9 REFLECTION OF LIGHT

In Class VI you saw how shadows are formed. You observed that the shape of the shadow changes according to the position of source of light and the position of object . You drew shadows of some objects and you noticed that the rays of light travel in a straight line, by the observation of shapes of the shadows.

You came to know that when light falls on an object it will be reflected by the surface of that object and if that reflected light reaches our eyes we can see that object.

In this class we try to learn more about reflection of light.

When will you be able to see clear images of yourself in a plane mirror?

Will you be able to see your image in a mirror if the mirror is in front of you in a dark room?

Let us do this (1)

Point a torch towards the mirror so that it's light falls on the mirror which you hold up as shown in figure 1(a), and try to see your image in the mirror.

Fig. 1(a)

Then turn the torch towards your face as shown in figure 1(b), and see your image in the mirror.

Fig. 1(b)

In which case is your image clear?

You will find that when light is focused on your face you can see your image clearly in the mirror.You also notice that when light is focused on the mirror you find a dim image of your face in the mirror. Why does it happen so?

Think:

We already know that, to see any object, light should fall on it. In daytime we are able to see all objects which are in our room even though sunlight does not fall directly on those objects. How is it possible?

The multiple reflection of sunlight from surfaces like wall, floor, ceiling etc. finally falls on the object and gets reflected by it and reaches us. This enables us to see the object.

Imagine that your friend sat in the middle of the room. Estimate how many times, reflection of sunlight should take place to finally fall on your friend. Identify the places from where light reflects.

How light reflects after striking an object?

We need to understand about light rays to know how light is reflected after striking an object.

Rays of light

Let us do this (2)

Take a mirror strip and a black paper as shown in figure 2a. Cover the mirror strip with black paper and cut a 1 mm wide slit in the black paper, as shown in figure 2b.

Fig. 2 (a)

Fig. 2 (b)

Hold the mirror strip with the slit facing the sun as shown in figure 2c. You will see some light coming through the slit. Let this light fall on a sheet of paper spread on the ground.

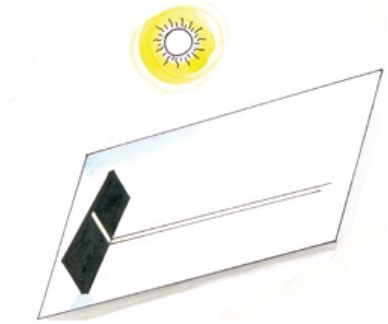


Fig. 2(c)

Light coming from such a slit or any other small hole looks like a ray of light.

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

Let us observe how light (ray of light) reflects.

Let us do this (3)

Place a blank sheet of paper on the ground such that part of it is in the sunlight and other part of it is in the shadow. 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 such that the ray coming from first mirror falls on the second mirror as shown in fig 3.

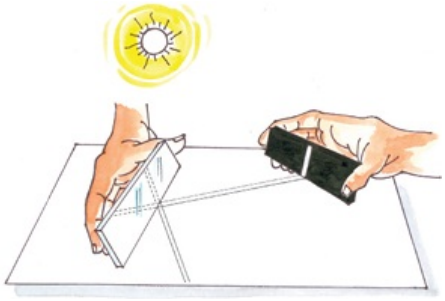


Fig. 3

What do you observe?

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

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

Laws of reflection:

Is there any relationship between the direction of the incident ray and the direction of the reflected ray.

Let us do this (4)

Take a sheet of blank paper. Draw a line segment AC across the middle. Draw another straight line at right angles (90 degrees) to segment AC. The second line should bisect segment AC at point B. We shall call this line as **Normal.** See in figure 4a.

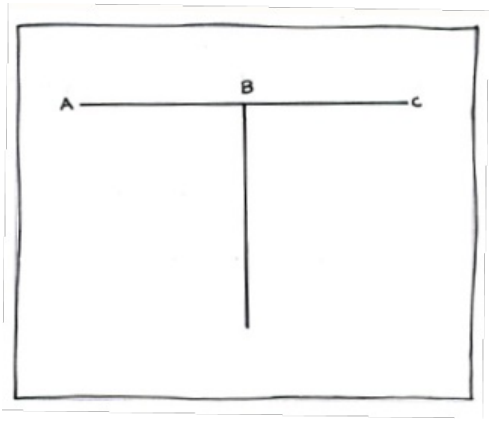


Fig. 4(a)

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° and 60° respectively from the normal. Number these lines 1, 2, 3, 4 as shown in figure 4b.

