We know that vibrations of objects in any medium produce waves. For example, vibrator of ripple tank produces water waves. The medium in this case is liquid, but it can also be a gas or a solid. Now we will discuss another type of waves that we can hear i.e., sound waves.

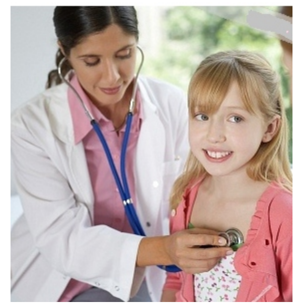
Physics of Sound

All sounds are produced by the vibrations of objects. Sound is a form of energy that travels in the form of waves from one place to another.

11.1 SOUND WAVES

Like other waves, sound is also produced by vibrating bodies. Due to vibrations of bodies the air around them also vibrates and the air vibrations produce sensation of sound in our ear. For example, in a guitar, sound is produced due to the vibrations of its strings (Fig. 11.1). Our voice results from the vibrations of our vocal chords. Human heart beats and vibrations of other organs like lungs also produce sound waves. Doctors use stethoscope to hear this sound.

For your information



Stethoscopes operate on the transmission of sound from the chest-piece, via air-filled hollow tubes, to the listener's ears. The chest-piece usually consists of a plastic disc called diaphragm. If the diaphragm is placed on the patient’s body sounds vibrate the diaphragm, creating acoustic pressure waves which after multiple reflection travel up the tubing to the doctor's ears.

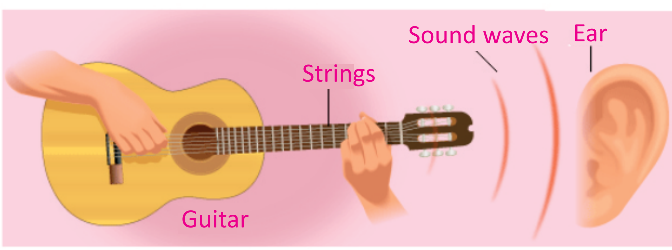


Fig. 11.1: Vibrations of guitar strings produce sound waves

SOUND IS PRODUCED BY A VIBRATING BODY

Activity 11.1: In school laboratories, we use a device called tuning fork to produce a particular sound. If we strike the tuning fork against rubber hammer, the tuning fork will begin to vibrate (Fig. 11.2). We can hear the sound produced by tuning fork by bringing it near our ear. We can also feel the vibrations by slightly touching one of the prongs of the vibrating tuning fork with a plastic ball suspended from a thread (Fig. 11.3). Touch

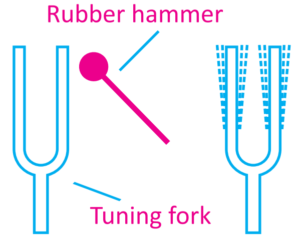


Fig. 11.2: Strike a rubber hammer on a tuning fork

the ball gently with the prong of a vibrating tuning fork. The tuning fork will push the ball because of its vibrations. Now if we dip the vibrating tuning fork into a glass of water, we will see a splash (Fig. 11.4). What does make the water splash?

From this activity, we can conclude that sound is produced by vibrating bodies.

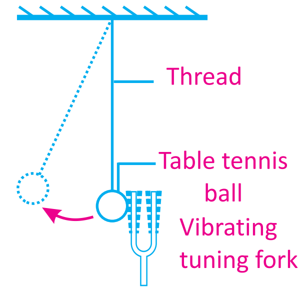


Fig. 11.3: The production of sound waves from a vibrating tuning fork

Sound Requires Material Medium for its Propagation

Activity 11.2: Unlike light waves which are electromagnetic in nature and can also pass through vacuum, sound waves require some material medium for their propagation. This can be proved by bell jar apparatus (Fig. 11.5). The bell jar is placed on the platform of a vacuum pump.

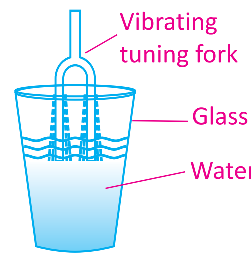


Fig. 11.4

An electric bell is suspended in the bell jar with the help of two wires connected to a power supply. By setting ON the power supply, electric bell will begin to ring. We can hear the sound of the bell. Now start pumping out air from the jar by means of a vacuum pump. The sound of the bell starts becoming more and more feeble and eventually dies out, although bell is still ringing. When we put the air back into the jar, we can hear the sound of the bell again. From this activity, we conclude that sound waves can only travel/propagate in the presence of air (medium).

