Light

Sources of Light

The two brightest objects we see in the sky are the Sun and the Moon. The brightness of the Sun is so high that during day time, the Moon is not visible in the sky. During night, when the Sun has set, we can see the Moon. Apart from the brightness of light, is there any other difference between sunlight and moonlight?

The answer is YES. There is a big difference between the two. The Sun emits its own light, whereas the Moon does not have its own light. The Moon is illuminated by sunlight. So, what we call moonlight is basically reflected sunlight.

Like the Sun, candles, light bulbs, kerosene lamps also emit light. So, these objects are different from the objects that do not emit light. Therefore, all objects can be classified into two categories—**luminous** and **non-luminous**.

The objects that emit their own light are known as luminous objects. The Sun, candle, stars are all luminous objects.

The objects that do not emit their own light are called non-luminous objects. Chairs, tables, clothes, etc., are all non-luminous objects.

In normal temperature, many objects are non-luminous; but many of them can become luminous when raised to higher temperatures. In normal temperature, you will find that an iron rod does not emit light and thus, is a non-luminous object. When you heat the same iron rod to a very high temperature (near 1000°C), you will find that the iron rod becomes red hot. You will observe light being emitted from the rod. Therefore, at high temperature, the iron rod becomes luminous.

The objects that are produced by the humans to emit light are called artificial light-emitting objects. Bulbs, LEDs, etc are some of the examples**.**

The luminous body that emits light is known as an **extended source of light,** while the **point source of light** is obtained from a small hole made on the screen placed in front of the luminous body.

Transparent, Translucent and Opaque Objects

What is the difference between the nature of the materials used to make the lenses of sunglasses and spectacles? And what is the difference between the nature of the materials used to make a carton of juice and a cold drink bottle?

Let us see.

Therefore, we can easily classify materials into three categories according to their optical properties.

Transparent objects	Translucent objects	Opaque objects
These objects allow light to pass through them.	These objects allow light to pass through them partially.	These objects do not allow light to pass through them.
One can clearly see through transparent objects.	One can see through translucent objects but not very clearly.	One cannot see through opaque objects.
Transparent objects do not cast shadows because they do not block light.	Translucent objects cast faint shadows as they block light partially.	Opaque objects cast dark shadows as they block light completely.

Curtains and Windows

One afternoon, after coming home from school, Ravi goes inside his room and notes that the room is dark. Ravi draws the curtains, allowing sunlight to enter the room through the window. As a result, the room is lit up. **Now, can you identify the types of materials the curtain and windowpanes are made of?**

You can classify a variety of objects as transparent, translucent, or opaque by observing the shadows they cast and by trying to observe other objects through them. The following table lists some common substances as transparent, translucent, and opaque.

Substance	See-through	Shadow cast	Classification
Pencil	Not at all	Dark	Opaque
Paper	Not at all	Dark	Opaque
Glass	Fully	No shadow	Transparent
Water	Fully	No shadow	Transparent
Smoke	Partially	Light	Translucent
Butter paper	Partially	Light	Translucent

Collect various materials from your daily life (for example, eraser, ruler, book, bottle, cup, chalk, duster, glass, tissue paper, paper bag, sunflower oil, coconut oil, kerosene, etc.). Now, observe the shadows cast by these objects and classify them as transparent, translucent, or opaque.

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.

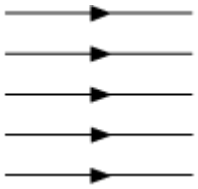
Light rays travelling outward in straight line

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.

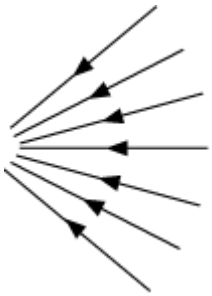
Have you seen a lighthouse from a distance? The light beam that comes out from it travels in a straight path because of the property of rectilinear propagation of light.

