5

Light — The Basic Idea of Shadow

SYLLABUS

1. Sources of light (sun, fire, electric bulb and fluorescent tubes, heated bodies) – luminous and non-luminous bodies – how we see the Moon – bioluminescence (brief mention).
2. Transparent, translucent and opaque bodies/materials – examples.
3. Rectilinear propagation of light – pinhole camera – variations caused by changing distance between screen and pinhole – simple ray diagrams to show formation of image.
4. Shadows – umbra, penumbra – eclipses of the sun and the moon – simple ray diagrams.
   - Classifying a set of objects/materials as luminous/non-luminous; transparent/translucent/opaque (E).
   - Construction of a simple pinhole camera (E).

LIGHT

Imagine yourself entering a room which is dark. Will you be able to see the objects inside the room ? No.

Suppose the light is switched on, now will you be able to see the objects inside the room ? Yes. Why is it so ?

An object is visible to us when the light falling on the object bounces towards our eyes. The light falls on the object, reflects and then reaches our eyes. This makes the object visible to us.

We see the beauty of nature around us, coloured pictures in cinema halls, on television, in books and magazines, etc. This is all due to **light**. Light is, therefore, a vital and useful factor not only to our environment but also to our life.

Light is a form of energy which helps us to see objects. In absence of light, we cannot see anything. Although light itself cannot be seen but in the presence of light, other objects can be seen.

Light is thus defined as **from of an external physical cause that affects our eye to produce the sensation of vision.**

Light is a form of energy like sound. But unlike sound, light can travel through space, *i.e.*, it does not require a medium to travel. That is how we receive light from the sun.

Light always travels in a straight line path in the form of rays. It is considered to be the fastest moving energy.

SOURCES OF LIGHT

In the daytime, we see things due to the light from the Sun. At night, we use an electric light, a torch or a candle. The Sun, an electric light, a torch and a burning candle are some examples of light source. The light from a source of light spreads in all direction. When

it falls on objects, it spreads out from them. When this light enters our eyes, we are able to see the objects. We see a source of light or an object when light from it reaches our eyes. So, we may think that every object that we see is a source of light. But, it is not so. The light from an object, such as a burning candle or match stick is its own but the light emitted by the moon is not its own rather it is reflecting the light received by it from the sun. The light emitted by a source helps us to see other object.

An object which is capable of giving out light is called a *source of light*.

The sources of light can be divided into two categories : (i) natural and (ii) man-made or artificial sources of light.

Natural Sources of Light

The sun is the biggest and the most important natural source of light. It is very bright. It is about 150 million kilometres away from the earth, still it makes the day absolutely bright for us. Stars other than the sun are also ever natural sources of light. Some stars are brighter than the sun but they are too far away from us, as compared to the sun; we therefore do not realise the light given out by the stars, so they appear to be tiny trembling spots.

BIOLUMINESCENCE

A few typical plants and animals emit light, for example, *jugnu* (or glow worm) and firefly. This emission of light given out by a living organism is called **bioluminescence.** This results from a chemical reaction in which chemical energy is directly converted into light. In this process, very little heat is evolved. Bioluminescence objects such as jugnu, *etc*. are considered as natural sources of light.

The emission of light by a living organism as a result of some chemical energy getting converted into light energy is called ***bioluminescence****.*

JUGNU (GLOW WORM)

Fig. 5.1 Some natural sources of light

ACTIVITY 1

To show that the objects that do not give light of their own can be seen only when light is made to fall on them.

Materials required : A rectangular cardboard box, a piece of thick black cloth, a few common things and a torch.

Procedure : Take a rectangular cardboard box (may be a shoes box) and cut a peeping window on one of its smaller faces. Place a few objects such as pen, pencils, geometry box, pocket diary etc. inside the box. Cover the box as well as your head with a piece of thick black cloth. Peep into the box through the window.

Can you see the things placed inside the box ?

No, you will not be able to see anything.

Now place a lighted torch inside the box, and peep into the box again. Can you see the torch and the other things placed inside the box?

Yes, you will be able to see the torch as well as the other things in the box.

Conclusion : We can see the objects like a lighted torch because it emits light of its own.

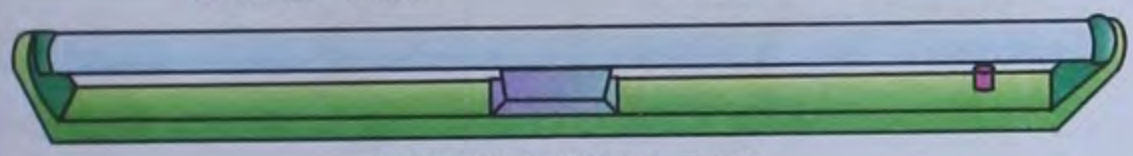
We can see the objects that do not emit light of their own but can be seen only when light from some other source is made to fall on them.

Artificial Sources of Light

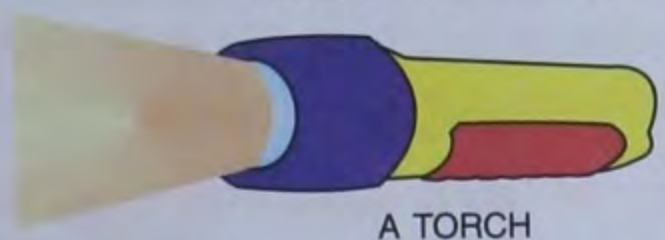
During night time, there is no sunlight, so we cannot see things in its absence. But to perform various activities at night, man has made some artificial sources of light. *For example*, a burning candle, an oil lamp, a bulb, a tube-light, a torch, *etc.*, are all man-made, so they are known as artificial sources of light.

A TABLE LAMP

A BURNING CANDLE



A FLUORESCENT TUBE



A TORCH

Fig. 5.2 Some artificial sources of light

Scattering of Light

Why it becomes bright all around us when the sun rises ?

There are many gas and dust particles floating in the air. When the sun rays fall on these particles, they absorb and re-emit some light in all directions. This is called the **scattering of light**. Due to scattering of sunlight, our surrounding becomes bright.

Remember that a light source spreads an equal amount of light in all the possible directions. As you move away from the source, you will observe that the brightness starts decreasing. Let us try to understand it from the following activity.

ACTIVITY 2

Take a candle and a card board having a hole at its centre. Light the candle and place the card board with a hole in front of it so that the flame is just in front of the hole. Now take another card board and place it at a distance of 20 cm as shown. You will see a bright spot on this card board. Now move it to a distance of 100 cm and then to 200 cm. You will find that the spot becomes dimmer and dimmer on moving farther from the candle, and ultimately, it will disappear.

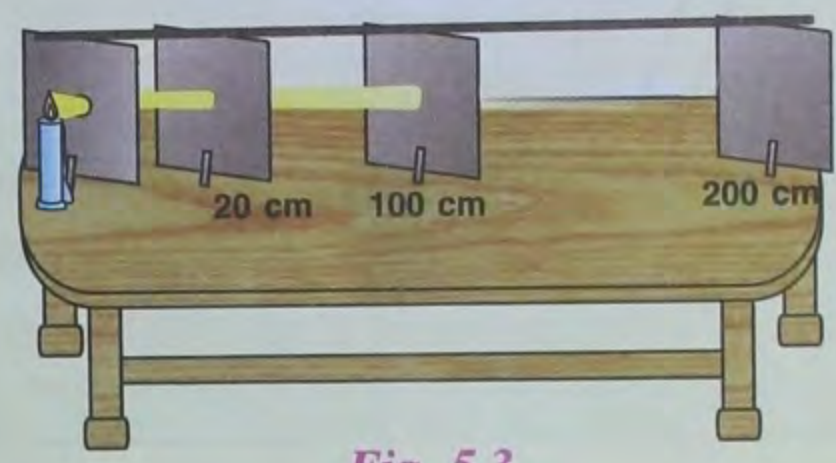


Fig. 5.3

The air also scatters some part of the light. It is this scattered light that helps us to see the objects that are not in direct sunlight. When we light a torch in a darkroom, we not only see directly lighted objects but also other nearby objects. This is also due to scattering of light.