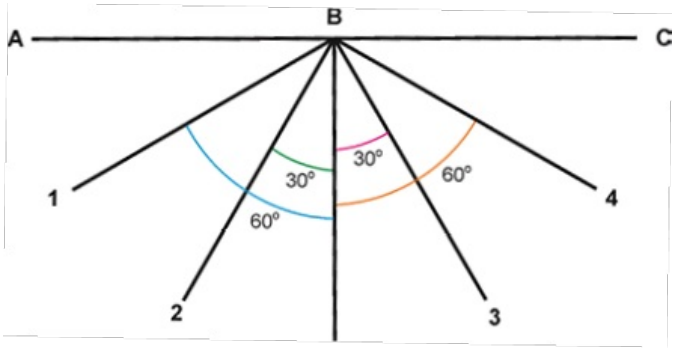


Fig. 4(b)

Place a mirror strip vertically on segment AC with its reflecting surface facing the normal. See that the back of the mirror coincides with segment AC. Take the mirror strip with a slit and let its light ray fall along line 4, as you did in the earlier experiment. Now this ray is the incident ray for the mirror . The angle between the normal and the incident ray is called the **Angle of Incidence (*L*∠i).**

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

The angle between normal and the reflected ray is called the **Angle of Reflection (∠*L*r).**

Adjust the mirror strip with the slit so that its light ray falls along line 3 and observe on which line the reflected ray falls?

Adjust the mirror strip with the slit so that its light ray falls along normal, then the angle of incidence is 0^o (the angle between normal and incident ray "that is also normal here", is 0^o)

What happens? Where did you find the reflected ray?

Record your observations in the table - 1.

TABLE - 1

S.No.	**Incident ray** **Angle of Reflection**	**Angle of Incidence**	**Reflected Ray**
1.	On line - 3		On .....
2.	On normal		On .....
3	On line - 4		On .....

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 here.

.....

Let us verify this rule.

If the two incident rays form angles of 20° and 45° respectively with the normal, what will be the angles formed by the reflected rays with the normal?

Verify your answer by conducting the experiment.

Note: observe this diagram carefully (figure 5). The ray of light from the candle is reflected at the mirror, and bounces off at the same angle as it come to the mirror. Our eye does not know that the light has been reflected. Our eye sees the object (the candle) in the mirror, and feels that light is coming from that candle which seems to be behind the mirror. In this way we see an image of the candle.

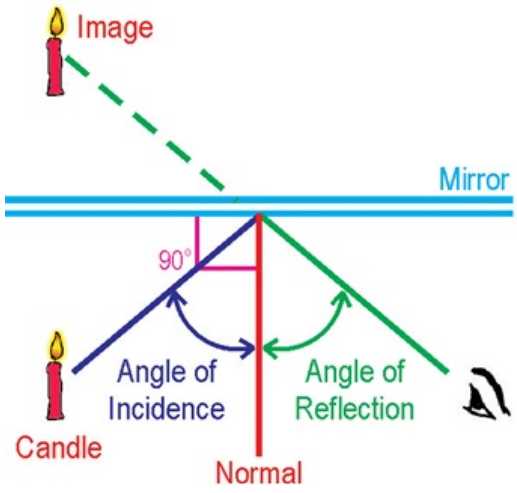


Fig. 5

We are able to see a person who is walking on the road through a window or a door. At the same time that person can also see us. Is it possible to see that person while hiding oneself?

Make your own periscope

Let us do this (5)

Collect the following materials to make your periscope:

Empty agarbatti box, two mirror strips, scale, pencil, blade, match box, candle, glue.

Close both ends of the agarbatti box. Draw squares at both ends. Draw the diagonal to these squares as shown in figure 6(a). Slit the diagonals with a blade. The slits should equal to the length of the mirror strips.

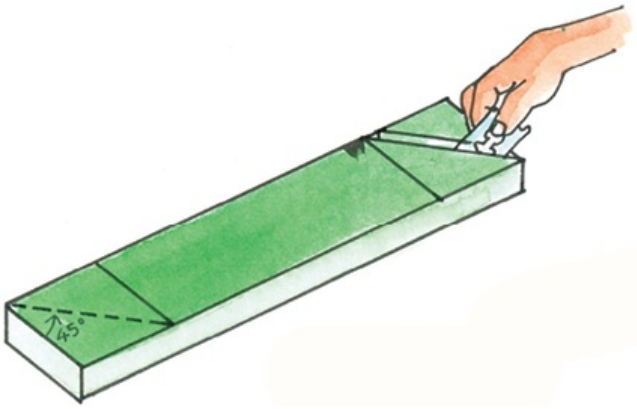


Fig. 6(a)

Fix the mirror strips in these slits as shown in figure 6(b). Take care to see that these mirror strips 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 can also use glue or fevicol instead of wax.

