15 *Light, Shadows and Images*

One day Raju started for his home from school, late in the evening. When he started, he was able to see trees, buildings, animals, buses etc. on the road and on either side of the road. As he kept walking, it started growing dark and soon he was not able to see objects either on the road or on the sides as clearly as earlier. When he reached home, it was already dark. He started doing his homework. Suddenly the power went off. He was not able to see any objects in the room.
Raju started wondering.

- Why am I not able to see the objects clearly when it gets dark?
- Why am I not able to see the objects when power went off?
- How are we able to see the objects in the presence of light?
- Why are we not able to see the objects in the absence of light?

Activity-1: How can we see objects?

Make your room dark by shutting the door and windows; put on the light. Look at any one of the objects in the room. After that, hold a plank or a writing pad in front of your face. Is the object visible to you? Why is it not visible though there is light? What happens when you hold a plank between the object and you?

The object is visible when there is no obstruction between your eyes and the object. If we keep obstructions like plank or writing pad, they do not allow some thing that is coming from the object to reach us. What is that some thing coming from the object?

When we put on the bulb, light falls on the object, bounces from the object and reaches us. We can see an object only when light falls on it and bounces back to our eyes. See Fig. 1 and observe the direction of the arrowheads.

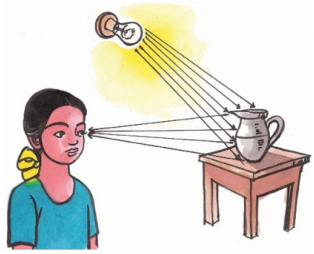

Fig. 1

It takes 8 minutes 17 seconds for light to travel from the Sun's surface to the Earth.

- Where does light come from? Which objects give us light? Think and write below :

....., ...

....., ...

A substance which gives light is known as a light source. Sun, a glowing bulb, lighted candle etc. are some sources of light. Any object which burns or glows acts as a source of light.

- Can you give some more examples for source of light?

You might have seen your shadow many times

- When did you see it? Is it during day time or at night?

It is our common experience that we see shadows in daytime. Are shadows formed at night?

Try to see your shadow in moonlight on a full moon day. It is also possible to get your shadow at night, in your house, when the electric bulb is on. Is it possible to form shadows when there is no sunlight, bulb or any other light?

• What do we need to form a shadow?

We need light to get the shadow of any object.

Activity-2: Do all objects form shadows?

Try to form shadows of a book, a pen, a duster, a polythene cover, and a glass plate on the wall of your classroom with the help of a torch.

Do you find any differences in the shadows of the above objects? Do all objects form shadow?

• Which objects form the shadows?

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....., ...

• Which objects do not form shadows?

....., ...

....., ...

• Think and write why some objects form shadows? And others do not?

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The substances like paper, plank, wood, iron etc. don't allow light to pass through them. These objects form shadow. These are called **opaque substances.**

The substances like glass and air allow light to pass through them and hence we don't get their shadows. Such substances are called **transparent.**

The substances such as polythene cover and oily paper partially allows the light to pass through them. Their shadows are unclear. These are called **translucent** substances. You have also come across these terms in the chapter on materials.

Red, green and blue are the primary colours of light. Mixing them in various ways will make all other colours, including white.

Observe Fig. 2. Write whether the sheet held by the boy is transparent, translucent or opaque below each of the pictures.

Fig. 2

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Think, guess and write in table 1 which objects in your classroom and at home form shadows, which do not form shadows and which form an unclear shadow.

Table 1

Objects which form shadows. .....

Objects which form unclear shadows.....

Objects which don't form shadows.....

Check the above objects in sunlight to verify your guess and make corrections in table 1 if needed. After checking, give your own examples for transparent, translucent and opaque

substances.

Transparent Substances : .....

Translucent Substances : .....

Opaque Substances : .....

Thus we see that all objects do not form shadows. Only opaque objects form shadows. We need a source of light and an opaque object to get a shadow.