Intext Questions

1. Name any *four* man-made sources of light.
2. Why do objects in a room become visible even if sunlight does not enter it ?
3. Does the flame of a gas stove emit light ?
4. Name few living things which emit light.

INTENSITY AND UNIT OF LIGHT

We see that every source of light has its own brightness. The measurement of brightness produced by a light-source is called its **luminous intensity** of the light source. Earlier, we used to measure the brightness of light in

comparison with the brightness of a candle and we used the unit called **candle power**. *For example*, the luminous intensity of a bulb was considered to be about 100 candles power *i.e.*, a bulb gives the same brightness as 100 candles will give it together.

The modern internationally accepted unit for brightness or intensity is called **lumen. One candle power is equal to 1256 lumen.**

Do You Know ?

Speed of light is very high *i.e.*, nearly 3,00,000 km/s, or 3×10^8 m s^{-1}. Light takes about 8 minutes to travel from the Sun to the Earth.

HOT AND COLD SOURCES OF LIGHT

The sources of light which emit light and heat simultaneously are called hot sources of light.

The sources of light which emit only light and no heat are called cold sources of light.

The bodies which emit light when heated to very high temperature are called incandescent bodies.

Consider the light given out by a fire-fly (Jugnu) and the tip of an **incence stick**. The brightness of their light is almost the same. But is the temperature of the two sources also the same ? No. Similarly you can touch a tube-light which is giving out light but you cannot touch a glowing bulb. If you touch the tip of an agarbatti or a glowing bulb, you will burn your hands. But, if you touch a firefly or a tube-light, your hands are safe.

LUMINOUS AND NON-LUMINOUS BODIES

The sun, stars, bulb, candle, *etc.*, which emit their own light are called **luminous** bodies, while those which do not have their own light like the moon, a chair, a table, *etc.*, are called **non-luminous** bodies. However, if light falls on non-luminous bodies, they become visible to us. Look around and try to list some more examples of luminous and non-luminous bodies in your notebook.

Examples of luminous bodies : Hot filament in an electric bulb, burning candle, oil lamp, torch, a lantern, etc.

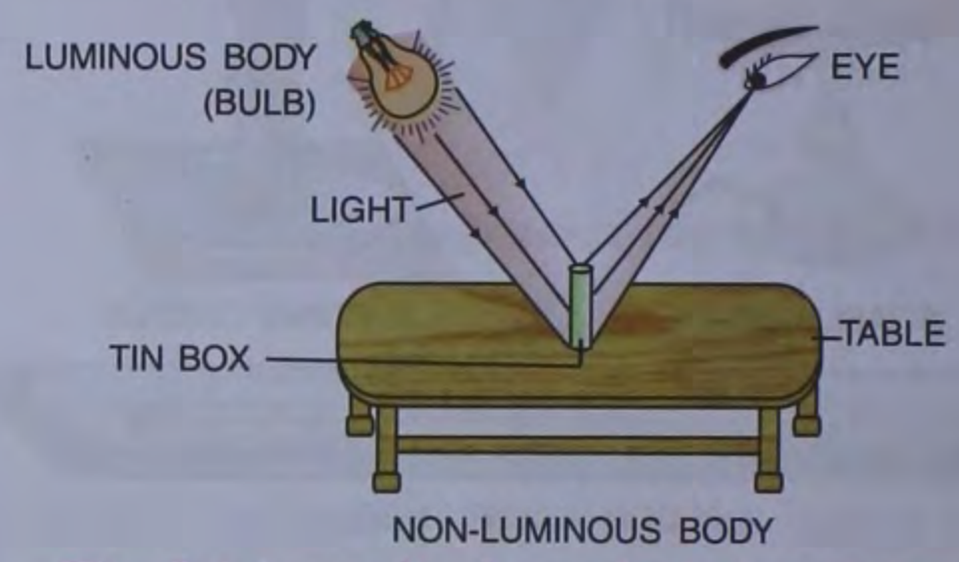


Fig. 5.4 A non-luminous body becomes visible when light falls on it from a luminous body

Examples of non-luminous bodies : Earth, all planets, pen, book, paper, stones, wood, bricks, living organisms, etc.

Luminous bodies may be natural or man-made. For example, the sun, stars and firefly (jugnu) are natural luminous bodies.

A glowing electric bulb, a burning candle or oil lamp are man-made luminous bodies.

Any non-luminous object can be made luminous by heating it. If we heat an iron wire over a gas flame, it becomes red hot and after sometime it will start emitting light. When the temperature is about 800°C, it is able to emit out its own light.

All of you must have seen moon at night giving out cool milky white light. Also some nearby planet like venus appearing like a

bright start during early evening. Why do we call them to be non-luminous although light is coming out of them ?

The simple reason is that, they do not produce their own light. They appear bright as they reflect the light they receive from the sun.

Viewing the Moon

We see the beautiful moon shining at night. We know moon is a non-luminous body *i.e.*, it has no light of its own. Then how does it shine ? The simple answer is that the moon receives light from the sun and the sunlight after bouncing (or reflecting) from the moon reaches us on the earth. Thus, we see the moon shining. Figure 5.5 shows how the moon is visible to an observer on the earth.

Fig. 5.5 The moon is a non-luminous body

Optical medium : Any medium through which light can pass partially or completely is called an optical medium.

(i) Homogeneous medium : It is an optical medium which has uniform density throughout.

(ii) Heterogenous medium : An optical medium which has different density at different points is called heterogeneous medium.

Glass, silver, diamond, distilled water, pure alcohol, etc. are homogeneous medium whereas, air, fog, mist, etc. are heterogeneous medium.

TRANSPARENT, TRANSLUCENT AND OPAQUE BODIES (MEDIUM)

When light or a ray of light falls on an object, three things can happen (Fig. 5.6) :

(i) it may pass through the object almost completely;

(ii) only a part of it may pass through the object.

(iii) it may completely be obstructed by the object.