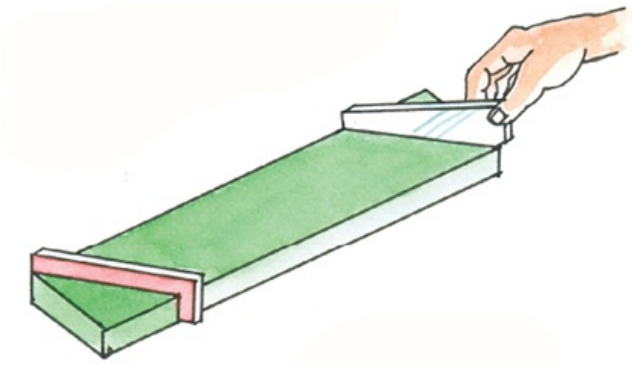


Fig. 6(b)

Cut out two windows on the narrow sides of the box as shown in figure 6(c). The windows should open directly on the reflecting surfaces of the mirror strips. Now your periscope is ready.

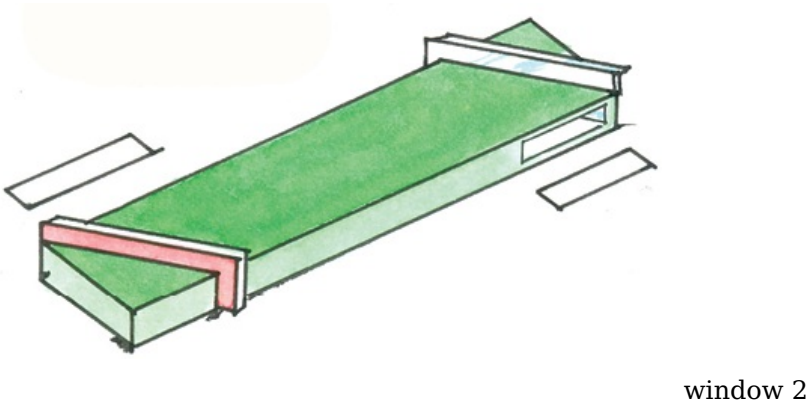


Fig. 6(c)

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. Observe in figure 6(d), the girl is viewing objects outside the room through the window while hiding herself in the room,with the help of a periscope.

Fig. 6 (d)

Think: why should we keep mirror strips parallel to each other in periscope?

What happens if they are not parallel?

Let us do this (6)

Place a mirror (1ft. × 1ft.) on the floor. You and your friends A, B, C stand on four sides of the mirror as shown in figure 7. Adjust your places of standing, in such a way that each one of you can see the image of the person opposite to you in the mirror kept on the floor.

Fig. 7

Your friends A, C are able to see images of each other in the mirror. Why can't you see their images?

Ask your friend – B, who is in front of you to move a feet aside from his place. What happens? Did you see his image in the mirror? If not, why?

Imagine a normal to the mirror. It would be perpendicular to the mirror as well as to the floor. Imagine an incident ray coming from your friend B, falls on the mirror then the reflected ray from mirror and reaches you. Observe that the incident ray, reflected ray and normal lie in the same plane.

Now think why the image of your friend B is not visible to you when he moves aside. Where should you stand to see his image? Once again imagine the incident, reflected rays and normal and assumed plane. What do you understand?

The incident ray, reflected ray and normal should be in same plane, only then can you see your friend.

Are the incident ray coming from your friend A, reflected ray going towards your friend C and normal in the same plane?

Now let us try to answer why the mirrors in periscope are kept parallel to each other: In a periscope the incident ray for the second mirror is the reflected ray of the first mirror. When these two mirrors are parallel to each other, only then the rays lie in the same plane and can pass through the windows of the periscope. If these mirrors make some angle with each other, then the reflected ray of the first mirror may not reach the second mirror or the reflected ray of second mirror may not pass through the window of periscope. In both cases we can't see the object with the periscope.

How do we get an image in a mirror?

You would have seen your image in a mirror many times. Do you know how it is formed? During day time the light which falls on you gets reflected and a number of reflected light rays from you that fall on the mirror also get reflected back. These reflected rays reach your eye and make you see your image. See figure 8. Thus formation of image in mirrors is due to reflection of light rays from the mirror.

