ALLEN®

LIGHT

Light is a form of energy which excites our sense of sight.

Sources of light

- The primary source of light is the Sun.
- Secondary source is the brightness of the sky.
- Other common sources are flames, electric bulbs, tube lights (fluorescent tubes), compact fluorescent lamps (CFLs) and light emitting diodes (LEDs).

Luminous objects

- The objects which emit their own light are called 'luminous objects'.
- Examples : Sun and other stars, lamp (bulb), tube light, candle flame, etc.

Non-luminous objects

- The objects which do not emit their own light but only reflect the light which falls on them are called 'non-luminous' Objects (or illuminated objects).
- Examples : Table, chair, animals, plants, planets, satellites, moon, etc.





Types of Objects

Opaque object

An opaque object or material only absorbs and reflects light, no light passes through it.
You cannot see through opaque objects.

Translucent Object

Object or material that allows small portion of light to pass through them are described as translucent.
You cannot see clearly through the translucent objects.

Transparent object

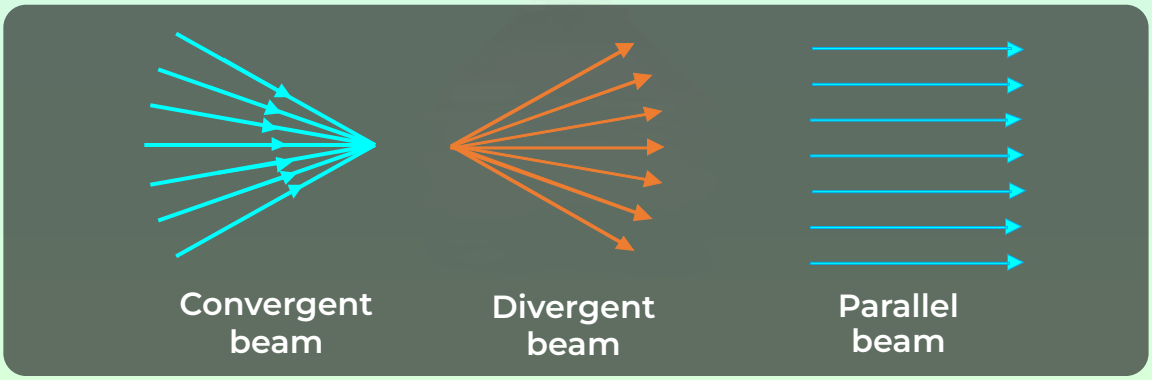
Transparent object or material transmits almost all the light striking them.
You can see objects clearly through them.







Ray of light : The direction in which light travels.
Beam of light : A bundle of light rays.
Convergent beam : A beam of light in which all the rays move towards a single point is called convergent beam.
Divergent beam : A beam of light in which all the rays emerge out from a single point is called divergent beam.
Parallel beam : A beam of light in which all the rays are parallel to each other is called parallel beam.



Rectilinear propagation of light

Light always travels in straight lines. This is called the rectilinear propagation of light.

There are three main effects of rectilinear propagation of light
1. Formation of shadows
2. Formation of eclipse
3. Formation of images

Properties of light

- Light is a form of energy that travels in the form of waves.
- Light waves spread out in all directions as they move away from a source.
- Light can travel through empty space (vacuum), without needing a solid, liquid, or gas medium.
- Light rays from any source always travel in straight lines. This is called rectilinear propagation of light.
- Regardless of its source, a ray of light will not change direction unless it travels through a different medium or is disturbed in some way.
- A light wave will spread out if it travels past the edge of a object or if it moves through a narrow opening.
- Light travels through space at the fastest speed, about 300000 km/s or 3×10^8 m/s.
- Light has colours.
- Light has different intensities.

Reflection of light

Reflection is the bouncing of light rays off a surface. In other words 'reflection is the sending back of all or a part of a beam of light as it strikes a surface'.