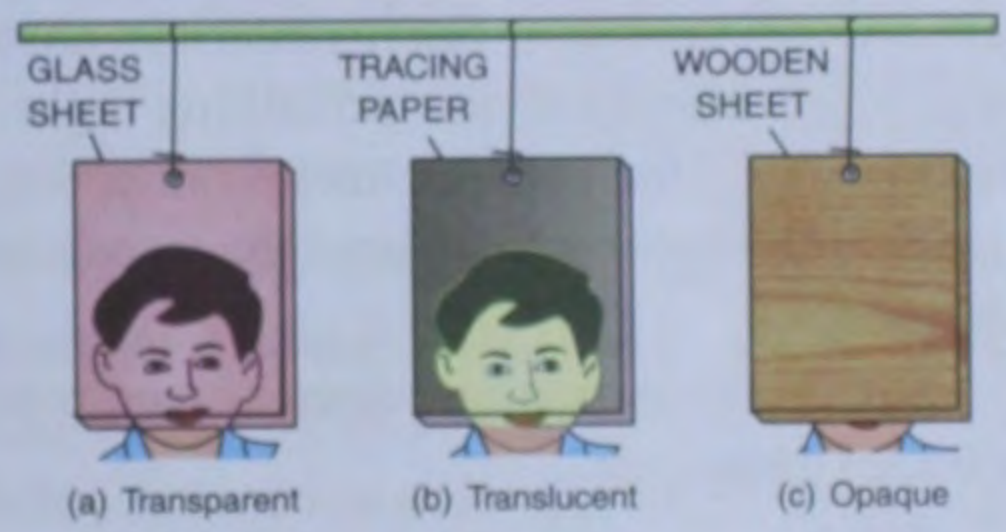


Fig. 5.6

On this basis, we can classify materials into following three categories.

(i) Transparent medium

(ii) Translucent medium

(iii) Opaque medium.

(i) Transparent Medium

A medium through which light can pass completely is called a **transparent medium** and the property due to which the light can pass through the medium is called the **transmitting** property of the medium. One can see through such mediums clearly. Glass and water are examples of transparent media. Sometimes, the transparency of a given material may decrease due to environmental factors, *for example*, fog

or suspended impurities decrease the transparency of air and water.

Uses of transparent materials

Transparent materials, specially glass is used for many purposes.

1. In making window panes and doors
2. In spectacles
3. In binoculars
4. In making microscopes and telescopes, etc.

(ii) Translucent Medium

The medium through which light can pass partially is called a **translucent or semi-transparent medium.** Such materials absorb some light and allow the remaining light to pass through. One can just make out a rough sketch of an object kept behind the translucent material.

For example, tracing paper, waxed paper, grounded glass, *etc.*

Uses of translucent materials

Windows and doors are made of translucent materials so that only a small amount of light can enter into the room.

(iii) Opaque Medium

Objects like wood, black paper, metals, *etc.* do not allow light to transmit through them at all. Such medium which does not allow any light to pass through is known as **opaque medium.** When light falls on opaque materials, most of it is either absorbed or reflected. Thus, one cannot see through an opaque material and also cannot make even a rough sketch of the object kept behind it.

Uses of opaque materials

Opaque materials are used when we do not want to allow light to pass through it. Opaque objects when kept in the path of light, cast a shadow.

ACTIVITY 3

To identify if the given material is transparent, opaque or translucent.

Materials required : Plywood sheet, glass sheet, PVC sheet, aluminium foil, white paper with an oil spot, compact disc and rubber ball.

Procedure : Close the window and doors of your room. Switch off the lights. Leave a small gap (slit) in the window facing sun. Now place, one by one, all the materials given to you infront of the gap. Divide these materials into separate groups depending upon their behaviour towards light.

- If a material allows all the light to pass through it, it is called transparent.
- If the material does not allow any light to pass through it, it is called opaque.
- If the material allows only a part of light to pass through it, it is called translucent.

Observations : Record your observations as follows:

Materials placed in front of the opening in the window	Does the light pass through the material	Type of material
Plywood sheet	No	Opaque
Glass sheet	Yes, fully	Transparent
PVC sheet	Partially	Translucent
Aluminium foil	No	Opaque
White paper with an oil spot	Partially	Translucent
Compact Disc	No	Opaque
Rubber ball	No	Opaque

Intext Questions

From among the following objects, list out the opaque, translucent and transparent bodies in the space provided below :

A glass strip, an ordinary paper, greased paper, tracing paper, polythene sheet, wooden

piece, steel plate, glycerine, kerosene oil, mustard oil, grounded glass, stone, book, water and milk.

Opaque	Transparent	Translucent
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

LIGHT TRAVELS IN A STRAIGHT LINE

Light always travels from the object to our eyes through a straight line path in the form of rays.

A ray is a very narrow path of light represented by a straight line with an arrow. The arrow shows the direction in which the light is travelling.

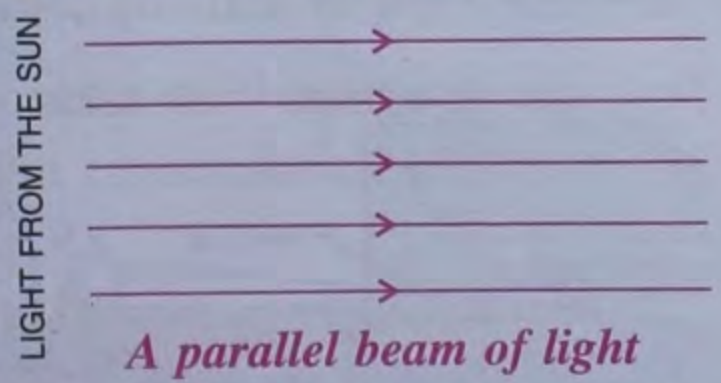
Or

The straight path along which light travels in a particular direction is called **ray of light**.

A ray of light

A large number of rays, all moving in the same direction, form a **beam** of light. The beam of light is classfied into the following *three* types :

(i) If the rays from a far-off object like the sun are found to be parallel to each other, it is called a **parallel beam** of light.

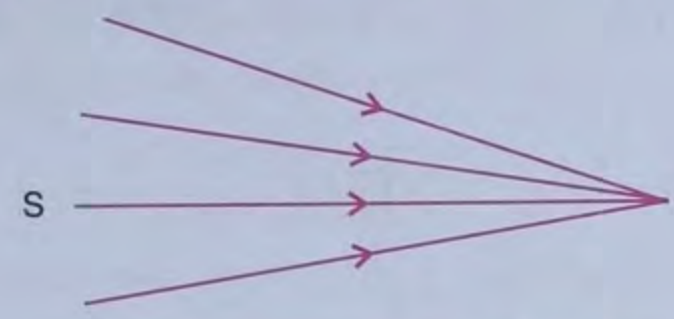


A parallel beam of light

(ii) If the rays are coming out from a very small source (called a point source) and spread out, it is called they produce a **divergent beam of light**.

A divergent beam of light

(iii) If all the rays are coming together and meet at one point, then the beam is known as a **convergent beam of light**.



A convergent beam of light

You might have seen beams of searchlights from a lighthouse or an airport.

Similarly, beams of light can also be spotted in the cinema hall from the projection room to the screen. These days, small laser torches are used as pointers. They produce very sharp light beams. Laser beams are also used in entertainment shows, which you might have seen on your TV screens, *etc*.

RECTILINEAR PROPAGATION OF LIGHT

In all the three types of beams discussed above, you might have observed that rays travel in a straight line. This property of light to travel along a straight path is called **rectilinear propagation of light**.

