## What is light?

Light is a radiation or a form of energy that our eyes can detect. Light enables us to view our surroundings. Light travels from one place to another in a straight line.

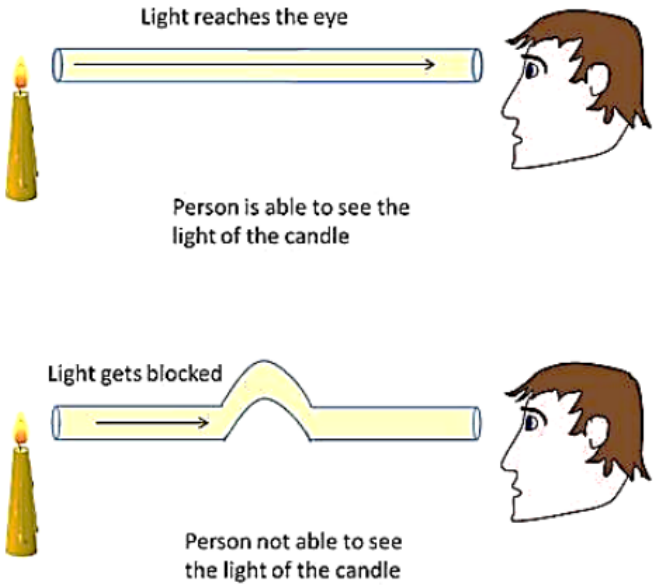


**Figure 1: Light always travels in straight line**

For instance, if you look at the flame of a candle with a straight pipe we can easily view the candle. However, if we bend the pipe we cannot view the candle and the light coming through it because it is blocked.

## Reflection of Light

- Whenever light hits an object it is either absorbed or reflected back.
- **Reflection of light** can be defined as the phenomenon of an object throws back the light that falls on it. Hence, the reflection of light changes its path.
- A **mirror** is generally any shiny surface that can reflect back light.
- A mirror that has a plane surface is called a **Plane Mirror**.
- A mirror that is curved, it either bulges in or out, is called a **Curved Mirror**.

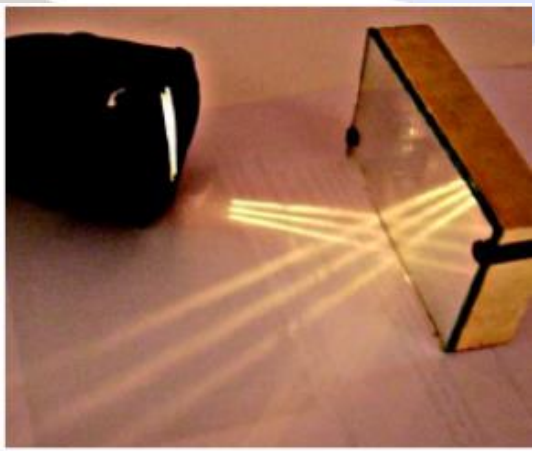

**Figure 2: Reflection of light by plane mirror**

## What is an image?

**Figure 3: Image of Candle Formed by a Mirror**

- As a mirror reflects light, an **image** of the object that is in front of the mirror is formed on it.
- The image of an object can be defined as the impression of the object created by the light on the mirror.
- The distance between the image and the mirror, and the object and the mirror always remain the same.
- If we increase or decrease the distance between the object and the mirror, the distance between the image and the mirror also increases or decreases, respectively.
- However, the size of the image formed on the mirror can vary with respect to the distance between the object and the mirror.
- If the distance between the object and the mirror increases, the size of the image decreases and vice-versa.
- An image is said to be **erect** if the image is formed the same side up as that of the object.
- The image will be called **Inverted** if it is formed upside-down compared to the object.

