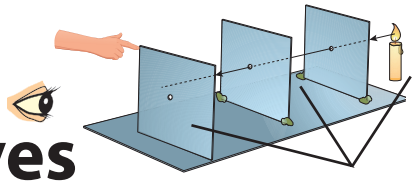
14 Reflection and Refraction of Waves



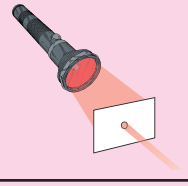
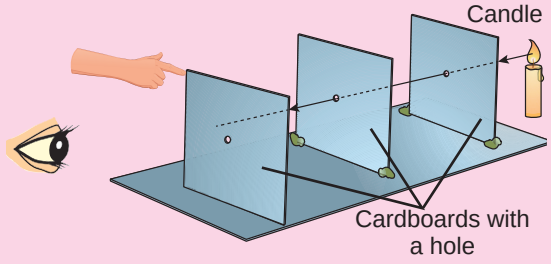
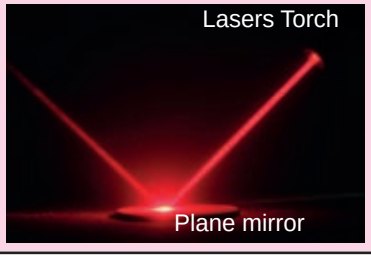
14.1 Reflection of light

Light is a very important form of energy for man. Let us briefly recall what we have learnt about light in grades 6 and 7. Let us do the assignment 14.1 for this.

Assignment 14.1

- According to the activities in table 14.1 what are the conclusions you can made regarding the characteristics of light.

Table 14.1

Activity	Conclusion
	
	
	

Light is composed of very thin light rays which travel in straight lines. Light travels through a vacuum or a transparent medium in straight lines, and reflects when strikes on a reflecting surface (mirror).

Bouncing back of light ray into the same medium, when strikes on a surface, is known as reflection of light.

Let us study further about the reflection of light.

14.1.1 Reflection of light by a plane mirror

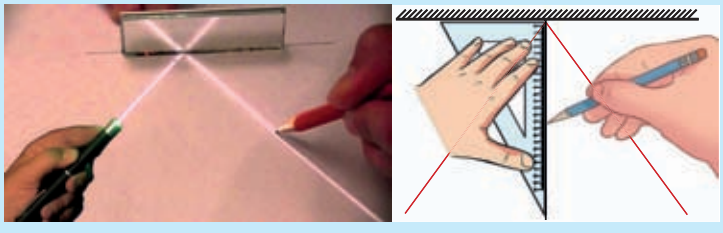
Let us do the activity 14.1 to study how light rays get reflected from a plane mirror.

Activity 14.1

You will need :- A plane mirror, a sheet of white paper, an electrical torch or a laser torch, a pair of scissors, a ruler, a protractor, a pencil

Method :-

- Place the sheet of white paper on the table
- Place the plane mirror perpendicular to the paper using a stand.
- Draw the mirror line on the paper
- Direct a narrow inclined beam of light, along the paper on to the mirror using the electrical torch or the laser torch.
- Observe how the beam of light reflects from the mirror
- Trace the incident and reflected rays on the paper using the pencil
- Remove the mirror and complete the rays using the ruler
- Construct the normal line to the plane mirror at the point of incidence
- Measure the angles at either sides of the normal line



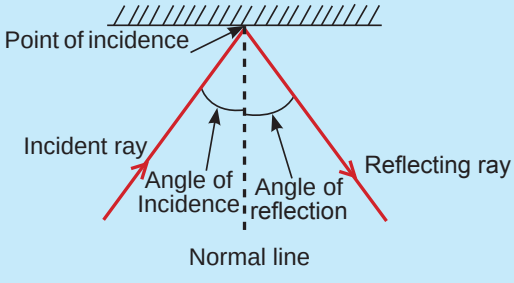


Figure 14.1

A diagram that shows the way the rays are traveling is known as a ray diagram.

In the activity 14.1, what you have constructed is a ray diagram to show the reflection of a light ray from a plane mirror after its incidence.

- The ray that falls on the mirror is called the incident ray.
- The point where the incident ray contacts with the mirror is the point of incidence.
- The ray that reflects away from the mirror is known as the reflecting ray.
- The perpendicular line drawn to the mirror at the point of incidence is the normal or the normal line.
- The angle between the incident ray and the normal line is called the angle of incidence and the angle between the reflected ray and the normal line is called the angle of reflection.

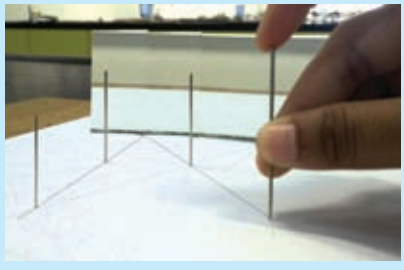
We can do the activity 14.1 using pins instead of using electrical torch. Let us do the activity 14.2 by using pins.

Activity 14.2

You will need :- A sheet of white paper, A plane mirror, four pins, a ruler, a pencil, a protractor, a stand

Method :-

- Place the sheet of paper on the table
- Place the plane mirror perpendicular to the paper using the stand
- Draw the mirror line on the paper
- Fix two pins in front of the plane mirror which should be on an inclined straight line to the mirror.
- Observe the images of the pins through the mirror
- Fix another two pins on the paper, which are in line with the two images.
- Now remove the pins and the mirror. Draw straight lines connecting the pin marks. Complete the ray diagram by constructing the normal line at the point if incidence, as done in activity 14.1
- Measure the angle of incidence and the angle of reflection.



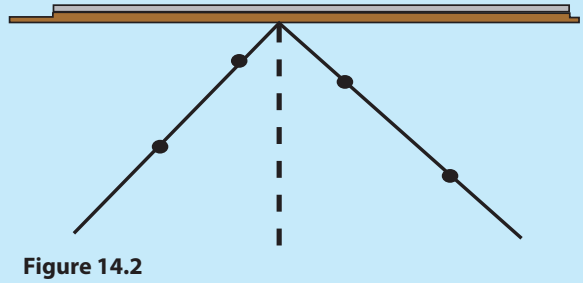


Figure 14.2

14.1.2 Laws of reflection

Observations of the activities 14.1 and 14.2 can be summarized as follows.

- When light is reflecting; that the incident ray, reflecting ray and the normal line are in the same plane.
- That the values of the angle of incidence and the angle of reflection are equal.

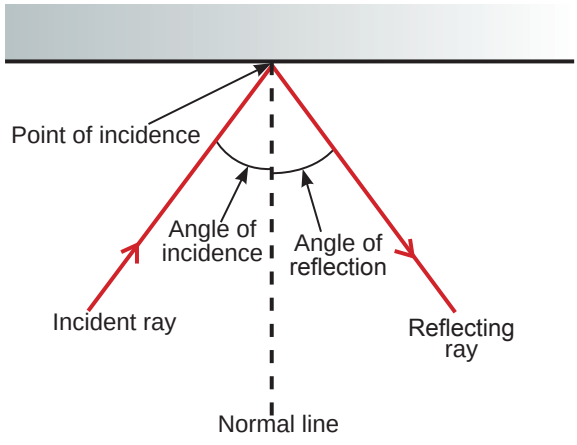


Figure 14.3

Above conclusions are true for all the instances of reflection of light. Therefore, they are considered as the laws of reflection. There are two laws of reflection.

