LIGHT, SHADOW AND REFLECTIONS

INTRODUCTION

Light is a invisible form of energy that causes the sensation of vision.

SOURCES OF LIGHT

Those bodies which emit light in all directions are called sources of light. The sources can be point one or extended one. The sources of light are of two types :

(I) LUMININOUS SOURCES :

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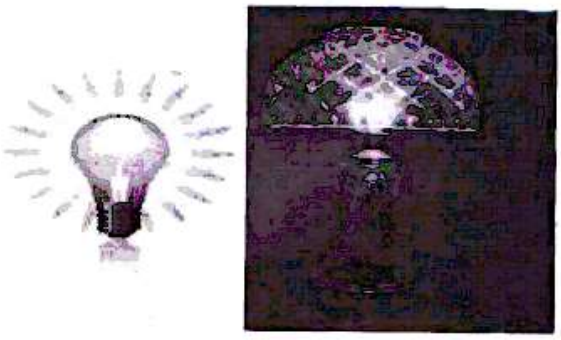
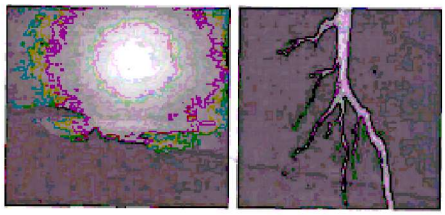
Eg : Sun and stars (natural luminous sources), electric lamps, candles and lanterns (artificial luminous sources).



Bulb **Lamp**

(Artificial luminous sources

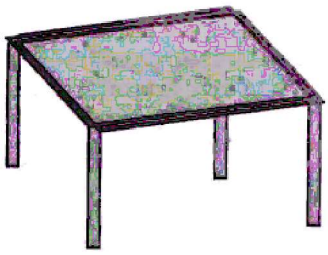


Sun **Lightning**

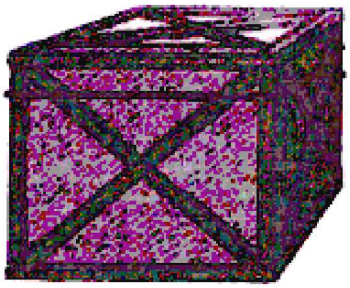
(natural luminous sources)

(II) NON - LUMINOUS SOURCES : Those objects which do not emit light but become visible only when light from luminous objects falls on them. They are called non - luminous sources.

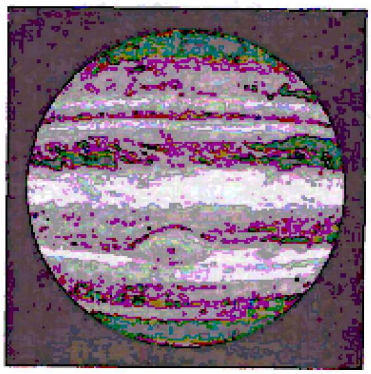
Eg. : Moon, planets (natural non - luminous sources), wood, table (artificial non - luminous sources) etc.



Table



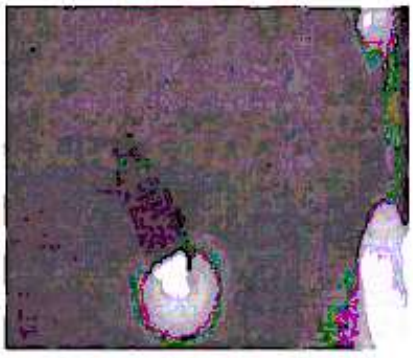
Wooden box
(Artificial non-luminous sources



Planet

Moon
(Natural non-luminous sources)

- **Bioluminescence:** The production or emission of light by a living organism as a result of some chemical energy getting converted into light energy is called bioluminescence. The name originates from the Greek word bios for 'living and the Latin word lumen for 'light'. Fireflies are insects that give off a pale, greenish yellow light that flashes or glows in the dark . Some of the fish, such as angler fish, living deep under the sea are also bioluminescent.



