10 SOUND

10.1

We hear different type of sounds around us, for example the school bell, chirping birds, thundering clouds and sound of vehicles etc. We also hear the loud sound of an empty metal utensil falling. We are familiar with the melodious sound of the harmonium. We don't like when everyone in the class start speaking simultaneously. It is clear from the above examples that some sounds are low and some are loud. Some sounds are pleasant to the ears and some are not. Let us try to find how sound is produced and how we hear it.

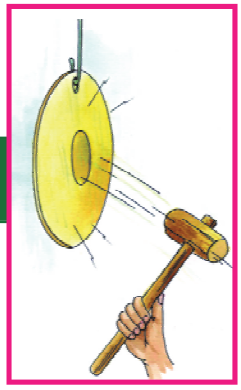

Fig. 10.1

Activity 1

Materials required :- School bell, hammer.

Ring the school bell with the hammer(fig.10.1). When you hear the sound touch the bell gently with your hand. You would certainly feel the vibration. Did the vibrations stop on your touching the bell? Can you still hear the sound?

Activity 2

Materials required :- Tuning fork, rubber pad.

Hit one arm of a tuning fork (fig. 10.2) on the pad of hard rubber. Bring it near your ear and hear the sound. Watch its prongs carefully. Can you see them vibrating? Now touch the tuning fork. You would observe that on touching the fork the vibrations stop and we cannot hear the sound. When we are speaking, we can feel the vibrations on touching our throat.

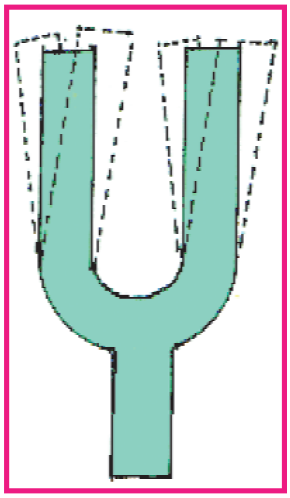

Fig. 10.2

From the above activities it can be seen that vibrating objects produce sound. When we touch vibrating objects they stop vibrating and the sound is also not heard. In some situations these vibrations can also be easily seen but in most cases they are too minute for us to see.

10.2 Amplitude, frequency and the time period of vibration

In the previous class we learnt about oscillatory motion. We know that the to and fro motion of an object about a mean position is called oscillatory motion.

Activity 3

Materials required : - Scale or spoke of a bicycle.

Put one end of a scale or of the spoke of a bicycle at the corner of a table and press it hard on the table. Let the other end be outside the table and not resting on anything. Press this end downwards and release. It starts vibrating (fig.10.3) and produces sound. Now repeat this experiment with different lengths of the free end of the scale or spoke. Here, the motion of scale or spoke is oscillatory. Spoke moves up and down and vice versa and keeps oscillating for sometime.

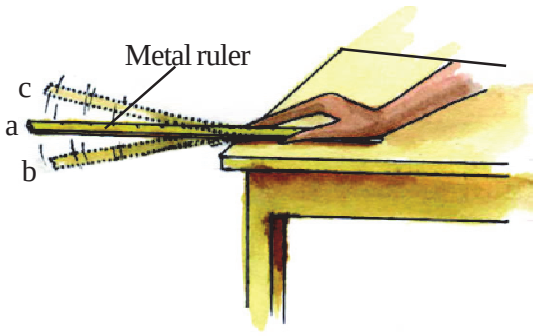

Fig. 10.3

Amplitude -

When scale or spoke goes to the position 'b' from its mean position 'a' and returns back to mean position 'a' via position 'c', then we call it one vibration or one oscillation. The maximum displacement of the spoke or the scale upto 'b' or 'c' from the mean position 'a' is called the amplitude of the vibration. The distance from 'a' to 'b' and from 'a' to 'c' is equal. By applying a small or a large force we can increase or decrease the amplitude.

