INCREASING ACCESS TO SECONDARY SCHOOL LEVEL EDUCATION THROUGH THE PRODUCTION OF QUALITY LEARNING MATERIALS

JUNIOR SECONDARY LEVEL

PHYSICS

Module 4:
Sound, Waves and Light

Partners:
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JUNIOR SECONDARY LEVEL SCIENCE - PHYSICS

MODULE 1 – Measurement

MODULE 2 – Matter

MODULE 3 – Energy

MODULE 4 – Sound, Waves and Light

MODULE 5 – Magnetism and Electricity

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MODULE 4

SOUND, WAVES AND LIGHT

INTRODUCTION

In the last Module, you will recall, we mentioned sound and light as forms of energy. In this Module we shall learn about sound, waves and light. We'll be looking at two types of waves, namely longitudinal and transverse waves. Sound is an example of a longitudinal wave while light is an example of a transverse wave. You will know more about these two terms as you study through the Module.

OBJECTIVES

After completing this Module, you should be able to

- distinguish between longitudinal and transverse waves
- explain the terms - amplitude, wavelength and frequency
- demonstrate that sound is produced by vibrating sources
- describe how reflection of sound may produce an echo
- explain the terms loudness and pitch of sound
- describe and explain the formation of images by reflection and refraction of light
- state simple applications of image formation.

4.1 WHAT IS A WAVE?

If you just drop a small stone into a pool of steady water, you can observe circular disturbances. These move away from the point the stone strikes the water. The spreading of these disturbances or ripples on the surface of water is an example of wave.

Water wave is just one example of wave motion. In fact any vibration or oscillation can result in a wave.

We can illustrate this by attaching one end of a rope to a wall or a tree. Then we move the other end of the rope up and down. These up and down movements produce vibrations or oscillations.

We can now proceed with the following simple investigation.

INVESTIGATION 1: Waves using a rope

For each investigation you will require the material indicated. **You should record your answers in the space provided.**	**Material needed -** A rope **Method**: *Fix a fairly long rope at one end to a pole or a tree. Holding the other end move it up and down regularly. What do you notice?*

I am sure you noticed waves travelling along the rope.

Let's now use a spring to produce waves.

INVESTIGATION 2: Waves using a spring

For each investigation you will require the material indicated. **You should record your answers in the space provided.**	**Material needed -** • A long spring (slinky) **Method**: *Take a fairly long spring (slinky). Fix one end to the wall at floor level.* *Push the other end towards and pull away from the wall.* *Write down your observations.*

You should have observed regions of compactness (compressions) and non-compactness (rarefactions) along the spring. It's useful to note that wave motion results in the transfer of energy from one point to another. However the medium through which the wave moves, is not transferred. This is true for all types of waves.

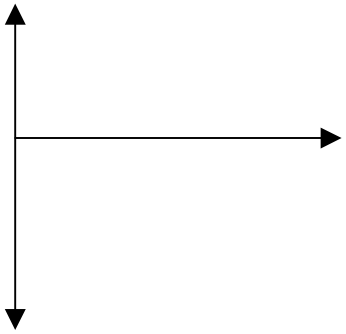
4.1.1 TYPES OF WAVES

In general, we can group waves into two types:

- Transverse waves
- Longitudinal waves

The waves obtained by disturbances on the surface of water (i.e. water waves) are transverse waves. Another example is the waves you obtained by moving the rope in the previous investigation.

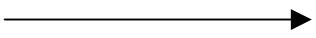
In fact, a transverse wave is one which moves in a direction perpendicular to the direction of vibration.



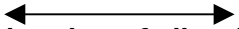
Direction of wave motion

Direction of vibration

On the other hand, a longitudinal wave is one where the direction of wave motion is the same as the direction of vibration



Direction of wave motion

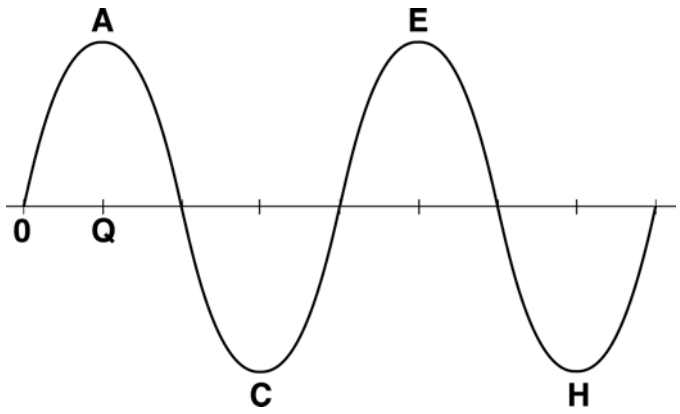


Direction of vibration

Sound waves are longitudinal waves.

4.1.2 REPRESENTATION OF A WAVE

We can represent a transverse wave by the following sketch



- The point O represents the rest position or mean position.
- The greatest displacement corresponds to QA. This is called the amplitude. It is expressed in metres.
- The points A and E correspond to the highest points and are called **crests**. The points C and H correspond to lowest points and are called **troughs.**
- The wave length is the distance between two successive crests or two successive troughs. The distance AE is one example. The distance CH also corresponds to the wavelength. Wavelength is denoted by λ and is measured in metres.
-
- The frequency of a wave means the number of complete oscillations or cycles in one second. Frequency is denoted by f and is measured in Hertz (Hz).

- The period is defined as the reciprocal of frequency, that is,

$$\text{period} = \frac{1}{\text{frequency}}$$

Period is denoted by T and is measured in seconds.

$$T = \frac{1}{f}$$

- The speed of the wave is called wave speed. This is the distance moved in one second. It is denoted by v and measured in metre per second.

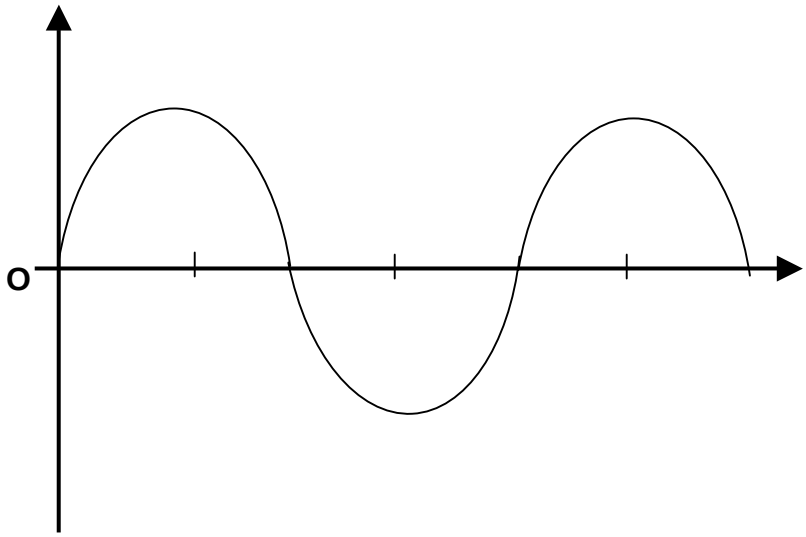
Relationship between wave velocity (v), frequency (f) and wavelength (λ)

These three quantities are related. You will find the following formula $v = f\lambda$ useful.