1. The incident ray, the reflecting ray and the normal line drawn at the point of incidence are in the same plane.
2. The value of the angle of incidence is equal to the value of the angle of reflection.

14.1.3 Regular reflection and diffuse reflection

Let us observe how parallel rays of light are reflected from a smooth surface and a rough surface. Let us do the activity 14.3, using a plane mirror as a smooth reflecting surface and a crushed aluminium foil as a rough reflecting surface.

Activity 14.3

You will need :- An electrical torch or a laser torch, A plane mirror , an aluminium foil, a joss stick

Method:-

- Aim a beam of light on to the plane mirror and the crushed aluminium foil separately as shown in the figure 14.4
- Observe how the light is reflecting in each instance
- Discuss your observations in the class room

(For clear observation, spread some smoke near the set-up using the joss stick)

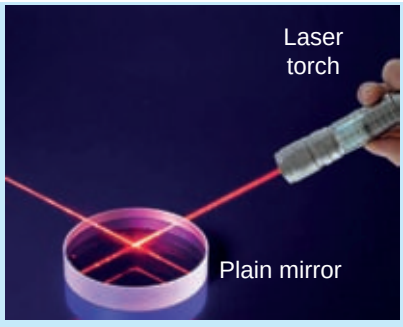


Figure 14.4 (a) - Regular reflection

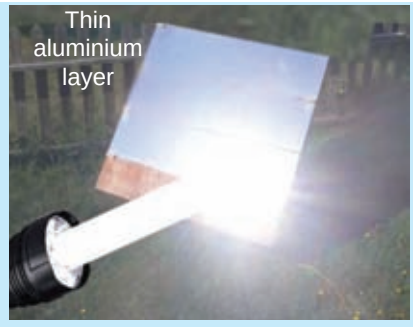


Figure 14.4 (b) - Diffuse reflection

Figure 14.4 - Regular and diffuse reflections

Note :- Do not aim the laser rays into eyes, as they are harmful to eyes.

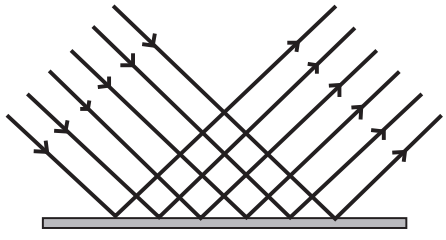
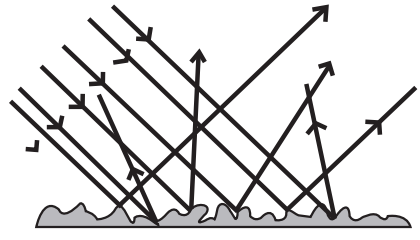
You may have observed that parallel light rays are reflected parallelly by plane mirror (figure 14.4 a) and parallel light rays are reflected to various directions by crushed aluminium foil (figure 14.4 b).

According to the activity 14.4, it is clear that light reflection is of two types.

1. Regular reflection 2. Diffuse reflection

More information of these two types are given in the table 14.2.

Table 14.2 - Regular and diffuse reflection

Regular reflection	Diffuse reflection
	
• This is done by smooth surfaces • Parallel light rays are reflected parallelly e.g. Reflection of sun light by a plane mirror Reflection of laser rays by a plane mirror	• This is done by rough surfaces • Parallel light rays are reflected to various directions e.g. Reflection of sun light by the pages of a book Reflection of sunlight by objects like the Earth, plants, buildings and rocks

Think whether regular reflection or diffuse reflection is commonly found in day-to-day life.

Both regular reflection and diffuse reflection are useful in day-to-day life.

Instances where regular reflection is useful

- Regular reflection is commonly found, when using mirrors
  e.g. To watch ones own face, to use light microscope
- To create vivid light patterns in various shows.
- To get information of the motion of machine parts in industrial plants

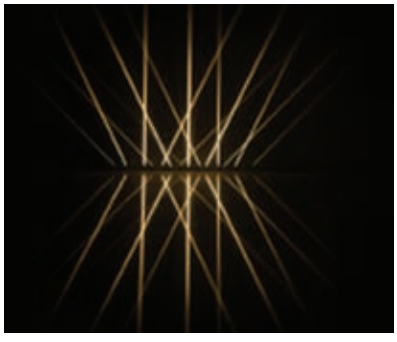


Figure 14.5 - Create vivid light patterns in various shows

Figure 14.6 - Using light microscope

Instances where diffuse reflection is useful

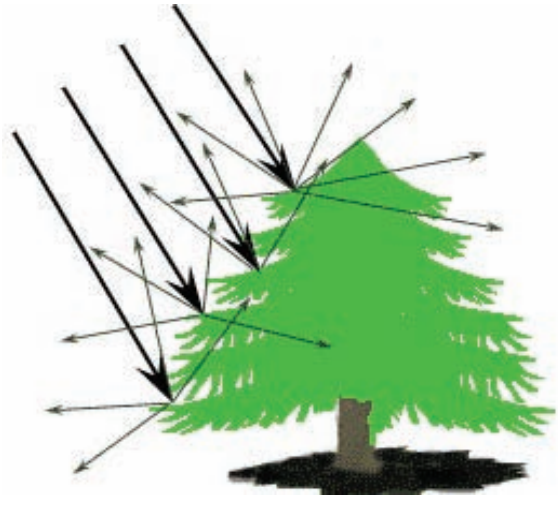


Figure 14.7 - Objects in the environment can be seen from all directions as they reflect sun light diffusely

Figure 14.8 - Letters in a book can be seen from all directions

Assignment 14.2

- Discuss in the classroom, the instances where regular reflection and diffuse reflection are useful. Tabulate the facts you discussed.

14.1.4 Images formed by plane mirrors

Images are formed because of the reflection of light, emitted by objects, from a plane mirror. For instance, the image of an electrical torch place before a plane mirror can be seen through it.

Let us do the activity 14.4 to study how an image is formed by reflection of light.

Activity 14.4

You will need :- A cardboard box, an electrical torch, plane mirror, a stand, piece of cardboard, a pair of scissors, white paper

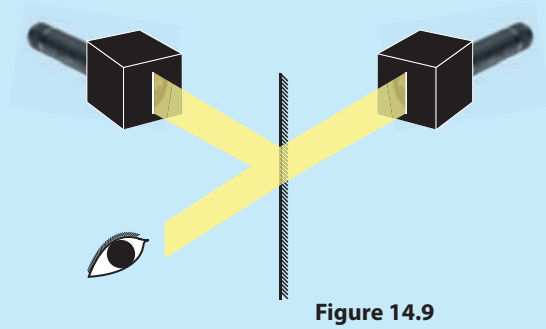


Figure 14.9

Method:-

- Place the white paper on the table.
- Fix the plane mirror, perpendicular to the white paper.
- Place the lighted torch inside the box, with a long slit. Focus the beam of light, to the slanted mirror plane, emitted by torch.
- Look at the reflected beam of light.
- What can you observe through the plane mirror.
- Get the help of teacher to explain your observation.