Fig. 8

See the figure 9 and observe the lines. They will explain how the image of a candle is formed in the mirror and how you are able to see the image of the candle in the mirror

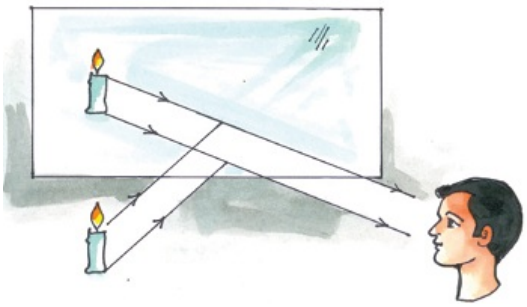


Fig. 9

Can you see the image in the mirror though the object is not seen by you? Look at figure 10.

Take a mirror and an object and try.

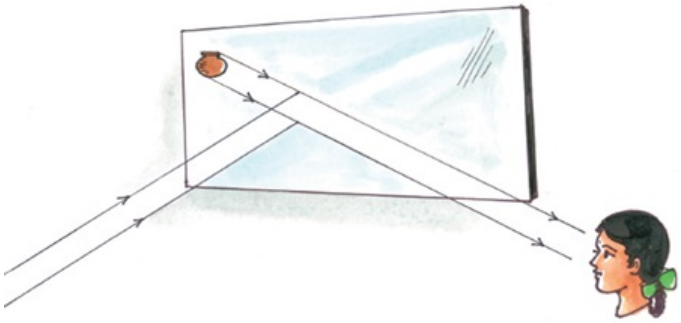


Fig. 10

Think: All of you are sitting in your classroom, where and how would you place a mirror to see a tree which is outside the class?

Can all of you see that tree at a time?

If not, what will you do so that each one of you can see the tree without changing your seat?

Take a mirror and try.

Is there any difference between you and your image?

Stand in front of a mirror as shown in figure 11 and observe on which side of you does the pocket on your shirt appear, when you look into the mirror.

Fig. 11

Fig. 12

Raise your right hand in front of a mirror as shown in figure 12. Which hand of your image appears raised?

To make your image to comb hair with its right hand, what will you have to do?

What do these observations suggest?

In a mirror, right of an object appears ..... and left of the object appears .....

Note that only sides are interchanged. This is called lateral inversion.

Let us do this (7)

Take a drawing sheet and cut it into a few pieces. Write an English letter in capitals on each piece of drawing sheet. Observe the images of the letters formed in the mirror as shown in figure 13.

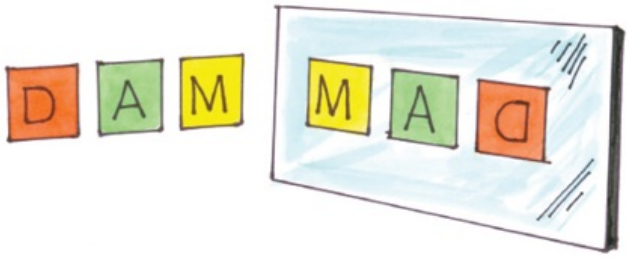


fig. 13

i) Which of the images appear same as the original letter?

ii) Which of them appear reversed? Why?

Repeat above activity with **Telugu/Hindi/Urdu** letters and also with numbers 1 to 9 then try to answer the above questions.

Can you spell your name as it appears in a mirror?

Spelling of my name is ..... It appears in the mirror as.....

Think: On the front side of ambulances, Why the word AMBULANCE is written like

Is the size of an object and its image same?

Let us do this (8)

Stand in front of a big mirror. Observe your image. Step back two feet and step forward one foot. Observe your image while you move to and fro. What do you notice? Did your image also move? Estimate the distance from you to the mirror and the distance from the mirror to the image. Is the size of your image equal to your size? Place an object in front of the mirror. Compare the size of the object with its image. Is the size of the object and its image the same?

What can you say about the size of your image when you stand in front of a small mirror and a big mirror? Do you find any difference in the sizes of those images?

You may notice that irrespective of the size of mirrors, the size of image and the size of object are equal.

Think:

Anuvugani chota adhikulamanaradu
Konchamundutella koduva kadu
Konda addamandu konchamai undada
Viswadabhi rama vinuravema

Have you heard of this poem?
Why does a mountain look tiny in the mirror?

Images are many . . . Object is one. .

- Have you gone to a hair cutting saloon?
- How many mirrors does the barber generally use in a saloon?

You may notice there is one mirror in the front and another at back of the sitting place. Sometimes barber places a mirror behind your head, as shown in figure 14.

Fig. 14

- Why do they use more mirrors?
- How many images do you see when you sit in the chair? Why?

How to form multiple images?