Laws of reflection

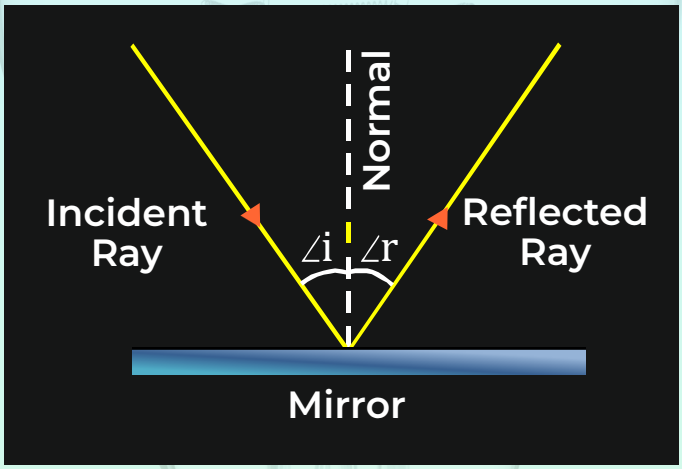
First Law

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

Second Law

Angle of incidence is always equal to the angle of reflection.

$$\angle i = \angle r$$



Incident ray

The ray of light which falls on the mirror surface is called incident ray.

Reflected ray

The ray of light which is sent back by the mirror is called 'reflected ray'.

Point of incidence

The point at which the incident ray falls on the mirror is called 'point of incidence'.

Normal

A line perpendicular to the surface of mirror passing through the point of incidence is called 'normal'.

Angle of incidence

The angle made by incident ray with the normal at the point of incidence is called 'angle of incidence'.

Angle of reflection

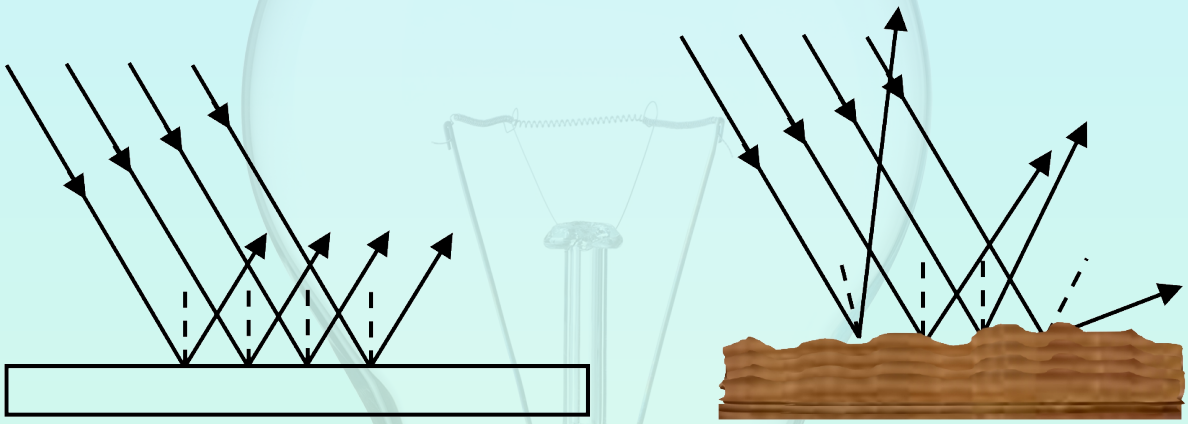
The angle made by reflected ray with the normal at the point of incidence is called 'angle of reflection'.

Regular reflection (Specular Reflection)

If a parallel beam of light is incident on a smooth plane mirror, the reflected beam is also a parallel beam, as all the normals are parallel to each other on a smooth surface.

Diffuse reflection (Irregular reflection)

If a parallel beam of light is incident on a rough surface or mirror, the rays of reflected light becomes non-parallel to each other, as all the normals are not parallel to each other on a rough surface.