Are sources of light and an opaque object enough to get shadows? Do we need something more?

When sunlight is intercepted by a drop of water in the atmosphere it gives RAINBOW.

Activity-3

Do this activity in a dark room with a torch and a book. Focus the light on the book with a torch as shown in Fig. 3 (keep the distance about 30 cm between the book and the torch).

- Where do you find the shadow of the book in the room?

Fig. 3

Now put the torch under the book at a distance of about 30 cm (Fig. 4).

- Where do you find the shadow of the book this time?

Fig. 4

Do the same activity, in open air (outside) at night. Where are the shadows formed in this situation? Do you see a shadow in open air when the torch is under the book? If not, why?

Place a drawing sheet or a plank (Fig. 5) at a distance of 1 m. above the book and try to find the shadow of the book.

Fig. 5

- Do you find the shadow of the book if you remove the sheet?
- What do you understand from the above activity?

We understand that only light and opaque object are not enough to form the shadow of an object. In addition to these, we need a screen. In the above activity, we used a drawing sheet or plank to get the shadow.

When you turn on a light bulb only 10 per cent of the electricity used is turned into light, the other 90 per cent is wasted as heat

In our day-to-day life, we observe many shadows on the surface of the Earth. In all these cases, the earth is the screen.

Do you know?

Shadow puppetry is one of our traditional recreational activities. In this, some puppets are used to form shadows on a screen and a story is narrated with the help of these shadows. Observe Fig. 6. Try to make puppets and do a shadow puppet show in your school.

Can we guess the object by observing its shadow?

Observe the shadows given in Fig. 7(a). Guess and write the names of the objects which form the shadow

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Fig. 7(a)

See the objects in Fig. 7(b) and compare them with the names guessed by you.

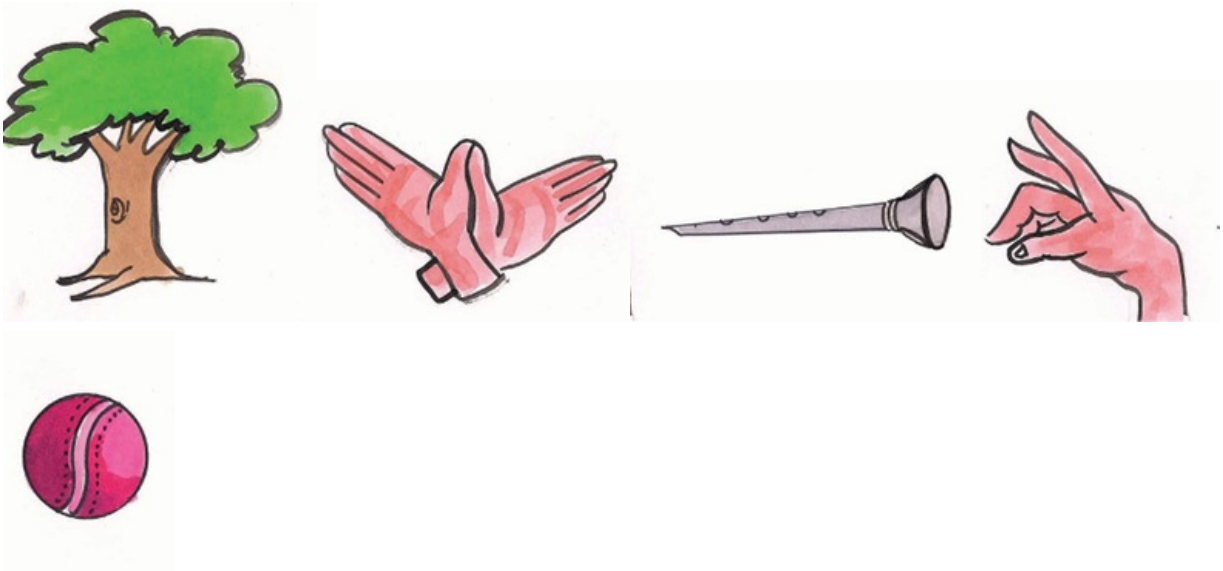


Fig. 7(b)

The speed of light is the speed at which light travels. It is about 300,000 kilometres per second. Nothing travels faster than light.