Let us understand this property by the following activities :

ACTIVITY 4

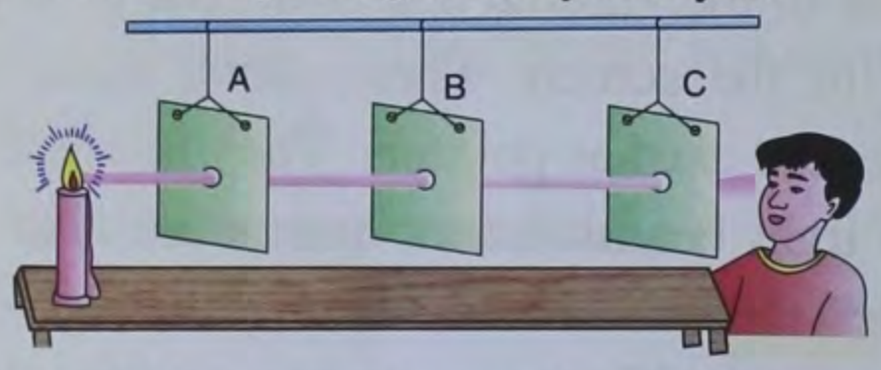
Take a piece of clean rubber pipe. Keeping one eye closed, try to look at a small source of light like a lighted bulb through one end of the pipe, as

shown in Fig. 5.7. You will see the light rays being emitted by the glowing bulb. Now bend the pipe a little and then try to see through this pipe again. You will not be able to see the bulb as well as the light rays being emitted by it. This proves that light travels in a straight line.

Fig. 5.7 Rectilinear propagation of light

ACTIVITY 5

Take three card boards with a hole in each, at the same height. Now hang the card boards over a table top as shown in Fig. 5.8. Put a burning candle on the table in the same straight line and in such a way that the flame of the candle is in line with the card board holes. Now look through the holes. You will be able to see the candle flame. This means the light is travelling straight into your eyes.



Now lift the middle card board a little up. You will not be able to see the flame any more because the light cannot bend and reach your eyes.

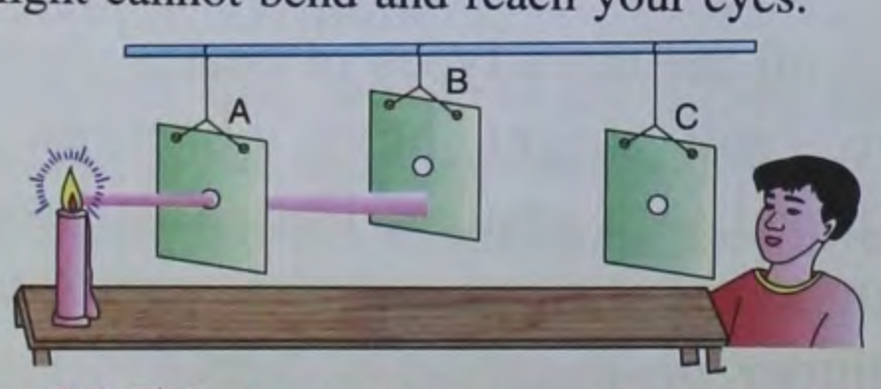


Fig. 5.8 This is another example of rectilinear propagation of light

Hence, we conclude that **light travels in a straight line.**

In a laboratory, we can produce a beam of light with the help of a light box. This box consists of a bulb kept inside a card board box. If light is allowed to come out through a small hole in the box, it acts as a **point source**. If the size of the hole is increased, it gives a beam of light coming out of a wider source of light.

ACTIVITY 6

Take a torch and cover its front with a black tape. Make a small hole in the tape. You will see a point source of light. If the size of the hole is increased, a bigger source of light will be seen.

PINHOLE CAMERA

It is a simple device which helps us to understand about the rectilinear propagation of light.

Pinhole camera is based on the principle that light travels in a straight path.

Construction of a Pinhole Camera

Take an ordinary hollow rectangular cardboard box. Make a small hole in the middle of one face of the box. The size of the hole should be equal to the pinhead of a common pin. Remove the opposite face of the box and fix wax paper in its place with the help of some thread or a rubber band. Blacken the box from inside so that any light which falls on its walls directly or indirectly is absorbed. Figure 5.9 shows the pinhole camera.

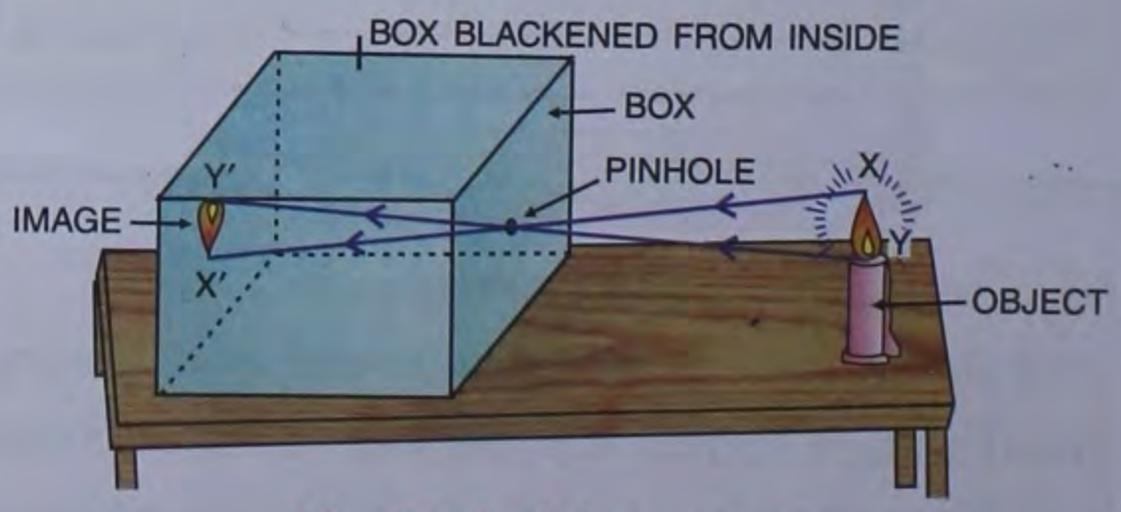


Fig. 5.9 A pinhole camera

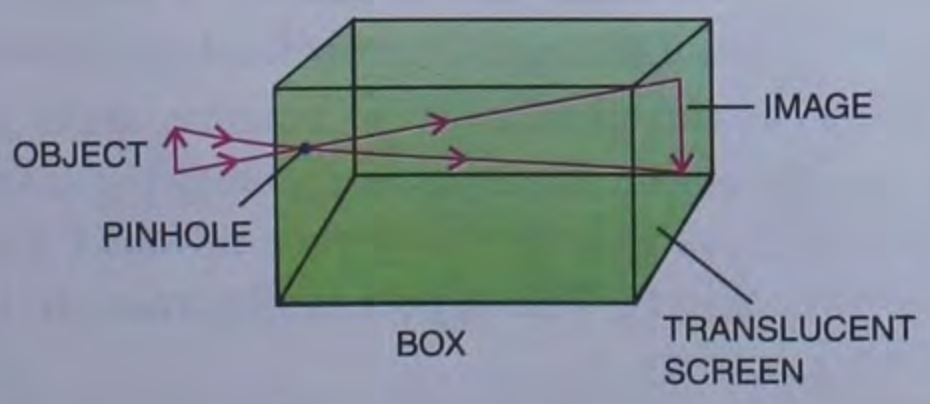
Working of a Pinhole Camera and Formation of Images

When a luminous object such as a burning wick (XY) of the candle is placed in front of the pinhole, an inverted picture X′Y′ of the wick is obtained on the wax paper. This picture is called the **image**. The image obtained is inverted. The reason for the formation of such an image is that light travels in a straight path. Hence, light from the upper point X of the wick passes through the pinhole and strikes the wax paper at X′. Similarly, light from the lower point Y of the wick passes through the pinhole and strikes the wax paper (or screen) at Y′. Light from all other points between X and Y on passing through the pinhole strikes the wax paper in between X′ and Y′. Hence, an inverted image is seen on the wax paper (Fig. 5.9).