Firefly

MEDIUM OF LIGHT

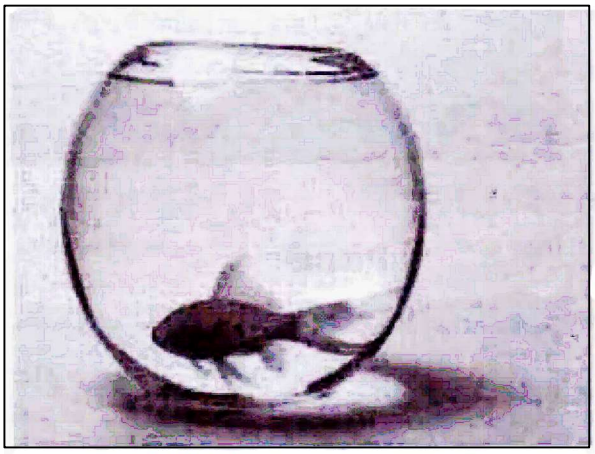
Substances through which light propagates or tends to propagate is called a medium of light.

According to the medium of light objects are divided into three parts :

(i) Transparent object :

Bodies that allow light to pass through them i.e. transmit light through them, are called transport bodies.

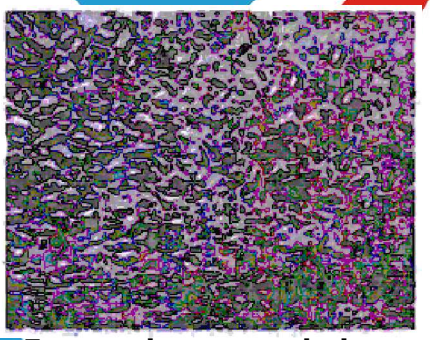
Eg.: Glass, water, air etc.



Transparent beaker filled with water

(ii) Translucent object : Bodies that can transmit only a part of light through them are called translucent object.

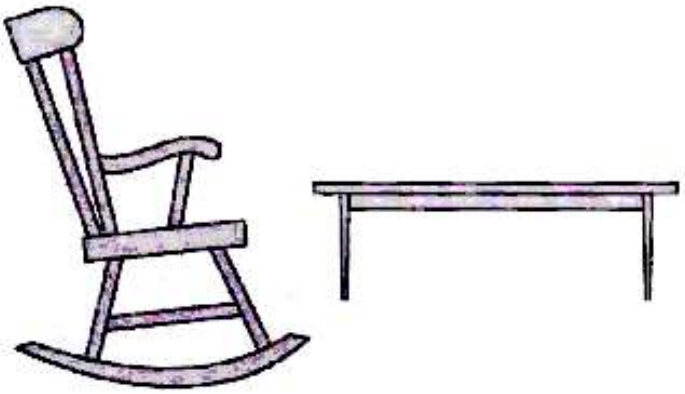
Eg.: Frosted or ground, greased paper, paraffin wax etc.



Froasted or ground glass

(iii) Opaque object : Bodies that do not allow light to pass through them at all called opaque objects.

Eg.: Chair, desk etc.

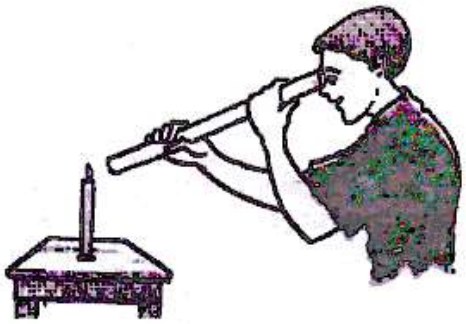


RECTILINEAR PROPAGATION OF LIGHT

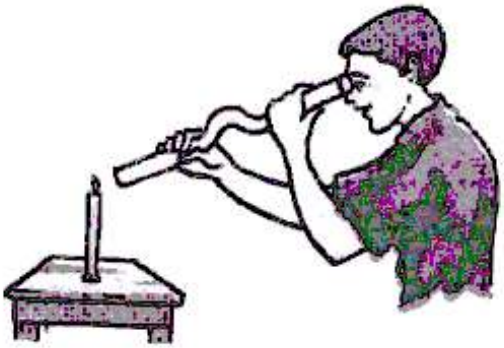
Light travels in a straight line. In vacuum or air, light travels with velocity of 3×10^8 m/s.

Activity : If we see at a lighted candle through a straight pipe as shown in figure, we are able to see the candle but if we see the candle through a bent pipe we are not able to see the candle flame.