- What do you find?
- Were you able to guess the object correctly in all cases?

You must have wondered when you compared your guesses and the actual objects of which shadows are formed. You may notice that the shadows that look like bird and animal are actually formed by hands. (Try to form similar shadows with your hands.)

- What can you conclude from the above activity?
- Can we guess the object by observing its shadow?

Activity-4: Colour of a shadow

Take four balls of equal size but different colours. Try to form shadow of each ball as shown in Fig. 8. Ask your friend who is facing the screen and not able to see the balls to guess the colour of each ball.

Fig. 8

• Is your friend able to guess the colour of the ball correctly?

• Is it possible to guess the colour of the object by observing it's shadow? If not why?

Shadow is an area where light is absent. Hence, the shadow is colourless irrespective of colour of the object.

We have seen that we can't guess the object by observing it's shadow.

• Can we guess the shape of the shadow that would be formed by an object?

Let us find.

Activity-5: Shape of shadow

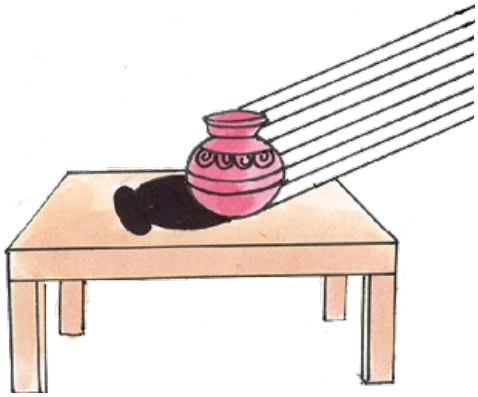
Observe the shadows of a book, a pen a duster, a ball and a round plate, one by one, in sunlight. While doing this, rotate the objects to change their positions and observe the changes in shadows. Try to answer the following questions on the basis of your observations :

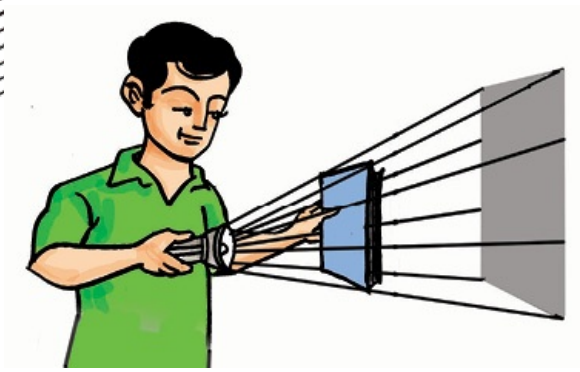
• Is there any similarity between the shadows of ball and a plate? If yes, what?