Size of the image

The size of an image depends upon (i) the distance of the screen (wax paper) from the pinhole and (ii) the distance of the object (wick of the candle) in front of the pinhole. It is to be noted that, greater the distance of the screen from the pinhole, bigger is the size of the image. Also, greater the distance of the object from the pinhole, smaller is the size of the image.

The ratio of the size of an image to the size of the object is known as *magnification*.



We may write

$$\text{Magnification } (m) = \frac{\text{Height of Image (I)}}{\text{Height of Object (O)}} = \frac{\text{Distance of Image from Pinhole } (v)}{\text{Distance of Object from Pinhole } (u)}$$

$$m = \frac{\text{I}}{\text{O}} = \frac{v}{u}.$$

Do You Know ?

The pinhole camera is considered to be an Arabic invention of the eleventh century. It is believed that it was used for viewing eclipses of the sun without seeing the sun directly and was called **camera obscure**, meaning dark room. In the sixteenth century, it was Leanardo da Vinci who named it as pinhole camera.

Characteristic of the image formed by pin hole camera

1. It is real *i.e.* formed on the screen
2. It is inverted
3. It is generally smaller than the size of the object.

Advantages of a pinhole camera

1. No focussing is required.
2. There is no lens in the pinhole camera. Therefore, the image is free from spherical and chromatic aberrations.

Disadvantages of a pinhole camera

1. The image formed does not give any details. Usually, the image is faint.
2. Image is obtained on the screen is temporary. No permanent record of the image can be obtained.
3. Pinhole camera cannot be used for studying moving objects.

Knowledge Bank

The nature has provided you a large number of pinhole cameras. You have to simply stand under a thick tree on a sunny day and watch the round patches of light on the ground. These round patches are the images of the sun. The gaps between the leaves are the pinholes.

SHADOW

You are well aware of the fact that opaque objects do not allow light to pass through them. So, when an opaque object is placed between a light source and a screen, it blocks the passage of light and produces a dark patch on the screen. It is called the **shadow** of the opaque object.

Normally, shadows of objects are similar in outline to the object and you can identify the objects from their shadows easily. In the morning, when you stand in the Sun, your shadow is longer and formed on the ground on the side opposite to the Sun. Around noon, the shadow is shorter and in the evening, the shadow is again bigger.

To be more clear about the concept of shadow, let us take an example. Light a torch which is the source of light in a room and keep a piece of cardboard at a distance which acts as a screen. Now keep a pencil between the source of light and the cardboard, close to the screen. The pencil acts as an obstacle to the path of the light. Due to this obstacle, some portion of the screen will appear dark. This dark region is the shadow of the obstacle. When we increase the distance between the object and the screen, we will see that one region of the screen is very dark which is called umbra and the other region which is partially dark (surrounding the umbra), is called **penumbra**. In general, if the source of light is a point source, umbra region is formed whereas if the source of light is extended source of finite size, both umbra and penumbra regions are formed.

Remember, the shadow of an object will form only if there is (i) a source of light, (ii) an opaque object (iii) a screen and (iv) the opaque object is placed between the source of light and the screen.

Specifically, an opaque object casts a dark shadow, a translucent object casts a weak shadow, while a transparent object casts no shadow at all.

To study this fact more precisely, let us perform the following activities.

Sometimes the shadow may be dark and clear, but sometimes it may be fuzzy. This depends upon the distance of the object from the surface/sheet of paper.

ACTIVITY 7

To show that a surface or a screen is needed behind the object to obtain the shadow of an object.

Materials required : A bright torch.

Procedure : Go with a few friends late in the evening on a dark night to the roof of your house. Ask your friend to stand in open. You should hold the torch closer to the ground. Shine the torch upwards on the upper part of your friends body.

Look around if any shadow is formed. There is no shadow around. Now ask your friend to stand closer to a wall behind him and shine the torch towards him. What do you see now?

The shadow of your friend is formed on the wall.

Conclusion : This shows that for a shadow to form, we need a surface/screen behind the object.

Shadows can give some information about the shape of the object. However, sometimes the shapes of the shadows may be altogether different from that of the objects. This aspect is illustrated in the following activity.

ACTIVITY 8

To show various shadows of the hand.

Materials required : A torch

Procedure : In a dark room, lit a torch and make the light to fall on the wall/screen. Now create various hand gestures and observe the screen.

You will find the shadows matching various animals. So, you have created shadows which do not match with the object. Have fun!

ACTIVITY 9

(i) Shadow due to a point source of light :

Take a ball, a torch with a very small hole through which light can pass and a screen. Arrange them as shown below.

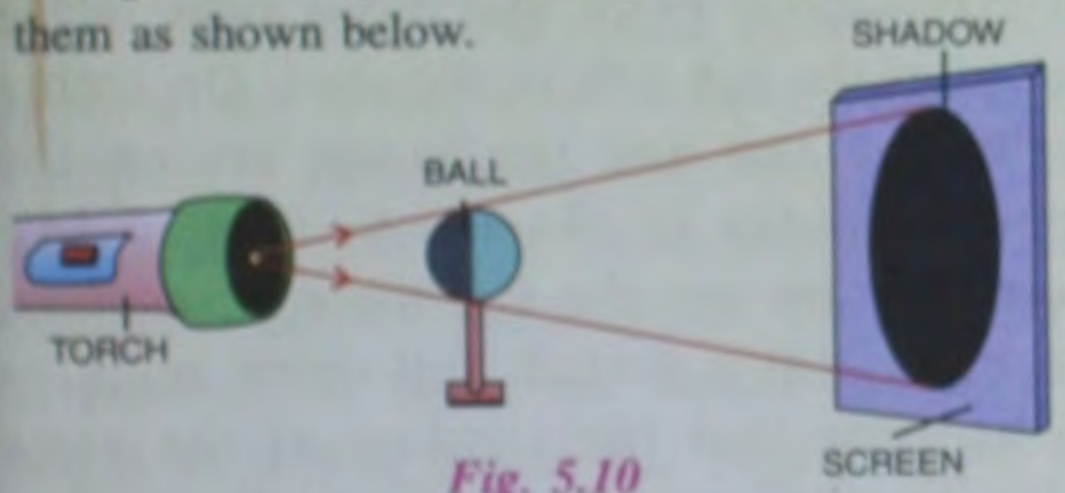


Fig. 5.10

On glowing the torch, you will see a dark patch on the screen which is called the shadow. The shadow will have sharp dark edges. It is called **umbra**. In this case, the size of shadow will always be bigger than the size of the obstacle between the source of light and the screen. (i) An umbra is formed when an opaque object obstructs all the light rays falling on it from a point source of light.

(ii) Shadow due to an extended source of light :

Now increase the size of the hole through which torch light would pass; the rest of the things remain the same. Arrange the objects as shown below. See what happens now on glowing the torch?