Smooth surface
Regular reflection

Rough surface
Diffuse reflection

Reflection from plane mirrors

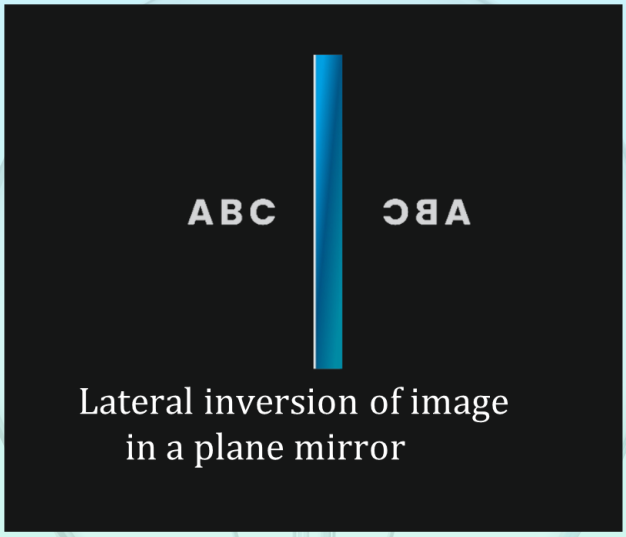
A plane mirror is a highly polished surface used to reflect the light falling on it, and is usually made by depositing a thin layer of silver metal on one side of a plane glass sheet.

POINT OBJECT	EXTENDED OBJECT
An object whose dimensions are negligibly small is called point object.	An object whose dimensions are quite large is called extended object.

Point Objects •
Extended Objects ↑
} Symbols used in ray diagrams

Lateral inversion

When an asymmetric object is placed in front of a plane mirror, then the right side of the object appears to be the left side of image and the left side of the object appears to be the right side of its image. This change of sides of an object seen in the image is called 'left - right inversion' or 'lateral inversion'.



Lateral inversion of image in a plane mirror

Image

An image of an object is formed when light rays coming from the object meet or appear to meet at a point after reflection from a mirror or refraction from a lens.

Real image : A real image is one which is formed when the light rays actually meet at a point and which can be obtained on a screen.

Virtual image : A virtual image is one which is formed when the rays do not actually meet at a point but they appear to meet at a point. Such images cannot be obtained on the screen.

Image formed by a plane mirror

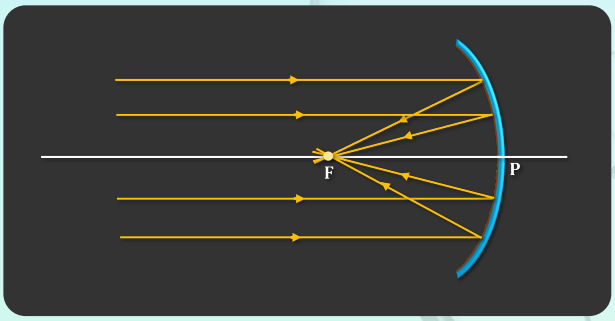
The properties of image formed by plane mirrors are
(1) The image is virtual and erect.
(2) The distance of image from mirror is equal to distance of object from mirror.
(3) The size of image is exactly equal to the size of object.
(4) The image is laterally inverted.

Reflection from spherical mirrors

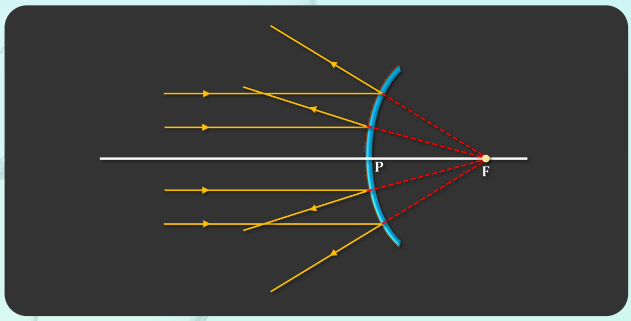
A spherical mirror, as the name suggests, has the shape of a section of a hollow sphere. A spherical mirror is a mirror whose reflecting surface is made by the part of a hollow sphere.

