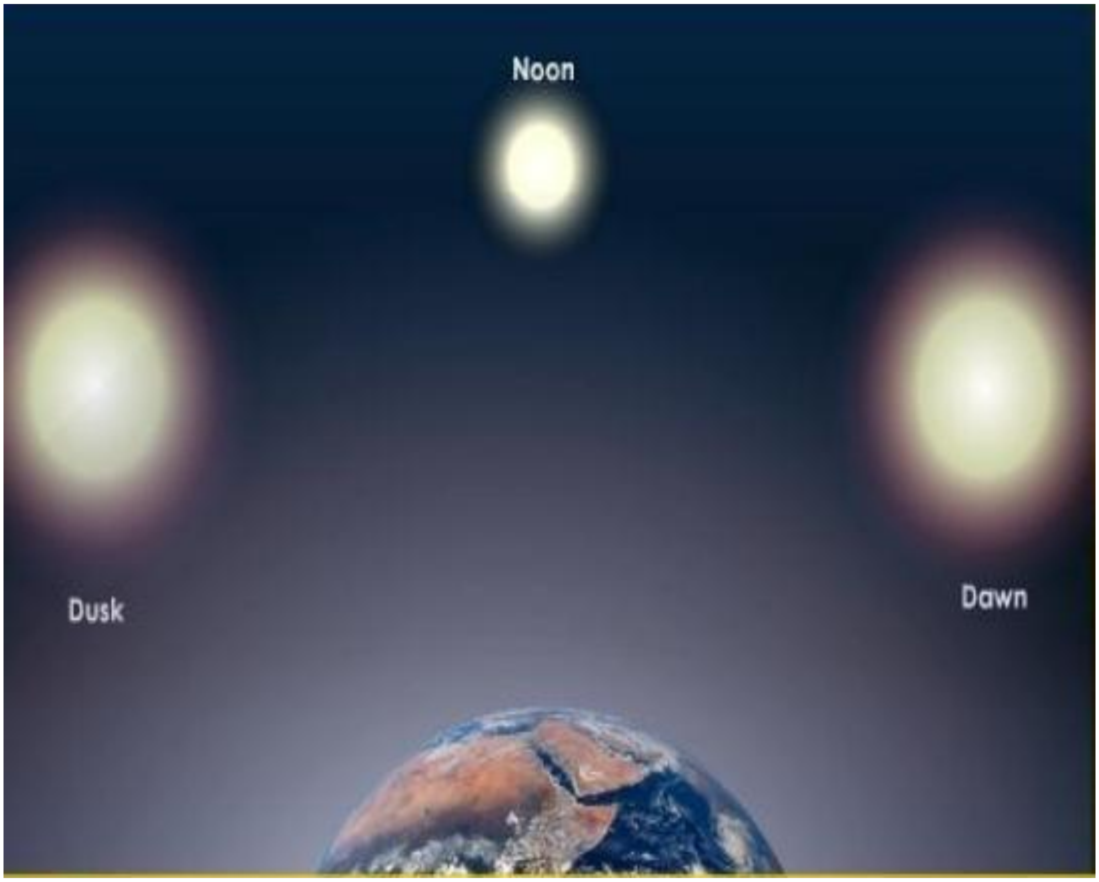
Atmospheric refraction is the apparent direction shift of a celestial object caused by light ray refraction as they pass through Earth's atmosphere. Starlight refraction causes the twinkling of stars and variations in the size of the Sun.

Twinkling of Stars



Light rays from the stars travel through layers of air of varying densities. These rays are continuously refracted and bend towards the normal as the refraction occurs from a rarer to a denser medium. The density of the layers of air changes as a result of air movement and convection currents. As a result, the position of the star's image changes after every short interval. The varying positions of the images formed at short intervals of time create the illusion that the star is twinkling.

Variation in the Size of the Sun



The Sun appears larger at dusk or dawn than it does at noon. This is due to the fact that when the sun is near the horizon, the rays of light it emits must pass through layers of air of increasing density. The sun appears to be larger due to the continuous bending of light. The sun appears smaller at noon than it does at dusk or dawn. This is due to the fact that light rays that normally fall on the earth's surface are not refracted.

Scattering of Light

Scattering is a general physical process in which certain types of radiation, such as light or moving particles, are forced to deviate from a straight trajectory due to one or more localized non-uniformities in the medium through which they pass.

The earth's atmosphere contains a large number of molecules. These molecules scatter light in a variety of ways. The air contains numerous tiny particles, including dust and water vapour. As sunlight passes through the air, the shorter blue light waves are reflected and refracted by the particles, whereas the longer other colored light waves are unaffected and are not reflected by the water vapour or dust in the air. As a result, blue is the most scattered color, which explains the bluish color of the sky. At sunset or sunrise, the sunrays must travel long distances through the atmosphere to reach us, and most of the blue light is scattered and does not reach us. As a result, the sky and sun appear reddish at sunrise and sunset.

Tyndall Effect

The atmosphere of the Earth is a heterogeneous mixture of minute particles. Smoke, tiny water droplets, dust particles suspended in the air, and air molecules are examples of these particles. When a light beam collides with such air particles, the path of the beam becomes visible. Likewise, the path of a light beam passing through a true solution is not visible. However, its path becomes visible in a colloidal solution where the particle size is relatively large. The Tyndall effect is caused by the scattering of light by colloidal particles.

The Tyndall effect is the visible scattering of light on the path of a light beam passing through a colloid system.