LIGHT

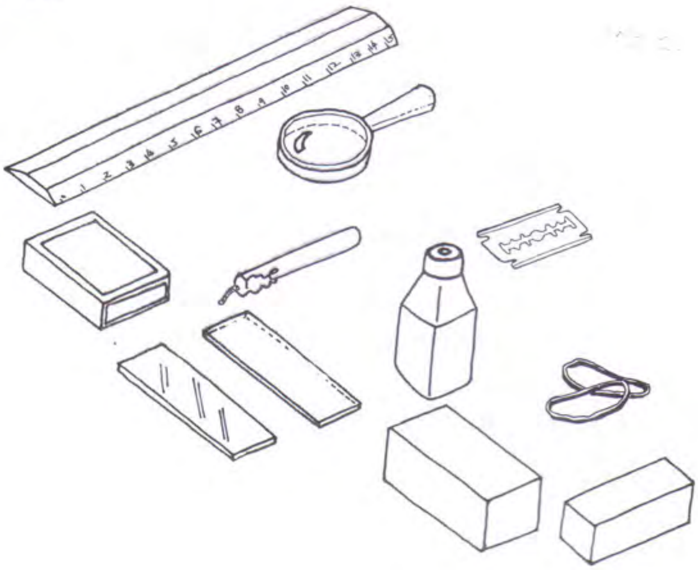
Chapter 15

We cannot see in the dark. Darkness means the absence of light. When we enter a room and say the room is dark, it means there is no light reaching our eyes from any object in the room. So we cannot see any of these objects.

We see an object only when light from it reaches our eyes. This can happen in two ways. First, the light reaches our eyes after striking the object. For example, during the day, sunlight strikes objects around us and then falls on our eyes. So we see those objects. Or else the object is itself a source of light, in other words it produces light. This light reaches our eyes and we see the object. Some examples of such objects are a burning candle, a glowing electric bulb, etc.

You may have heard that cats and owls can see in the dark. Yes, cats and other animals that hunt at night can see better than us in dim light. But even a cat cannot see in total darkness.

In this chapter, we shall try to understand many things about light. For example, what is the path of a ray of light? What happens when light rays fall on a mirror or a lens? How do our eyes see things? How are microscopes and telescopes made? And so on.



Shadows

If light does not fall on a surface, there is darkness. A shadow forms when an object prevents light from reaching a surface. If you spread your hands in sunlight, they cast a shadow on the ground.

In Class 6, you learned to make animal shapes by casting shadows with your hands in different ways. Rotate your hands to see whether the shape of their shadow changes.

We said earlier that we see an object only when light from it reaches our eyes. Is that why we can't see an object situated on the other side of a wall? But the question then is, why doesn't the light from this object reach our eyes? Is it because the rays of light travel only in a straight line? Let us find out by performing an experiment.

Experiment 1
The path of light

In this experiment, you will have to arrange empty match boxes and wooden blocks in the way shown in Figure 1.

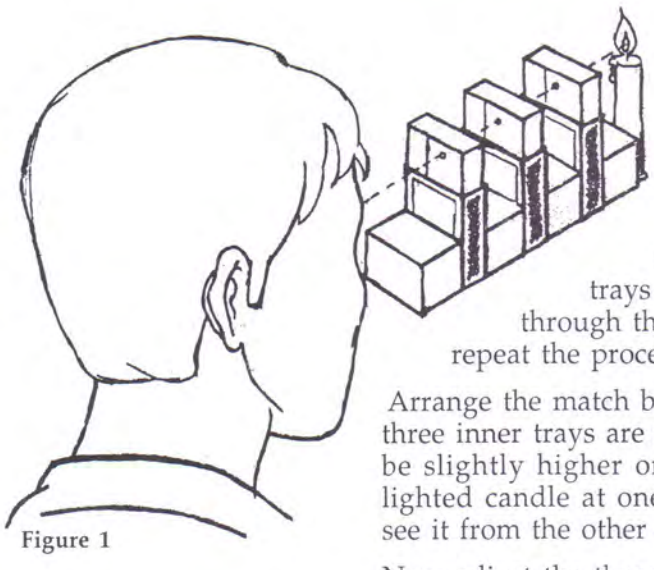


Figure 1

Before you do this, you must first make a hole in the inner tray of each match box in such a way that all three holes are in the same spot in the three inner trays. To do this, hold the first and second match boxes back to back, slide the inner trays out of their covers and pierce a small hole through them with the help of a pin (Figure 2). Now repeat the process with the second and third match boxes.