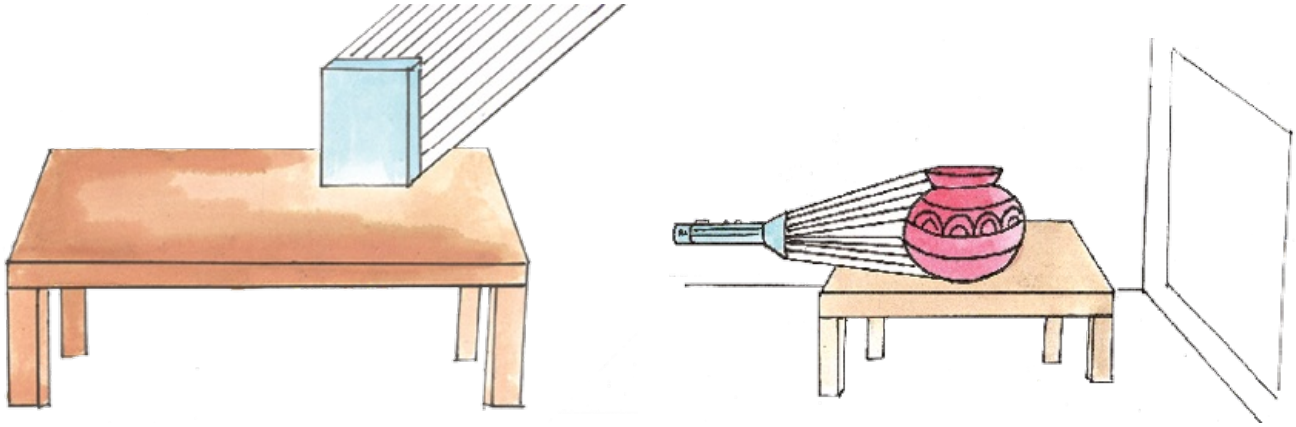
• What change do you observe in the shadows formed when you hold the pen horizontally and then vertically?

• What differences do you observe in the shadows when the duster is kept in different positions by rotating it?

• Why are the shapes of the shadows of the same object different when you change the position of the object?







Observe the objects, formation of shadows and the path of light in Fig. 9(a) and 9(b). Similarly, draw the shadows for the objects given in Fig. 9(c, d). Extend the path of light and draw shadow on given screen.

We have drawn arrows in the above figures assuming that light travels like rays that are straight. We can predict the shapes of the shadows only when we consider that light travel as rays along a straight path. In ancient days people by observing the shapes of shadows came to an understanding that light travels in a straight line.

Scientists study the properties and behaviors of light in a branch of physics known as optics.

Activity-6: Getting different shapes of shadows of a single object:

Take a rectangular piece of cardboard. Try to form shadows of different shapes by using it. You can do this in the sunlight or with the light from torch. Now, answer the following questions :

- Were you able to make a square shaped shadow?
- Were you able to make a triangular shadow?
- Were you able to make a circular shadow?
- What are the other possible shapes?
- Why are we getting different shapes of shadows when the object is same?

Because of the straight line path followed by light rays, we can get different shaped shadows for a single object by changing its position. The nature of straight line motion of light can also be understood by pinhole camera.

- Have you ever heard of a pinhole camera?

With this camera we can observe a big object through a pinhole. Isn't it interesting? Lets make a pinhole camera.

Light takes 1.255 seconds to get from the Earth to the Moon.

Activity-7: Making a pinhole camera

You will need :

A pvc pipe, about 8 cm in diameter and of length 30 cm.

A pvc pipe, about 7 cm in diameter and of length 20 cm.

One black drawing sheet.

oil - 1 ml, two rubber bands, a pin, and A4 sheet.

(If you cannot get pvc pipes, take a thick sheet of paper and roll it to form tubes. The

diameter and length of the tubes should be the same as that given for the pipes.)

Cut a piece of black paper and put it like a cap at one end of the big pvc pipe and fix it with a rubber band as shown in Fig. 10(a). Put the white paper like a cap at one end of the thinner pvc pipe. Fix it with a rubber band as shown in Fig. 10(a). Now make a hole in the middle of black paper cap with the help of a pin. Put 2 to 3 drops of oil on the white paper cap so that it becomes translucent.

Insert the thin pipe into the big pipe. Your pinhole camera is ready.

Arrange a lighted candle in front of the pinhole of the camera. Move the thinner pipe forward and backward to get a clear picture of the candle on the screen of the thin pipe.

