Light Energy

Light: Nature and Properties

Have you already figured out the answer to the last question asked in the animation?

You are not able to see the ball through the curved pipe because the reflected light rays coming from the surface of the ball do not reach your eyes. This happens because light always travels in a straight line.

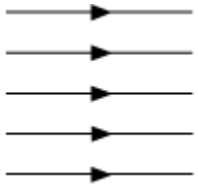
Light rays travelling outward in straight line

After emanating from a source, light travels only in a straight line in all directions. This phenomenon is called the **rectilinear propagation of light**. The straight lines are also called rays of light. The collection of rays of light is known as beam of light.

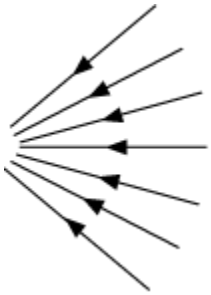
Have you seen a lighthouse from a distance? The light beam that comes out from it travels in a straight path because of the property of rectilinear propagation of light.

The light rays emitting from a source can be either parallel, convergent or divergent.

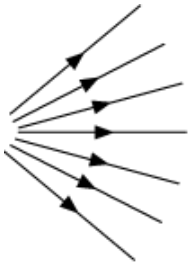
Parallel- the rays of light which are equidistant from each other at all places and do not meet are called parallel rays of light.



Convergent- the rays of light which come from different directions and meet or appear to meet at a point are called convergent rays of light.



Divergent- the rays of light which emit from a common source or point of light and travel in different directions after emitting are called divergent rays of light.



Video(s) by teachers

The light rays propagate in different media with different speeds, the maximum being in air or vacuum.

Medium	Speed of light (in m/s)
Air/ Vacuum	3×10^8
Water	2.25×10^8
Glass	$2\times\times10^8$

Laws of Reflection and Image Formation by Plane Mirror

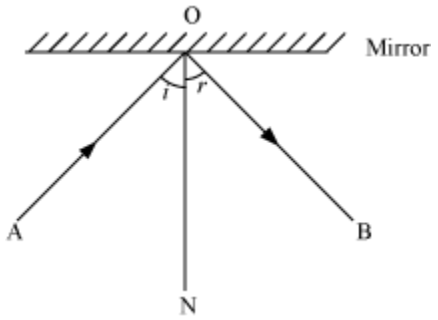
We are able to see things because of our sense of sight. It enables us to see beautiful landscapes, buildings, stars, moon, and everything else around us. **Have you ever wondered how we are able to see these objects?**

We are able to see different objects when light from these objects enters our eyes. This light may have been emitted by the object or reflected by it. We cannot see in dark. **Can you explain why?**

Laws of reflection

Consider a ray of light falling on a plane mirror. When the ray of light hits the mirror, it gets reflected in a certain direction. The ray of light which was incident on the mirror is known as the **incident ray,** whereas the ray of light reflected by the mirror is known as the **reflected ray**.

A straight line drawn perpendicular to the surface of the mirror at the point of incidence is known as **normal (N)** to the surface. The angle made by the incident ray with the normal is known as the **angle of incidence** (i). The angle made by the reflected ray with the normal is known as the **angle of reflection(r).**



Reflection from a plane mirror

Is it possible to find the direction of a reflected ray? Let us perform an activity to find out.

Activity:

Remember that in the activity, you have to take incident ray, reflected ray and normal on the same piece of paper. This shows that **incident ray, reflected ray and normal lie in the same plane**. This is the **second law of reflection**.

Reflection of light ray incident normally on a plane mirror

When a light ray is incident normally on a plane mirror, then the angle between the normal and the incident ray will be 0^o i.e. $\angle i = 0^o$. Thus, following the law of reflection of light, angle of reflection will also be 0^o i.e. $\angle r = 0^o$. This shows that the light rays

retraces its path after reflection if it is incident normally on a plane mirror or any reflecting surfaces.

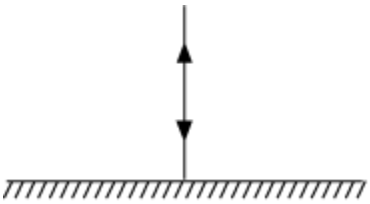


Image formation of a point object by a plane mirror:

Consider a plane mirror MM_1 and a point object O is placed in front of it. Rays from the point object travel in all directions but for its image formation (*I*) only two rays would be sufficient to consider.

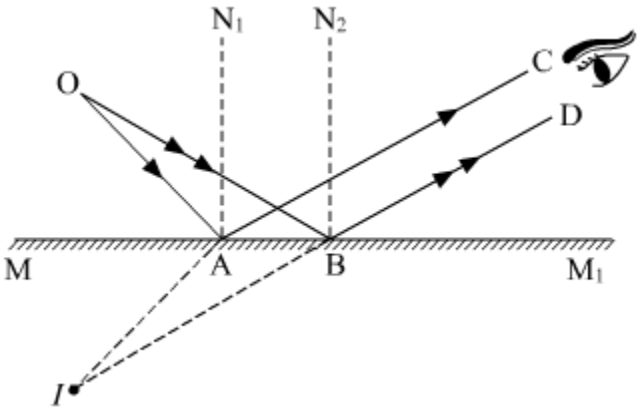
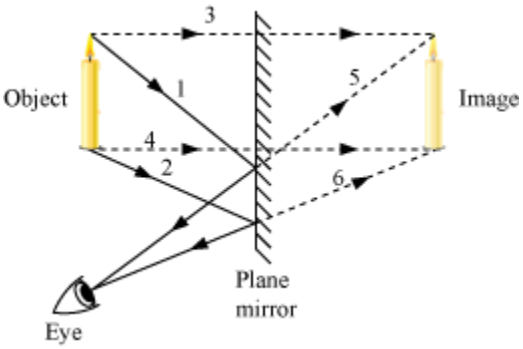


Image formation of an extended object by a plane mirror:

Take a candle and place it in front of a plane mirror. Mark the two rays coming from it as **1** and **2**. After reflecting from the mirror, these rays reach your eye.