Let us do this (9)

Take two plain mirrors of same size and join them with a cellophane tape as shown in figure 15. Fold the mirrors through certain angle and place an object between them. How many images can you see?

Fig. 15

Count the number of images after changing the angle between the mirrors.

What should we do to get more images?

Observe:

Keep the mirrors in such a way that the angle between the mirrors is 90 degrees and observe the images and compare them with the object. What do you notice? Is there any difference between those images?

Imagine the reason for that.

- How can we use the property of reflection in daily life?
- Have you seen any instrument (or) toy which works, based on reflection?

Let us do this (10): A Garden in box

Take an empty shoe box. Place two plane mirrors along the edges. See that the pair of mirrors are parallel to each other and their reflecting surfaces face each other as shown in figure 16.

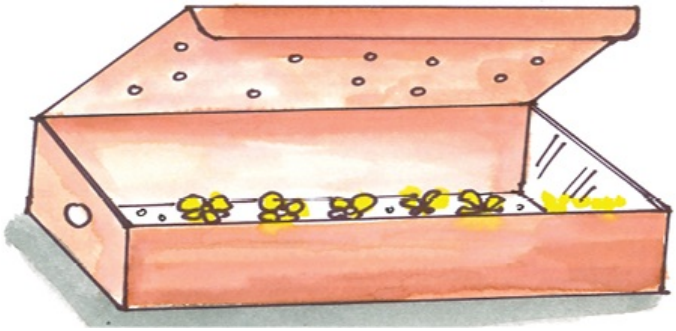


fig. 16

Scratch the centre part of a mirror at its back and make a hole to the wall of the box such that it coincides with the scratched portion of the mirror. Put some flowers in the box. Make a few holes in the lid before closing the box so that light enters into the box. Now look through the hole. You can see a wonderful and beautiful vast garden.

Why does the small area look like a vast garden?

The light which enters the box falls on the flowers, gets reflected and travels in all directions. The rays which fall on the mirrors reflect back to the opposite mirror. This process happens again and again. Due to this multiple reflection we can see that small area as a big garden.

Make your own Kaleidoscope

Let us do this (11)

Take three mirror strips of the same size. Tie these strips with rubber bands to form a triangular tube as shown in figure 17(a).

fig. 17(a)

While tying the strips together, remember to keep their reflecting surfaces facing each other inside the tube. Cover one end of the tube with translucent paper using a rubber band. Cover the second end with card board sheet and make a hole in it. So that you can look inside it. Your kaleidoscope is ready.Now put few small pieces of coloured glass bangles inside the triangular tube as shown in figure 17(b).

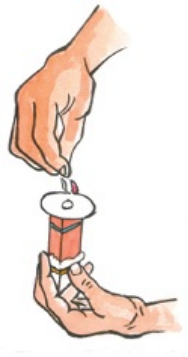


fig. 17(b)

Look at the bangle pieces through the hole as shown in figure 17(c).

fig. 17(c)

What do you see?

Shake the kaleidoscope and try to see through the hole slowly rotating it. What happens?

Can you explain why this happens?

Think: Have you seen these types of patterns (those observed in kaleidoscope) in your daily life?

Have you ever observed your image in a rearview mirror?

Have you observed the mirrors at both the sides of driver in motor vehicles like bus, car or motorcycle? See figure 18.

Fig. 18

These are rearview mirrors. These are used by drivers to see vehicles which are moving behind or beside of the vehicle without turning their heads.

Have you ever observed your image in that mirror? How is your image in that mirror?

Let us do this (12)

Take a plane mirror. Go to a vehicle. Observe your image in the rearview mirror and as well as in the plane mirror. What difference do you find?

You might have noticed that the image formed by a rearview mirror is smaller than the image in a plane mirror. Why it is like that?

What is the difference between these two mirrors? Observe their shapes and find the difference.

Have you observed reverse image of yourself in any mirror?

Let us do this (13)

Try to observe your image in a stainless steel spoon. The curved shining surfaces on either side of a spoon acts as a mirror as shown in figure 19.

Fig. 19

How is the image on the outer portion of the spoon?

How is the image on the inner portion of the spoon?

When you look at the inner portion of the spoon you find a reversed image. The inner portion of spoon acts as concave mirror. When you look at the outer portion of the spoon you find small size image of you. Outer portion of spoon acts as a convex mirror.

Have you seen the mirrors whose reflecting surfaces look like the head of a steel spoon? (See figure 20) The mirrors which contain curved reflecting surface are called **spherical mirrors.** They are two types.

1) Concave mirror 2) Convex mirror

Fig. 20

Why do we call concave and convex mirrors as spherical mirrors?