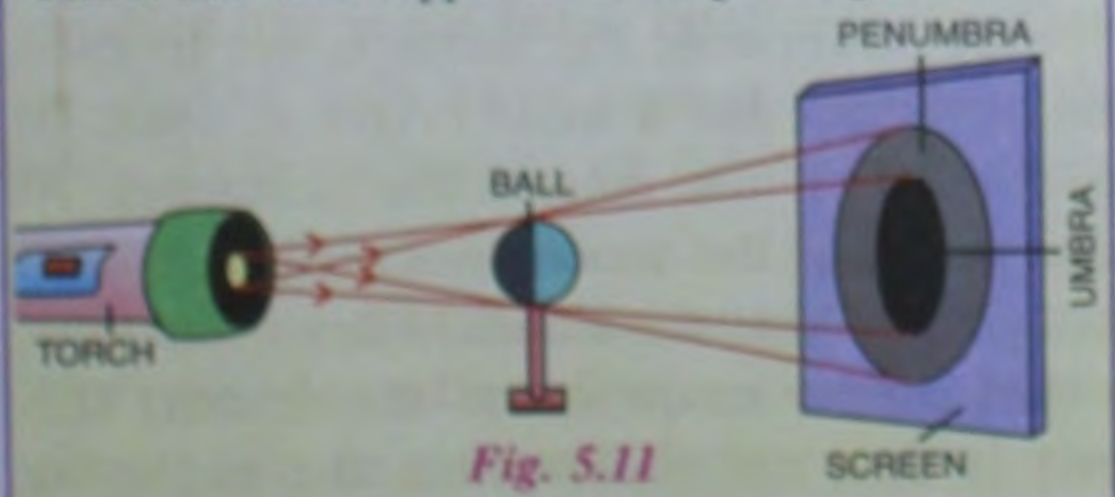


Fig. 5.11

You will again see a shadow appearing on the screen but little different from the one described earlier.

This shadow will have a dark patch surrounded by a partially dark patch called **penumbra**.

In the umbra portion of the shadow, no light can reach, but in penumbra, the light can reach partially. You can clearly make out from the figure that no light is reaching the umbra portion.

The size of the shadow depends on

(a) the distance between the source of light and the obstacle,

(b) the distance between the obstacle and the screen, and

(c) the size of the obstacle and the size of the source of light.

(iii) Shadow due to a source bigger than the obstacle :

In this case, the obstacle is smaller in size than the source (torch). You will notice that the shadow on the screen has one dark circular patch (umbra) surrounded by a partially dark circular patch (penumbra). The size of umbra is very small, as shown in Fig. 5.12. If the screen is moved away from the obstacle, the umbra gradually become small and finally disappears.

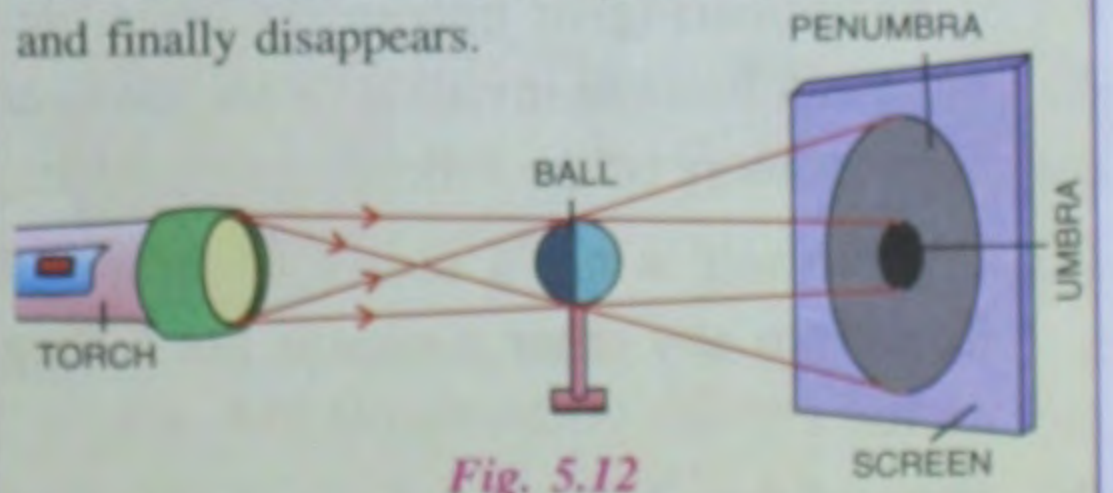


Fig. 5.12

ACTIVITY 10

Choose a pole fixed in your school ground. Watch its shadow on the ground in the morning, at noon and in the evening before sunset. Note down the differences that you observe during these periods in your notebook. Then discuss them with your teacher.

The shadow changes its size and shape in accordance with the relative movement of the sun.

A shadow forms in the opposite side of light source *i.e.*, the sun. When the sun moves, the shadow of the obstacle also shifts accordingly. The size of the shadow varies with the movement of the sun.

Do You Know ?

An eclipse is the partial or complete hiding of one heavenly body by shadow of another.

Birds flying in the sky or the aeroplanes flying high in the sky do not cast their shadow on the ground.

Source of light *i.e.* sun is very large as compared to the opaque object *i.e.* bird or aeroplane. The umbra cone formed by the bird or aeroplane is so small that it does not reach the ground; only penumbra is formed which is very faint and hence no visible shadow is formed on the ground.

NATURAL SHADOWS – ECLIPSE

The term **eclipse** literally means the act of disappearing or becoming invisible. An object can become invisible to an observer under one or more of the following conditions.

(a) Object itself is not a source of light and light from any other source is not falling on it.

(b) View of the object is completely blocked by an obstacle situated or arising between the object and the observer.

An **eclipse** is formed when the shadow of the earth falls on the moon or the shadow of the moon falls on the earth. Thus, there can be two types of eclipses.

(i) Lunar eclipse

(ii) Solar eclipse

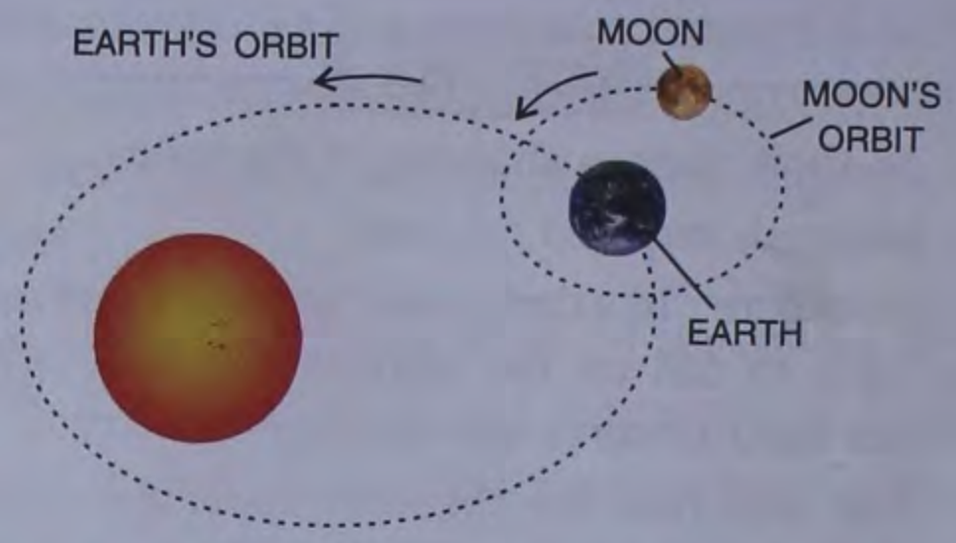


Fig. 5.13 The Earth's and the Moon's orbits

Lunar Eclipse

A lunar eclipse occurs when the earth comes in-between the sun and the moon and casts its shadow on the moon. You know that on a full-moon night, the moon rises in the east after the sun sets in the west. On such a night, the sun and the moon are on the opposite sides of the earth. (Fig. 5.14). Normally, we see the full-moon throughout the night. On a certain full-moon night, it so happens that the shadow of the earth falls on the moon's surface. In such a situation, a part or whole of the moon is not visible to us for sometime from some parts on the earth. Under such conditions, a lunar eclipse takes place. A lunar eclipse does not occur on every full-moon night, because the centres of the sun, the earth and the moon do not lie in a straight line on every full-moon night. Figure 5.14 shows the various positions of the moon as it passes through the penumbra and umbra regions of the earth during a lunar eclipse.