Spherical Mirrors

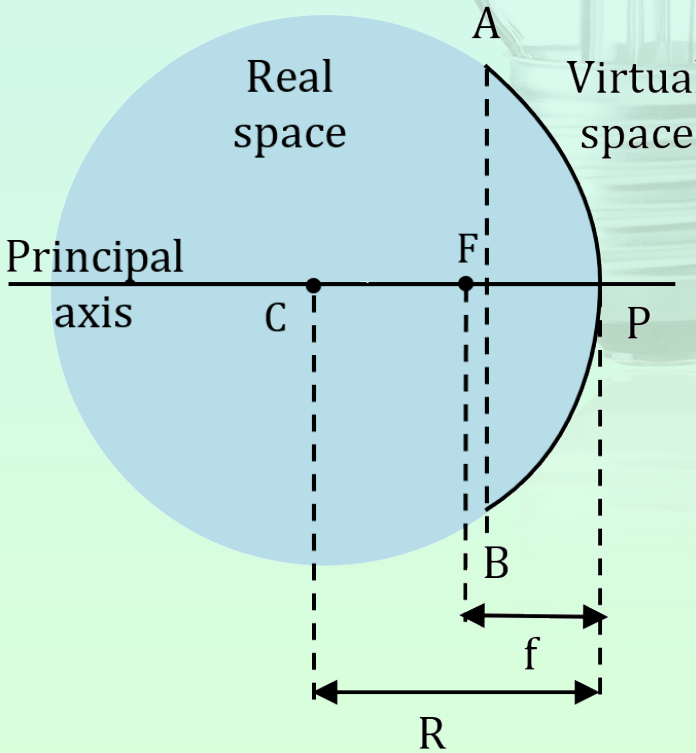
Concave mirror (Converging mirror)



Convex mirror (Diverging mirror)



Basic terms related to spherical mirrors



R → Radius of curvature

C → Centre of curvature

P → Pole (or vertex)

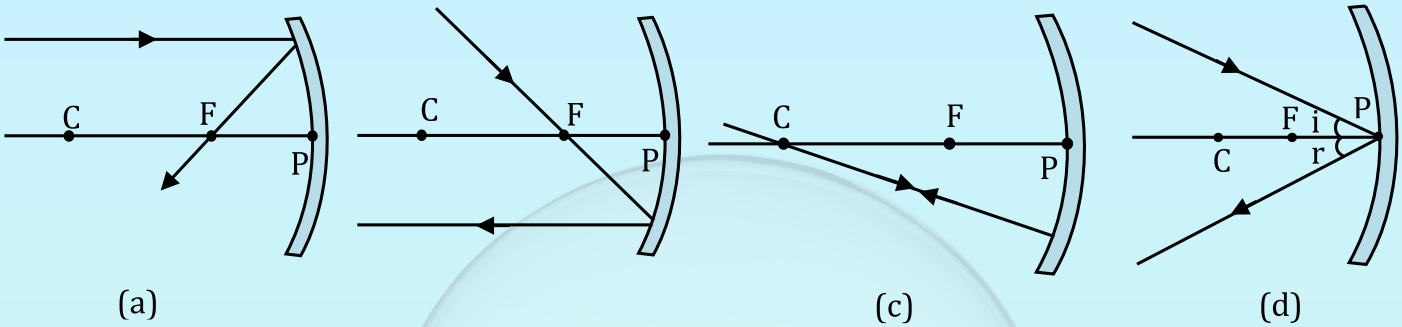
F → Principal focus

f → Focal length

AB → Aperture

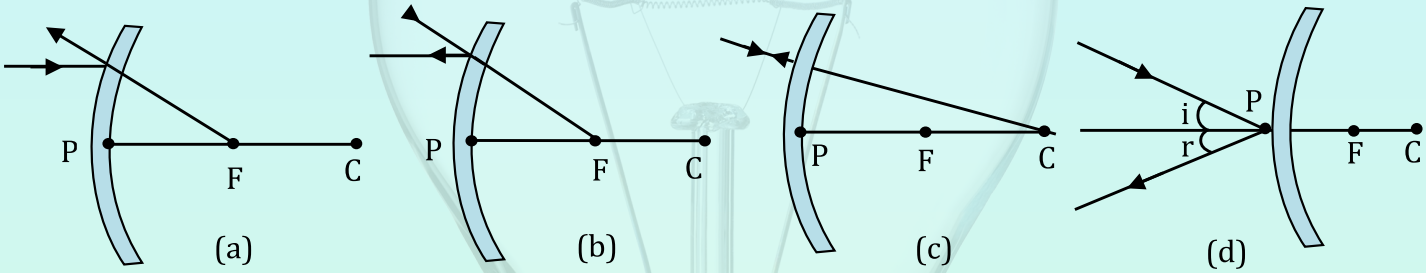
Rules to obtain images in spherical mirrors

Concave mirrors :



Rules for concave mirrors to obtain images

Convex mirror :



Rules for convex mirrors to obtain images

Uses of concave mirrors

- Concave mirrors are used as shaving mirrors to see a larger image of the face.
- Concave mirrors are used as reflectors in car head lights, search lights, hand torches, table lamps, etc. to get powerful parallel beams of light.
- Concave mirrors are used in solar power plants to produce electricity.
- Concave mirrors are used by doctors to concentrate light on body parts like ears and eyes.
- Concave mirrors are also used by dentists to see large images of the teeth of patients.