In this activity you observed, the image of lighted slit. The light reach to eye from object (slit) which get reflected from the mirror.
We see as the light reaches to eye from a point behind the mirror. It is known as image.

Let us draw the ray diagram for the image formed by plane mirror.

Two rays are enough for drawing a ray diagram.

Let us do the activity 14.5 to draw a ray diagram of an image of pointy object, kept infront of a plane mirror.

Activity 14.5

You will need :- Two laser beams, a white paper, a plane mirror, a stand, a pair of scissors

Method :-

- Make a slit in the piece of cardboard
- Place the white paper on the table and fix the mirror to the stand perpendicularly (figure 14.10)
- Direct two lazer beams through the slit, slantly to the mirror.
- Observe the reflected beams of light.

What can you observe now?

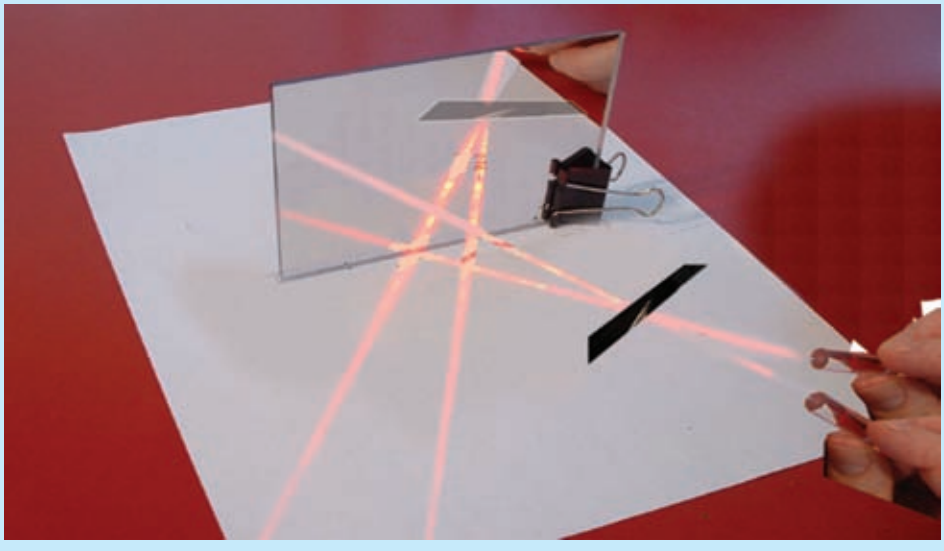


Figure 14.10

In the activity 14.5, the pointy object is the slit made in cardboard. The light rays reach from slit, get reflected by the plane mirror and from an object behind the mirror.

According to the observation done in activity 14.5 we can illustrate the ray diagram. For that let us engage in activity 14.6.

Activity 14.6

You will need :- A sheet of white paper, a ruler, a pencil, a protractor

Method :-

- Draw a straight line, on the sheet of paper to indicate the plane mirror.
- Mark a point, about 5cm away from the mirror plane (point-form object).
- Starting from this point, draw two inclined light rays to the mirror plane.
- Mark the points of incidence and construct the normal lines for the two rays drawn.
- Measure the angles of incidence and mark the angles of reflection equals to them.
- Now construct the reflecting rays.
- Extend back the reflecting rays by dotted lines to meet them together.
- Mark the point where the reflected rays meet together when extended back. That is the point where the image is formed.
- Connect the object and the image by a dotted line.
- Measure the distance between the mirror and the object (object distance) and the distance between the mirror and the image (image distance).
- Confirm the object distance is equal to the image distance.

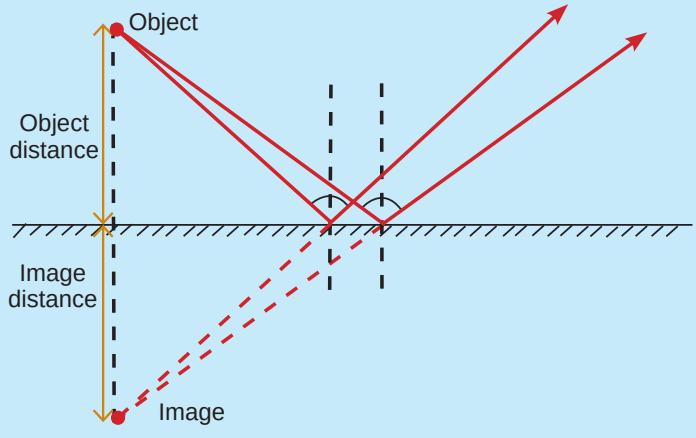


Figure 14.11

Assignment 14.3

Construct a ray diagram to show how the image is formed, of a point-form object kept 8 cm away from a plane mirror
(It is suitable to use an A4 sheet of paper for this)

Measure the object distance and the image distance

You have already learnt in grades 6 and 7, some of the characteristics of images formed by the objects kept infront of plane mirrors. Recalling them, let us do the activity 14.7 to study the characteristics of images formed by plane mirror.

Activity 14.7

You will need :- A plane mirror, a white screen, a ruler, a stand, pieces of cardboard on which letter **O**, **B**, **F** and **d** are drawn to the height of about 5cm (When you write the letter **O** draw a vertical line and colour half of it).

Method :-

- Fix the plane mirror vertically to the stand.
- Place each piece of cardboard, on which a letter is drawn, in front of the plane mirror. Observe the image of the letter through the mirror.
- See whether the image can be taken on to a screen.
- Repeat the activity, keeping some other objects in front of the mirror.
- Tabulate your observations in the table 14.3

Table 14.3

Letter/ Object	How the image is seen upright/inverted	Whether lateral inversion occur/not occur	Equality of the sizes of object and image	Whether image can be/cannot be taken on to a screen
B	upright	occur	equal	cannot be taken on to a screen (virtual)
F	.....	.....	.....	.....
d	.....	.....	.....	.....
O	.....	.....	.....	.....

Changing right hand side and the left hand side of the image is known as lateral inversion.

If the image can be taken on to a screen it is known as a real image, if it cannot be taken on to a screen, it is known as a virtual image.

According to the activity 14.7, the **characteristics of images** formed by the objects, kept in front of a plane mirror can be listed as below.

- Virtual (cannot be taken on to a screen)
- Upright
- Equal to the size of object
- Object distance and image distance are equal
- Lateral inversion occur

Letters like O, A and X cannot be identified under lateral inversion as these letters are symmetrical.

Assignment 14.4

Stand in front of a large mirror which is on a dressing table or any other place.

Observe the size and the lateral inversion of your image in the mirror.