At position A, the moon is yet to enter the penumbra and it looks bright as usual. At position B, it has entered the penumbra. At this position, the moon looks pale, as if it has gone behind the clouds. After some time, a part of the moon enters the umbra. This part is then not visible from the earth; but

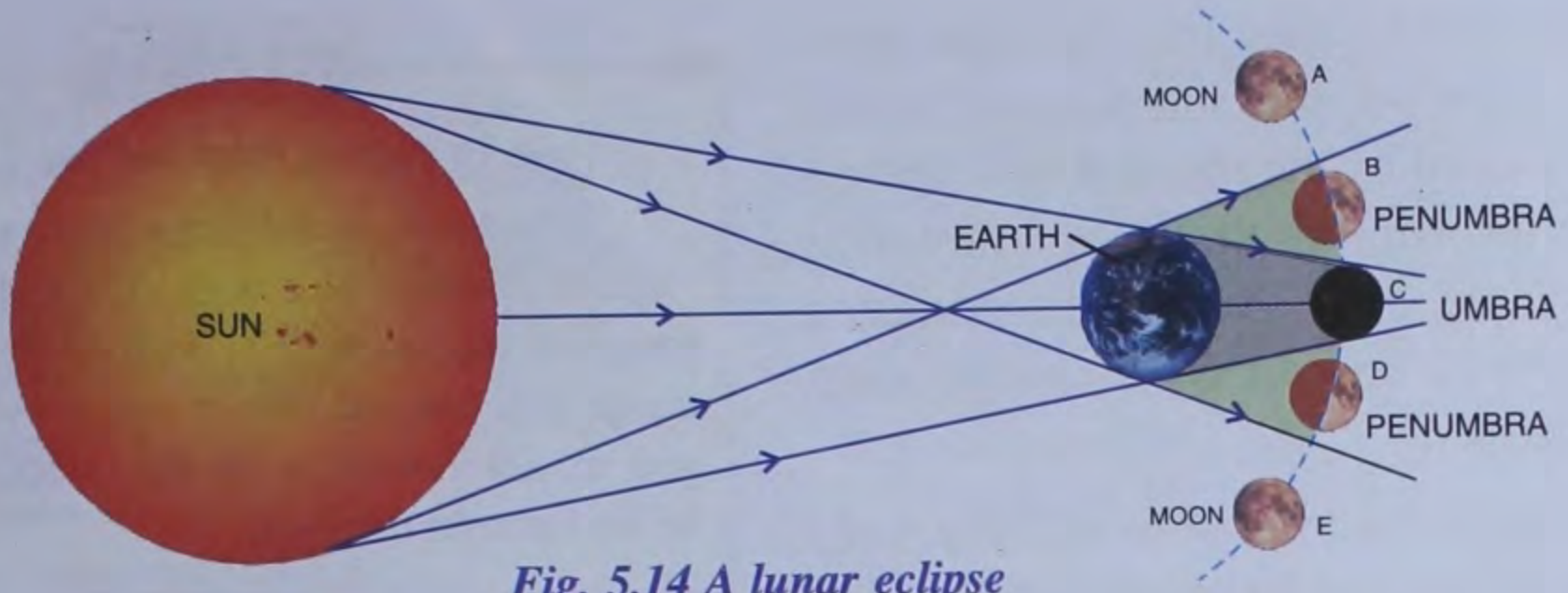


Fig. 5.14 A lunar eclipse

the remaining part of the moon is still visible. This is called a **partial lunar eclipse**. At position C, the moon has completely entered the umbra and is not visible from the earth. This is called **total lunar eclipse**. During the total lunar eclipse, the moon completely disappears from the sight. The Moon then enters the penumbra and finally emerges out of the shadow of the Earth at position E. Now, the moon becomes as bright as it was before the beginning of the eclipse.

Solar Eclipse

A solar eclipse occurs when the moon comes in-between the sun and the earth and casts its shadow on the earth. The portion where the shadow falls becomes dark during the daytime.

On a certain new moon's day, the moon happens to come in-between the sun and the earth. Also, the centres of the sun, the moon and the earth are in a straight line. In such a situation, the moon being smaller in size casts its shadow only on a limited region on the earth. In these regions of the earth, the solar eclipse occurs.

A solar eclipse may be partial or total. The type of a solar eclipse as viewed from a given place on the earth depends on whether it lies in the umbra or the penumbra region of the moon. The sun is not at all visible from that region on the earth where the umbra of the moon falls. This is because the moon blocks the view of the sun.