Image Formation By a Concave Mirror

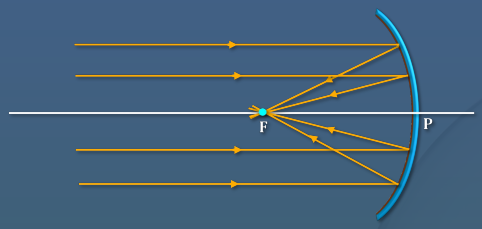
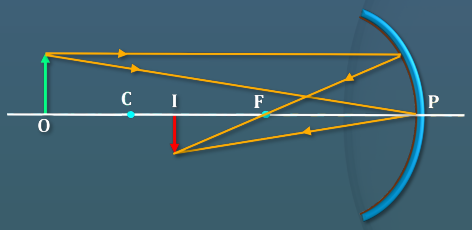
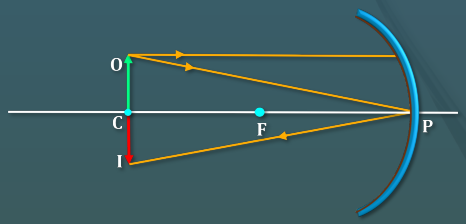
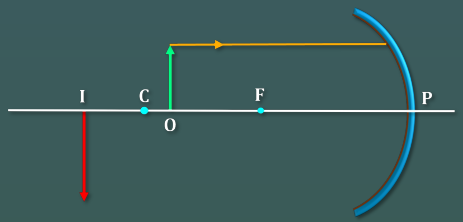
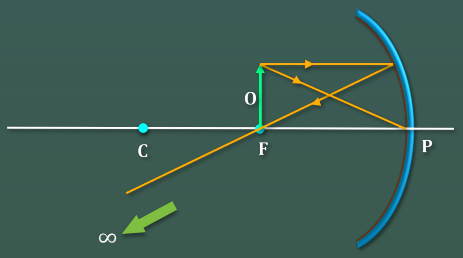
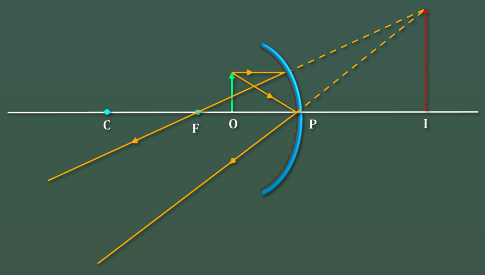
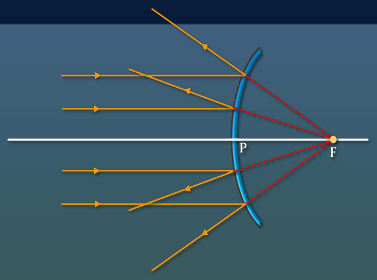
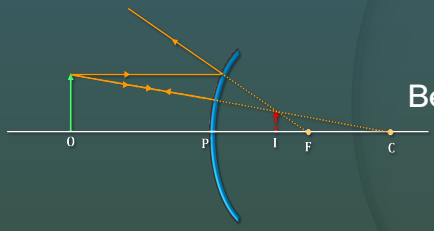
Ray Diagram	Position of the object	Position of the Image	Size of the Image	Nature of the Image
	At infinity	At focus F	Highly diminished, point sized	Real and inverted
	Beyond C	Between F and C	Diminished	Real and inverted
	At C	At C	Same size	Real and inverted
	Between C and F	Beyond C	Enlarged	Real and inverted
	At F	At infinity	Highly enlarged	Real and inverted
	Between P and F	Behind the mirror	Enlarged	Virtual and erect

Image Formation By a Convex Mirror

Ray Diagram	Position of the object	Position of the Image	Size of the Image	Nature of the Image
	At infinity	At the focus F, bihind the mirror	Highly diminished, point sized	Virtual and erect
	Between infinity and the pole	Between P and F behind the mirror	Diminished	Virtual and erect

Uses of convex mirrors

- Convex mirrors are commonly used as rear-view (wing) mirrors in vehicles. These mirrors are fitted on the sides of the vehicle, enabling the driver to see traffic behind him/her to facilitate safe driving.
- Convex mirrors are preferred as rear view mirrors because they always give an erect, though diminished, image. Also, they have a wider field of view as they are curved outwards. Thus, convex mirrors enable the driver to view much larger area than would be possible with a plane mirror.