✍ ***Before proceeding further, complete the following activity.***

Activity 1

The diagram represents a wave.



Mark, on the diagram of a wave the following terms:

(i) *Displacement*
(ii) *Time*
(iii) *Mean position*
(iv) *Amplitude*
(v) *One wave length*
(vi) *If the time for completing one wave were 0.1 sec, work out the frequency of the wave.*

You will find the answers at the end of the Module.

At this stage, perhaps you could think of the waves in the water at the seaside.

✍ ***Before proceeding further, complete the following activity.***

Activity 2

(a) In what direction do the waves in the wave move?

……

(b) Describe the movement of objects which are afloat. (e.g. corks)

……

……

……

You will find the answers at the end of the Module.

✍ ***Before proceeding further, complete the following activity.***

Activity 3

(a) Distinguish between transverse and longitudinal waves.

……
……

(b) Give one example of each type.

……
……

You will find the answers at the end of the Module.

4.2 SOUND

One important reason for learning about sound is that we experience it every moment of our lives. If you live near the main road, you often hear the sound of motor vehicles moving. When you switch on the television or radio, you hear sound. Even when your mother/father is cooking in the kitchen, different types of sounds are heard.

Thus our surroundings have a wide variety of sounds. Some are pleasant while others can be disturbing!

✍ Before proceeding further, complete the following activity.

Activity 4

Write down a list of sounds you come across in everyday life

……
……
……

You will find the answers at the end of the Module.

4.2.1 NOISE

You will recall, we said earlier some sounds are pleasant while others are not.

You can think of the sounds we often hear:

- on a busy main road
- near the airport
- at a busy railway station
- when a group of dogs bark furiously
- when workers are using drilling machines.

All the above sounds are disturbing. We often say these are forms of disorganized sounds or noise. Such noises are the common causes of noise pollution.

✍ ***Before proceeding further, complete the following activity.***

Activity 5

Enumerate the causes (sources) of noise pollution.

……
……

What are the harmful effects of noise?

……
……
……
……

You will find the answers at the end of the Module.

4.2.2 PRODUCTION OF SOUND

How is sound produced?

If you strike two metal pieces, they vibrate. These vibrations produce sound. Thus sound is produced as a result of vibrations. Musical instruments such as a violin or a guitar produce sound when the 'strings' vibrate.

We can now proceed with a simple investigation.

INVESTIGATION 3: Production of sound by a metal plate

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed –** • A metal plate • A metal spoon (or fork) **Method**: *Place the metal plate on a table* *(a) strike it with a metal spoon (or fork) can you hear a sound?* ……. *(b) feel the plate with your fingers. Can you feel the vibrations?* ……. *(c) when sound stops, feel the plate again. Record your findings* …….

I am sure that in (a) you heard a sound

In (b) you should have felt the vibrations while in (c), when vibrations of the plate stop, there is no sound which is produced by the plate.

Whenever you hear a sound, there is something vibrating. These vibrations involve particles in solids, liquids or even gases.

You can think of the sound produced by the water waves at the seaside, the sound produced by the wind or even the sound produced when you drop a stone in water.

✍ ***Before proceeding further, complete the following activity.***

Activity 6

Study each situation in the list given carefully.
Identify the vibrations (in each case) which are responsible for the sound produced.

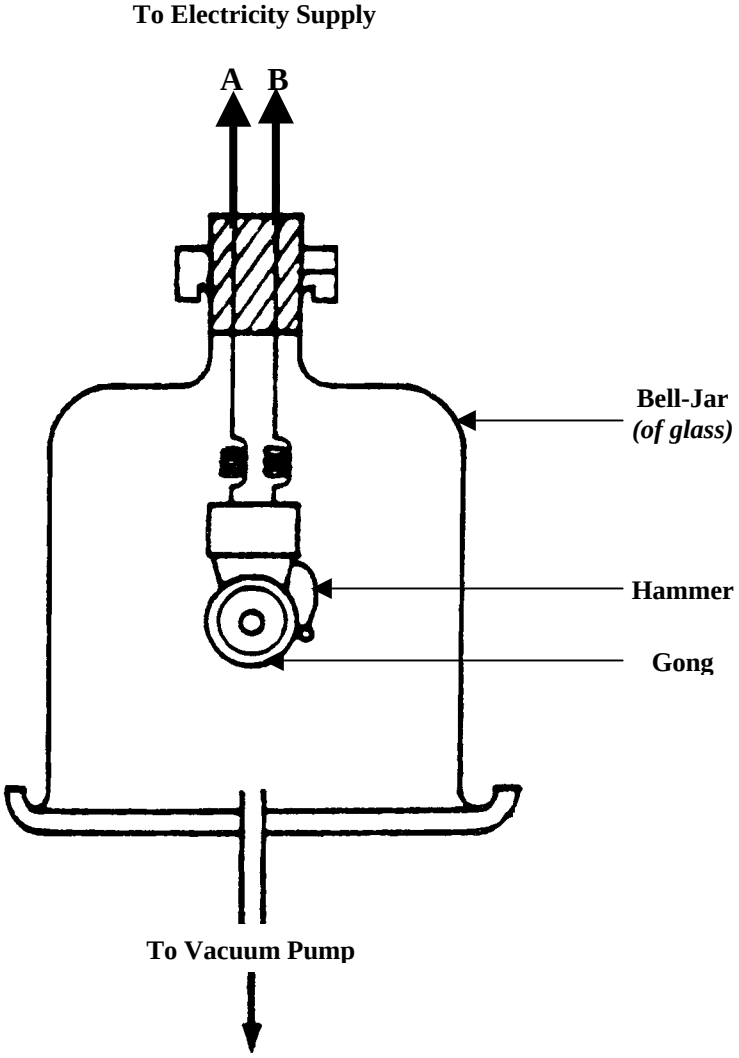
1. *A loudspeaker*
2. *Yourself shouting*
3. *Somebody whistling*
4. *The door bell ringing*
5. *A coin having just fallen on the hard floor*

You will find the answers at the end of the Module.

4.2.3 PROPERTIES OF SOUND

You should have noted that sound is produced by vibrations of a body. It is useful to note that sound has a number of important properties.

- Sound requires a medium for transmission. The medium has particles. Once set into vibrations, the particles will transmit the sound. If no particles are present, for example, in a vacuum, transmission of sound is NOT possible. This can be shown by the bell-jar experiment.