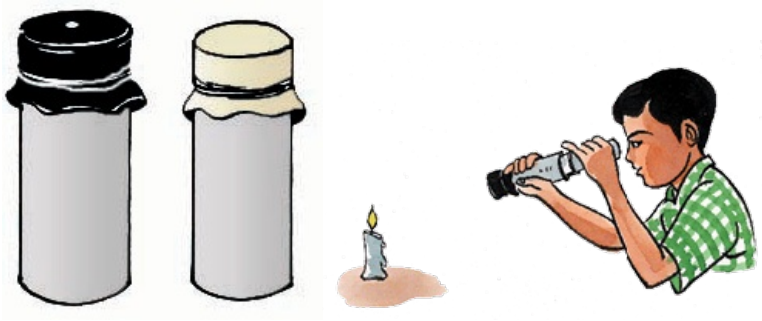
This picture is to be observed from the back of the thin pipe (see figure 10b).

What do you see? The flame of the candle appears inverted on the screen. Why is it like that? This is not the shadow of the candle. It is its image.

By observing Fig. 11(a), try to understand how light enters into the pinhole camera. This will explain the reason for inversion of image.

The light from the candle travels straight in all directions from each point of the flame of the candle. But only the light coming in some particular directions can enter into the camera through its pinhole.

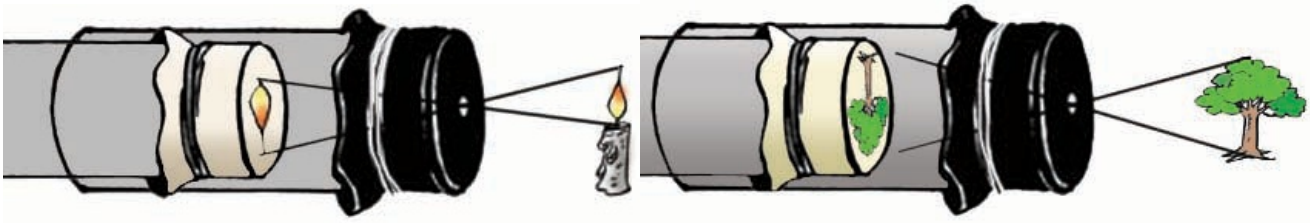
Light which comes from the point at the top of the flame goes straight towards the bottom of the screen and light which comes from the point at the bottom of the flame goes straight towards the top of the screen, as shown in Fig. 11(a). In this way, the light coming in a particular direction from each point of the flame, will be able to enter into the pinhole, and light going in other directions is blocked by the black sheet.



This leads to the formation of an inverted image.

The formation of inverted image on the screen of the pinhole camera explains that light travels in a straight line.

Now look at a tree through the pinhole camera as shown in figure 11(b).



What do you see?

We get the full image of the tree in the pinhole camera. But when we put a candle in front of the pinhole camera, we get the image of the flame only. Why is it so?

- Predict what would happen if we make two pin holes in the camera? Try it and write down your observations in your notebook.
- Did your predictions match with your observations?

Sunlight can reach a depth of around 80 metres (262 feet) in the ocean.

The white light from the sun is a mixture of all colours of the rainbow.

Activity-8: Fun with a magnifying lens

Take a magnifying lens and try to form an image of a tree on a white drawing sheet.

- What do you observe in the image formed on the sheet?

The image on the white drawing sheet is inverted. Isn't it? What difference do you notice between the images formed through the pinhole camera and through the magnifying glass?

You may notice that the image formed through the magnifying lens is clearer than that formed with a pinhole camera.

Difference between Image and Shadow:

We see our face in the mirror everyday. Is this picture in mirror a shadow or an image? How did you decide that?

We know that shadows are not coloured but an image has colours that are same as that of the object. Also, a shadow shows only the outline of the object but an image shows the complete object as it is, just like a photograph.

- Can you find any other differences or similarities between shadows and images? Write in your note book.

Can you show the difference of a shadow and an image through a drawing?

Draw the shadow and image of the object shown in Fig. 12

Activity-9: Observe the Reflection

Make your calss room dark by closing doors and windows. Ask one of your friends to hold a mirror in his hand. Take a torch and cover its glass with a black paper leaving only slit in the middle. Now switch on the torch and adjust it so that light falls on the mirror in your friend's hand. Ask your friend to adjust the mirror so that the patch of light falls on another friend standing in front of him at some distance. (see Fig. 13).