Arrange the match boxes as shown in Figure 1. Ensure that the three inner trays are not at the same height. Their levels should be slightly higher or lower in relation to each other. Place a lighted candle at one end of the three match boxes and try to see it from the other end. Is the flame of the candle visible?

Now adjust the three inner trays to exactly the same height. To ensure that the three holes are in a straight line, pass a long needle through them. Now look at the burning candle at the other end through these holes. Is it visible?

What does this experiment tell you about the path of light? (1)

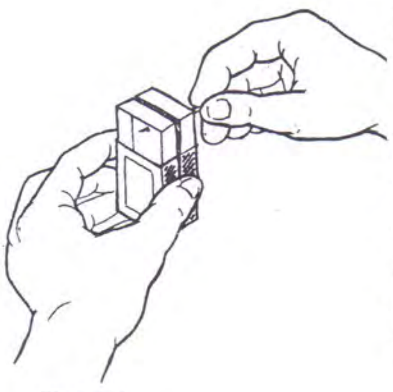


Figure 2

Experiment 2
Make your own pinhole camera:

Take two used postcards and roll them into tubes as shown in Figure 3. One tube should be slightly narrower than the other so that it fits easily into it. It would be better to use fevicol instead of gum to paste the edges of the postcards while making the tubes. Cover one of the open ends of the wider tube by pasting a piece of black paper over it, as shown in the figure. You could

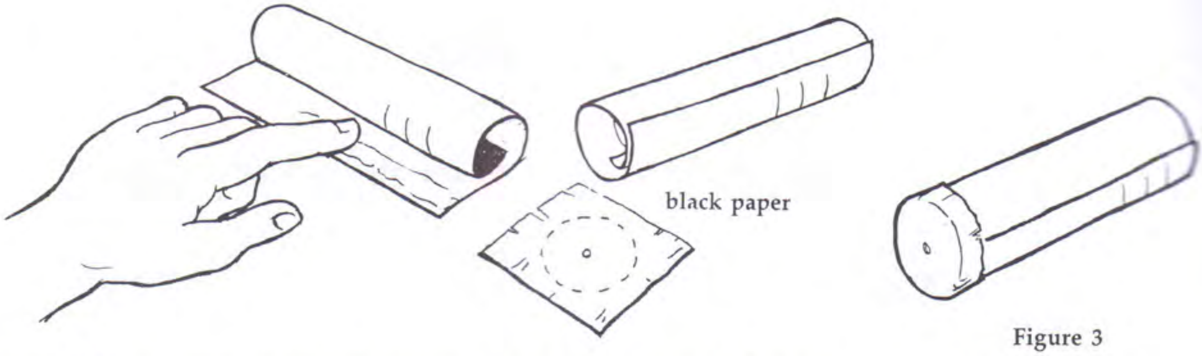


Figure 3

use either glazed or carbon paper. Use a pin to make a hole in the centre of the glazed paper. This is your pinhole tube. Similarly, cover one end of the narrower tube by pasting a piece of white paper over it. Apply some oil on this paper so that it becomes **translucent**. This is your screen tube.

Insert the open end of the screen tube into the open end of the pinhole tube as shown in Figure 4. This is your **pinhole camera**. Place a burning candle in front of the pinhole of the camera and look at it on the screen at the other end.

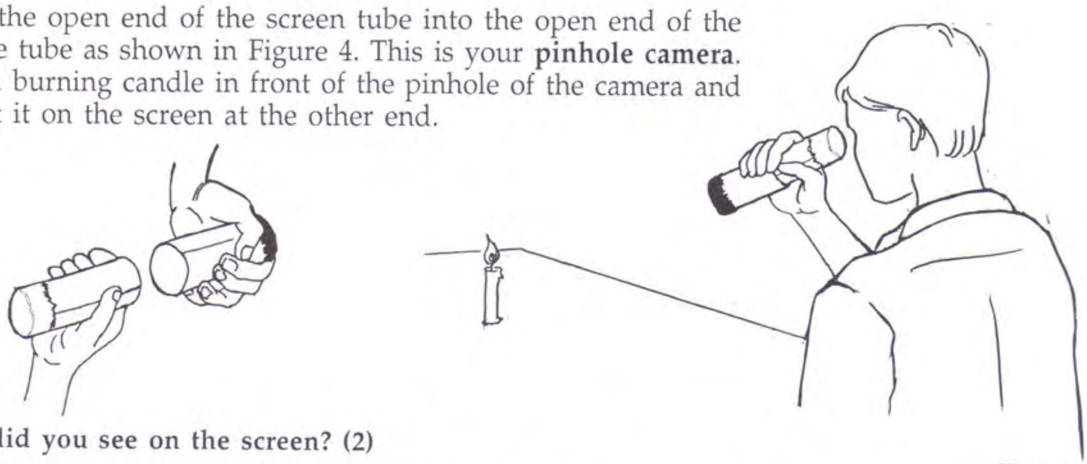


Figure 4

What did you see on the screen? (2)