Think whether your observations agree with the characteristics of the images formed by plane mirrors.

14.1.5 Use of plane mirrors

Plane mirrors are widely used for various tasks in day-to-day life. Some of them are given below.

1. Used in beauty salons and to watch ones own face, for dressing (figure 14.12)
2. In shops to show the number of items increased (figure 14.13)
3. To reflect light for laboratory activities (figure 14.14)
4. To produce multiple images (figure 14.15)
5. To observe the shape and the back side of costumes when selecting items for fashion activities (figure 14.16)
6. To observe backside of the head when one is having a haircut in a salon (figure 14.17)

Figure 14.12

Figure 14.13

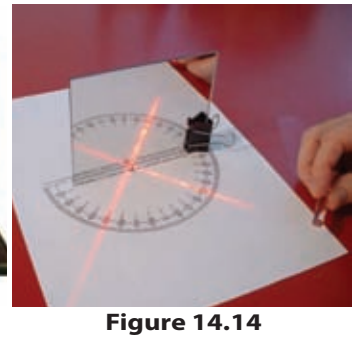


Figure 14.14

Figure 14.15

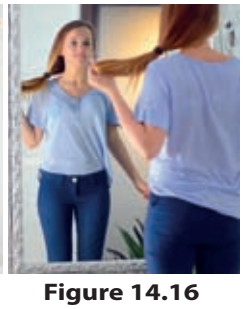


Figure 14.16

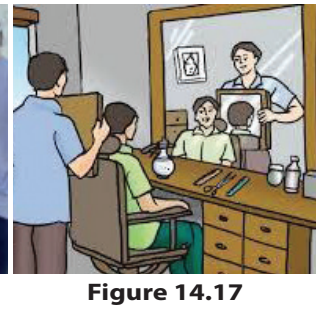


Figure 14.17

7. For making kaleidoscope

Various colourful patterns can be observed through this, when small pieces of petals, leaves or pieces of colourful papers are put into this.

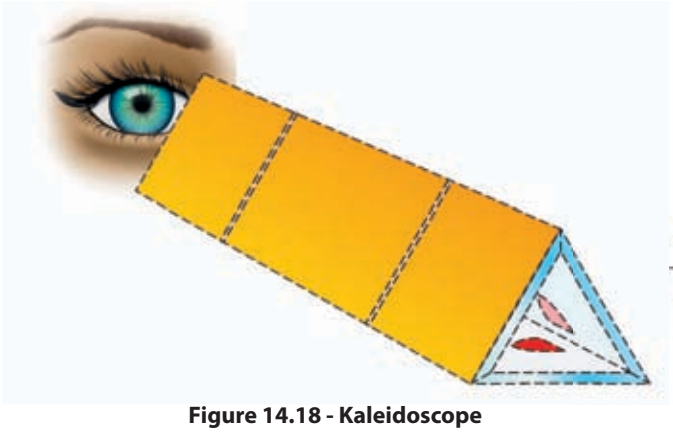


Figure 14.18 - Kaleidoscope

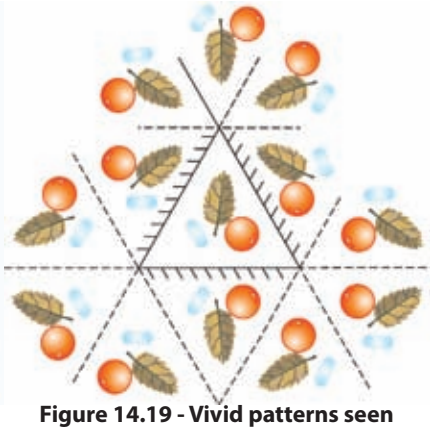


Figure 14.19 - Vivid patterns seen through a kaleidoscope

8. For making periscope

Periscopes are used to observe objects which are located above or below the position of the observer. (to watch out side from a submarine or a bunker)

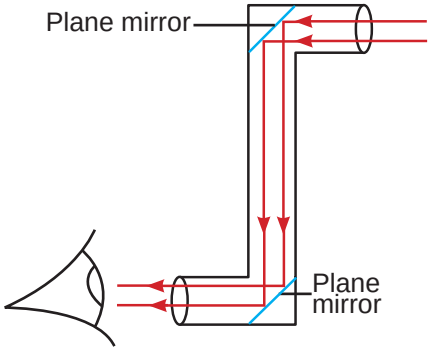


Figure 14.20 - Periscope

14.2 Sound

14.2.1 Reflection of sound

Be silent and listen to the environment for a moment. You may observe sounds generated by the vibration of various objects. Let us pay our attention to an important property of sound. Let us do the activity 14.8 for this.

Activity 14.8

You will need :-

A small mechanical clock or a stop watch, two pieces of PVC tubes to the length of 30cm each (dia.2.5cm), two stands, a piece of cardboard to the size of 30 cm × 50 cm, a smooth metal or glass sheet to the size of 30 cm × 30 cm

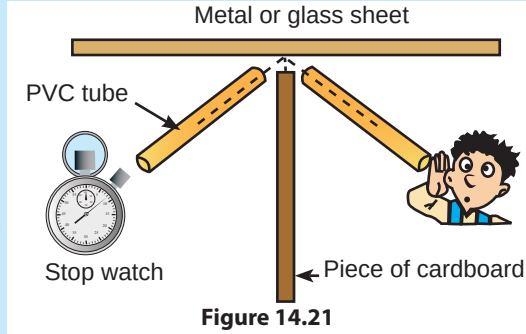


Figure 14.21

Method :-

- Place the metal or glass sheet vertically on the table.
- Place the cardboard sheet perpendicular to it.
- Fix the PVC tube to a stand as shown in figure 14.21 and place the stop watch closer to one end of it.
- Aim the other PVC tube to the glass sheet from the other side of the cardboard sheet. Adjust the position of the tube till a clear "tick" sound is heard through it. Mark the position of the tubes on the table.
- Now remove the glass sheet and listen for the "tick" sound of the watch.
- Repeat the activity, changing the position of the watch and using suitable sound sources instead of clock or stopwatch.
- Discuss in the classroom, the conclusions that can be made for the activity.
- Think of the reason for placing a cardboard sheet between the PVC tubes.
- What is the conclusion that can be made according to the results of this activity?

It is observed that the sound generated by the source was listened clearly at a certain point when the metals or glass sheet was there. And the sound could not be heard when the glass sheet was removed. The reason for this is the reflection of sound from the metal or glass sheet.

Bouncing back of sound from an obstacle is known as reflection of sound.

The obstacle that reflected sound, in the activity 14.8 was the metal or glass sheet.

Sound is in the environment are constantly subjected to reflection by various obstacles. Most of the sound reflecting instances cannot be noticed. But, there are some observable instances. Now let us consider some of them.

14.2.2 Echo

You may have observed that, when a strong sound is made in front of a large obstacle (a mountain/a building), it is heard over and over again. Let us do the activity 14.9 to experience this.

