Ultra-violet rays.

Skin synthesizes vitamin D with the help of ultraviolet rays. They also cause tanning of the skin. Excess of these rays damage the skin and the retina of the eye. Sometimes these rays may cause cancer of the skin.

Fluorescent substances emit visible light when they absorb ultraviolet rays. In fluorescent tube lights there is a fluorescent substance applied in the inner surface. When an electric current passes through the gas inside the tube, ultra violet rays are produced. When these rays fall on the fluorescent material, visible light is given out. To get a brilliance, fluorescent compounds are mixed with some paints. Ultraviolet rays are used to detect false currency and cracks in small objects. Some washing powders also include fluorescent compounds to make clothes look brighter.

X-rays

These waves are of very high frequency. As these rays contain a great deal of energy they can penetrate through the body. Therefore they are used in the medical field.

X-ray photographs are shadow pictures. X-rays can detect only bones and coloured tissues. X-rays are used to detect faults in steel pipes as well as to examine the electron patterns in atoms. X-rays sometimes may cause gene mutations.

1.3 Sound

We learnt earlier that there should be a vibration to form a sound, and that sound waves are mechanical, longitudinal waves.

During thunder we see the lightning before the sound. But these two happen at the same moment in the sky. But light reaches us faster. We hear the sound after a few seconds.

Assignment 1

- Can you find the distance to a cloud which causes thundering and lightning on a rainy day?
- Note the time you see the lightning.
- Note the time you hear the thunder. Taking the velocity of sound in air as 330 ms^{-1}, calculate the distance to the cloud.

Propagation of sound waves

The travelling of sound from one place to another is due to the propagation of sound waves.

There should be a medium for sound to travel. Sound does not travel in a vacuum. Let us try an experiment to find it.

As shown in Fig 1.9, an electric bell is kept in a bell jar containing air. The air can be removed from the jar by using a vacuum pump. As we go on removing air from inside, the sound of the bell gets weaker and weaker until finally it is not heard, although the bell can be seen to be operating as before.

The reason is that as there is no more air, sound waves cannot travel without air particles. If air is introduced back into the bell jar, the sound is heard again. This shows that sound cannot travel through a vacuum.

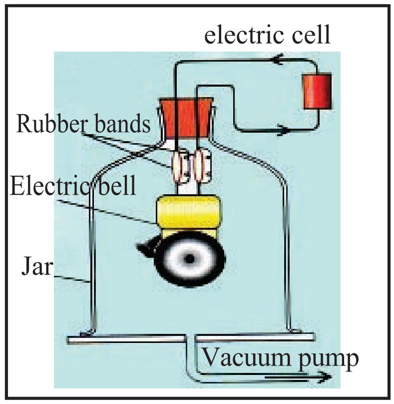


Fig 1.9 There should be a medium for sound to travel

Sound travels through liquids as well as in solids

Velocity of sound in air	=	330 ms^{-1}
Velocity of sound in water	=	1461 ms^{-1}
Velocity of sound in steel	=	5000 ms^{-1}

Assignment 2

Try to build up a co-relation between the propagation of sound in solids, liquids and gases and the arrangement of particles in each of them.

Reflection of sound waves

Sound too show reflection, similar to light.

Activity 1.4

Get two cardboard tubes or PVC tubes. Keep them at equal angles to a vertical flat board X Y as shown in the Fig 1.10.

Keep another flat board (C) perpendicular to the wooden board, between the two tubes.

Set a stop clock at A and keep the ear at B and listen.

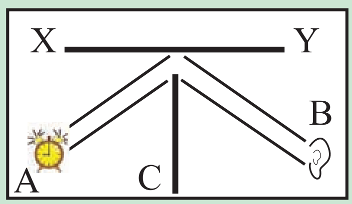


Fig 1.10

You will hear the ticking sound of the clock clearly.

The reason for that is the reflection of sound from the vertical board.

Echo

The reflected sound that we hear clearly after a time lag from the original sound heard is called an echo. Can we hear every reflected sound? When we hear a sound it remains in our ear for 1/10 of a second. Therefore, when a reflected sound comes back after 1/10 seconds we can hear it, as an echo.

The velocity of sound in air	=	$330\ ms^{-1}$	
The distance travelled in 1 second	=	330 m	
The distance travelled in 1/10 seconds	=	330/10	= 33 m
The minimum distance to the reflecting surface from the source of sound to hear the echo is	=	$\frac{33\ m}{2}$	= 16.5 m
	=	17 m (approximately)	

Therefore, for an echo to be heard there should be at least a distance of 17 m to the reflecting object. The frequency range of sound waves which are sensitive to the human ear is 20 Hz - 20,000 Hz. Higher frequencies than 20,000 Hz cannot be heard by humans, but dogs are able to hear them. Sound waves of frequency higher than 20,000 Hz are called **ultra sound waves**.