Frequency -

The number of oscillations in one second is the frequency of oscillation. Frequency is measured in oscillation per second or in hertz. The unit hertz has been named after scientist Heinrich Rudolph Hertz as a mark of respect. If an object oscillates ten times in one second, then its frequency will be ten oscillations per second or ten hertz.

Time period -

The time taken by a vibrating object to complete one oscillation is called the time period. It is measured in seconds.

The relation between frequency and time period is the following :

$$\text{Frequency} = \frac{1}{\text{Time period}}$$

NOW ANSWER THESE

1. What makes an object produce sound?
2. When we ring a cycle bell with one hand while holding it with the other, then its sound is not heard clearly. Why?
3. The frequency of an vibrating object is 20 hertz. What do you understand by this statement?
4. An object completes 20 oscillations in ten second; find its frequency and time period.

10.3 Sound and medium

Sound is produced by an object when it is vibrating. These vibrations make the surrounding air vibrate. When the vibrating air reaches our ears, it makes the ear-drum vibrate and we hear the sound. For the vibrations of the vibrating object to reach our ears a medium must be present between them.

Activity 4

Keep your ear close to one end of the table (Fig. 10.4). Ask your friend to knock softly on the other end. Do you hear a sound? Through which medium did the sound reach you? Now try to hear the sound again after raising your ear from the table. Through which medium would the sound reach you in this situation? What is the reason for the difference between these two sounds?

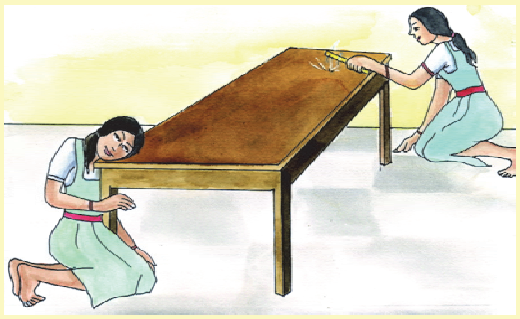

Fig. 10.4

Activity 5

Materials required :- Two match boxes, 10m long thread, two pins.

Take the inner part of two match boxes. Using them make a toy like in Fig. 10.5 by piercing a hole in each of them and put a thread and pins through the holes. Let the length of thread be about 10m. More away from your friend so that the thread is stretched. Now ask your friend to say something into one of the boxes, keeping it close to the mouth like a phone. Keep the other box on your ear and try to listen to the voice. Is the voice heard clearly? Remove the box from the ear. Can you hear the voice clearly even now? If not then why? It is clear from the above activity that sounds can travel through the thread.

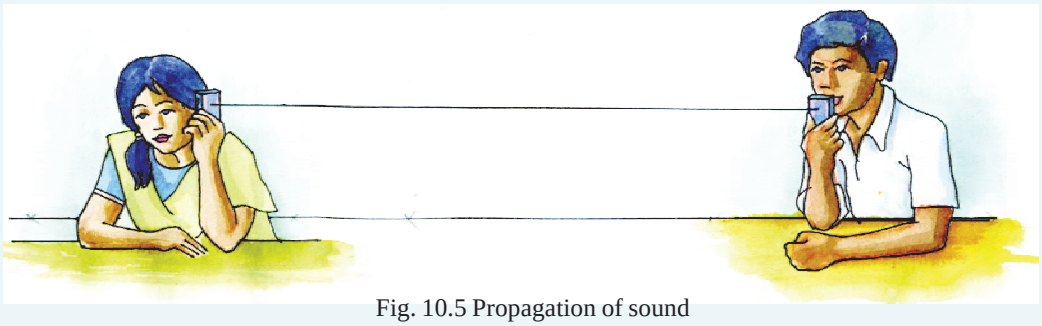

Fig. 10.5 Propagation of sound

Activity 6

Materials required : - Plastic funnel, balloon, rubber tube, bucket full of water and a rubber band, some pebbles.

Cut the top of the balloon and tie it to the wider end of the funnel with the help of a rubber band. Attach the rubber tube to the other end of the funnel. Immerse the wider end of the funnel into the water filled in a bucket. Attach the free end of the rubber tube to your ear. Drop some pebbles into the bucket one by one and listen to the sound produced by the stone hitting the bottom of the bucket. This instrument is called hydrophone. This activity shows that sound can travel even in liquids.