Let us do this (14)

Take a rubber ball and cut a portion of it with knife as shown in figure 21. (Be careful. Ask your teacher to help you in cutting the ball).

Fig. 21

The inner surface of the cut piece of ball is called concave surface and the outer surface of it is called convex surface.

If the reflecting surface of a mirror is concave, it is called a concave mirror see figure 22(a).

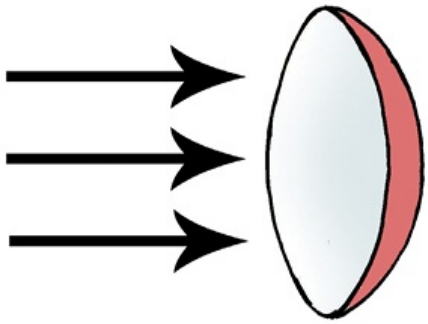


Fig. 22(a)

If the reflecting surface is convex, then it is called as convex mirror. See figure 22(b).

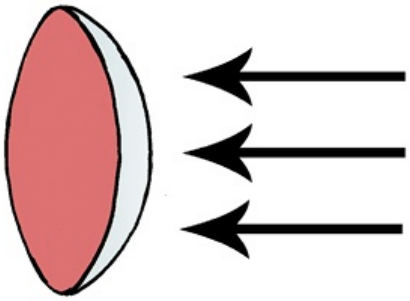


Fig. 22(b)

Any concave or convexmirror is a part of a sphere. Hence these mirrors are called spherical mirrors.

Let us form images with Spherical mirrors

Let us do this (15)

Place the concave and convex mirrors on two different V- stands. Put two candles of same size in front of them as shown in figure 23.

Fig. 23

Adjust the position of candles, to form clear images in the mirrors. Observe the sizes of images and compare them with candle sizes.

- What difference do you notice between the image and object in a concave mirror?
- What difference do you notice between the image and object in a convex mirror?

Can we obtain the images formed by mirrors on the screen?

Let us do this (16) (try this in a dark room)

Place a concave mirror on a V-stand. Place a lighted candle in front of it. Place a thick white paper or white drawing sheet behind the candle. This acts as a screen. See figure 24.

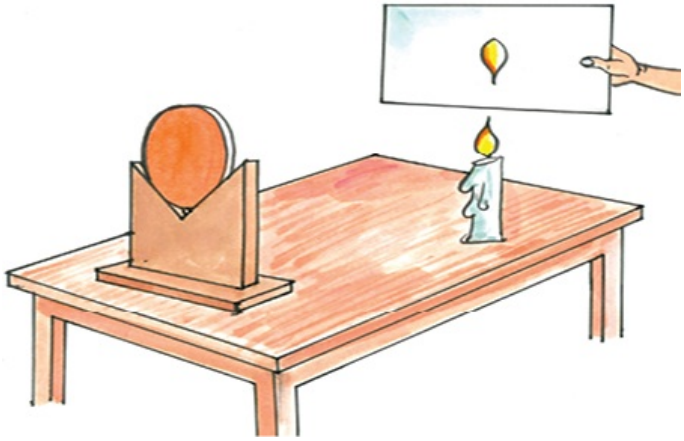


Fig. 24

Adjust distances between candle and mirror, screen and mirror by moving them either forward or backward till a clear image appear on the screen.

Repeat the activity using a convex mirror and plane mirror in place of concave mirror.

Images of which mirror are formed on the screen?

The image that can be obtained on a screen is called a Real Image. We can see this image in the mirror too.

The image that can't be obtained on a screen but can be seen only in the mirror is called a Virtual Image.

Think: Every day we see our image in a plane mirror. Is it a real or virtual image? How can you decide?

Have you noticed the surface of reflection in a torch light? Or in a head light of a vehicle?

Observe the torch light or headlight of a vehicle. You notice a concave mirror behind the bulb (See figure 25). Due to this concave surface the brightness of a small bulb is increased.

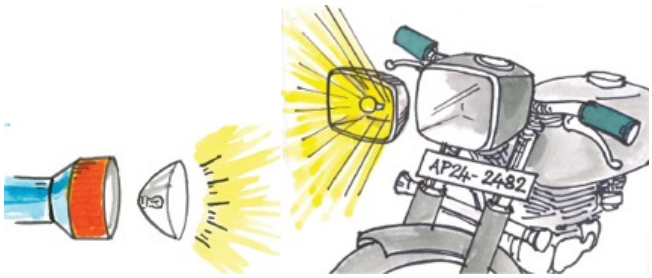


Fig. 25

Imagine: What happens if the surface of reflection in the torch or in a head light of a vehicle is convex like in figure 26?