If the reflected sound reaches the ear before losing the sensation of the initial sound, we (the listner) feel that the initial sound is prolonged in the ear. Here the initial sound and the reflected sound are not differentiated as in echo. This phenomenon is called **reverberation**.

The sound is reflected uniformly by smooth surfaces, but it is not reflected uniformly from rough surfaces. This minimizes echo and reverberation.

Uses of echo

Echos are useful to measure the depth of the sea bed, to detect the remnants of sunken ships, shoals of fish in deep water and oil deposits. Submarines are used to detect obstacles in the sea.

The apparatus used to detect under water objects or places by sending ultrasonic waves is called **Echo sounder**. These are carried in ships. It sends out ultra-sonic waves to the bottom of the sea. The waves reflected from the sea bed are detected by a receiver. By measuring the time taken by the waves to return to the ship and knowing the speed of sound in sea water, we can find the depth of the sea, or the distance to the barrier.

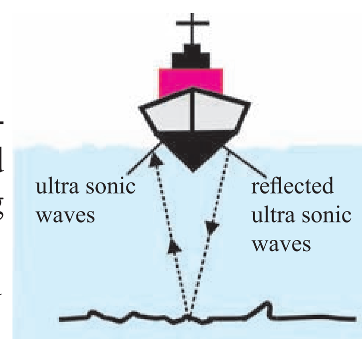


Fig 1. 11

Assignment 3

Find out and record the methods that are used in cinemas and lecture halls to prevent echo.

Bats use reflection of sound to find out their path when flying. The bat gives out ultrasonic waves and receives the echo. This helps the bat to detect obstacles and take an accurate path when flying.

Fig 1.12
How a bat uses ultra sound waves (SONAR)

Characteristics of sound

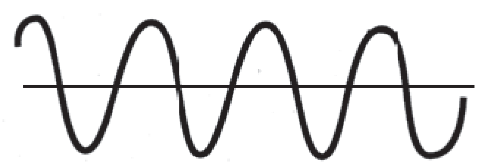
We hear different types of sounds in the environment. The sound of a thunder is rough. A whispering is soft. Men's voices are rough. Women's voices are soft. The notes of music may be high or low. All these differences are due to the characteristics of sound.

These are three main characteristic features of sound :

- **i. Pitch**
- **ii. Loudness**
- **iii. Quality of sound**

Pitch

Pitch depends on the frequency of the sound wave. When frequency is high, pitch is also high. And the sound is sharp. When the frequency is low, pitch is also low and the sound is rough.



Loudness is low

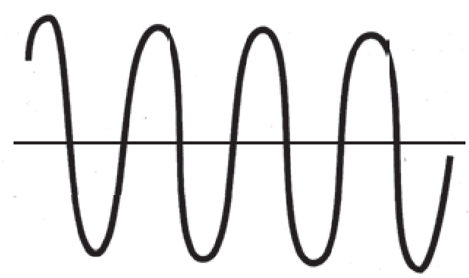


Fig 1. 13 Loudness is high

Loudness

Beat a drum softly. Then beat it harder. You will observe a difference. The second time the sound will be louder than at first. Loudness of a sound depends on the energy that the sound brings to the ear.

When a stretched string is plucked harder the sound is louder. To vibrate a string hardly we should supply energy. The wave thus formed also gets more energy.

When a string or a membrane is vibrated hard, its displacement is more. Then the amplitude of the wave is more. When the amplitude is high, the loudness of the sound is also high.

The intensity of a sound produced by a source, reduces when it travels a long distance. The reason is the decrease of the amplitude of the sound wave. The loudness of a sound depends on the amplitude of the wave. When the amplitude is more, the loudness is high.

Quality of sound

By the quality of sound we can identify different musical instruments separately, thoush the pitch and loudness.

When the same note is played by two different musical instruments, the quality of sound is different because the pattern of waves too is different.

The patterns of the wave forms can be detected by a special instrument which is named as Cathode Ray Oscilloscope. (CRO)

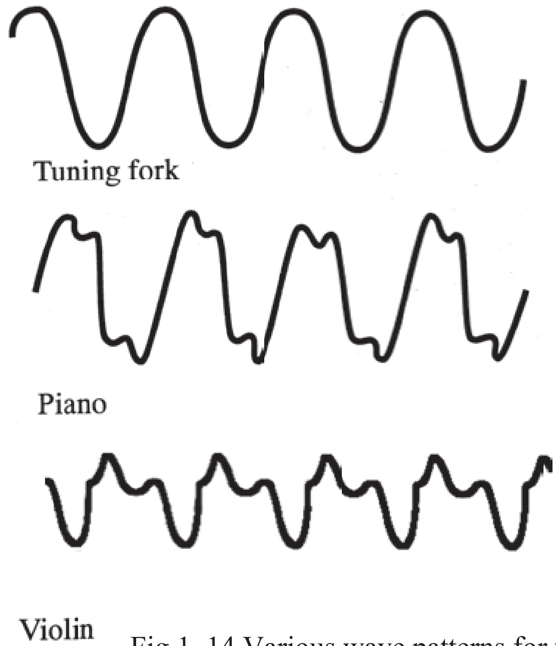


Fig 1. 14 Various wave patterns for the same note produced by different instruments

When the playing instrument is connected to the instrument CRO, the pattern of wave formation is automatically displayed on the screen.