In the above activities we saw that a medium (solid, liquid or gas) is needed for the propagation of sound. Can sound travel through vacuum? A medium is required for the propagation of sound. When we placed an electric bell connected to a battery in an air tight bell jar. On ringing the bell, sound

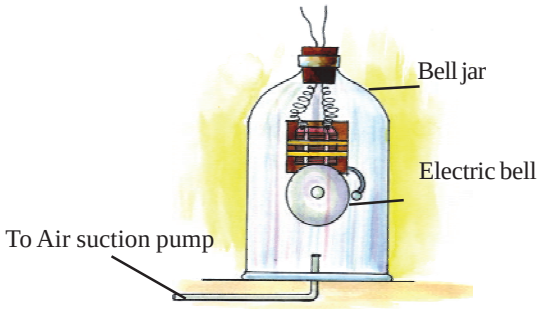

Fig.10.6

could be heard as the jar was filled with air. Then the air in the jar was evacuated with the help of an air suction pump. Now, no sound could be heard when the bell. (fig. 10.6). From this we came to the conclusion that sound cannot propagate through vacuum. As compared to air sound travels 16 times faster in some metals and 4 times faster in water.

Have you ever wondered how astronauts can communicate with each other on the moon where there is almost no atmosphere? Astronauts use radio waves for communication. Radio waves do not require a medium for their propagation.

NOW ANSWER THESE

1. On the surface of the moon why can the voice of an astronaut not be heard by the other astronaut standing nearby?
2. Who was the first to suggest that a medium is needed for the propagation of sound?

10.4 How do we hear sound?

Sound reaches our ears through a medium. From the ears it reaches our brain as signals and then we hear the sound. Human ear consists of three main parts – outer ear, middle ear and inner ear. The sound coming from outside gets transmitted from the outer ear to the middle ear. The vibrations of the diaphragm present in the middle ear are propagated to the inner ear. The audio nerves present in the ear send these vibrations to the brain in the form of signals (fig. 10.7). Ear is a very sensitive organ. We should take proper care of our ears. We should not insert anything, that can damage the diaphragm in our ear. The damage to the diaphragm may even make a human being deaf.

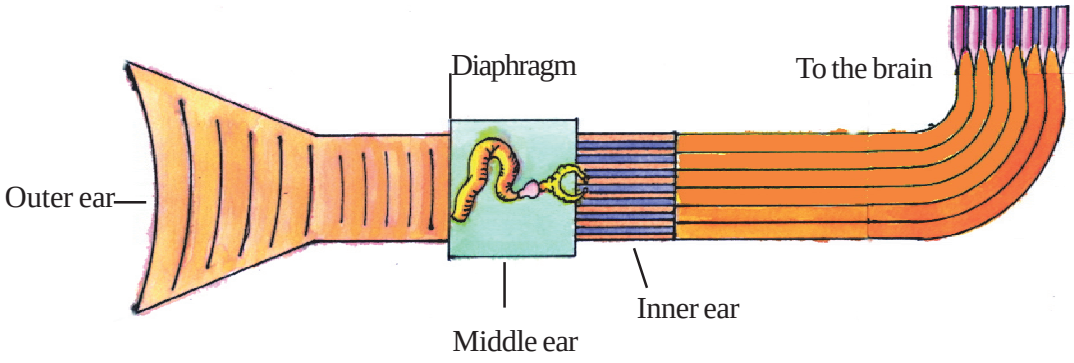

Fig. 10.7 Transferring sound from the ear to the brain.

10.5 Audible and in-audible sounds

We know that in order to produce sound, it is necessary for the object to vibrate. Do all objects that vibrate produce sound? Can we hear all sounds? Let us see.

Activity 7

Move your hands up and down as fast as you can. Do you hear any sound? You cannot move your hands more than five or six times in a second. The sound produced by this movement can not be heard by you.