Fig. 26

Dentists use mirrors to examine our teeth (See figure 27).

Fig. 27

These mirrors used by doctor help to see a bigger image of teeth. What type of mirrors are they?

In our daily life while we stand in front of windows we observe our images on the glass of some windows but don't find images on the glass of some other windows. Why?

Our image is clear when we stand in front of certain types of glass as shown in figure 28(a). Our image is not clear when we stand in front of some other types of glass as shown in figure 28b.

Fig. 28(a) Fig. 28(b)

- Why do certain glasses form clear images?
- Why are images in some other glasses not clear?

Reflection from a smooth surface like that of a mirror is called **regular reflection (**see figure 29). Clear images are formed in case of regular reflection.

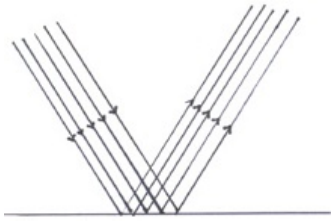


Fig. 29

Reflection from a rough or irregular surface is called **irregular reflection** or diffused reflection (see figure 30). Images are not clear in case of irregular reflection. In some cases we can't find the image at all.

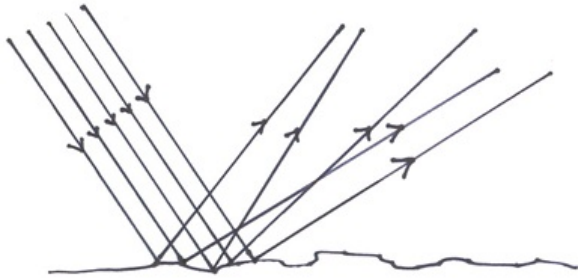


Fig. 30

If the surface of the window glass is smooth, due to the regular reflection we are able to see our image in that glass. But if the surface of the window glass is rough, due to the irregular reflection we can't find our image or we find unclear images in that glass.

Let us try this

Observe the image of the sun or a tree in still water. Later, disturb the water by throwing a pebble. How does the image of the Sun or the tree appear now? Why?

Let us try this

Keep a mirror close your face and look into it. Move the mirror backward and observe the image. What change do you observe? Try this activity using Convex, Concave mirrors. In which mirror do you get an inverted image? At what distance does it happen?

Key words:

Incident Ray, Reflected Ray, Normal, Angle of Incidence (∠ i), Angle of Reflection (∠ r), Periscope, Lateral Inversion, Kaleidoscope, Rear view mirror, Spherical mirror, Convex Mirror, Concave mirror, Real Image, Virtual Image, Regular Reflection, Irregular Reflection.

What we have learnt

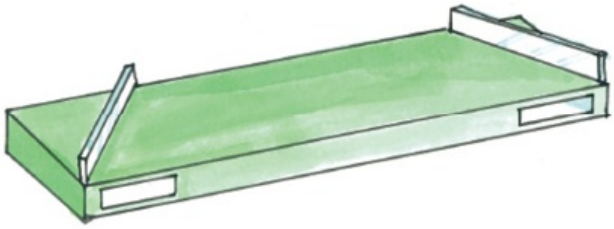
1. Light changes its direction when it is obstructed by any object. This phenomenon is called reflection.
2. Angle of incidence is equal to an angle of reflection. We denote angle of incidence with ∠**i** and the angle of reflection with ∠**r**.

   Measure of ∠**i** = measure of ∠**r**. (for a plane mirror)
3. In the image formed by a mirror, right of the object appears as left and left of the object appears as right. This is called Lateral Inversion.
4. The distance from the object to a plane mirror is equal to the distance of the image from the mirror .
5. Irrespective of size of the plane mirror, the size of the image in the mirror is equal to the size of the object.
6. Any object which is far away from us looks smaller in size. In the same way its image in the plane mirror will also look smaller.
7. Plane mirror forms single image. If we want to form multiple images two plane mirrors need to be kept at an angle.
8. The number of images increases when we reduce the angle between two mirrors.
9. In a rearview mirror (convex mirror) we get diminished image of the object.
10. In a mirror which is used by Dentist (concave mirror) we get enlarged image of the object.
11. The image that can be obtained on a screen is called a Real Image.
12. The image that can't be obtained on a screen but can be viewed in the mirror is called a Virtual Image.
13. Torches, headlights of vehicle have concave mirrors behind the bulb for reflection.
14. Reflection from a smooth surface is called regular reflection.