With air inside the bell jar, we can hear the sound of the bell when the hammer strikes the gong.

As the space below the bell jar is evacuated, the sound slowly vanishes. Even if the hammer can be seen striking the gong, no sound is heard.

- ***Sound travels faster in solids***

Just study the following figures

Medium	Approximate speed of sound in m/s
AIR	300
WATER	1500
IRON	5000

You will realise that that sound travels approximately five times faster in liquids compared to gases and approximately fifteen times faster in solids compared to gases.

Of course these figures give you a rough idea about how fast or how slow sound travels in different mediums.

- ***Sound travels slower than light***

  When there is lightning, thunder or thunderstorm, we **see** the lightning first then we **hear** thunder. This is because light travels faster than sound in air.

Before proceeding further, complete the following activity.

Activity 7

Consider each statement below about sound.
Write True or False for each as appropriate

1.	*Sound travels faster in air than in water.*	☐
2.	*Sound can travel through vacuum*	☐
3.	*Light and sound travel at the same speed in air*	☐
4.	*Sound can travel in a solid*	☐
5.	*Sound travels faster in air than in any other medium*	☐
6.	*Musical instruments do not involve vibrations for producing sound*	☐
7.	*Music is considered as organised rhythmical and pleasant sound or mixture of such sounds*	☐
8.	*Noise can be considered as sound of disorganised type*	☐

You will find the answers at the end of the Module.

Speeds of sound and light

Let's now look at another example which illustrates that sound and light DO NOT travel at the same speed.

✍ ***Before proceeding further, complete the following activity.***

Activity 8

Consider lightning and thunder.

(a) What do you notice first?

……

(b) What explanation can you offer in terms of the speeds of sound and light?

……
……
……

You will find the answers at the end of the Module.

4.3 HEARING

Like other waves, sound waves transfer energy through vibrations. The vibrations from the source of the sound are transmitted through the air. The particles in air are in turn set into vibrations which enter our ears. These vibrations are detected by our ears. You will learn about the 'ear' in the Biology learning materials of this programme.

Note: You'll learn about the structure of the ear and reception of sound waves by the ear in Biology - Module 6, Unit 2: 2.2.4.

✍ ***Before proceeding further, complete the following activity.***

Activity 9

Explain, in terms of tiny particles (molecules) in the air, how sound travels from the vibrating source to our ears

……
……
……
……
……
……

You will find the answers at the end of the Module.

4.3.1 AUDIBLE FREQUENCIES

When the ear can detect a sound, it can be heard. We say it is AUDIBLE. Whether a sound is heard and detected by the ear or not, depends upon the frequency of the sound – that is the number of vibrations (or cycles) per second. One vibration per second is called one hertz (Hz). The Kilohertz (KHz) is a bigger unit for frequency (1KHz = 1000 Hz)

In fact, the ear can detect sound only within a range of frequencies. The lower limit for the human ear is approximately 20Hz. This means a sound with a frequency of less than 20 Hz cannot be detected by the human ear, and hence not heard. The upper limit is 20000 Hz (or 20 KHz). This means a sound of very high frequency (ultra sound) cannot be detected by the human ear. The range of frequency within which a listener can hear is known as the **range of audibility or audible frequencies**. These depend to a certain extent upon age.

Pitch of sound

When we describe a sound as being of high pitch, we imply that it is more shrill, more piercing or sharp.

Pitch depends on frequency. The higher the frequency, the greater the pitch. However, pitch is relative. 200 Hz sound has a high pitch compared to a 100 Hz sound. But 200 Hz sound has a low pitch compared to a 400 Hz sound.

Loudness of sound

Loudness of sound is a subjective quantity, that is, it depends on the person. For example if you set your radio at a particular 'volume' some people may say it is loud while some may say it is soft. Loudness is related to the "amplitude". A loud sound has a larger amplitude or larger wave amplitude. You will recall you learnt about amplitude earlier in this Module.

✍ ***Before proceeding further, complete the following activity.***

Activity 10

Complete

(a) In general, human beings cannot hear a sound if ……..

……

(b) The loudness of a sound wave depends upon ……

……

(c) A sound is said to have a higher pitch if ……

……

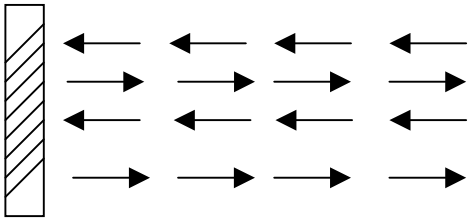
You will find the answers at the end of the Module.

Reflection of sound

In addition to the properties of sound you learnt so far, you should know that sound waves can be reflected.

If you stand at some distance, say 50m from a wall, and you clap your hands, you will hear an echo. This echo of your clap is produced by the reflection of sound from the wall.

An echo is the sound heard after reflection of sound from a hard surface such as a wall or cliff.



Wall

ECHO (by reflection of sound at a wall/cliff)

You will find the following calculation useful.

A boy stands some distance away from a wall. He claps his hands once. He hears an echo 4 seconds later. The speed of sound is 330 m/s. What is the distance of the boy from the wall?

The distance travelled by sound in 4 secs = 4 x 330 = 1320 m

This is twice the distance of the boy from the wall because the sound has moved to the wall and has come back.

Thus distance of boy from wall = $\frac{1320}{2}$ = 660 m

✍ ***Before proceeding further, complete the following activity.***

Activity 11

(a) What is an echo?

……

(b) Describe how this occurs.

……

……

(c) How could you use the method of echoes to determine the speed at which sound travels in the air?

……

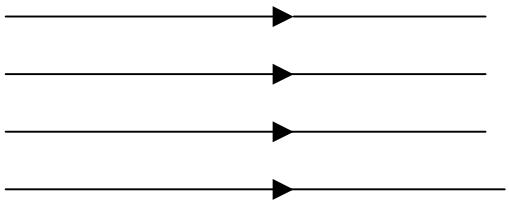
……

You will find the answers at the end of the Module.