We can hear only those sounds that have frequencies in the range 20 vibrations per second (Hertz) to 20000 vibrations per second (Hertz). The sounds which can be heard by our ears are called audible frequencies. The sound having a frequency less than 20 vibrations per second is called infrasonic sound while the sound having a frequency greater than 20000 vibrations per second is called ultrasonic sound. Some animals can hear sounds with frequencies even more than 20000 vibrations per second.

Dogs can hear frequencies up to 40000 vibrations per second while bats can hear frequencies up to 70000 vibrations per second and can also produce it.

Uses of ultrasonic sound -

1. For searching cracks inside metals.
2. For destroying bacteria.
3. For cleaning parts of watches.
4. For locating tumors inside the brain.
5. For curing gout pain.
6. For treatment of cataract.
7. For removing stones from the kidneys.

NOW ANSWER THESE

1. Write the difference between audible and ultrasonic sounds.
2. Write two uses of ultrasonic sound.
3. Write the audible range of normal human beings.

10.6 Reflection of sound and Echo–

When we speak loudly in to a deep well or shout facing a hill then after some time we may hear same sound as if somebody is repeating it from the well or from the hill. This return of sound from a surface is called the reflection of sound and the reflected sound is called the echo.

Activity 8

Materials required :- Two tubes of length one meter and diameter of five centimeter each, a watch and a board with plane surface.

Place the plane board vertically on a table. In front of this surface keep a tube parallel to the dotted line PQ on the table. Keep the watch with a tick-tick sound on the other end of the tube. Now move the other tube around QR and keep it in a position such that the sound of the watch can be heard clearly after reflection (fig. 10.8). A thick board (N) must be placed between the two tubes before doing the experiment so that the sound from point P can not reach the point R directly. When the sound of the watch is the clearest then you will see that $\angle PQN = \angle RQN$ or angle of incidence = angle of reflection.

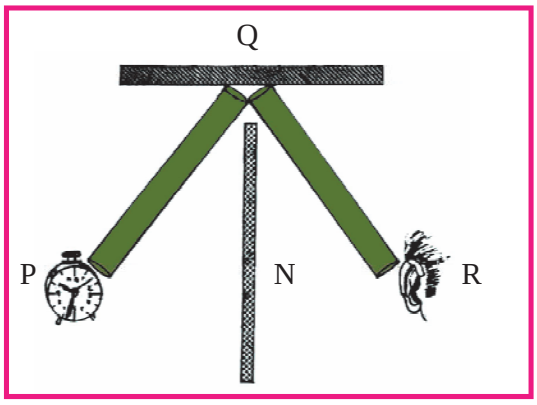

Fig. 10.8 Reflection of sound

If the reflecting surface is at a distance of 17 metre or more from the source of sound then the reflected sound can be heard as distinctly seperate from the original sound. Different materials do not reflect sound equally. Metal sheets and plywood are good reflectors of sound. Clothes, corks, thermocole etc. are not good reflectors of sound. Good absorbers of sound are used on the ceilings, floors and walls of cinema halls. They stop the reflection of sound and echo is not heard.

Human ear can hear two sounds separately and distinctively only when the sounds have a time gap of atleast 1 / 10 second. The speed of sound in air at 20^0C is approximately 340 metre per second.

The distance covered by the sound in 1 / 10 second = speed $\times$ time

= 340 $\times$ 1 / 10

= 34 meter

Therefore, it is possible to hear both original sound and reflected sound distinctively only when we are at a distance of 17 metre or more from the reflecting surface.

The reflection of sound is used to measure the depth of the sea. For this a sound signal is send in to the sea. The depth of the sea is calculated by the time taken by the sound signal in going to the bottom and coming back.

NOW ANSWER THESE

1. Under what condition will you hear your echo?
2. From the sounds falling on wood, steel, asbestos, paper and thermocole for which-
   (a) You will hear a clear echo?
   (b) Echo will not be heard?