This activity showed that light travels along straight lines.



(a) we can see the candle through the straight pipe.



(b) we cannot see the candle through bent pipe.

CHARACTERISTICS OF LIGHT

Some common characteristics of light are given below :

(i) Light is invisible form of energy.

(ii) Light does not require material medium for its propagation i.e., light can travel through vacuum.

(iii) The speed of light in free space (vacuum) is 3×10^8 m/s. Its speed is marginally less in air. Its speed decreases.

(iv) Light undergoes reflection from polished surfaces such as mirrors etc.

(v) When light goes from one medium to another, it changes its path. This phenomena is called refraction.

SOME DEFINATION RELATED TO THE LIGHT

(A) Ray of Light :

The path along which light energy travels in a given direction is called ray of light. A ray of light is represented as a straight line. The arrow head on it gives the direction of light.

(B) Beam of Light :

A collection of rays of light is called beam of light. However, if the number of rays is too small then such a collection of rays is - called Pencil of light.

(C) Parallel Beam :

When the rays of light travel parallel to each other, then the collection of such rays is called parallel beam of light. For example, sun rays entering into a room through a ventilator constitute a parallel beam.

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The opaque objects do not allow light to pass through them, therefore they give rise to the formation of shadow of the opaque object on the opposite side of the source of light.

(a) The cause of formation of shadows is

Rectilinear propagation of light (light travels on straight lines)

(b) Essential of a shadow:

(i) Source of light

(ii) Presence of opaque object in the path of light

(iii) Screen on which shadow is formed

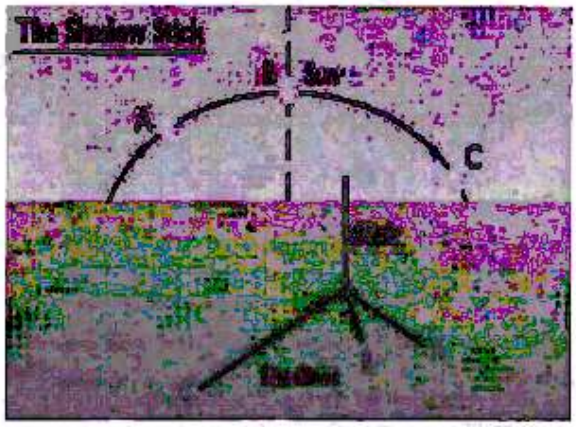
(c) Location of a shadow :

Shadow fills the space between the opaque object and the screen. It is the volume and not area on the screen.

(d) **Formation of shadow :** Sunlight is parallel, so its shadows remain the same size as the object's profile. A desk lamp or a street light also casts shadows because the light is streaming out in all directions away from the source. However, since Its rays are not parallel, shadows get bigger farther away from the object.

Shadow sticks :

A shadow stick is a vertical pole placed in the ground. Sunlight casts its shadow on to a level surface below.(e.g. a sheet of card or just level ground)



As the Sun moves from A to C, the shadow shortens and then lengthen accordingly

The length and position of the shadow then depends on both the time of year and the time of day. Local noon can be found from the time when the shadow is shortest. At this time the Sun is highest in the sky and crossing the meridian.

However, shadow sticks are not good clocks -the azimuth of the Sun's shadow at a given time changes throughout the year with the Sun's declination.

(i) The shape, size and other characteristics of a shadow depend upon :

(ii) Position and distance of the source of light with respect to the object.

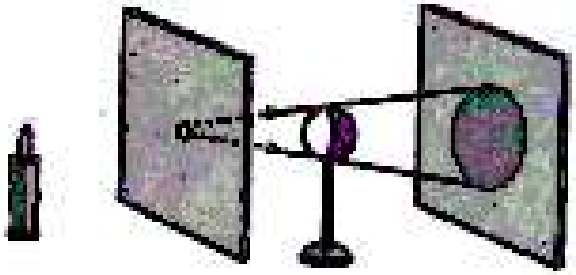
(ii) The distance between the object and the surface on which the shadow falls.