4.4 LIGHT

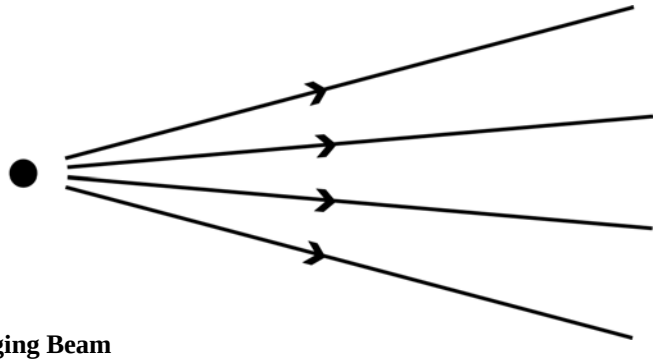
You will recall that light is a form of energy. The sun is a natural source of light energy. The path taken by light is called a ray of light. A set of rays is called a beam of light. It's useful to note that there are three types of beams of light

(i)



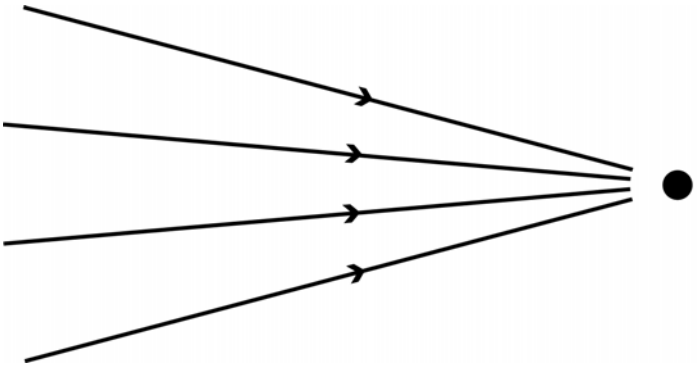
Parallel beam

(ii)



Diverging Beam

(iii)



Converging Beam

4.4.1 PROPAGATION OF LIGHT

It is useful to remember that light travels in straight lines. As a result it casts shadows of opaque objects which occur on its path. In fact formation of shadows provide evidence for the fact that light travels in straight lines.

Examples of formation of shadows include:

- formation of the eclipse of the moon.
- formation of the eclipse of the sun.

✍ ***Before proceeding further, complete the following activity.***

Activity 12

An eclipse of the moon takes place when the shadow of planet Earth (from the sun) falls on the moon.

(a) the source of light in this case is ……..

(b) Illustrate the situation using a diagram. (You will bear in mind that the moon is the smallest and the sun is the largest of the 3 i.e. Sun, Earth and Moon)

You will find the answers at the end of the Module.

✍ ***Before proceeding further, complete the following activity.***

Activity 13

This activity is about the eclipse of the sun

(a) When does it occur?
……

(b) How does it occur?
……

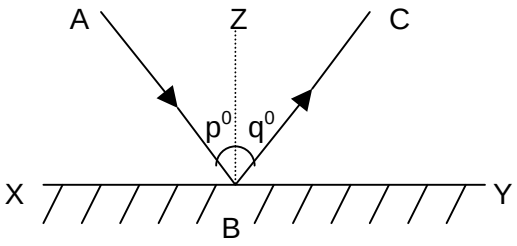
(c) Illustrate with a simple diagram.

You will find the answers at the end of the Module.

4.4.2 REFLECTION OF LIGHT

We have already considered the reflection of sound. You will remember that reflection of sound from a hard surface produces an echo. Here we shall look at refection of light from plane mirrors.

Consider a ray of light AB incident on a plane mirror XY.



The ray AB is reflected along BC such that angles p^0 and q^0 are equal. BZ is perpendicular to XY, that is at right angles to XY.

✍ ***Before proceeding further, complete the following activity.***

Activity 14

Complete the diagrams to show the reflection of light in all 3 cases

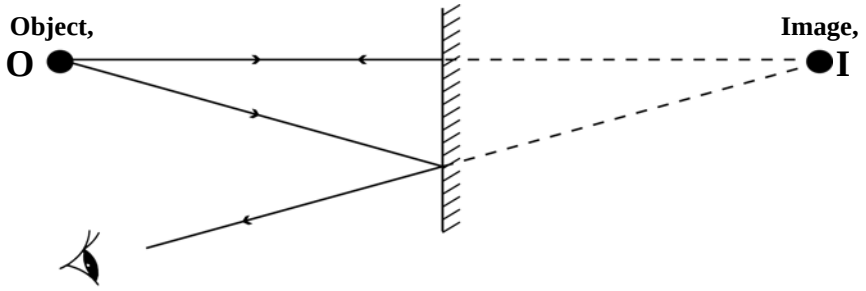
(i) Plane mirror

(ii) Plane mirror

(iii) Plane mirror

You will find the answers at the end of the Module.

Images in plane mirrors



The object O, placed in front of the plane mirror, forms image I.

The characteristics of the image are:

(i) It is behind the mirror.

(ii) It is as far behind the mirror as the object is in front of it.

That is, distance of object from mirror = distance of image from mirror.
Also, from the experience you have when looking in a mirror, the image is of same size as the object. Moreover, the image is described as “laterally inverted” - your left hand appears to be your right hand.

Images in plane mirrors cannot be cast on a screen. Such images are said to be virtual. (In contrast, real images can be cast on a screen, as in the cinema).

Reflections in the optic fibre

Reflection of light has many useful applications. We can mention one here. Car drivers make use of reflection in mirrors to view vehicles coming from behind. Can you think of others?

Have you heard of optic fibres?
They are flexible optically transparent fibres, such as of glass or plastic, through which light can be transmitted by successive internal reflections.

These are becoming very important, especially in the field of telecommunication.

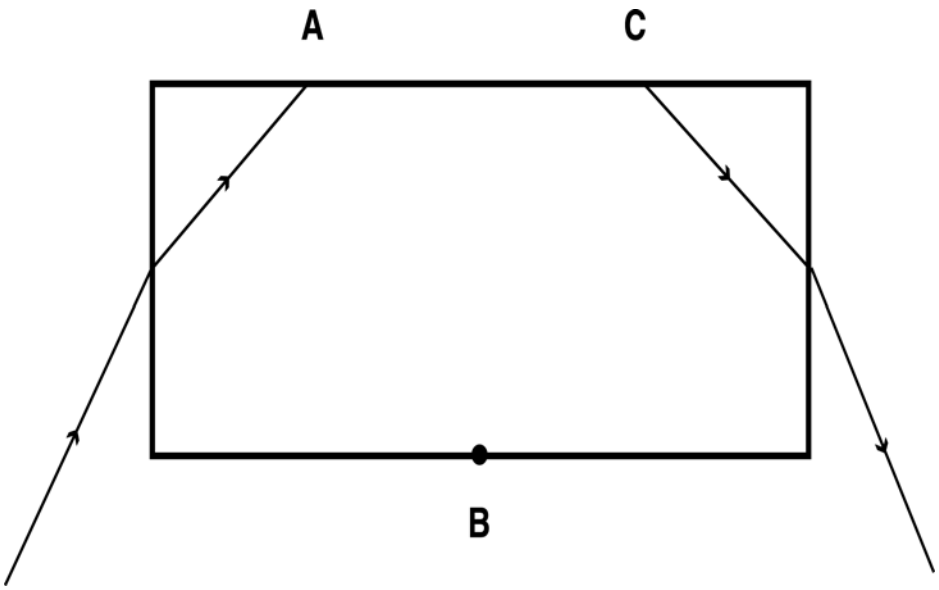
Optic fibres work by reflecting light.