Activity 14.9

You will need :- A clapper used for starting running events or two wooden sticks

Method :-

- Select a place where there is a suitable obstacle like a tall building or a wall.
- Stand about 17 m apart from the obstacle (minimum distance between the obstacle and the observer to hear an echo is 16.5 m).
- Make strong sounds by striking the clapper several times.

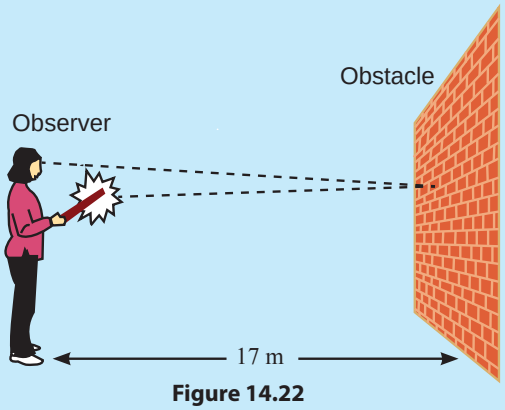


Figure 14.22

- Listen carefully after each instance of making the sound.
- Discuss the reasons for observations.
- Repeat the activity while coming closer to the obstacle.
- Make the sound while you are at a distance of 15 m or less to the obstacle (you can use even the walls of your classroom for this).
- Compare the latter observations with the earlier ones.

Sound generates by the clapper, was reflected by the obstacle. After hearing the first sound, the reflected sound was also heard after a short while later.

A second hearing because of the reflection of sound after the first one, is known as echo.

When the obstacle is too close the echo is not clear. This fact is confirmed in activity 14.9.

Sometimes several echoes can be heard, because of the reflection of the first sound. This happens when the sound is reflected several times. For instance, sound reflection in an auditorium can be mentioned.

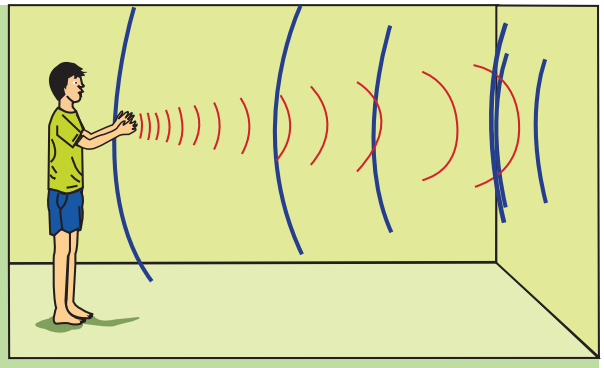
Assignment 14.5

- List out the instances of sound reflection that you have experienced in your day-to-day life. Mentioned the obstacle that is responsible for the reflection of sound in each instance.

For extra knowledge

Though the sound is reflected, clear echo is not heard when the obstacle is too close to the observer.

There is a minimum distance that should be maintained between the obstacle and observer to hear an echo. That minimum distance can be calculated as given below.



- The sense of sound is retained in human ear for 0.1 seconds.
- Sound travels 330 meters per second in air.
- To distinguish two sounds separately, difference between them should be more than 0.1 seconds.

The distance that sound travels in one second = 330 m

Distance that sound travels in 0.1 seconds $= \frac{330\ m \times 0.1s}{1s}$

Total distance that sound should travels to occur an echo = 33 m

∴ The distance that should be between the obstacle and the observer $= \frac{33\ m}{2}$

= 16.5 m

14.2.3 Reverberation

There are some instance in an auditorium or a cinema hall, that the sound emitted by the loud speaker is not clear. The reason for this is that the echo generated by the reflection of sound is heard before the initial sound fades off from the ear. Final result of this is, that the observe experiences a mixed unclear sound.

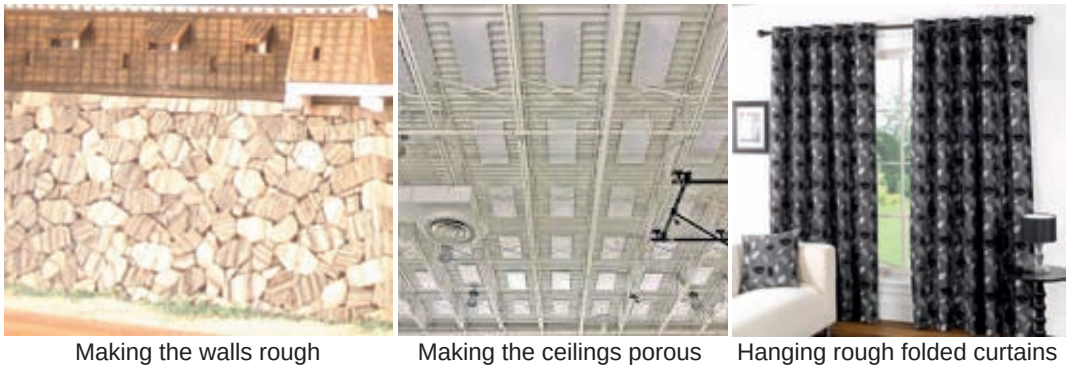
The persistence of sound for a long time because of the disability to distinguish the original sound and the echo is known as reverberation.

Reverberation is a disturbance for clear hearing. Therefore, methods are used to prevent the reflection of sound in auditoria, lecture halls and cinema halls where clear hearing is expected.

Reverberation occur because of the reflection of sound. Reflection of sound can be minimized by making the surfaces that sound strikes, to absorb it. Thus reverberation can be prevented.

Following methods are used in places like cinema halls, auditoriums and studios to absorb sound and thus prevent reverberation (figure 14.23).

Methods used to prevent reverberation



Making the walls rough | Making the ceilings porous | Hanging rough folded curtains

Figure 14.23 - Methods used to prevent reverberation

Instance where reflection of sound is applied usefully

Let us consider briefly some instances where reflection of sound is used.

1. Ultra sound scanning

Reflection of ultra sound waves is used to observe the shape of internal organs. This method is known as ultrasound scanning. Ultra sound waves are generated by a machine and are aimed at the relevant organ from outside of the body. Ultrasound waves that reflect from the organ are received by the machine. Those waves formulate the external appearance of the relevant organ on a screen.

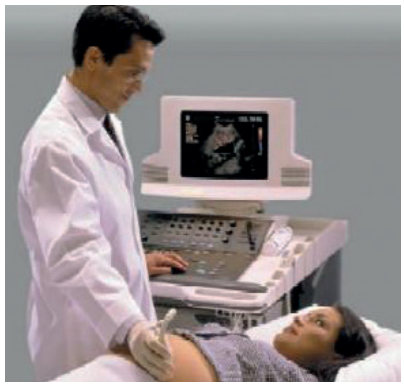


Figure 14.24 - Womb of a pregnant mother is being subjected to ultrasound scanning

Figure 14.25 - How the foetus developing in the womb is seen in ultrasound scanning

For extra knowledge

X-ray photographing may be harmful to organs and living body. But the harm is very less in ultrasound scanning.