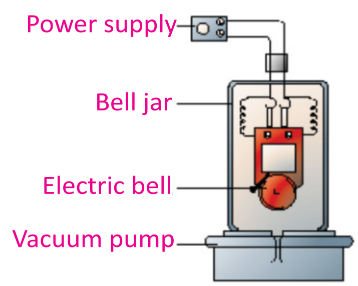


Fig. 11.5: Bell jar apparatus

Longitudinal Nature of Sound Waves

Propagation of sound waves produced by vibrating tuning fork can be understood by a vibrating tuning fork as shown in Fig.11.6. Before the vibration of tuning fork, density of air molecules on the right side is uniform (Fig.11.6-a). When the right prong of tuning fork moves from mean position O to B (Fig.11.6-b), it exerts some pressure on the adjacent layer of air molecules and produces a compression.

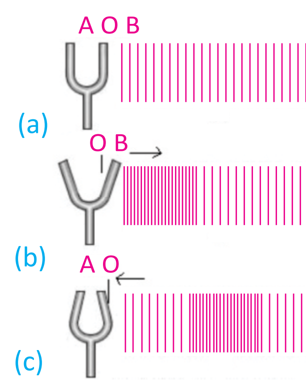


Fig.11.6: Vibrations of tuning fork after striking with a rubber

This compressed air layer in turn compresses the layer next to it and so on. A moment later, the prong begins to move from B towards A (Fig.11.6-c). Now the pressure in the adjacent layer decreases and a rarefaction is produced. This rarefaction is transfered to the air layer next to it and so on. As the tuning fork moves back and forth rapidly, a series of compressions and rarefactions are created in the air. In this way, sound wave propagates through the air.

As in the Fig.11.6, the direction of propagation of sound wave is along the direction of oscillating air molecules. This shows the longitudinal nature of sound waves. Distance between two consecutive compressions or rarefactions is the wavelength of sound wave.

Physics Insight

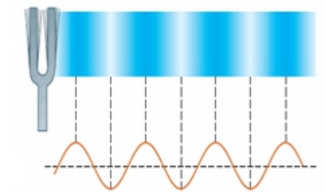


Illustration of longitudinal wave formed by vibrating tuning fork in the air. Compressions are places where air pressure is slightly higher than the surrounding air pressure due to high density of air particles. While rarefactions are the regions correspond to low air pressure due to low density of air particles.

11.2 CHARACTERISTICS OF SOUND

Sounds of different objects can be distinguished on the basis of different characteristics as described below:

Loudness: *Loudness is the characteristic of sound by which loud and faint sounds can be distinguished.*

When we talk to our friends, our voice is low, but when we address a public gathering our voice is loud. Loudness of a sound depends upon a number of factors. Some of them are discussed below:

Quick Quiz

Identify which part of these musical instruments vibrates to produce sound:
(a) electric bell (b) loud speaker (c) piano (d) violin (e) flute.

Self Assessment

1. Explain how sound is produced by a school bell.
2. Why are sound waves called mechanical waves?
3. Suppose you and your friend are on the Moon. Will you be able to hear any sound produced by your friend?

(a) **Amplitude of the vibrating body:** The loudness of the sound varies directly with the amplitude of the vibrating body (Fig.11.7). The sound produced by a sitar will be loud if we pluck its wires more violently. Similarly, when we beat a drum forcefully, the amplitude of its membrane increases and we hear a loud sound.

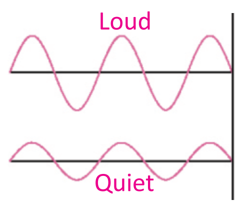


Fig. 11.7: Variation of loudness with amplitude

(b) **Area of the vibrating body:** The loudness of sound also depends upon the area of the vibrating body.

For example, sound produced by a large drum is louder than that by small one because of its large vibrating area. If we strike a tuning fork on a rubber pad, a feeble sound will be heard. But if the vibrating tuning fork is placed vertically on the surface of a bench, we will hear a louder sound. From this, we can conclude that the loudness increases with the area of the vibrating body and vice versa.