Before proceeding further, complete the following activity.

Activity 15

Complete the diagram by indicating the directions of reflection of light in the optic fibre.

(Hint: reflection occurs at each of the points A, B, C)



You will find the answers at the end of the Module.

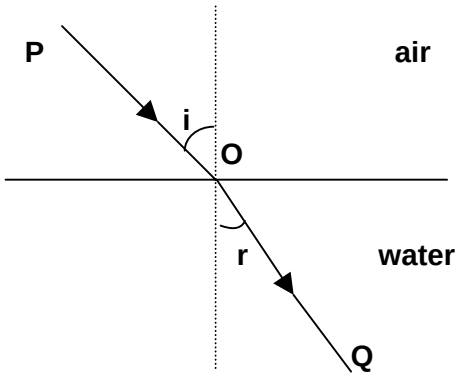
4.4.3 REFRACTION OF LIGHT

The term ‘refraction’ means ‘bending’. Refraction of light usually takes place when it travels from one medium to another.

Thus when a ray of light travels from one medium to another it bends. This ‘bending’ occurs because the speed of light is different in different medium.

Speed of light in air is greater than that in water. Light travels slower in water. Thus water is said to be optically denser. Consider a ray of light PO incident on the air-water boundary as shown. At the boundary the incident ray PO is refracted along OQ.

OQ is called the refracted ray.



i = angle of incidence

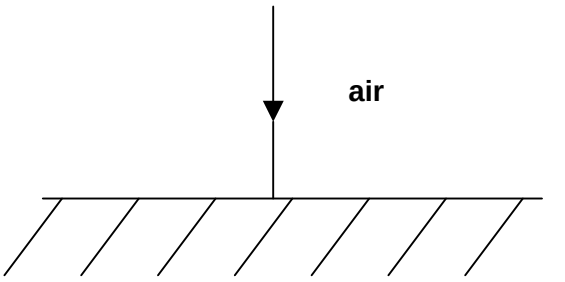
r = angle of refraction

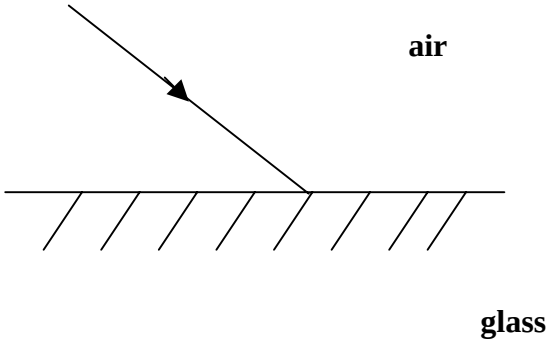
For the ray travelling from air to glass, the ratio $\frac{\text{Sin i}}{\text{Sin r}}$ is a constant. It is called the refractive index of water.

✍ ***Before proceeding further, complete the following activity.***

Activity 16

Complete the diagram below to show the refraction (of light) that takes place.



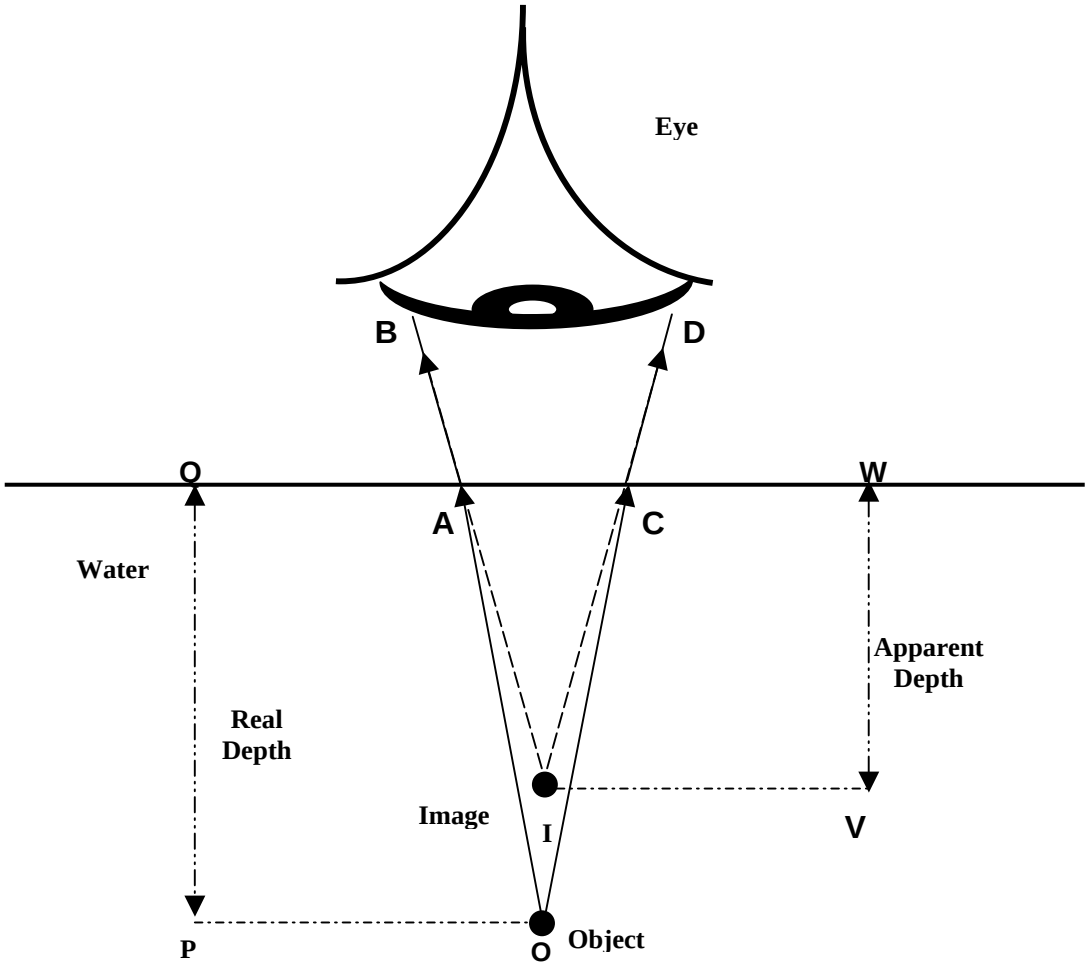


You will find the answers at the end of the Module. .

Effect of Refraction

It is a matter of common experience that a pond appears less deep than its actual depth.

The following ray diagram will illustrate this phenomenon of refraction.
Consider a ray of light OA. At the water/air boundary the ray is refracted along AB. This ray appears to be coming from the point I. Similarly the ray OC is refracted along CD and appears to be coming from the point I.