Slide the screen tube forwards and backwards and observe the **image** of the flame on the screen while you do this.

What happens to the image when the screen tube is moved forwards and backwards? (3)

Look at other things through your camera, for example a tree or a house. But ensure that there is plenty of light falling on the objects you look at. If scattered light falls on the screen from the sides, cup your hands around the screen to shield it from the light and then look at the object on the screen.

Rays of light

Take a mirror strip from the kit. Cover it with black paper. Cut a 1 mm wide slit in the black paper, as shown in Figure 5.

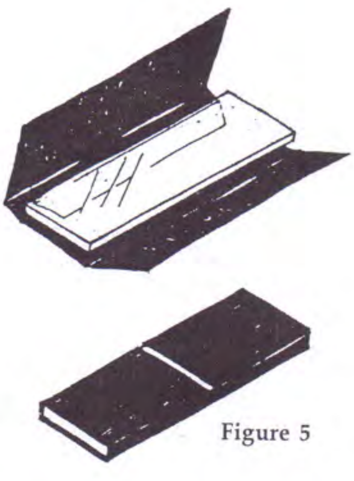


Figure 5

Hold the mirror strip with the slit facing the sun. You will see some light coming through the slit. Let this light fall on a sheet of paper spread on the ground.

Light coming from such a slit or any other small hole is called a **ray** of light.

We shall use this mirror strip covered with the slit black paper in the following experiments.

Experiment 3

Reflection - how light returns after striking an object

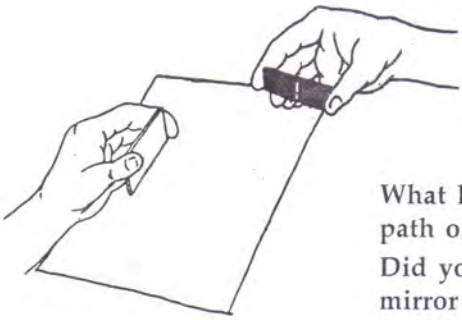


Figure 6

Place a blank sheet of paper on level ground, partly in the sunlight and partly in the shade. Hold the mirror strip with the slit facing the sun. Let a ray of light from the slit fall on the paper. Now take another mirror strip and place it in the path of this light ray (Figure 6).

What happened when you placed the second mirror strip in the path of the light ray? (4)

Did you see any other ray of light, apart from the one from the mirror slit, on the paper? (5)

This effect of the second mirror strip on the ray of light is called **reflection**. The light ray falling on the mirror is called the **incident ray** and the ray returning from it is called the **reflected ray**.

Experiment 4

Laws of reflection

We shall now see whether there is any relationship between the direction of the incident ray and the direction of the reflected ray.

Take a sheet of blank paper. Draw a straight line AC across the middle. Draw another straight line at right angles (90 degrees) to line AC. The second line should bisect line AC at point B. We shall call this line the **normal** (Figure 7).

Draw two lines from point B on the left side of the normal and two on the right side. The lines should be at angles of 30 degrees and 60 degrees respectively from the normal. Number these lines 1 to 4.

Stand a mirror strip vertically on line AC with its reflecting surface facing the normal. Take the mirror strip with a slit and let its light ray fall along line 4, like you did in the earlier experiment,

Did the reflected ray fall on any of the lines you have drawn? If yes, on which line did it fall? (6)

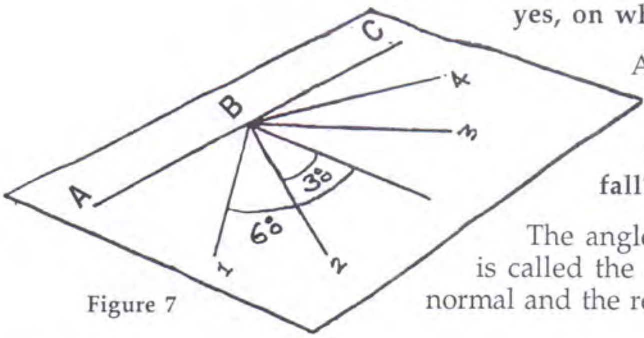


Figure 7

Adjust the mirror strip with the slit so that its light ray falls along line 3.