**Figure 4: Inverted Image of a Candle**

## Left-right inversion of the image

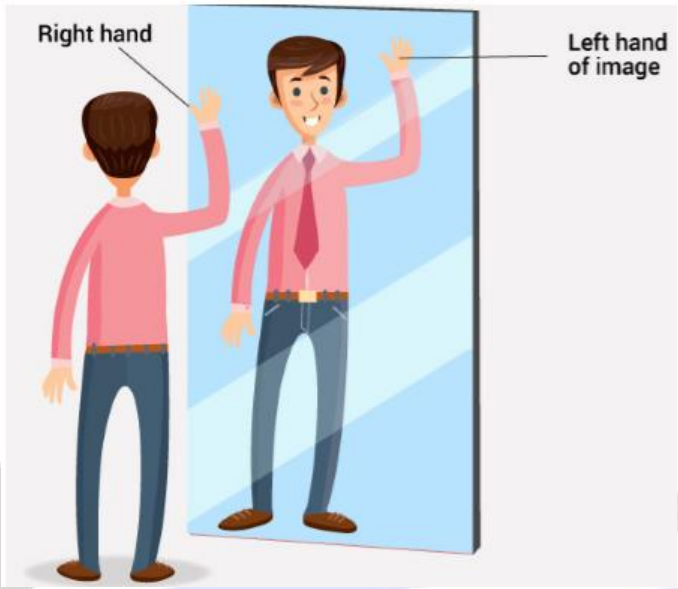


**Figure 5: Left-right inversion of the image**

The image formed by the mirror is always left-right inverted. This means that the right side of the object appears as the left side of the image, and the left side of the object appears at the right side of the image.

## Why the word 'AMBULANCE' is painted on an ambulance left-right inverted?


**Figure 6: Ambulance**

This is because of the left-right inversion of the image on a mirror. The word ambulance written as left-right inverted would, therefore, be read easily by the driver of the vehicle ahead of the ambulance in its rearview mirror. The rear view mirror will again invert the word left-right wise.

## The Laws of Reflection of Light

- **Incident Ray** - The light ray that falls on the reflecting surface is called an **Incident Ray**.
- **Reflected Ray** –Tthe light ray that gets reflected back from a reflecting surface is called a **Reflected Ray**.
- **Normal** - It is a line that is perpendicular to the reflected plane at the point of incidence of **Incident Ray**.

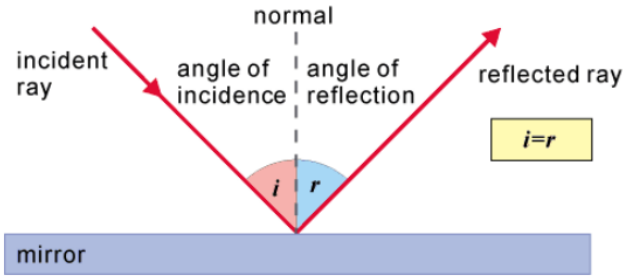


**Figure 7: Incident Ray, Reflected Ray and Normal**

## The Two Laws of Reflection

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

## Types of Reflection

Depending upon the surface of the reflecting object, the reflection of light can vary.

- **Diffused Reflection or Irregular Reflection**: In this type of reflection, the light rays that fall on the surface are reflected back in different directions irregularly. This generally happens in the case of an irregular or roughly surfaced object.
- **Regular Reflection**: In this type of reflection, the light rays that fall on the surface of the reflecting object reflect back in a particular direction. The reflected rays are always parallel to each other. This generally happens in case of a smooth and shiny surface.

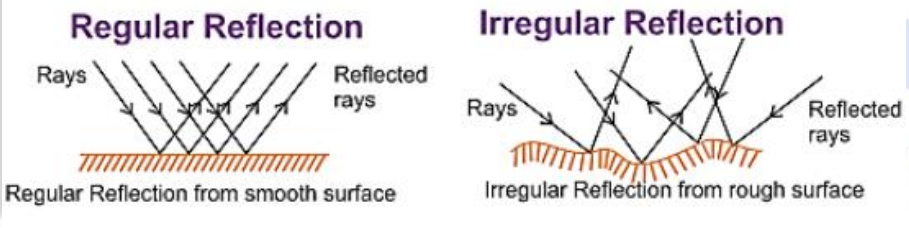


**Figure 9: Types of Reflection**

## Spherical Mirrors

Spherical mirror, as the name suggests, has a sphere-like shape. It appears as if it is a part of a sphere. There are two types of spherical mirrors:

- **Concave Mirror** - It is a spherical mirror whose reflecting surface is curved inwards.
- **Convex Mirror** - It is a spherical mirror whose reflecting surface is curved outwards.