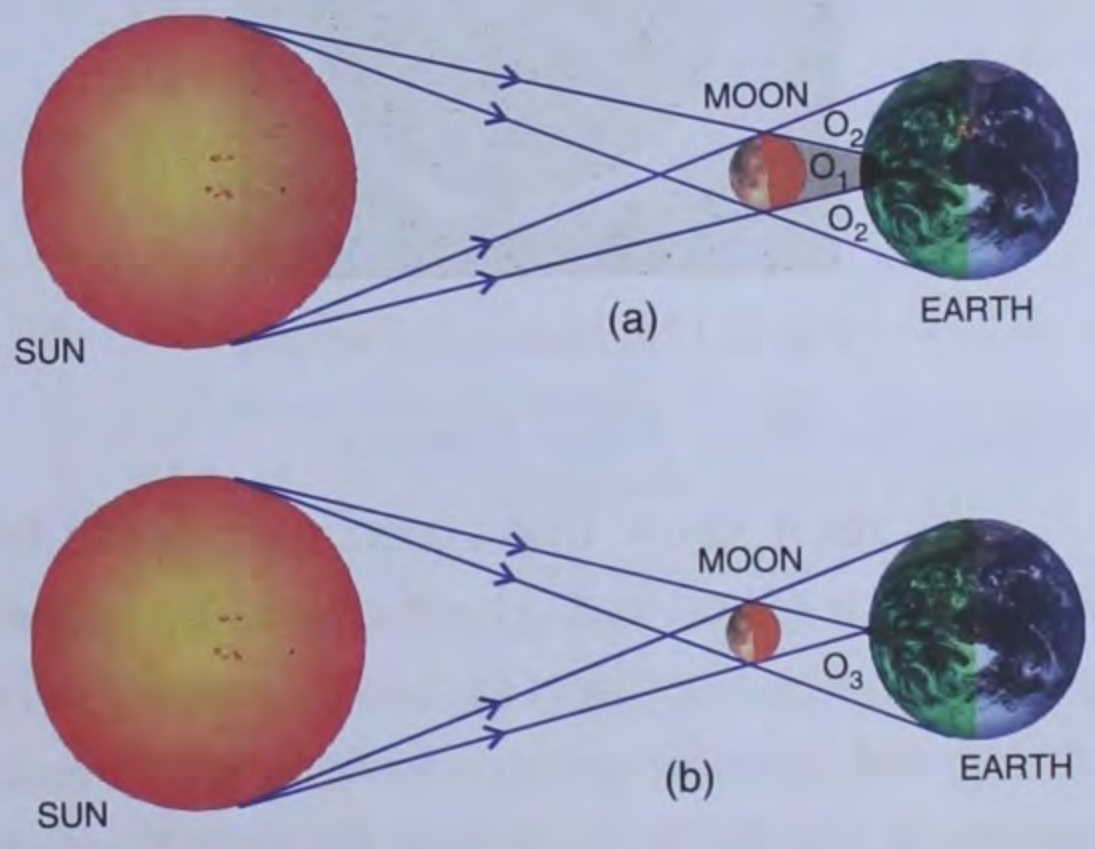


Fig. 5.16 Occurrence of different types of solar eclipses

From a point like O_1 on the Earth, as shown in Fig. 5.16(a), the sun is completely blocked by the Moon. This is called a **total solar eclipse**. Similarly, from a region like the points O_2 in the penumbra, the sun is only partly visible. A **partial solar eclipse** occurs when this happens. An **annular solar eclipse** occurs when only the tip of the umbra of the moon falls on the earth. In such a situation,

for the people in the region on which the point O_3 lies, the view of the sun would be just completely blocked by the moon (Fig. 5.16(b)). Only the outer rim of the sun, known as **corona**, is visible. For a very short period, a very bright ring, known as diamond ring, appears in the sky.

At the time of a total solar eclipse, only the flames of the outer edge of the sun are visible. The rest appears as a dark patch Fig. 5.17.

Fig. 5.17 A total solar eclipse

Protection from Solar Eclipse

We must know that no eclipse should be seen with a naked eye. There should be proper protection because direct rays of the sun are very strong and harmful to our eyes as it may cause parament blindness. It should be seen through a piece of glass which is blackened with soot.

ACTIVITY 11

How to view a solar eclipse ?

Take a card board and make a small hole in it. Place it in front of a wall. Through the hole, the image of the sun will be formed on the wall. This image you can see with a naked eye. In this case, you are not looking at the sun directly, so there will be no harm to the eyes.

Intext Questions

1. Write the names of some transparent objects.
2. What happens in a solar eclipse ?
3. What do you understand by candle power ?
4. Write the names of some cold light emitting objects.

Do You Know ?

The largest solar eclipse of 21st century was seen at the early hours of 22 July, 2009. This lasted for 6 minutes and 39 seconds and covered a wide range of 250 km which included India, Nepal, Bangladesh, Bhutan, Vetnam, China and the pacific region. It was an extremely rare chance for the scientific community to study the sun's corona, which in regular conditions would be impossible to observe.

TEST YOURSELF

A. Tick the correct answer :

1. Light causes
   (a) Sensation of heat (b) Sensation of vision
   (c) Sensation of sound (d) None of these
2. Light is a form of
   (a) Work (b) Energy
   (c) Power (d) None of these
3. The natural source of light is
   (a) Sun (b) Electric lamp
   (c) Candle flame (d) Kerosene lamp
4. A tubelight is a
   (a) Hot source (b) Cold source
   (c) Incandescent source
   (d) None of these

5. Glass is
   (a) Opaque (b) Luminous
   (c) Transparent (d) None of these
6. Substance which don't allow light to pass through them
   (a) Transparent substance
   (b) Opaque substance
   (c) Translucent substances
   (d) Non-luminous substance
7. The image formed by a pinhole camera is
   (a) inverted (b) upright
   (c) always enlarged (d) always diminsihed
8. Shadow forms on the
   (a) Opposite side of the object
   (b) Same side of the object
   (c) On the same plane of the object
   (d) None of these
9. When the moon comes in between the sun and the earth, and all three are in a straight line, then it is
   (a) Solar eclipse
   (b) Lunar eclipse
   (c) Either solar eclipse or lunar eclipse
   (d) No eclipse
10. Umbra is a region of
   (a) Partial darkness
   (b) Partial brightness
   (c) Complete brightness
   (d) Complete darkness

B. Fill in the blanks :

1. The ..... and ..... are natural sources of light.
2. There are ..... and man-made ..... of light.
3. The brightness of light is measured in .....
4. Shadows are formed when ..... blocks .....
5. Eclipses are the formation of ..... in nature.
6. A lunar eclipse is formed on ..... moon day.
7. A ..... is formed when the path of light is obstructed by an .....
8. Light consists of ..... colours.
9. Pinhole camera is based on the ..... propagation of light.
10. A solar eclipse occurs only on a .....
11. Speed of light in vacuum is .....

C. Match the following :

1. Transparent object	(a) Football
2. Eclipses	(b) Glass
3. Translucent object	(c) Fluorescent tube
4. Luminous object	(d) Tracing paper
5. Non-luminous object	(e) Shadows

D. Write true or false :

1. The moon has its own light.
2. The earth has its own light.
3. The stars have no light.
4. Opaque objects do not allow light to pass through them.
5. Image formed in a pinhole camera is erect.

E. Answer the following :

1. What is light ?
2. List *three* natural sources of light.
3. Write down *five* man-made sources of light.
4. Does light travel in a straight line ? Describe an experiment in support of your answer.
5. What is meant by luminous intensity ? What is one lumen ?
6. Distinguish between transparent, translucent and opaque objects.
7. List *two* transparent objects.
8. Name some sources of light that are not hot.
9. How is a shadow formed? Write the conditions required for a shadow to form.
10. Explain the solar eclipse with a properly labelled diagram.
11. When does a lunar eclipse occur. Explain with a diagram.
12. Differentiate between luminous and non-luminous objects.
13. How can you see the solar eclipse safely?

RECAPITULATION

- Light is an invisible form of energy which produces the sensation of vision.
- Light sources are either natural or artificial *i.e.*, man-made.
- The sun and stars are natural sources of light.
- A bulb, a candle, etc., are artificial sources of light.
- We measure the brightness of a source of light in lumens.
- Objects are luminous or non-luminous. The sun is luminous while the moon and the earth are non-luminous.
- Light travels in a straight line. This is called the rectilinear propagation of light.
- Objects are of three types — transparent, translucent or opaque.
- The pinhole camera is a simple application of the rectilinear propagation of light.
- When an object blocks light, it casts a shadow.
- Eclipses are formed due to the formation of shadows of the earth and the moon..
- Solar and lunar eclipses are the examples of formation of shadow of heavenly bodies in nature.
- Eclipses should not be seen directly with a naked eye, but through a darkened glass.
- The dark shadow with sharp edges is called umbra. An umbra is formed when an opaque object blocks out all the light rays falling on it from a point source of light.
- A shadow of lesser brightness surrounding the umbra is called penumbra. Penumbra is formed when the source of light is large.
- An object which has its own light is called a luminous source of light.
- During a lunar eclipse, the earth comes in between the sun and the moon.
- During a solar eclipse, the moon comes in between the sun and the earth.

PROJECT ACTIVITY

Make a room dark. Place a torch on a table and put it on. Now take different types of object before it and observe the shadow formed on the wall. Write your observation on a paper and show it to your teacher.

THINGS TO THINK ABOUT

Opaque objects cast shadows, isn't it? Now, if we hold a transparent object in the sun, do we see anything on the ground that gives us a hint that we are holding something in our hand ?