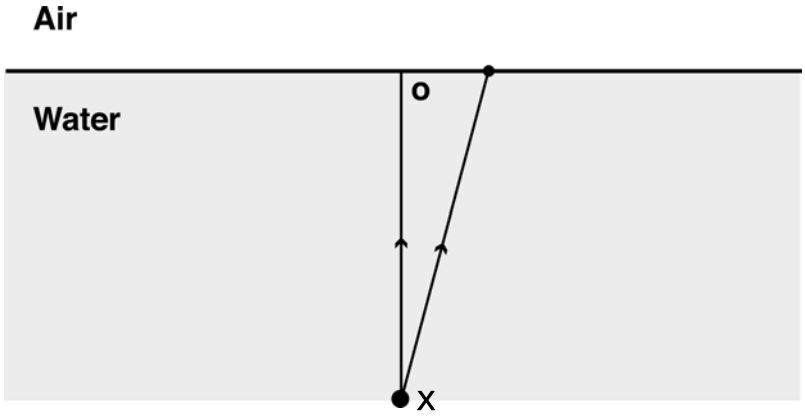
Thus the object O appears to be displaced vertically upwards to I. Consequently the apparent depth of the object is given by VW while the real depth is given by PQ. It's useful to note that the ratio $\frac{PQ}{VW}$ is the refractive index of water.

Before proceeding further, complete the following activity.

Activity 17

The object marked **X** *is at the bottom of a pond.*

Continue and complete the 2 rays of light in the fig.



Mark the position ***Y*** *of the apparent position.*

The real depth is ……

The apparent depth is ……..

What can you conclude?

……
……

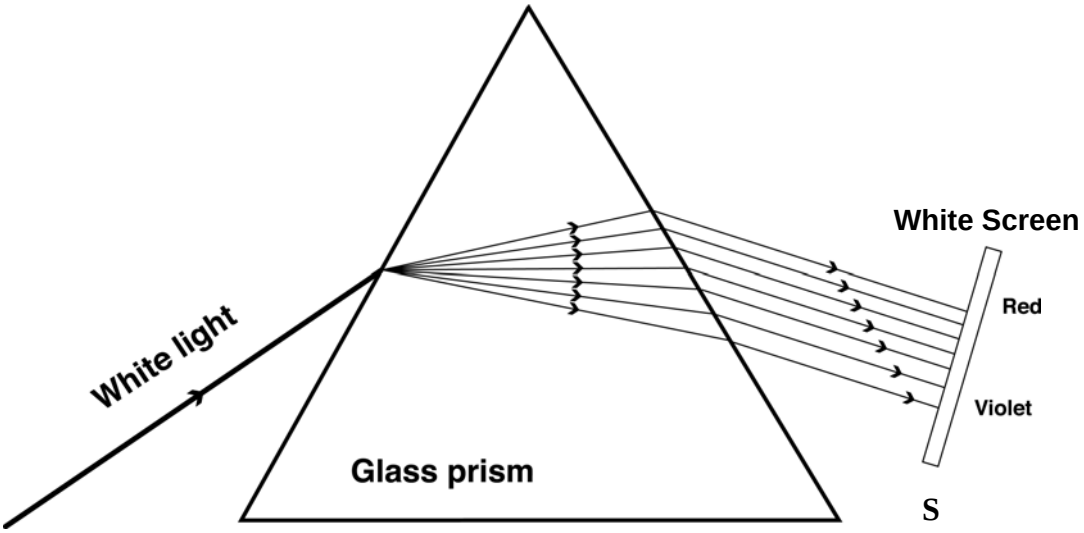
You will find the answers at the end of the Module.

4.4.4 DISPERSION OF LIGHT

So far we have considered two important properties of light.

- Reflection of light
- Refraction of light

Another property of light is **dispersion**. This is the splitting up of ordinary (white) light into its seven constituent colours. This effect is visible when there is a rainbow. The separation of white light can also be demonstrated by passing white light (ordinary light) through a glass prism.



At S on the white screen the colours consist of red, orange, yellow, green, blue indigo, violet. The seven colours from a spectrum.

Before proceeding further, complete the following activity.

Activity 18

The rainbow is formed when sunlight is dispersed. Write down the 7 colours of the rainbow.

……

……

Is there any method to remember the colours (in the same order which they occur?)

You will find the answers at the end of the Module.

4.4.5 VIRTUAL IMAGE AND REAL IMAGE

We have already seen that a plane mirror forms a **virtual** image e.g. of an observer in front of it.

A simple microscope also forms a virtual image. It makes use of a 'lens' - made of a special type of glass.

There are various types of lenses. The two most common ones are:

- Converging lenses
- Diverging lenses

Converging lenses are thicker in the middle.

Diverging lenses are thinner in the middle

In contrast to a virtual image, a real image can be cast on a screen. Real images are formed when slides are projected. The image formed by a camera is again a real image. The projector and the camera both use converging lenses.

You will realise that the functioning of your eyes is based on lenses. The eye forms an inverted image of an object at the back of the eye. This is formed a high sensitive 'screen' - called the retina.

When our eyes become defective, we have to rely on appropriate spectacles.

Note: You will learn about the human 'eye' and its structure in Biology Module 6, Unit 2: 2.2.4.

We can now proceed to a simple investigation.

INVESTIGATION 4: Producing a real image with a lens

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed –** • A converging lens • A cardboard (serving as screen) **Method**: *Hold the lens properly between the fingers so that it faces the sun.* *Place the cardboard behind the lens, at random.* *Now adjust the position of the lens till a sharp focus of the sun occurs on the cardboard.* *Is the image real?* _____

I am sure that you got the answer for (a). The image is **real**.

4.4.6 OTHER PHENOMENA ASSOCIATED WITH LIGHT

Up to now we have considered

- Eclipses
- Image in a plane mirror
- Apparent depth (of a pond)
- Colours of the rainbow

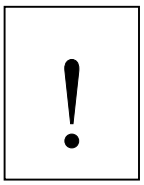
Before proceeding further, complete the following activity.

Activity 19

*Study each statement below. Indicate whether it is **TRUE** or **FALSE***

1. *Mirages usually occur on hot sunny days. _____*
2. *The main colour of the sky is blue but at sunset it can be partly red. _____*
3. *At night the sky is normally dark and stars can be seen. _____*
4. *A mirage is caused purely by reflection of light. _____*
5. *The blue colour of the sky in daytime is due to the multiple reflection (scattering) of blue light in greater proportion than the other colours of light. _____*
6. *The stars in the night sky have been used by travellers in deserts and on the sea to determine direction.*

You will find the answers at the end of the Module.