A Shadow has two Regions :

For a non - point source of light (i.e., and extended source of light), the shadow of an object has two parts, namely, the umbra and the penumbra. The umbra is the darkness inner part of the shadow where no light falls at all. The penumbra is the part which surrounds the umbra. Some rays of light fall on this region and partially illuminate it. Thus, the penumbra is called the region of partial darkness.

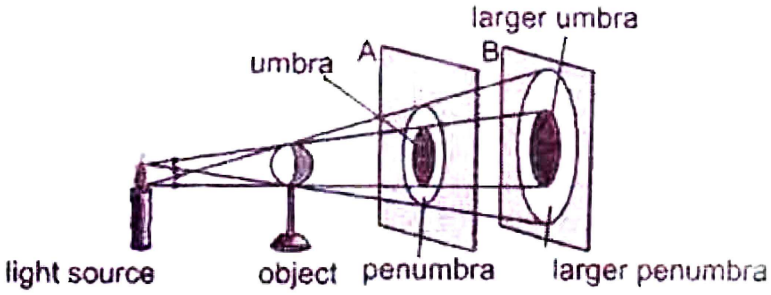
(i) Umbra : The inner region of total darkness is called umbra. It is the evenly dark part of a shadow. Umbra means 'shade' in latin.

(ii) Penumbra : The outer region of partial darkness is called penumbra. It is the fuzzy part between the dark and the light . Pene means 'almost' in Latin. Umbra and penumbra are clearly formed only when the source of light Is big and opaque body is small If one is in the umbra of an object, the light source is completely obscured. If one is in the penumbra, the source is only partially obscured, to a greater or lesser degree as one moves through the penumbra.

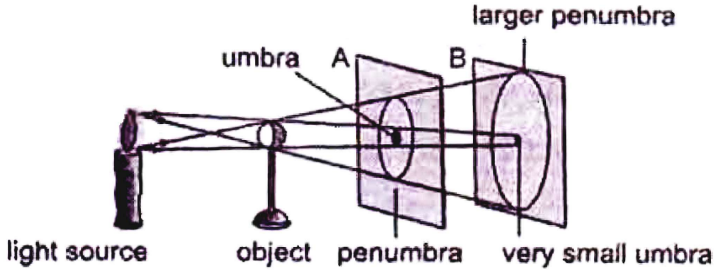


Shadow formed by a point source of light

The wider the light source, the fuzzier, is the shadow.



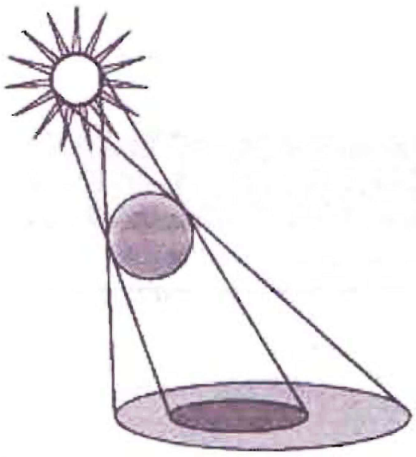
Shadow formed by an extended source
(When size of source is smaller than object)



Shadow formed by an extended source
(When size of source is bigger than object)

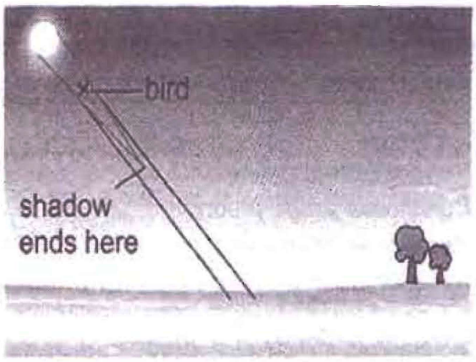
With a wider light source,the shadow becomes fuzzier Also, closer the object to the light, the larger and fuzzier is the shadow. In other words, the closer the object to the screen, the smaller and well defined is the shadow. Thus, the size of the umbra becomes smaller and smaller if the screen is moved farther and farther from the light source and the object.

Shadow are often fuzzy, particularly when the surface on which the shadow lies is far from the object casting the shadow. This fuzziness is because of only point light source in space. All sources have some geometrical size.Thus, light from one edge of the source is not quite parallel to light from the other edge.



When object is very near to the earth's surface

The result is a larger and fainter penumbra that is hardly visible. This is the reason why we cannot see the shadow of a bird flying high up in the air.