2. Finding the depth of ocean bed

It is important to know the depth of the ocean bed in navigation. Reflection of ultrasound waves is used for this purpose. The method used is known as Sound Navigation and Ranging (SONAR). The equipment used for this is known Echo Sounder.

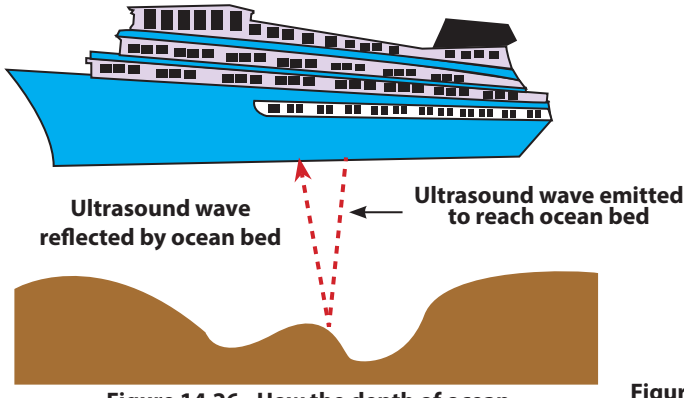


Figure 14.26 - How the depth of ocean bed is determined using echo sounder

Figure 14.27 - How the information of ocean depth is depicted in an echo sounder

The depth of the ocean is determined by the time taken to receive the wave, back to the equipment after reflecting from the ocean bed.

3. For bats, to identify obstacles at night

Reflection of ultrasound waves helps nocturnal animals like bats to identify obstacles at night. Ultrasound waves emitted by them, reflect after bouncing on the obstacles. According to the time taken for this, they can determine the distance to the obstacle.

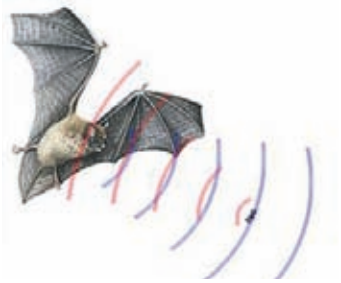


Figure 14.28 - How the ultrasound waves emitted by bat is reflected after bouncing on an obstacle

14.3 Refraction of Light

When light is travelling through a transparent medium, it travels rectilinearly. Now let us consider an instance that a light ray entering from one transparent medium to another transparent medium. Let us do the activity 14.10 for studying this phenomenon.

Activity 14.10

You will need :- A beaker of water, some soap, an electrical torch or a laser torch

Method : -

- Mix some soap in water in the beaker. (without allowing to form lather)
- Direct a thin inclined beam of light using the electrical torch or laser torch.
- Observe how the path of light beam changes when it enters into water.

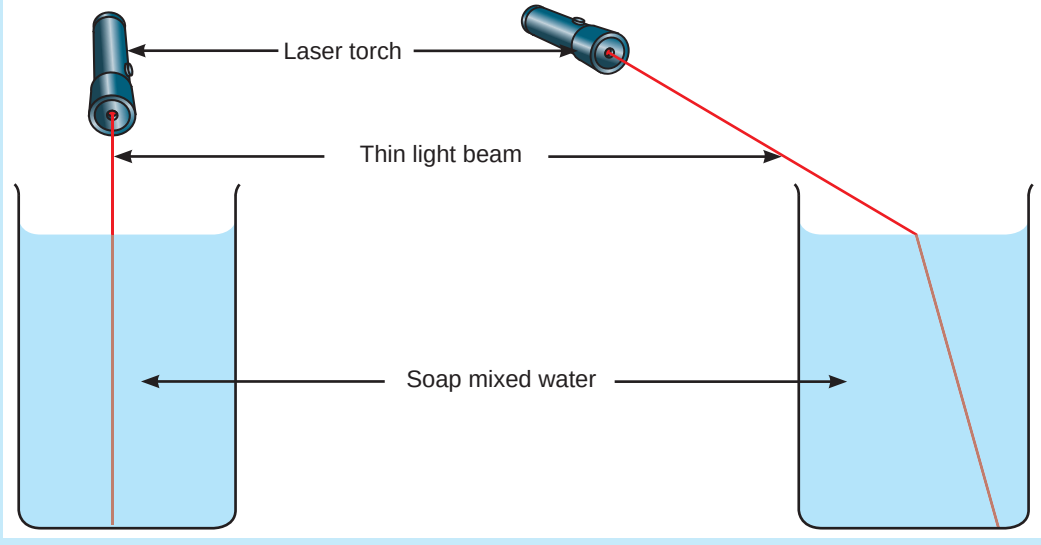


Figure 14.30 - Directing the light beam perpendicularly to the water surface

Figure 14.29 - Directing the light beam with an inclination to the water surface

- Carryout the activity changing the inclination of the thin beam of light
- Discuss your observations in the classroom.
- Answer the following questions while engaging in the activity.

1. What are the two transparent media that the thin beam of light travelled through?
2. At what place did the beam of light bend?
3. What is the reason for mixing soap into water?
4. What happens when light is directed perpendicular to the water surface?

In the activity 14.10, light rays have traveled from one transparent medium (air) into another transparent medium (water). The surface where two media come to contact each other is known as the interface. Light travels from one medium into another medium through the interface. It may be clear that, always the change of direction of light occurs at the interface.

It is important to mix soap into water to see the beam of light in water.

The change of direction of light when traveling from one transparent medium into another transparent medium is known as refraction of light.

The beam of light directed perpendicular to the interface, do not occur refraction.

- During refraction, the ray that is reaching the interface is the incident ray.
- The ray that travels after refraction is the refracted ray.
- The point on the interface where the incident ray falls, is the point of incidence.
- A normal line also can be constructed at the point of incidence.

The way of refraction occurs when a light ray enters from air to water can be shown by a ray diagram as in figure 14.31.

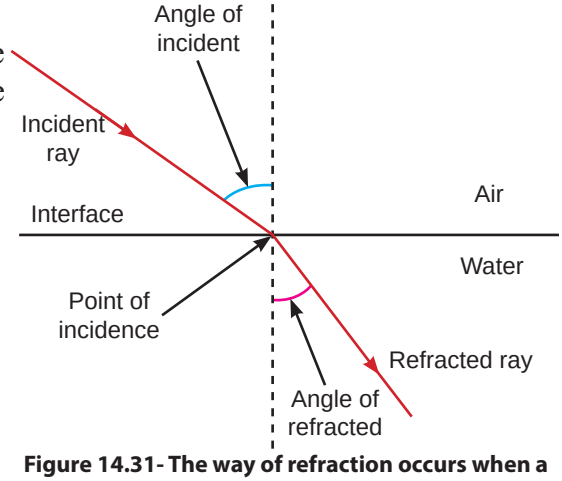


Figure 14.31- The way of refraction occurs when a light ray enters from air to water

For extra knowledge

Light travels in a definite velocity in a given medium. Velocity of light differs from medium to medium.

e. g.

Medium	Velocity of light (meters per second)
Vacuum or air	3.0×10^8
Water	2.25×10^8
Glass	2.0×10^8

Refraction of light occurs because of change of its velocity when traveling from one medium to another medium.