10.7 Speed of sound

You must have heard the thundering of clouds and must have seen the lightening on rainy days. The thunder and the lightening are generated almost at the same time but we see the lightening first and hear the thunder later. Why?

The reason for this is that the speed of light is much more than the speed of sound. The speed of light 30,00,00,000 metre per second and the speed of sound at 0^0C is 332 metre per second and at 20^0C is 340 metre per second.

10.8 Properties of sound –

1. **Intense and soft sound –** The intensity of sound depends on the amplitude of vibrations. Vibrations of large amplitude produce sounds of high intensity. Vibrations of small amplitude produce soft sounds. When we hit an object hard then the object starts vibrating with a large amplitude and intense sound is produced.

2. **Low and high pitched sound –** You all know that Indian music has seven notes Sa, Re, Ga, Ma, Pa, Dha, Ni. These notes are ordered according to increasing frequencies. Sounds starting from Sa keep on becoming sharper and shaper. This means the pitch of the sounds increasing.

   The sounds of high pitch have higher frequency. For example the voice of women, the voice of cuckoos, the sound of mosquitoes and any shrill sound. The sounds of low pitch have low frequency and it sounds heavier. The voice of men, roaring of lion and sound produced by drum are heavy due to the low pitch.

3. **Melodious sounds and noise –** The sound which is pleasent to our ears is called a melodious sound and the sound which is not pleasent to our ears is called a noise.

Non-harmonious vibrations produce noise. Harmonious vibrations that have a fixed relationship with each other produce melodious sounds. The vibrations of different musical instruments are examples of melodious sounds while the sound of a fired bullet is a noise.

10.9 The sound produced by different musical instruments -

We are familiar with different kinds of musical instruments. Musical instruments are mainly of three types: musical instruments having strings, Reed musical instruments and membrane musical instruments. In instruments having strings, the strings are made to vibrate by rubbing or stretching. Sitar, veena, violin etc. are some examples of musical instruments with string.

In Reed musical instruments an air column vibrates. Air is blown in to the Reed and flows through the Reed like in a flute. There is a vibrating membrane in the membrane musical instruments like drum, dhlolak and mridang.

Fig. 19.9 Musical instruments

You would have seen musical instruments like manjeera (Jhangh, kartaal), ghattam and noot (Clay pots). These musical instruments are played in many parts of our country. Sound is produced by hitting or tapping them. Jal tarang, bells etc. are examples of such musical instruments.

10.10 The sound produced by human

The throat is the most important source of sound in human beings. A narrow slit is found between the two vocal chords in the throat for passing air. When the air from the lungs passes through the slit with a force then the chords starts vibrating, this produces a sound. The muscles attached to the chords can increase or decrease the pull on them.

Activity 9

Take two rubber strips of the same size. Place them on each other and stretch them tightly. Blow air through the space between them. When air is blown between the stretched strips then a sound is produced. Our vocal chords also produce sound in the same manner. Sounds of high frequency are produced when the chords are tightly stretched and sound of low frequency is produced while they are lax. You can even use a thick rubber band in place of rubber strips. The vibrations can be felt by putting your hand on the throat while talking.

The length of the chord of an adult man is 20 mm. The length of the chord in women, is approximately 5 mm smaller than men. The vocal chords of children are very small, that is why their voice is quite sharp.

10.11 The sound produced by animals

Many animals like dogs, cows, goats etc. produce sounds with the help of vocal chords. But all animals do not have vocal chords. The birds produce sounds with the help of the special vocal instrument present in its breathing tube. Flies produce sound by vibrating their wings fast. Frog produces the croaking. (Terr-Terr) sound with the help of its vocal chords. Some fish generate sound by pushing air out of their airbladder. Snakes do not have vocal chords but produce sound by pushing air out of their mouths.

NOW ANSWER THESE

1. Give the two examples each for sounds with a high pitch and with a low pitch.
2. Which kind of sound is produced when vocal chords are thin and stretched?
3. How do birds, fishes and flies produce sound?