On which line does the reflected ray now fall? (7)

The angle between the normal and the incident ray is called the **angle of incidence** and the angle between normal and the reflected ray is called the **angle of reflection**.

Draw Table 1 in your exercise book and record your observations in it. (8)

Table 1

S.No	Incident ray	Angle of incidence	Reflected ray	Angle of reflection
1.	On line 3			
2.	On line 4			

Do you see any relationship between the angle of incidence and the angle of reflection? State this relationship in the form of a rule and write the rule in your exercise book. (9)

Let us verify this rule.

If the two incident rays form angles of 20 degrees and 45 degrees respectively with the normal, what will be the angles formed by the reflected rays with the normal? Verify your answer by performing the experiment. (10)

What will happen if the incident ray falls along the normal? Perform the experiment to find out and write your answer in your exercise book. (11)

It is not necessary for you to first draw the angle of incidence on the paper before performing the experiment, like you did in Figure 7. You can make the incident ray fall at any angle at point B and perform the experiment.

Let us use the laws of reflection to construct two gadgets.

Experiment 5

Make your own periscope

Collect the following materials to make your periscope:

empty *agarbatti* (incense stick) box, two mirror strips, candle, blade, match box, scale, glue.

Close both ends of the *agarbatti* box. Draw squares at the two ends of the broad surface of the box, as shown in Figure 8(a). The sides of the two squares should be equal to the width of the *agarbatti* box. Draw the diagonals of these squares and slit the diagonals with a blade. The slits should equal the length of the mirror strips. Fix the mirror strips in these slits as shown in Figure 8(b). The mirror strips should lie parallel to each other, with their reflecting surfaces facing each other. Fix the mirror strips firmly to the box with a few drops of molten wax from a burning candle. You could also use glue or fevicol instead of wax.

Cut out two windows on the narrow sides of the box as shown in Figure 8(c). The windows should open directly on the reflecting surfaces of the mirror strips. Your periscope is ready.

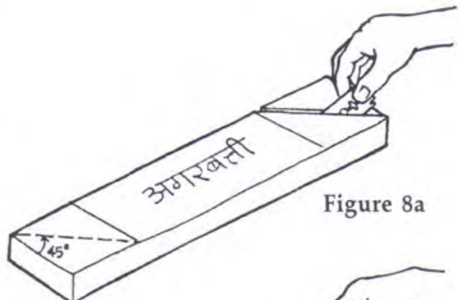


Figure 8a

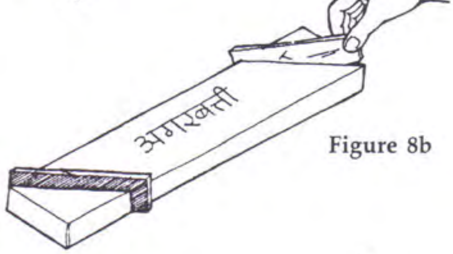


Figure 8b

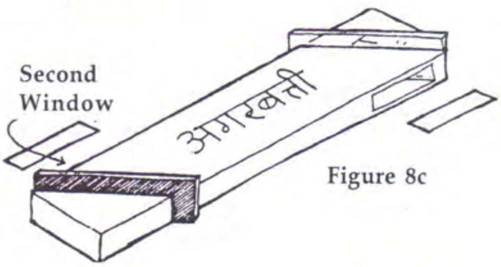


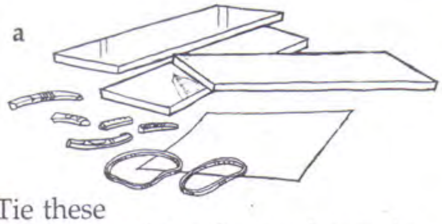
Figure 8c

Figure 9

When you look through Window 2, you will be able to see things lying in front of Window 1. If you hide behind a tree, you can easily see what is happening on the other side of the tree with your periscope. To do this, hold the periscope with one mirror in front of your eyes and the second mirror to one side of the tree trunk . You can also sit in a ditch and see what is happening outside, or look on the other side of a wall without anyone seeing you. (Figure 9)

You may have read about submarines. They move under water. They are fitted with periscopes.