Formulae related to spherical mirrors

- Relationship between radius of curvature and focus :

$$f = \frac{R}{2}$$

Lenses

A lens is a piece of transparent glass bound by spherical surfaces.

Convex lens

- This type of lens is thicker at the centre and thinner at the edges. An optical lens is generally made up of two spherical surfaces.



Convex lens

Concave lens

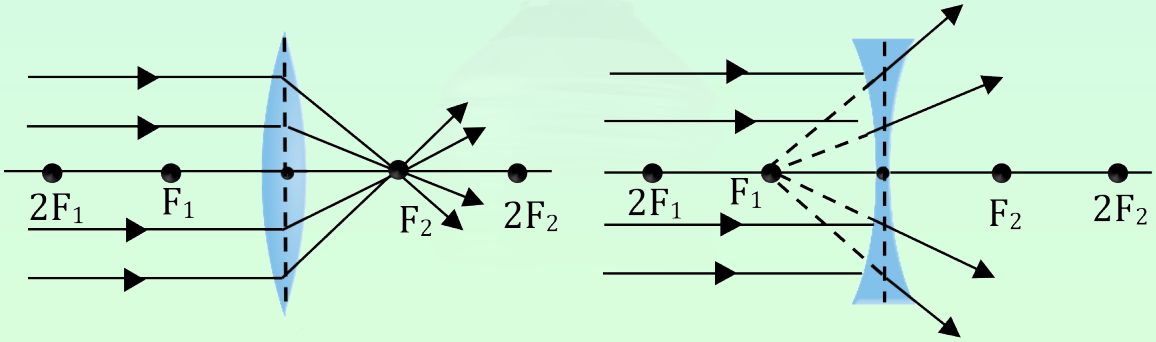
- A concave lens is a lens that diverges a straight light beam from the source to a diminished, upright, virtual image.



Concave lens

Basic terms used in lenses

Optical centre : The middle point of a spherical lens is called its 'optical centre'.
Principal axis : The line passing through the optical centre of the lens which is perpendicular to both the faces of the lens is called its 'principal axis'.
Principal focus : The point on the principal axis of a lens where all the rays parallel to principal axis, converge or appear to diverge after refraction is called 'principal focus'.
Focal length : The distance between the focus and the optical centre of a lens is called its 'focal length'.



Nature of convex lens and concave lens

Image formation by a convex lens

- The image formed by a convex lens can be real and virtual, depending upon the distance between the lens and the object.
- The image obtained from the lens is enlarged when the object is placed between optical center and the focus. This image is virtual and erect.

Image formation by a concave lens

The image formed by a concave lens is always on the same side as the object and it is always virtual and erect. Also, the size of image is always diminished, that is, its size is always smaller than that of the object.

Uses of curved lenses

(i) Convex lens is used as a magnifying glass as it can formed enlarged and erect image of an object.

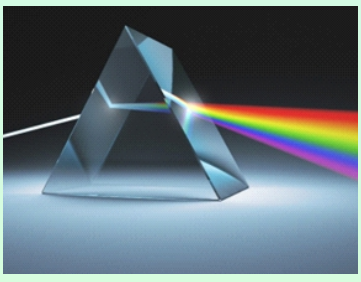
(ii) There is a convex lens in each eye.

(iii) Lenses are used in spectacles to correct short-sightedness and long sightedness.

(iv) Lenses are used in optical instruments like cameras, binoculars, microscopes, telescopes.

Dispersion of white light

Dispersion of light : The phenomenon of splitting up of white light into its constituent colours is called 'dispersion of light'.



Dispersion of light

Persistence of vision : The coloured disc appears white because of a property of our eyes called persistence of vision.