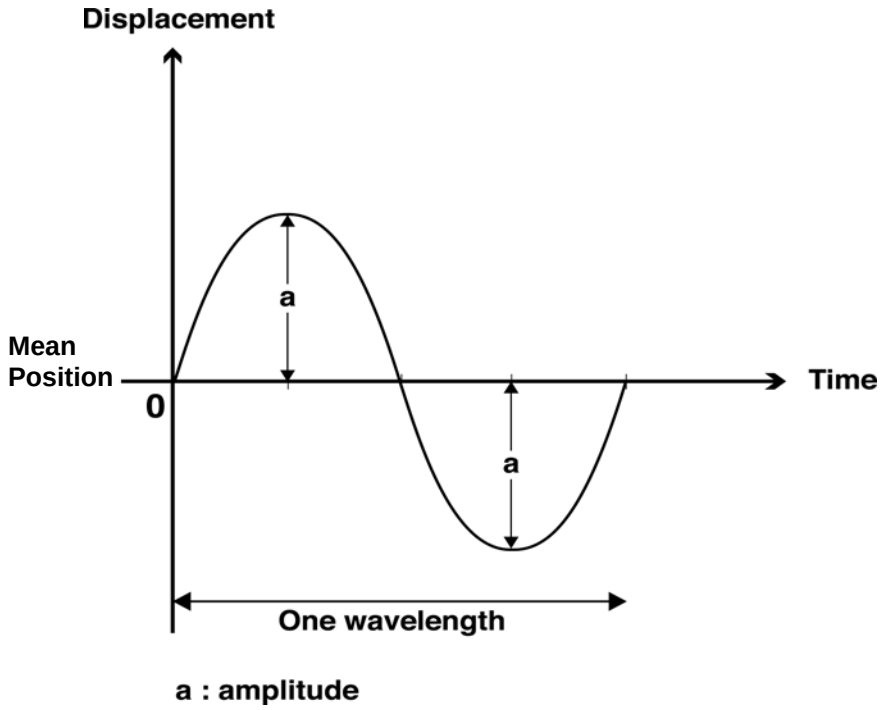
POINTS TO REMEMBER

- Sound is produced by vibrating sources.
- Sound waves are longitudinal.
- Sound travels at different speeds in different media.
- The reflection of sound can produce echoes.
- Sound travels in the air as a series of compressions and rarefactions.
- Our ears can detect sounds in the range of frequencies 20HZ to 20KHZ.
- The pitch of a sound is related to its frequency whereas the loudness of a sound depends on its amplitude.
- Noise pollution is to be avoided due to its harmful effects.
- A wave is characterised by: energy transfer, displacement, amplitude, wavelength, and frequency.
- The 2 types of waves are
  - longitudinal e.g. sound
  - transverse e.g. light
- Sound travels fastest in solids, slower in liquids, slowest in air.
- Light travels faster than sound.
- Light can be reflected.
- Images in plane mirrors have specific characteristics (virtual, of same size as object).
- Light can be refracted. As a consequence apparent depth (of pond) is less than the actual depth.
- Refractive Index = $\frac{\text{Sin i}}{\text{Sin r}}$
- Ordinary light is made up of 7 different colours (those of the rainbow).
- Light travels in straight lines. This leads to eclipses of the moon and the sun.
- An image can be virtual or real.
- Images in plane mirrors are virtual.

- A converging lens can form a real image e.g. of a far-off object on a screen.
- Mirages occur by the bending of light in successive layers of air on very hot sunny days.
- Blue colour of the sky is due to presence of larger amounts of blue in light ''scattered' by particles in the air during day time.
- The absence of sunlight in the sky at night time makes the sky look dark. Stars are visible at night in the sky.

ANSWERS TO ACTIVITIES

Activity 1



a : amplitude

In 0.1 sec the No. of waves = 1

In 1 sec the no. of waves = 1 ÷ 0.1 = 10

Activity 2

(a) The waves move towards the shore and then away from it.

(b) Objects which are afloat (e.g. corks) move up and down i.e. perpendicular to the direction of the waves.

Activity 3

(a) In transverse waves movement of particles is perpendicular to that of waves. In longitudinal waves movement is in the direction of the waves.

(b) One example of transverse waves: Light
One example of longitudinal waves: sound

Activity 4

- Music
- Chirping of birds
- Barking of dogs through crevices
- Talking among persons
- Singing
- Crying
- Whistling
- Hooting of motor vehicles
- hammering

Activity 5

- Aeroplanes at a busy airport
- Engines of motor vehicles
- Hooting of motor vehicles
- School children during break and recess
- Spectators at sports meetings
- Loudspeakers (when in use)
- Songs/music being played very loud

Harmful effects

- Decrease in mental concentration
- Nervousness
- Headache
- Damage to the ears
- Disturbance to sleep/rest

Activity 6

1. The metal case and the membrane attached to the metal and case
2. The vocal chords and air
3. Air
4. The ‘gong’ (when being struck repeatedly by the ‘hammer’)
5. The coin (its solid material)

Activity 7

1. False
2. False
3. False
4. True
5. False
6. False
7. True
8. True

Activity 8

(a) The fire (light) – before the sound

(b) Light travels much faster than sound (both in air)

Activity 9

The vibrating source of sound sets tiny particles of air in contact with it vibrating. The vibrations are transmitted to successive particles in contact. The process continues till the sound reaches our ears.

Activity 10

(a) its frequency is outside the range 20 to 20,000 Hertz.

(b) the amplitude of the vibrations – larger amplitudes lead to louder sounds

(c) its frequency is higher.

Activity 11

(a) An echo is a replica of a sound we hear after a time interval.

(b) An echo occurs when the sound which is emitted gets reflected. The reflection can occur at a wall or any solid surface.

(c) Two hard pieces of wood are held in the hands and are clapped together. The time taken for the echo from a tall wall, a suitable distance away, can be measured. If the time between the clap and the echo is **t** sec, and the distance between the person who is clapping and the wall is **d** metres,

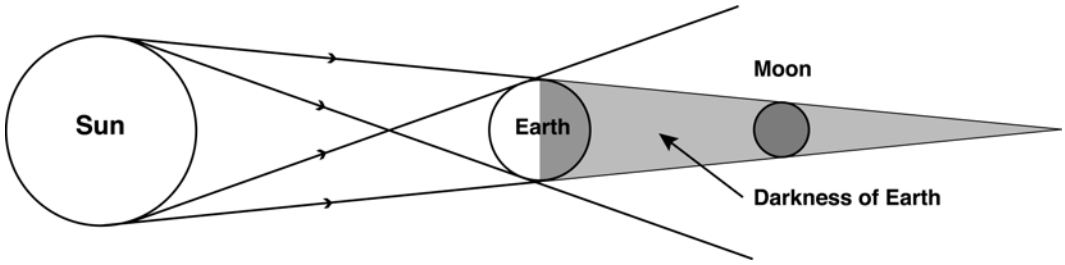
then sound has travelled a distance of **2d** in **t** secs. The speed of sound is

$$\frac{\text{distance}}{\text{time}} = \frac{2d}{t} \quad \text{m/s}$$

Activity 12

(a) The sun

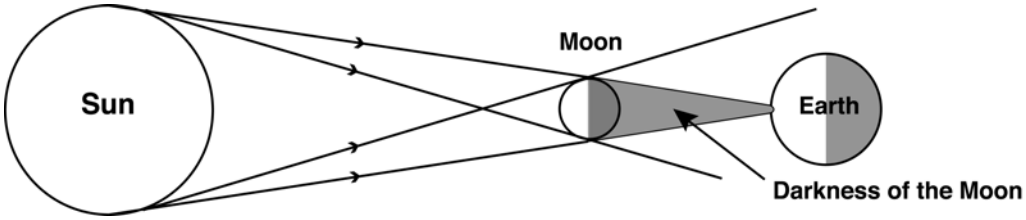
(b)