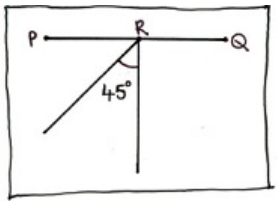
Reflection from a rough surface is called irregular reflection.

Improve your learning

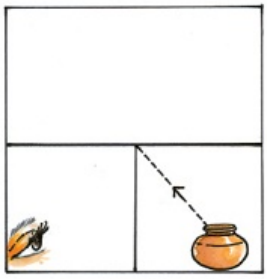
1. Vidya made a Periscope making slits like this as shown in the figure. Will it work or not? Explain your answer. Try to make a periscope like this and see whether it works or not?



2. (i) Draw reflected ray in the figure given here.



(ii) Mark the position of the image in the figure given here by dotted lines.



3. How do you relate angle of reflection and angle of incidence?

What will be the angle of reflection when angle of incidence is

i) 60° ii) 0°

4. Imagine that your sister is viewing a cricket match on a TV and you are viewing the same cricket match in a mirror which is opposite to the TV. What difference do you notice in the match?

5. Write the mirror image of your name?

..... (in English)

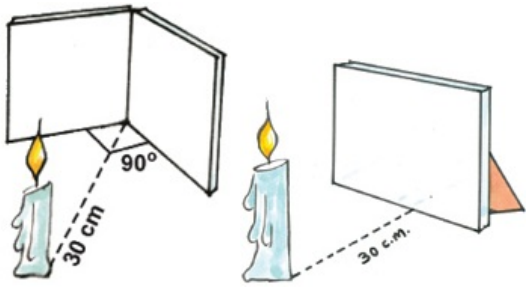
..... (in Telugu)

6. You are given the mirror image of a name. Can you find out the actual name?

Place a mirror in front of this figure and check your answer.

7. Get three mirror strips, two rubber bands, card board sheet, translucent paper, and broken bangle pieces and make a Kaleidoscope.

8. Observe the following figures.



How many images would you observe in the mirrors in the above cases? Write your guesses.

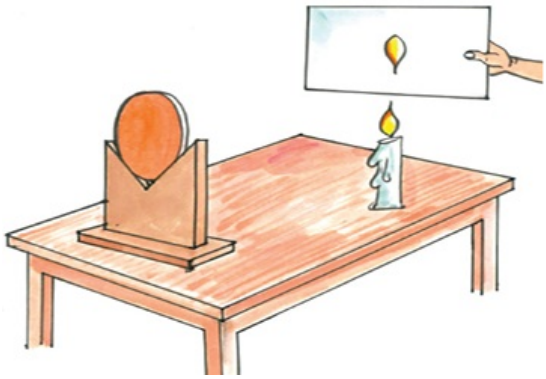
Fig – 1.....

Fig. – 2 .....

Do experiments and check whether your guesses are correct or not? Give reasons.

9. Write examples of multiple images formed in your daily life?

10. Observe the figure and identify which type of mirror is used? How do you justify it?



11. Sai lighted a candle in his house when power went off. His mother placed it in front of a mirror. Sai observed something that excited him. What change would have excited Sai? Some questions came to his mind. Can you guess the questions? Write a few such questions.

12. Unexpectedly some water sprinkled on a mirror while Madhu was shaving his face. Did he observe any difference in his image? If yes, explain why?

13. Imagine that all the houses in your street have elevation with mirrors. Suppose you and your friends are walking in the street. Would you experience any difficulties when you walk through that street? Predict and explain. Is it difficult for birds to live or fly in that street? Why?

14. Take a empty tooth paste box and two mirror strips of required size and make a periscope.

15. What is the angle between two plane mirrors when there are five images?

16. What is the difference between convex and concave mirrors? Draw the diagrams of concave and convex mirrors.

17. Where do you find irregular reflection in daily life? Give some examples.

18. Mirrors help us to see all the objects around us without turning our heads. Write about the role of mirrors in our life.

19. Army people can see their enemies while hiding themselves with the help of periscopes. Write about the use of periscope for their security.

20. Imagine what would happen if there are no rearview mirrors attached to vehicles and there are no concave mirrors in head lights of the vehicles. Write about the role of convex and concave mirrors in safe driving.

21. While constructing a new house, Kishan’s uncle rejected his wife’s request of glass elevation to the building, saying that “It is harmful to the birds and also our selves”. Why would you support the decision of Kishan’s uncle?

22. Collect information from your elders and shopkeepers about where we use more mirrors and why?

23. Collect information about which objects of your school and home work like a mirror and why? Identify the similarities among those objects.