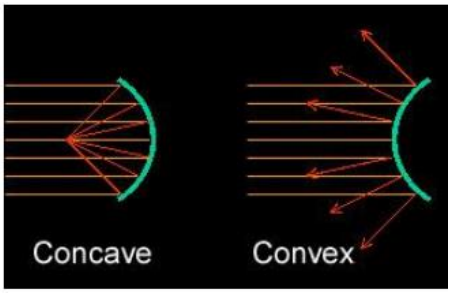


**Figure 10: Concave and Convex Mirror**

**The Image formed by a Concave and Convex Mirror**

An image can be of two types:

| Real Image | Virtual Image |
|---|---|
| The real image is formed when the light rays reflect and meet at the same point. | A virtual image is formed when light rays reflect and diverge from the same point. |
| It can be viewed on a screen. | It cannot be viewed on the screen. |
| It is always inverted. | It is always erect. |
| Formed by Concave mirror | Formed by Convex, Concave and Plane Mirrors |

**Figure 11: Formation of Real Image by Concave Mirror**

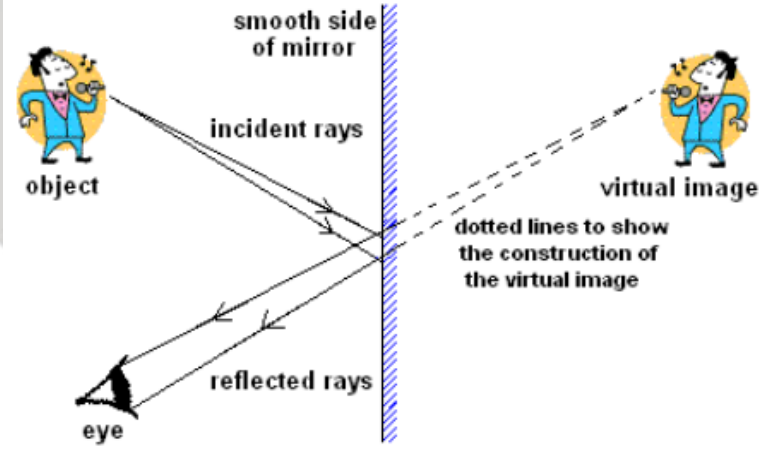


**Figure 12: Virtual Image by Plane Mirror**

## The image formed by a concave mirror has the following properties:

- It can either be real or virtual.
- It can either be inverted or erect.
- It can have the same size as that of the object, a larger size that of the object or smaller size than that of the object.

### The image formed by a convex mirror has the following properties:

- It is always virtual.
- It is always upright (erect).
- It is smaller in size as that of the object

### Applications of Concave Mirrors:

- Satellite dishes use a concave mirror to gather all the signals and reflect them on a certain point.
- Dentists use a concave mirror to reflect light on a particular tooth.
- Shaving Mirrors are concave in shape.
- Headlights of a car have a concave mirror so that we can reflect back light straight on the path.
- Torches also use concave Mirrors.


**Figure 13: Concave Mirror Used in Torch**

### Applications of Convex Mirrors

- The rear view mirrors are convex mirrors as they provide a wider view of the road behind.
- Security mirrors near an ATM are convex so that the user can detect easily if anyone else is watching from behind or not.

**Figure 14: Convex Mirror used in a Rearview Mirror**

## Lenses

A lens is a part of a reflecting material like glass or plastic but curved from both sides. Lenses are unlike mirrors that have a reflecting surface only on one side. Depending upon its shape a lens can be categorized as:

- **Convex Lens** - A Convex Lens is curved outwards. It is thicker in the centre and narrows down at the edges. It merges the light rays passing through it at a certain point. Therefore, it is also called a **Converging Lens**.
- **Concave Lens** - A Concave Lens is curved inwards. It has wider edges and a thinner centre. It reflects back the light that travels through it in different directions. Therefore, it is also called a **Diverging Lens**.