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

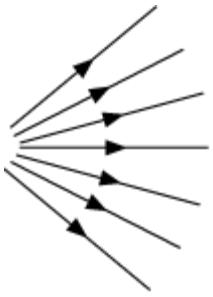
Parallel- the rays of light which are equidistant from each other at all places and do not meet are called parallel rays of light.



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.



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	$3\times\times10^8$
Water	$2.25\times\times10^8$
Glass	$2\times\times10^8$

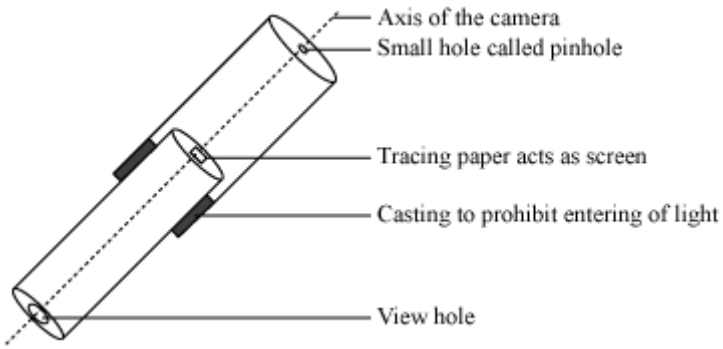
Pinhole Camera

Now, we will summarise what we have learned so far.

- A pinhole camera is a simple optical device that forms an image without using a lens or a mirror.

Construction of a Pinhole Camera

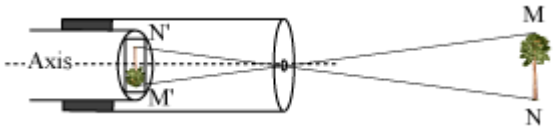
Here is a graphical representation of a simple pinhole camera.



Did you know that a pinhole camera does not require a lens or a mirror for image formation?

A Chinese scholar invented the pinhole camera in 400 B.C.

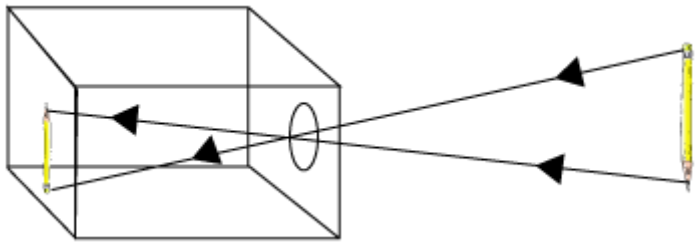
Working principle of a Pinhole Camera



The size and contrast of the formed image can be changed by sliding the smaller cylinder. In addition, the image also depends on the size of the pinhole; the smaller the pinhole, the sharper will be the image and vice-versa.

Try looking at your own hand through a pinhole camera. You will observe an upside down image of your hand. Now, move your hand downwards slowly. **What do you observe on the screen?** You will observe that the image of your hand is moving upwards.

A pinhole camera creates a real image of an object because the image can be captured on a screen. The image formed by a pinhole camera is **inverted** and **smaller** than the object.



Construct your own pinhole camera and look at the sun during a solar eclipse. Avoid looking at the sun directly.

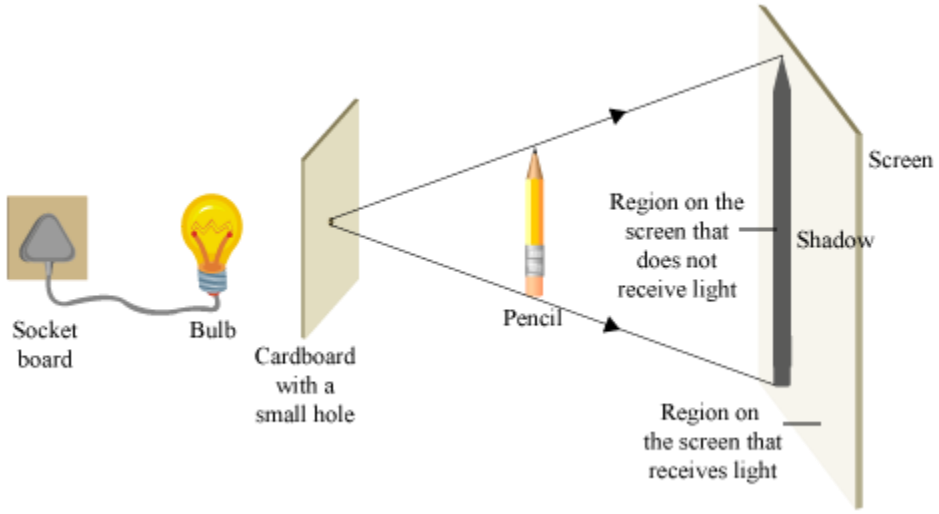
Does the size of the image formed in the pinhole camera remain same?