WE HAVE LEARNT

- Sound is produced by the vibrations of objects.
- The maximum displacement of the vibrating object from its mean position is called the amplitude.
- The time taken to complete one oscillation is called the time period.
- The number of vibrations per second is the frequency of oscillations.
- The frequency is measured in vibrations per second or in Hertz (Hz).
- Frequency = 1 / time period.
- The range of audible frequencies for human ear is between 20 Hz to 20,000 Hz.
- A medium is required for the propagation of sound. Sound does not propagate in vacuum.
- Sound can be reflected after striking an obstacle. Echo is produced by the reflection of sound.
- The voice of human beings is due to the vibrations of their vocal chords.
- The speed of sound at 0^0C and 20^0C respectively is 332 metre / second and 340 metre / second.

QUESTIONS FOR PRACTICE

1. Choose the correct answer out of the choices given–

1. The range of audible frequencies for human beings is –

(a) 0 – 20 Hertz (b) 20 – 2000 Hertz
(c) 0 – 20,000 Hertz (d) 20 – 20,000 Hertz

2. On increasing the frequency of a sound, what else increases –

(a) Its pitch (b) Its intensity
(c) Its time period (d) Its amplitude

3. To hear the echo clearly, the minimum distance of the reflecting surface should be –

(a) 11 metre (b) 34 metre (c) 17 metre (d) 50 metre

4. Sound propagation is not possible –

(a) In metals (b) In water (c) In vacuum (d) In air

2. Write the definitions of amplitude and frequency.
3. How would you show through an experiment that sound can propagate in gases?
4. Differentiate between a noise and a melodious sound.
5. Sound is heard clearly in a big room with curtains on its walls rather than in a room without curtains. Why?

TRY TO DO THESE

1. Use the hydrophone given in Activity 6 as a stethoscope and listen to the heartbeats of your friend.
2. Take some pieces of paper having dimensions 2×5 centimeter. Press these between your two fingers (fig. 10.10). Now blow air from mouth forcefully from one side. Were you able to produce a sound? Where did this sound come from? Try this experiment with thin, thick and long pieces of paper as well. Repeat the same experiment with increased or decrease a pressure exerted by the fingers. Did you notice any change in the sound?

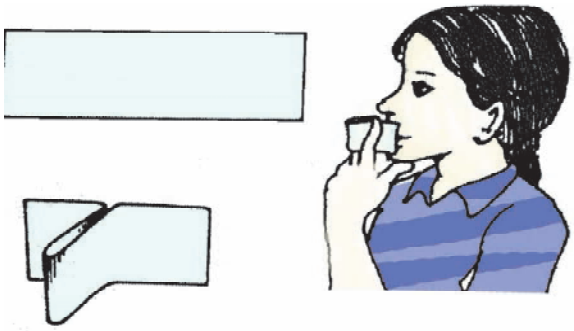

Fig. 10.10

3. Where and why may be the speed of sound high in Antartica or in your city. discuss it in your class room ?
4. Ektara

Materials required - Coconut shell/ tin box, thin bamboo stick, two nails, rubber band, thread.

Method - Take a hollow coconut shell or a tin box Make two holes as shown in fig 10.11. Take a thin bamboo stick which can get through these holes. Nail the two nails each on either side of the stick. Attach the rubber band to the nail tightly. Cover the coconut shell with a sheet of paper and secure it with the thread, now play this musical instrument and identify the part which shows vibration. Make a list of different stringed musical instruments you see in your area. Collect information about them.

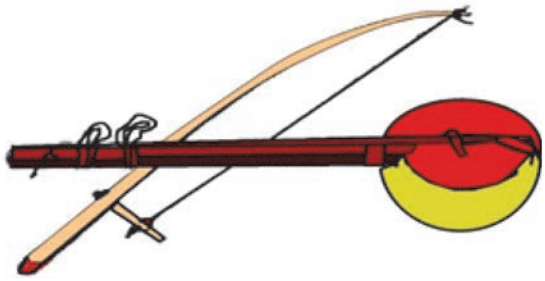

Fig 10.11 Ektara