How is the periscope used in a submarine? (12)



Experiment 6

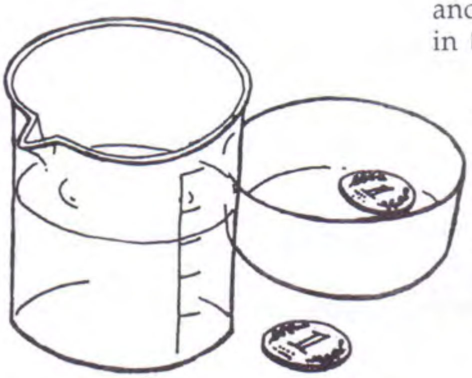
Make your own kaleidoscope

Take three similar mirror strips. Tie these strips with rubber bands to form a triangular tube as shown in Figure 10. While tying the strips together, remember to keep their reflecting surfaces facing each other inside of the tube. Cover one end of the tube with translucent paper with the help of a rubber band. Now put some small pieces of coloured glass bangles inside the triangular tube. Hold the tube so that some light enters through the translucent paper and look at the bangle pieces through the open end. What do you see?

Figure 10

Can you explain why this happens? (13)

Shake the kaleidoscope lightly to rearrange the bangle pieces and look at them again. You can make many beautiful patterns in this way.



A game of magic

Place a coin in a bowl or a large plate. Step back a little, close one eye and look at the coin. Now lower your head until the coin is no longer visible. That means light rays from the coin no longer reach your eyes - they are blocked by the edge of the bowl or plate.

Ask your friend to pour water in the bowl. Do not shift your position or move your head. The water should be poured slowly so that the coin is not shifted from its position.

Can you see the coin now?

Earlier, the edge of the bowl blocked light rays from the coin. But once water was poured into the bowl the coin became visible. How did this happen? How did the coin become visible? We shall perform another experiment to understand how this happens.

Experiment 7

Refraction

Take 7 or 8 clean glass strips and tie them together in a bundle with a thread or a rubber band.

Stand the bundle along its length on a sheet of paper, as shown in Figure 11. The paper should be in a spot which is partly in the shade and partly in the light. Let a ray of light from a mirror strip with a slit fall on the bundle. Look at the light ray from above the bundle.

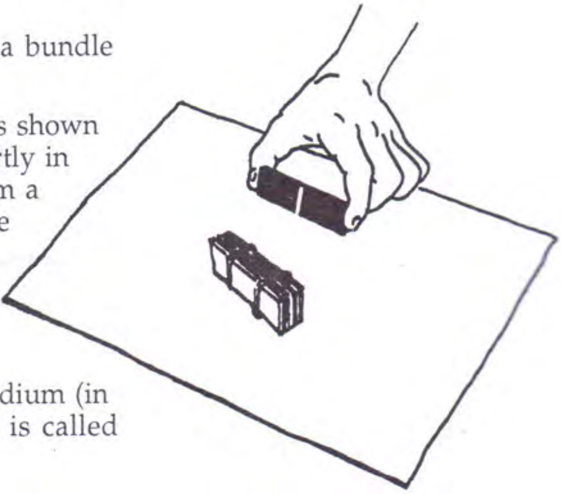


Figure 11

What happens to the ray of light when it enters the glass bundle and when it emerges from it? (14)

The effect on a ray of light when it passes from one medium (in this case, air) to another medium (in this case, glass) is called refraction.

Now think about the coin in the bowl and explain how it became visible when water was poured into the bowl. Write your answer in your exercise book. (15)

Another game with refraction

Take some water in a glass vessel and immerse a pencil halfway into it. The pencil should not be immersed vertically but at an angle.

Now look at the pencil from all four sides of the glass vessel. Does it look straight from all four sides? Draw diagrams to show how the pencil looks in these different positions.

Experiment 8

Refraction through a magnifying glass

Use a magnifying glass to focus the sun's rays on a spot. Move the magnifying glass up and down until you get the brightest and smallest spot possible. The distance of the bright spot from the lens in this position is called the **focal length** of the lens.

What is the focal length of your lens? (16)

Now use your magnifying glass to get this bright spot on a piece of newspaper. Keep your hand steady so that the spot does not shift. What happens? (17)

You can write your name on the piece of paper in this way. Try and do it.