Fig. 13

• What do you observe from the above activity?

When light falls on any object, it rebounds back. This is called **reflection**.

Ask your friend A to cover the mirror with a book. Now switch on the torch and focus it on the book. Can you see the patch of light on your friend? Why? Did the light that fell on the book not get reflected? We know that we can see the objects only after light is reflected from them, as mentioned in activity 1.

If light falls on any object, it is reflected back . But we see reflected light, as if from a source, only when it falls on the objects like mirror.

Precaution: You can reflect sunlight using mirrors and play with it. But make sure that the reflected light does not enter your eyes.

Laser is also a kind of light. Lasers are used to destroy and kill tumours and many other purposes.

Keywords

Light, sources of light, shadow, transparent substances, translucent substances, opaque substances, pinhole camera, image, reflection

What we have learnt

• We need light to see objects.

• A substance which gives light is known as a source of light.

• Shadows are formed when opaque objects obstruct the path of light.

• In addition to light and object we also need a screen to obtain the shadow of an opaque object.

• Colour of objects cannot be determined by looking at their shadows.

• Light travels in a straight line.

• Light gets reflected when it falls on any object.

• People came to an understanding that light travels in a straight line by observing the shapes of shadows.

• An image is different from a shadow.

Sundials use shadows to tell the time.

Light travels slower through different mediums such as glass, water and air.

Improve your learning

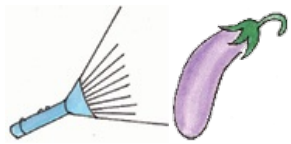
1. Classify the following objects into transparent, translucent, and opaque :

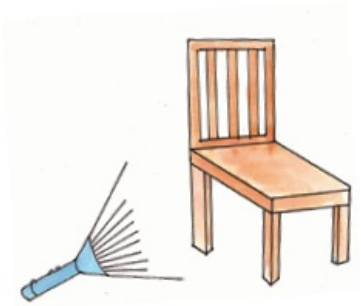
Cardboard, duster, polythene cover, oily paper, glass, spectacle lens, piece of chalk, ball, table, book, window glass, palm, school bag, mirror, air, water.

Which type of materials do you find more in your surroundings?

2. Hold a glass slab at one and with your hand and stand in sunlight. See the shadows of your hand and glass slab. Explain what you observed.
3. We can't identify the presence of completly transparent objects even in light. Is it correct or not? Support your answer.
4. Why can't we see objects which are behind us?
5. If we focus a coloured light on an opaque object, does the shadow of the object posses colour or not? Predict and do the experiment to verfiy your predictions. (Coloured light can be obtained by covering torch glass with transparent coloured paper)
6. Between an electric bulb and a tube light, which forms sharp shadows of objects? Do experiment to find and give the reason.
7. What is required to get a shadow of a opaque body?
8. How can you explain the straight line motion of the light?
9. Explain what happens if the size of the hole in a pinhole camera is as big as the size of a green gram? Increase the size of the hole in pin hole camera and look at any object with that camera. What do you find? Write reasons for that.
10. Draw the shadows in your note book for the objects given below assuming that the light source is exactly above these objects.

11. Where do you find reflection of light in your daily life? Write few examples.
12. We would not be able to see any object around us if light does not get reflected. How do you appreciate this property of objects?
13. Can we use a plain mirror as a rear view mirror? If not why?
14. A mirror is kept on the wall of your room. Your friend is sitting on a chair in that room. You are not visible to him in the mirror. How do you adjust your place so that you are visible to your friend in the mirror? Explain.
15. Why do we get shadows of different shapes for same object?
16. What are the diffrences between a shadow and an image?
17. Malati noticed changes in lengths of her shadows during the day time. She got some doubts about this. What could be those doubts?
18. Observe the light source and mark the place where the screens should be kept to get the shadows of the objects given below.





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