Refraction of light in a glass block

Let us study how a narrow beam of light (a pencil of light) refracts when directed into a glass block. Let us do the activity 14.11 for this.

Activity 14.11

You will need :- A glass block, a sheet of white paper, four pins, an electrical torch or a laser torch, a pencil, a ruler

Method :-

- Spread the sheet of white paper on the table and place the glass block on it.
- Direct an inclined beam of light on to the glass block as shown in figure 14.32.
- Fix two pins on the path of incident ray and the other two pins on the path of the light ray that travels away from the block.
- Sketch the position of glass block using the pencil
- Remove the glass block, the pins and the torch. Complete the ray diagram.

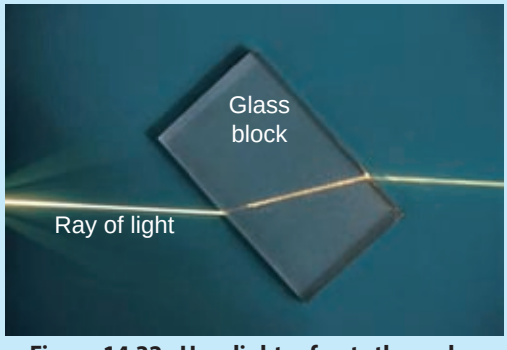


Figure 14.32 - How light refracts through a glass block

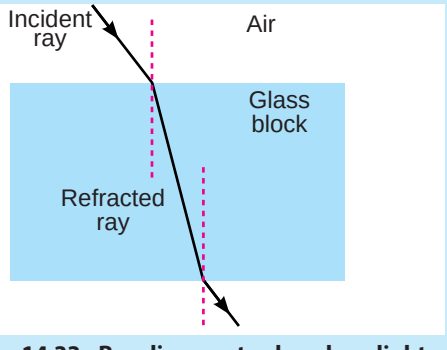


Figure 14.33 - Ray diagram to show how light refracts through a glass block

14.3.1 Effects of refraction of light

Let us consider briefly, some phenomena that can be seen in day-to-day life, due to refraction of light.

- **Apparent elevation of the bottom of a pond or a container of water**

Activity 14.12

You will need :- A tall glass tumbler or a beaker, water, a coin or a nail, a pencil

Method :-

- Put the coin or the nail into the glass tumbler or the beaker. Fill it with water.
- Observe the coin or the nail from above.
- Mark the apparent bottom (the coin or the nail) When viewed from top, on the side of the vessel using the pencil.
- Now measure the real depth and the apparent depth to the bottom of the vessel and note them down.

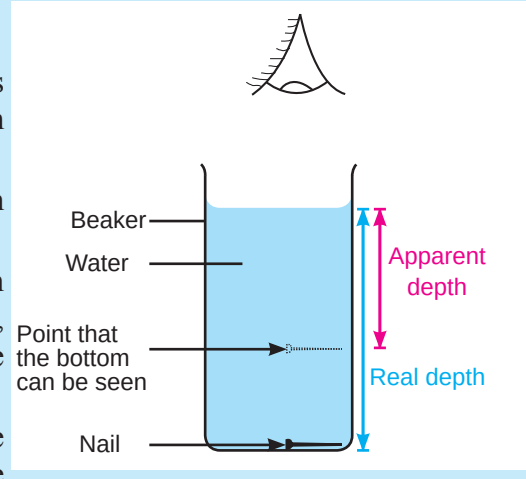


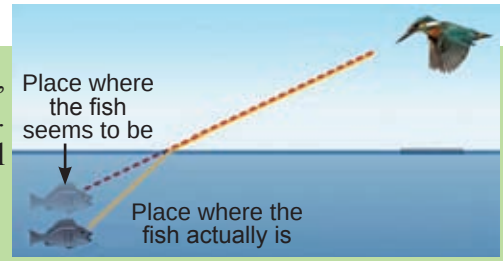
Figure 14.34 - Real depth and apparent depth

It is clear that the observable depth or the apparent depth when viewed from top, is always less than the real depth from the water surface to the bottom.

It is important to think carefully before step down into a well or a reservoir because the real depth of it is more than the apparent depth.

For extra knowledge

Birds like kingfisher observe fish in water, a little above than where they actually are. But, those birds have an idea of the real depth to the fish.



- **Pencil dipped partially in water seems to be broken at the water surface**

  A pencil which is partially dipped in water, seems to be broken at the liquid surface, when viewed from a side. The reason for this is the refraction of light when it comes from water to air.

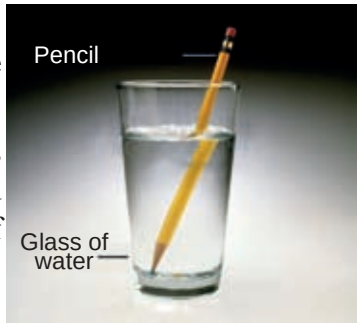


Figure 14.35 - How a pencil dipped in water seems to be

- **Refraction of white light through a prism**

  A wonderful occurrence can be observed when white light passes through a glass prism. Let us do the activity 14.13 to study about this.

Activity 14.13

You will need :- A glass prism (60 × 60 × 60), a white screen, a piece of cardboard, a plane mirror

Method :-

- Keep the glass prism on the table.
- Direct a narrow beam of light on to the prism using plane mirror and the piece of cardboard.
- Let the light that passes through the prism fall on the screen.
- Discuss the reason for your observations in the classroom.

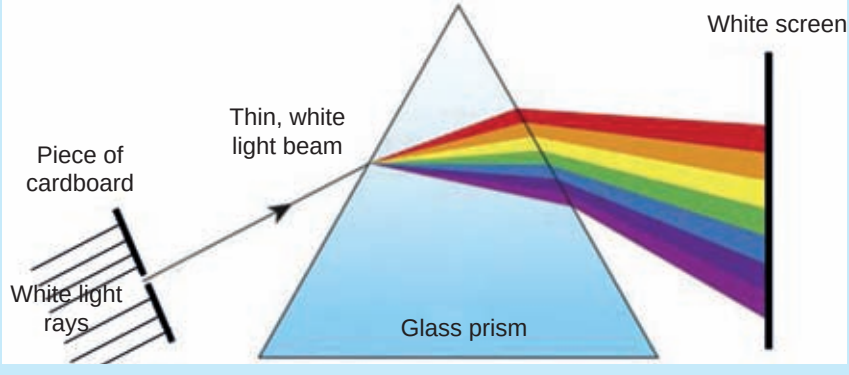


Figure 14.36 - How white light passes through the glass prism

A spectrum of seven colours can be seen on the screen during the activity 14.13. Separation of white light into seven colours when passing through a prism due to refraction is the reason for this. Colours of the spectrum are red, orange, yellow, green, blue, indigo and violet respectively.