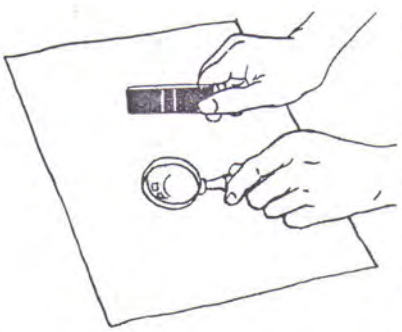


Figure 12

Experiment 9

Cut two 1 mm-wide slits on a piece of black paper. The distance between the two slits should be approximately 1 cm. Wrap this paper on a mirror strip as you did in Experiment 3.

Choose a spot where light and shade meet. Hold a magnifying glass vertically over a sheet of white paper in the shade. Use the two slit mirror strip to throw two rays of light on the magnifying glass. Tilt the magnifying glass a little and move it back and forth until the rays passing through it are clearly visible on the paper (Figure 12).

What happens when the light rays pass through the lens? (18)

Do the two rays cross each other after travelling some distance? (19)

Would this have happened if the lens was not placed in their path? (20)

Measure the distance from the lens to the point where these rays cross each other and compare this distance with the focal length of the lens. (21)

You have two more magnifying glasses with you. Find out their focal lengths using the same method.

In the beginning of this chapter, you had formed an image of a burning candle on a screen with a pinhole camera. Let us see whether a similar image can be formed with a magnifying glass.

Experiment 10

Image with a magnifying glasss

Light a candle and place your exercise book or a sheet of blank paper at some distance from it to serve as a screen. Place a magnifying glass between the candle and the screen and move the screen back and forth until the image of the burning candle is formed on the screen.

You can form images of other objects on your exercise book or on a wall in this way. You can make the image clearer by adjusting - increasing or decreasing - the distance between the lens and the wall.

Are the images you get inverted, like the images in the pinhole camera?

Our eyes, too, form images in the same way a magnifying glass does. Let us try to understand how the eye works.

How do we see?

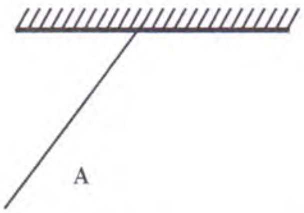
Look carefully at the eye of your friend and compare it with the figure given below. The eyeball is white in colour. There is a brown circle at the centre of the eyeball. It has a small black circular spot in its centre. This black circle is called the **pupil**. The pupil is actually a hole and it has a lens behind it. Behind the lens lies a screen called the **retina**. The retina is sensitive to light.

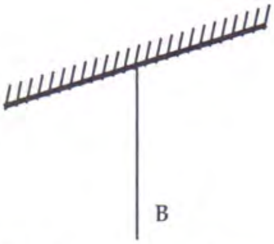
When an object comes in front of the eye, its image is formed on the retina. This image is inverted, like the image in the pinhole camera. However, we see the image in its upright position. The process by which we see the correct image and not the inverted image that falls on the retina is very complex. The brain plays a crucial role in this process.

On the basis of your answer to Question 19, explain why it is dangerous to look directly at the sun. (22)

Some questions for revision

1. **Why can't you see your friend who is sitting in the next classroom in your school?**
2. **Figure A and B given below show incident rays falling on two mirror strips. What is the angle of incidence in each case? Draw the reflected rays in the figures.**

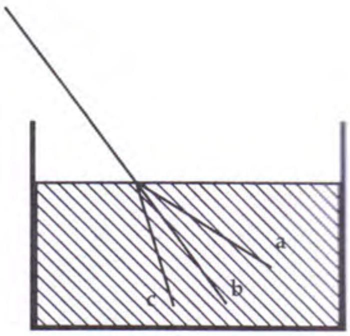




3. **Take two mirror strips and a candle. Place the mirror strips facing each other and put the burning candle between them. How many images are formed?**

   In some museums large mirrors are fixed on opposite walls of a room. If you stand in the middle of such a room, how many images of yourself would you see?
4. **A transparent cubical box is filled with water. A ray of light falls on it from one side as shown in the figure. Three refracted rays are shown in the figure. Which is the correct one?**

   Confirm your answer by performing this experiment. If you want to see the light ray more clearly, add 2 to 3 drops of milk to the water.



New words

Ray	Incident ray	Reflected ray
Angle of incidence	Angle of reflection	Normal
Image	Reflection	Refraction
Translucent	Focal length	Pinhole camera
Periscope	Kaleidoscope	Retina
Pupil		