The following factors affect the size of the image:

- **Distance between the pinhole and the screen:** The size of the image increases with the increase in distance between the screen and the pinhole and vice-versa.
- **Distance between the pinhole and the object:** The size of the image increases when the object is moved towards the pinhole and vice-versa.

Shadow and Its Formation

Here is the graphical representation of the experiment you have just seen in the animation.



Shadow of a pencil in a point source of light

Remember, a screen is must to obtain a shadow.

What happens to the size of the shadow when the pencil is moved towards the screen?

What happens when it is moved towards the source?

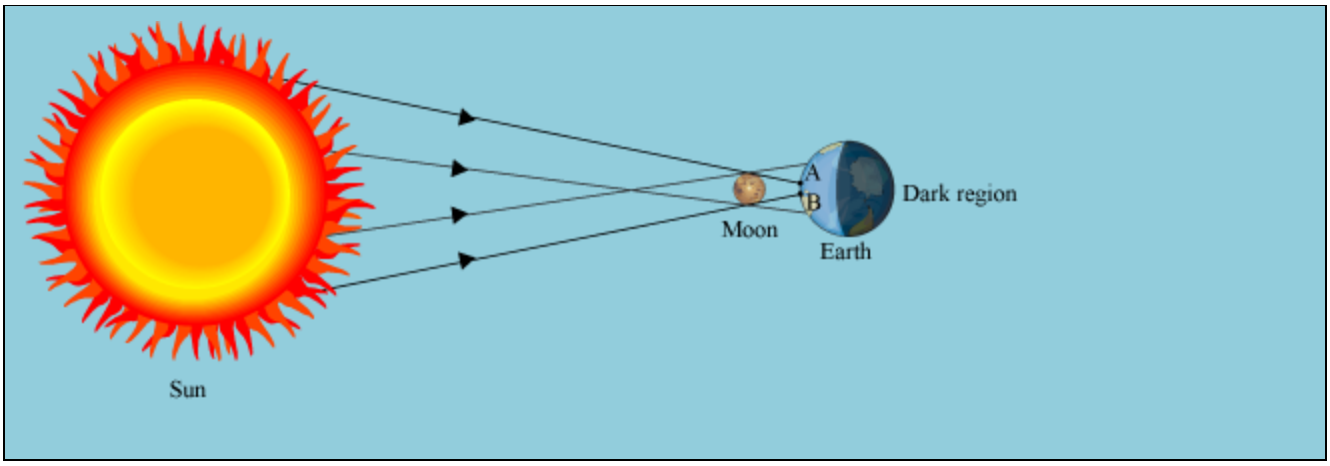
When the cardboard and the bulb are moved vertically upwards, the shadow of the pencil will move downwards on the screen. Why?

Eclipse

Why are we talking about eclipse when we are discussing shadows?