Separation of white light when passing through a prism is known as **dispersion.**

For extra knowledge

Scientist Sir Isaac Newton showed that white light is composed of seven colours. The equipment he used for this is known as Newton's disc. Newton's disc is made by painting the segments, equally divided through the centre of a circle with the seven colours. When this painted circle is rotated the seven colours mix to give white colour. You also can make a Newton's disc of your own.

- **Occurrence of rainbow**

Rainbow is another elegant phenomenon that occurs due to refraction of light. There are various folktales among people that in connection with the rainbow.

When there is bright sunlight with mist or drizzle, a rainbow can be frequently observed. Rainbow occurs because of refraction and internal refraction of sunlight by water droplets in the sky. Here white sunlight is dissociated into colours by water droplets. A large number of water droplets in the sky contribute to form a rainbow.

Figure 14.37 - How a rainbow is observed

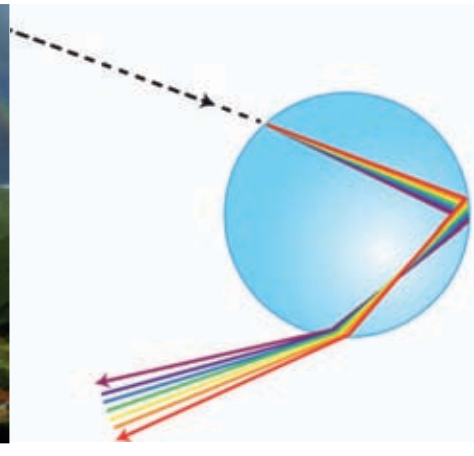


Figure 14.38 - Dispersion of light through a single water droplet

Summary

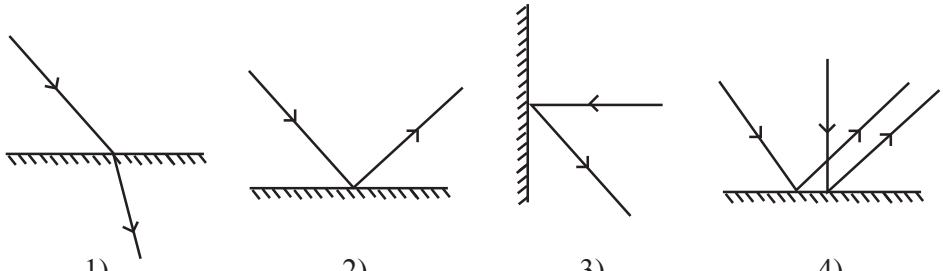
- Bouncing back of light to the same medium, after striking on a shiny surface is called reflection.
- Light reflects according to the laws of reflection.
- Regular reflection and diffuse reflection are the two ways of reflection of parallel light.
- Images are formed by reflection of light by mirrors.
- Images formed by plane mirrors are always upright, virtual and are subjected to lateral inversion.
- When images are formed by objects in front of plane mirrors, the size of the object is equal to the size of the image. Distance to the object is equal to the distance to the image.
- Instances of reflecting light by plane mirrors are used in day-to-day life.
- Bouncing back of sound by an obstacle is called the reflection of sound
- Echo and reverberation can be mentioned as two phenomena occurred by reflection of sound.
- Reverberation is a troublesome stage of echo.
- Various methods are used in auditoria, cinema halls and lecture halls to prevent reverberation.
- Ultrasound scanning and finding depth to ocean bed are some instances where reflection of sound is put into use.
- The change of direction of light when travelling from one transparent medium to another transparent medium is known as refraction of light.
- The apparent elevation of the bottom of a pond, dispersion of white light through prisms, forming of rainbow are some instances where refraction of light occurs.

Exercises

(01) Select the correct or most suitable answer.

1. Select the correct sentence out of the following.
   1. Regular reflection occurs well from rough surfaces.
   2. Angle of incidence is not always equal to the angle of reflection.
   3. Light rays that are falling perpendicular to a plane mirror do not get reflected.
   4. Angle of incidence is always equal to the angle of reflection.

2. Underline the correct ray diagram, which shows the reflection from a plane mirror.



1) 2) 3) 4)

3. Image formed by objects kept infront of plane mirrors are always;

   a - Upright and virtual

   b - Subjected to lateral inversion

   c - Distance to object is equal to the distance to the image

   of the above sentences which is/are true,

   1. Only a 2. Only a and b 3. Only b and c 4. a, b and c

4. Select the correct statement about echo.
   1. It can occur at any distance between the observer and the obstacle.
   2. Echo can be heard always when sound is reflected.
   3. Cause for reverberation is not the echo.
   4. Reverberation can be eliminated by preventing the reflection of sound.

5. White light can be separated into seven colours by a prism. Conclusion that can be made according to this phenomenon is;
   1. That light can be refracted by the prisms.
   2. That white light is harmful to the body.
   3. That white light is composed of seven colours.
   4. That white light is reflected by prisms.

6. Select the instances, out of those given below, which are associated with only the refraction of light.

a. Looking at the face using a plane mirror
b. Benching of light when passing through a block of glass
c. Seeing a pencil broken at the surface when it is put into a container of water
d. Occurrence of multi images in a kaleidoscope

1. a and b only
2. b and c only
3. c and d only
4. a and d only

(02) Explain briefly, the following terms which are associated with reflection of light.

i. Incident ray
ii. Reflecting ray
iii. Normal line
iv. Angle of incidence
v. Angle of reflection

(03) In a school where multi-storied halls are situated close to each other, the noise of students in classes at upper stairs are heard closely, by the students in down stairs. What is the reason for this?

(04) A student aimed a lighted electrical torch with an inclination from the top of a fish tank to observe its bottom. But unexpectedly the beam of light bent at the water surface. Explain this phenomenon scientifically.

Technical Terms

Reflection	- පරාවර්තනය	- தெறிப்பு
Uniform reflection	- සවිධි පරාවර්තනය	- ஒழுங்கான தெறிப்பு
Diffuse reflection	- විසාරී පරාවර්තනය	- பரவல் தெறிப்பு
Angle of incident	- පතන කෝණය	- படுகோணம்
Angle of reflection	- පරාවර්තන කෝණය	- தெறிகோணம்
Incident ray	- පතන කිරණය	- படுகதிர்
Reflecting ray	- පරාවර්තන කිරණය	- தெறிகதிர்
Normal line	- අභිලම්භය	- செவ்வன்
Refraction ray	- වර්තන කිරණය	- முறிகதிர்
Lateral apostrophes	- පාර්ශවික අපවර්තනය	- பக்க நேர்மாறு
Kaleidoscope	- බහුරූපේක්ෂය	- கலையுருகாட்டி
Periscope	- පරීක්ෂය	- சூழ்காட்டி
Light refraction	- ආලෝක වර්තනය	- ஒளி முறிவு
Dispersive	- අපකිරණය	- நிறப்பிரிகை
Hologram	- වර්ණාවලිය	- நேம வரையம்
Echo	- දෝංකාරය	- எதிரொலி
Reverberation	- ප්‍රතිනාදය	- தெறிப்பொலி
Echo sounder	- ප්‍රති ධ්වනි මානය	- எதிரொலி மானி