This characteristic feature is used in tuning musical instruments.

Musical instruments

Not only human beings, but also animals love music. We love to hear the chirp of birds, a pleasant form of music. Thus, man has constructed many musical instruments.

Three types of musical instruments are given below:

(1) Instruments with vibrating air columns

(2) Instruments with vibrating strings

(3) Instruments with vibrating membranes

- **Instruments with vibrating air columns**

  These instruments give out sound by vibrating an air column.
  e. g. Flute, trumpet, Pure organ, horn saxaphone.

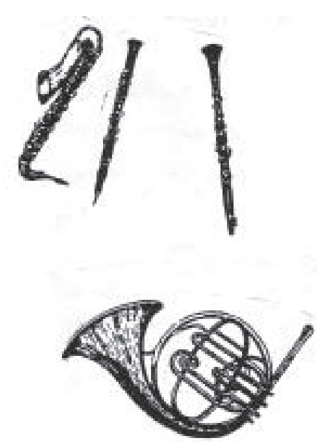


Fig 1. 15 Musical instruments with vibrating air colums

Activity 1.5 Let us make a flute

A tubular reed or a conduit pipe with a diameter of 20 mm is needed for this. If it is a reed, warm it over fire, make holes on it using a heated iron needle as in the Figure. The diameter of a hole should be 8 mm and the distance between two holes should be 22 mm. Close the opening close to the hole and blow it at hole A.

- **Instrument with vibrating strings**

Instrument like violin, mandolin, banjo, sitar, guitar. are played by vibrating stretched strings. These instruments have a box like section made of thin wood with a cavity, which is known as the **sound box**. Strings are fixed on the box so that they do not touch the box. Nails are there to adjust the tension of the strings. The sound generated by plucking the string is completed by the sound box, as the air inside the box too vibrates.

Fig. 1.16 Musical instruments with vibrating strings

String instruments are played by stroking the strings with a bow, by plucking the strings or by tapping the strings according to the type of the instrument.

- **Musical instruments wih vibrating membranes.**

These instruments have one or two stretched membranes.

e.g. drums, small drum (Udekkiya), rabana. They are played by tapping or beating the membranes. These instruments are used to maintain the rhythm.

Fig. 1.17 Musical instruments with vibrating membranes

Assignment 4

Using X-ray films, try to make a musical instrument with vibrating membranes.

Tuning of musical instruments

Adjustment of the musical instruments to get proper notes, when they are played is known as tuning. Tuning varies according to the instrument.

- **Tuning of string instruments**

  This is done by changing the characteristics of the notes of the sound produced by strings. The sound of different pitches are familiar to the ear of musicians. They tune musical instruments according to the auditory sensations.

The pitch of a sound depends on

(1) Thickness (area of cross section) of the strings
(2) Vibrating length of the strings
(3) Tension of the strings

If the thickness or length is more, the pitch is low. If the tension is high. the pitch is high. The strings of musical instruments are made of different metals in different forms.

- **Tuning of instruments with membranes**

You may have observed that a'rabana'is used in villages at weddings or during Sinhala and Hindu new year seasons. Some 'viridu' singers also play rabana with their 'viridu' songs.

A'rabana' membrane is made of an animal skin. Often the membrane is heated before playing. When heated the rabana membrane dries and shrinks. Since the membrane is fixed to a frame, shrinking is prevented, so the tension increases. Because of the increase of the tension, the pitch becomes high.

The local drum or 'dawula' is tuned by tightning the ropes attached to the membrane which are fixed to the sides of the drum. As the thickness of the two membranes is different, two different notes can be produced at the same time.

The hand drum or "udekkiya" is tuned by tightning the ropes while it is played.

Exercises

(1) List the type of motions you observe in your environment and classify them as normal motions and wave motions.

(2) State whether the following statements are true or false.

I. Human beings can hear sounds of any frequency.
II. We make many uses of ultrasound waves.
III. Radio waves have electric and magnetic properties.
IV. In the deep sea tsunami waves have a low amplitude but when it reaches the sea-shore the amplitude increases.
V. Velocity of sound increases in the order solids, liquids and gases.

(3) A person hears a thunder four seconds after he sees the lightning. Find the distance between the person and the charged cloud (The speed of sound in air is 330 m s^{-1}).

(4) An echo sounding equipment on a boat receives the echo of a sound after 0.3 seconds. Find the depth of water under the boat.

(The velocity of sound in sea water is 1400 m s^{-1}).

(5) Fill in the blanks in the concept map given below.