Activity 13

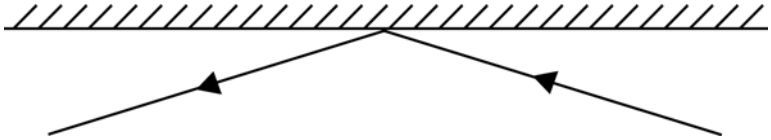
(a) It occurs when the moon comes in between the sun and the earth.

(b) The shadow of the moon falls on part of the Earth (from where the eclipse can be seen).

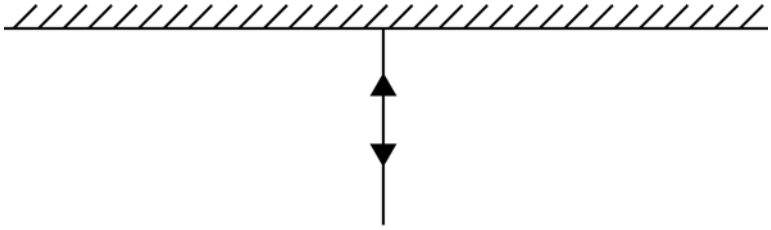


Activity 14

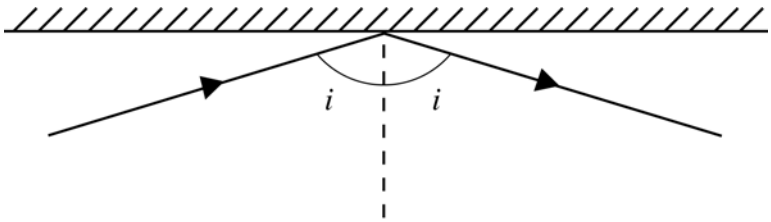
(i)



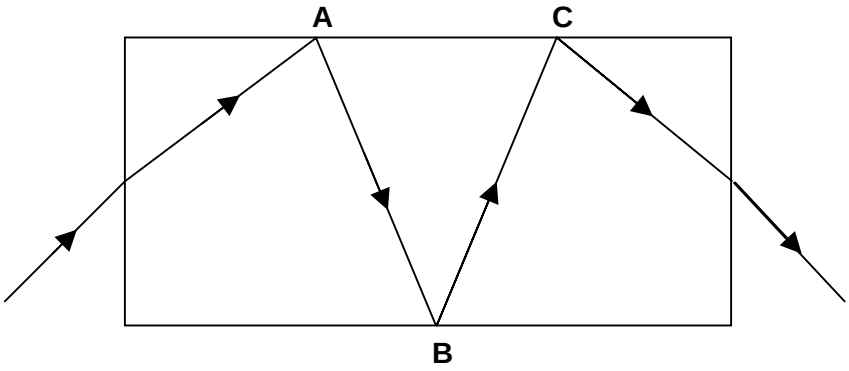
(ii)



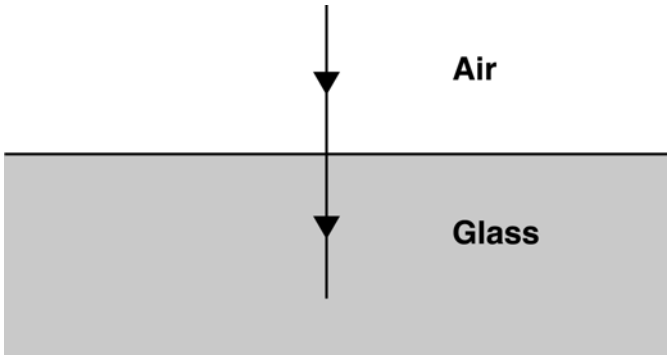
(iii)

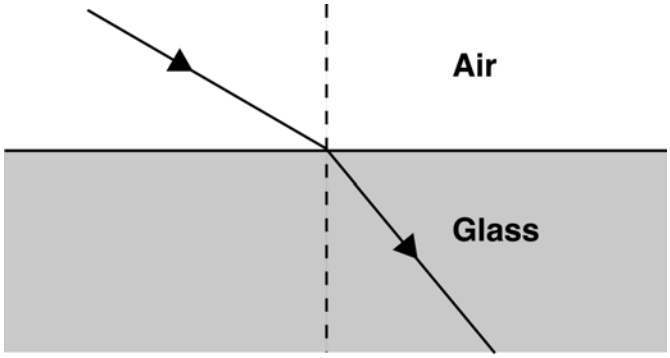


Activity 15

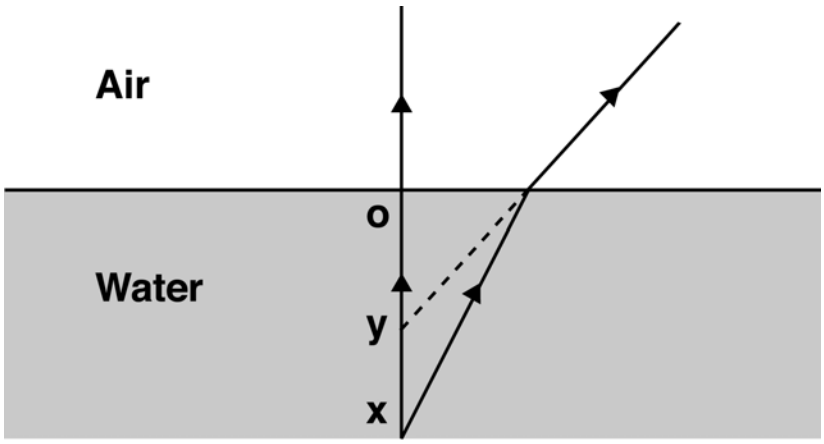


Activity 16





Activity 17



The real depth is **OX** .

The apparent depth is **OY**.

The apparent depth is less than the real depth. The pond appears less deep than what it is actually.

Activity 18

Violet

Indigo

Blue

Green

Yellow

Orange

Red

(way to remember is **VIBGYOR**)

or

(**R**ichard **O**f **Y**ork **G**ained **B**attle **I**n **V**ain)

Activity 19

1 True

2 True

3 True

4 False

5 True

6 True