(c) **Distance from the vibrating body:** Loudness of sound also depends upon the distance of the vibrating body from the listener. It is caused by the decrease in amplitude due to increase in distance.
Loudness also depends upon the physical condition of the ears of the listener. A sound appears louder to a person with sensitive ears than to a person with defective ears. However, there is a characteristic of sound which does not depend upon the sensitivity of the ear of the listener and it is called intensity of sound.

Pitch: ***Pitch is the characteristic of sound by which we can distinguish between a shrill and a grave sound.***

It depends upon the frequency. A higher pitch means a higher frequency and vice versa. The frequency of the voice of ladies and children is higher than that of men. Therefore, the voice of ladies and children is shrill and of high pitch. The relationship between frequency and pitch is illustrated in Fig. 11.8.

Quality: ***The characteristic of sound by which we can distinguish between two sounds of same loudness and pitch is called quality.***

While standing outside a room, we can distinguish between the notes of a piano and a flute being played inside the room. This is due to the difference in the quality of these notes.

Figure 11.9 shows the waveform of the sound produced by a tuning fork, flute and clarinet. The loudness and the pitch of

For your information

Thin-walled glass goblets can vibrate when hit by sound waves. This is due to a phenomenon of sound known as resonance. Some singers can produce a loud note of particular frequency such that it vibrates the glass so much that it shatters.

Interesting information

Some people use silent whistle to call dogs whose frequency lies between 20,000 Hz to 25,000 Hz. It is silent for human but not for dogs because the audible frequency range for dogs is much higher.

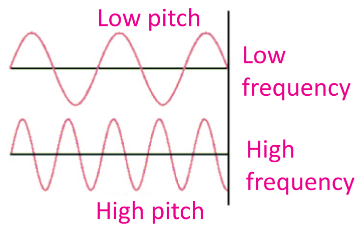


Fig 11.8: Variation of pitch with frequency

For your information

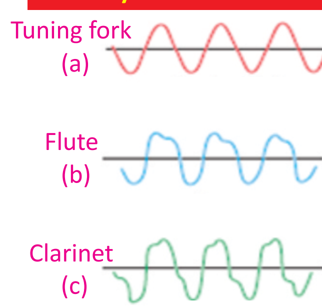


Fig 11.9: Sound waveforms produced by (a) a tuning fork, (b) a flute, and (c) a clarinet, are all at approximately the same frequency. Pressure is plotted vertically, time

these three sounds are the same but their waveforms are different. So their quality is different and they can be distinguished from each other.

Intensity

The sound waves transfer energy from the sounding body to the listener. The intensity of sound depends on the amplitude of sound wave and is defined as:

Sound energy passing per second through a unit area held perpendicular to the direction of propagation of sound waves is called intensity of sound.

Intensity is a physical quantity and can be measured accurately. The unit of intensity of sound is watt per square metre ($W\,m^{-2}$).

Sound Intensity Level

The human ear responds to the intensities ranging from $10^{-12}\,W\,m^{-2}$ to more than $1\,W\,m^{-2}$ (which is loud enough to be painful). Because the range is so wide, intensities are scaled by factors of ten. The barely audible and the faintest intensity of sound i.e., $10^{-12}\,W\,m^{-2}$ is taken as reference intensity, called zero bel (a unit named after Alexander Graham Bell).

The loudness of a sound depends not only on the intensity of sound but also on the physical conditions of the ear. The human ear is more sensitive to some frequencies rather than the others.

The loudness (L) of a sound is directly proportional to the logarithm of intensity i.e.,

$$L \propto \log I$$

$$L = K \log I \qquad .... (11.1)$$

where K is a constant of proportionality.

Let L_o be the loudness of the faintest audible sound of intensity I_o and L be the loudness of an unknown sound of intensity I, then by Eq. (11.1), we can write

$$L_o = K \log I_o \qquad .... (11.2)$$

Subtracting Eq. (11.2) from Eq. (11.1), we get

Quick Quiz

1. Why the voice of women is more shrill than that of men?

2. Which property of sound wave determines its:
(a) loudness (b) pitch?

3. What would happen to the loudness of sound with increase in its frequency?

Do you know?

Frequency of tuning fork depends on the mass of its prongs. The greater the mass, the lower the frequency of vibration which means the lower the pitch.