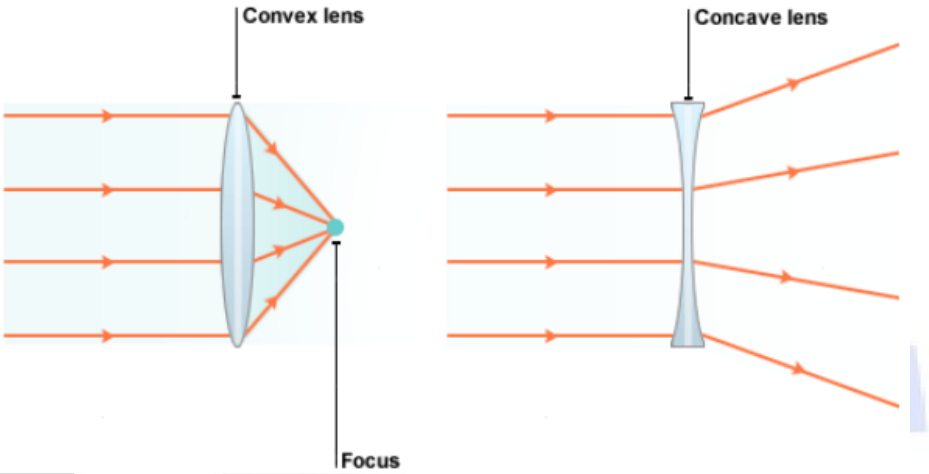


**Figure 15: Convex Lens and Concave Lens**

## Images formed by Convex and Concave Lenses

### A Convex lens forms an image that is:

- real
- inverted
- the image is large and appears close to the lens

### A Concave lens forms an image that is:

- virtual
- erect
- small and appears far away

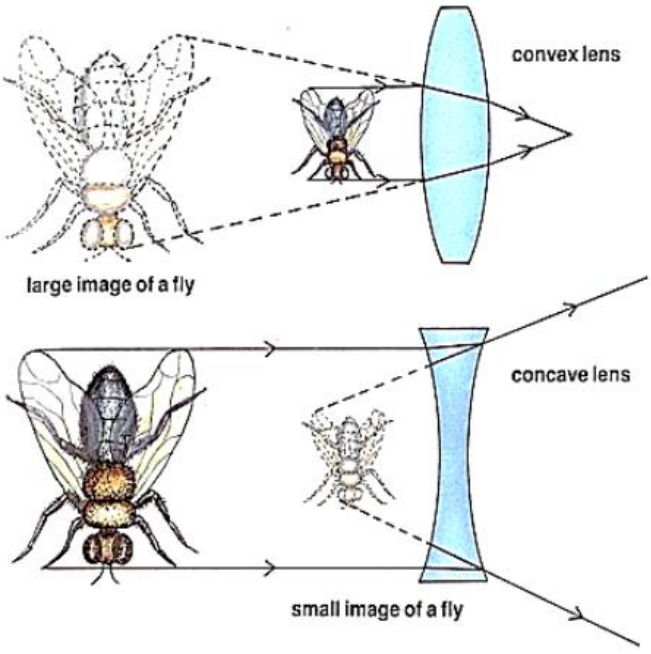


**Figure 16: Image formed by Convex and Concave Lense**

## Sunlight

### What is a Rainbow?

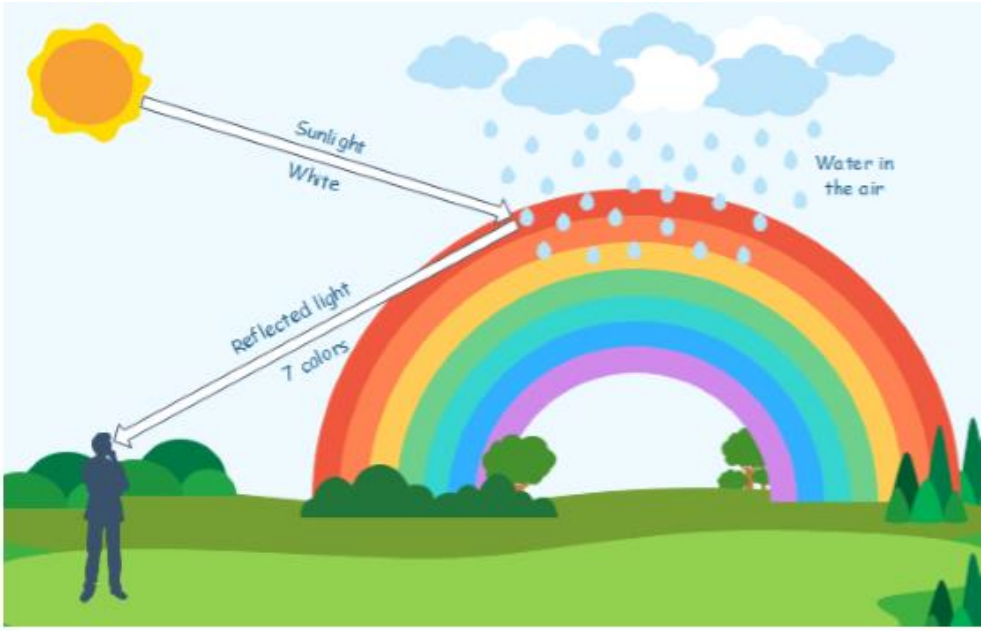


**Figure 17: Formation of Rainbow**

- A rainbow is a natural phenomenon in which the light rays of the sun are reflected and refracted by the water droplets present in the atmosphere.
- A rainbow appears as an arc on the sky that contains a band of seven colours – Red, orange, yellow, green, blue, indigo and violet.