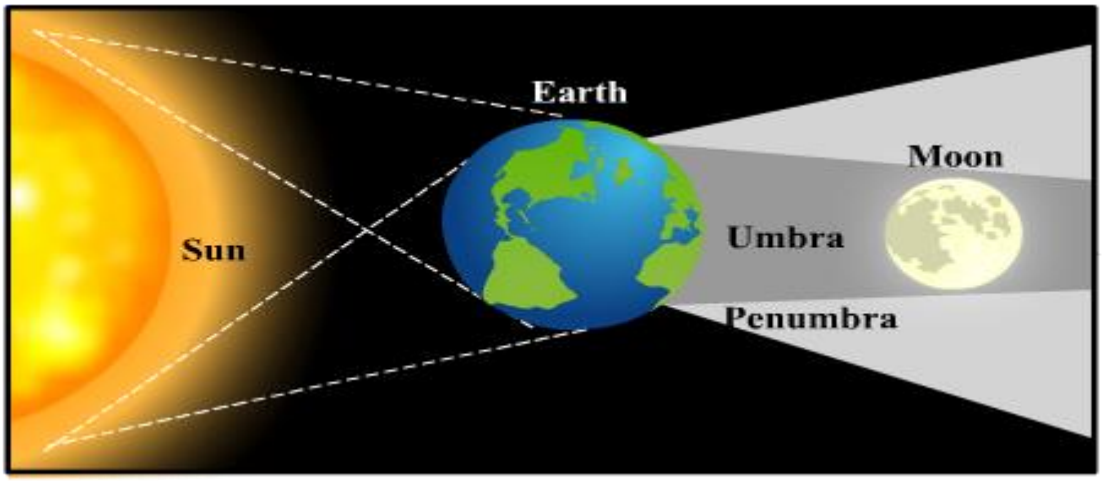
Let us see.

Can you identify the regions **umbra** and **penumbra** in the following figure of solar eclipse?



Why do the regions of umbra and penumbra occur on earth?

What happens when Earth comes between Sun and Moon?



Lunar eclipse occurs when Earth comes in between Moon and Sun and Earth's shadow falls on the Moon. The lunar eclipse occurs on the full night moon.
Total lunar eclipse: When the total moon comes under the shadow of the earth.
Partial lunar eclipse: When partial moon or some part of moon comes under the shadow of the earth.

Can we see lunar eclipse from anywhere on the night side of the earth?

Identifying Objects from their Shadows

Is it possible to identify an object from its shadow?

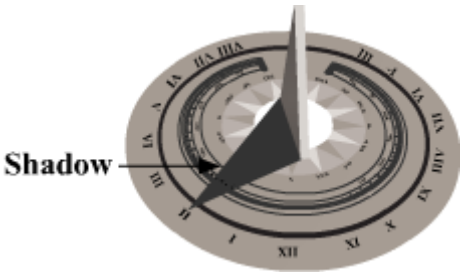
Let us find out.

So far you have learned that

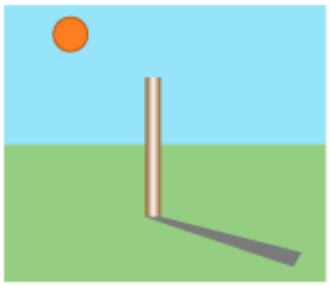
- the size and nature of the shadow of an object depend upon its position from the source of light. Hence, **actual size of an object cannot be determined by its shadow.**
- a shadow can provide some information about the shape of the object that casts the shadow. Therefore, **sometimes it is possible to identify the shape of an object by observing its shadow.**
- whatever be the color of an object, the color of the shadow cast by the object is always black. Therefore, **the color of an object cannot be identified by its shadow.**

Do you know how time was measured in early days?

In ancient times, people used to measure time by the shadow of an object cast by the sun. A device, named **Sundial** was invented for this purpose. This device used to tell the time of a day by casting of the shadow of a triangular blade on a reference plane with markings.



The largest sundial is situated at Jantar Mantar, Jaipur, India.

Fix an iron rod in an open ground and observe its shadow. Now, rotate the rod about its axis by some angle and observe its shadow again. **Will the shape or the size of the shadow change because of the rotation of the rod?**	

Shadows can also be used for fun. Several artists create shadows of different birds and animals using their hands. Some examples of such shadows are shown in the given figure.

Goat Pig Elk Hare Wolf Goose