However, these rays appear to be coming from somewhere inside the mirror. Also, the left part of the candle appears on the right and its right part appears on the left. This is known as **lateral inversion.**

Characteristics of image formed by plane mirror

- virtual and erect
- same size as of object
- laterally inverted
- image distance and object distance are same and perpendicular from mirror

Virtual images are those images which cannot be obtained on screen. But there are some images which can be obtained on screen. Such images are called real image.

Uses of plane mirror

- It is used as a looking glass.
- It is used to increase the effective length of an optician's room.
- In periscope, two parallel plane mirrors are inclined at 45 degrees with vertical walls such that they are facing each other.
- In kaleidoscope, three plane mirrors are inclined with each other at 60 degrees.
- It is used in solar heaters and cookers to heat substances by reflecting the sunlight towards the substances.

Differences between an image and a shadow

Image	Shadow
An image is formed by the reflection of light from a surface.	A shadow is formed when the path of light is blocked by an opaque object.
An image shows the details of an object.	A shadow does not show the details of the object.
An image has same colour as the object.	A shadow is always black.

Regular and Diffused Reflection

You have already learned about formation of image on plane and spherical mirrors. Now let us see how reflection of light rays takes place from different types of surfaces.

Therefore, we can define regular and irregular reflections as

When all the reflected rays from a given smooth surface are parallel for parallel incident rays, the reflection is known as regular reflection.

And

When for a given set of incident parallel rays, the reflected rays do not remain parallel to each other, the reflection is known as diffused or irregular reflection.

The laws of reflection are valid in regular as well as irregular or diffused reflections.

Objects that give their own light are known as **luminous objects**. The sun, candle, and bulb are a few examples of luminous objects.

However, most objects that we see around us are visible because of the light reflected from them. For example, moon does not have its own light. It reflects the light of the sun, which incidents on it. Objects that are visible because of reflected light are known as **illuminated objects**.

Constituent Colours of White Light

Newton's colour disc is a disc that consists of sections of the seven colours of the rainbow. These sections are arranged sequentially and in a circular order. Each colour occupies a small and equal section or pie of the disc (as shown in the figure).

Pass a nail through the centre of the disc, which acts as its axis, and rotate it about this axis. When the speed of rotation of the disc becomes high, it gets difficult to distinguish between the individual colours. At this point, a combination of colours can be viewed, which appears to be white in colour. This is due to the natural phenomena of the persistence of vision.

Persistence of vision

Persistence of vision is the phenomenon of eye by which an image formed is thought to remain for approximately 1/16th of a second on the retina.

Examples of persistence of vision:

(i) The persistence of vision helps us to watch movies.

(i) Newton's disc gives out white colour when rotated at a high speed.

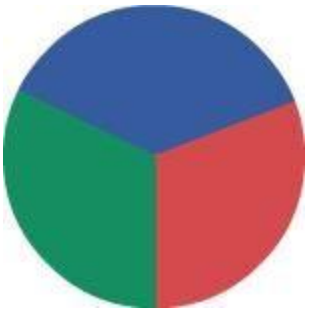
Primary and secondary colour

Primary colours

Primary colours are three basic colours that combine to give white colour. Red, blue and green are primary colours. Primary colours cannot be obtained from any combination of colours.

To understand this, let us perform an activity.

Take a disc and divide it into three equal sections. Paint one section red, the second section blue and the third green (as shown in the figure).

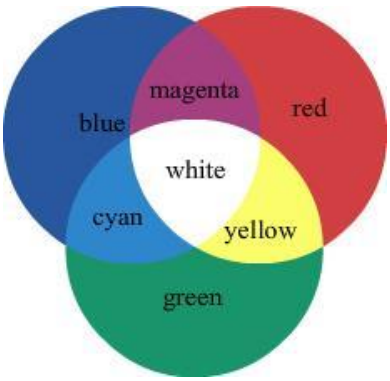


Pass a nail through the centre of the disc and rotate it with a high speed. Due to persistence of vision, the colours combine and appear to be white in colour.

This activity confirms that red, blue and green are primary colours.

Secondary colour

Colours formed by the combination of any two primary colours are called secondary colours.



In the above figure, yellow, magenta and cyan are secondary colours, which have been formed through the combination of green and red, red and blue, and blue and green respectively.

Complementary colours

A secondary colour is known as a complementary colour, if its combination with a primary colour gives a white light. Such combinations are given in the following table:

Primary colour + Complimentary colour	**Light obtained**
Red and cyan	White
Blue and yellow	White
Green and magenta	White

Here, secondary colours, cyan, yellow and magenta are complementary colours as their combination with red, blue and green respectively gives white light.

Colour of transparent and opaque object

A transparent object acquires the colour of light which is allowed to pass through it.
For example, a green cellophane paper passes only green colour of light through it and absorbs the light of rest of the colours.

An opaque object acquires the colour of light which is reflected by it.
Thus, if an opaque object reflects blue colour of light, it appears blue. But if the object reflects all the colours of light, it appears white and if it absorbs all the colours of light, it appears black.