- This also means that the white light of the sun contains seven coloured lights in it that separate out due to refraction (called a **Spectrum of Lights**). This spectrum of white light can be seen in the following:
  - Rainbows
  - Soap bubbles
  - Surface of a CD
  - Prisms

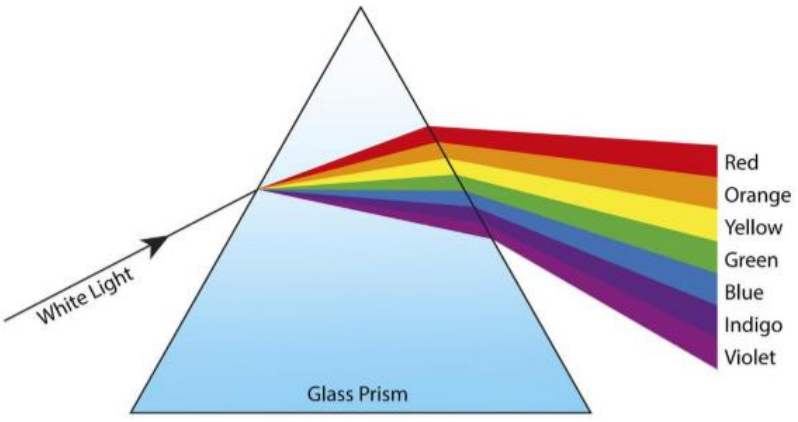


**Figure 18: Spectrum of White Light through a Prism**

## Newton's Disc

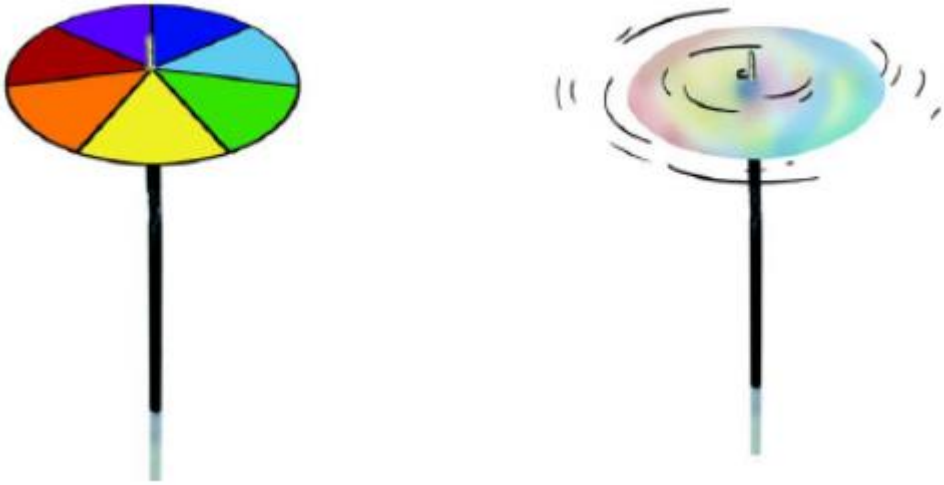

**Figure 19: Newton's Disc**

- The Newton's disc can be obtained by dividing a disk into 7 partitions and painting each of them with the seven colours of the rainbow.
- When the disc is rotated at a fast pace in daylight all the colours tend to mix together and the disc appears whitish in colour.