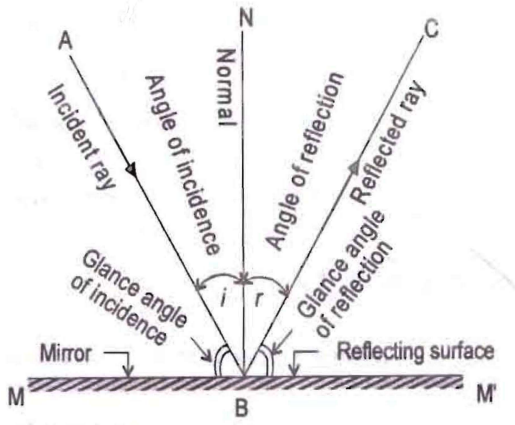
Shadow of a flying bird is not visible

REFLECTION OF LIGHT

When a beam of light falls on any surface, a part of it is sent back into the same medium from which it is coming. This phenomenon is known as the reflection of light.

(A) GENERAL DEFINITIONS ABOUT REFLECTION :

(i) Mirror : A smooth polished surface from which regular reflection can take place is called mirror. MM' Is the mirror as shown in figure.



(ii) **Incident ray :** A ray of light which travels towards the mirror is called incident ray. Ray AB is Incident ray in figure.

(iii) **Point of incidence:** The point on the mirror, where an incident ray strikes is called point of incidence. 'B' is the point of incidence in figure.

(iv) **Reflected ray :** A ray of light which bounces off the surface of a mirror, Is called reflected ray. BC is reflected ray in figure.

(v) **Normal:** The perpendicular drawn at the point of incidence, to the surface of mirror is called normal. BN is the normal in figure.

(vi) **Angle of incidence:** The angle made by the incident ray with the normal is called angle of incidence. LABN is the angle of incidence in figure. It is denoted by Li.

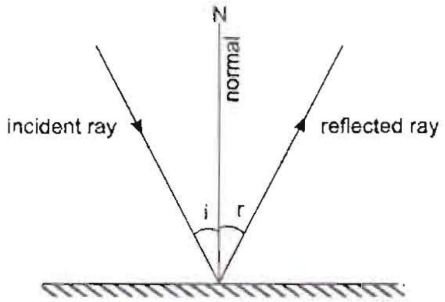
(vii) **Angle of reflection:** The angle made by the reflected ray with the normal Is called angle of reflection. LCBN is the angle of reflection In figure. It is denoted by L r.

(viii) **Glance angle of incidence:** The angle which the incident ray makes with the mirror is called glance angle of incidence. L MBA is the glance angle of incidence in figure.

(ix) **Glance angle of reflection:** The angle which the reflected ray makes with the mirror is called glance angle of reflection. LM'BC is the glance angle of reflection in figure

(B) LAWS OF REFLECTION :

The reflection of light from a surface obeys certain laws called laws of reflection. They are:



(i) Angle of incidence is equal to the angle of reflection, i.e. $\angle i = \angle r$.

(ii) Incident ray, reflected ray and normal to the reflecting surface always lie in the same plane.

PINHOLE CAMERA

The word camera comes from the Greek kamara, a vaulted chamber.

A pinhole camera is the simplest camera possible. It consists of a light-proof box, some sort of film and a pinhole. The pinhole is simply an extremely small hole like you would make with the tip of a pin in a piece of thick aluminum foil.

A pinhole camera works on a simple principle.

ACTIVITY :

Imagine you are inside a large, dark, room - sized box containing a pinhole, Imagine that outside the room is a friend with a flashlight, and he is shining the flashlight at different angles through the pinhole. When you look at the wall opposite the pinhole, what you will see is a small dot created by the flashlight's beam shining through the pinhole. The small dot will move as your friend moves his flashlight. The smaller the pinhole. The small dot will move as your friend moves his flashlight. The smaller the pinhole (within limits), the smaller and sharper the point of light that the flashlight creates.

Rays scatter off objects selects only the rays travelling in all directions. The pinhole in the front of the camera selects only the rays travelling in the direction of the pinhole. These rays pass into the camera and strike the back surface. The front and side wall shade that point on the back from rays coming from different points of origin.