For your information

A sound wave with a frequency of 3500 Hz and an intensity of 80 dB sounds about twice as loud to us as a sound of 125 Hz and 80 dB. It is because our ears are more sensitive to the 3500 Hz sound than to the 125 Hz. Therefore intensity by itself does not mean loudness. Loudness is how our ears detect and our brain perceives the intensity of sound waves.

$$L - L_o = K(\log I - \log I_o) = K \log \frac{I}{I_o}$$

This difference, $(L - L_o)$, between the loudness L of an unknown sound and the loudness L_o is called the intensity level of the unknown sound. Therefore, the intensity level of an unknown sound is given by

$$\text{Intensity level} = K \log \frac{I}{I_o} \quad .... \quad (11.3)$$

The value of K depends not only on the units of I and I_o but also on the unit of intensity level. If intensity I of any unknown sound is 10 times greater than the intensity I_o of the faintest audible sound i.e., $I = 10I_o$ and the intensity level of such a sound is taken as unit, called bel, the value of K becomes 1. Therefore, using $K = 1$, Eq. (11.3) becomes

$$\text{Intensity level} = \log \frac{I}{I_o} \text{ (bel)} \quad .... \quad (11.4)$$

bel is a very large unit of intensity level of a sound. Generally, a smaller unit called decibel is used. Decibel is abbreviated as (dB). It must be remembered that 1 bel is equal to 10 dB. If the intensity level is measured in decibels, Eq. (11.4) becomes

$$\text{Intensity level} = 10 \log \frac{I}{I_o} \text{ (dB)} \quad .... \quad (11.5)$$

Using Eq. (11.5), we can construct a scale for measuring the intensity level of sound. Such scale is known as "decibel scale". The intensity level of different sounds in decibel is given in Table 11.1.

Example 11.1: Calculate the intensity levels of the (a) faintest audible sound (b) rustling of leaves.

Solution: (a) Intensity level of faintest audible sound can be calculated by substituting $I = I_o = 10^{-12}$ Wm^{-2} in Eq. (11.5). Therefore,

$$\text{Intensity level of faintest audible sound} = 10 \log \frac{10^{-12}}{10^{-12}} \text{ dB}$$
$$= 0 \text{ dB}$$

(b) As the intensity of the rustle of leaves is $I = 10^{-11}$ W m^{-2},

Table 11.1

Sources of Sound	Intensity (Wm^{-2})	Intensity level (dB)
Nearby jet airplane	10^{3}	150
Jackhammer/Fast train	10^{1}	130
Siren	10^{0}	120
Lawn mover	10^{-2}	100
Vacuum cleaner	10^{-5}	70
Mosquito buzzing	10^{-8}	40
Whisper	10^{-9}	30
Rustling of leaves	10^{-11}	10
Faintest audible sound i.e., Threshold	10^{-12}	0

For your information

Logarithmic scale	Linear scale
Decibels (dB)	**Amplitude (m)**
0	1
20	10
40	100
60	1,000
80	10,000
100	1000,000
120	1,000,000

The decibel scale is a *logarithmic* measure of the amplitude of sound waves. In a logarithmic scale, equal intervals correspond to multiplying by 10 instead of adding equal amounts.

therefore,

Intensity level due to rustling of leaves = $10 \log 10^{-11}/10^{-12}$ dB

= 10 log10 dB

= 10 dB

11.3 REFLECTION (ECHO) OF SOUND

When we clap or shout near a reflecting surface such as a tall building or a mountain, we hear the same sound again a little later. What causes this? This sound which we hear is called an echo and is a result of reflection of sound from the surface.

When sound is incident on the surface of a medium it bounces back into the first medium. This phenomenon is called echo or reflection of sound.

The sensation of sound persists in our brain for about 0.1 s. To hear a clear echo, the time interval between our sound and the reflected sound must be at least 0.1 s. If we consider speed of sound to be 340 ms^{-1} at a normal temperature in air, we will hear the echo after 0.1 s. The total distance covered by the sound from the point of generation to the reflecting surface and back should be at least $340 \text{ m s}^{-1} \times 0.1 \text{ s} = 34.0$ m. Thus, for hearing distinct echoes, the minimum distance of the obstacle from the source of sound must be half of this distance, i.e., 17 m. Echoes may be heard more than once due to successive or multiple reflections.

Activity 11.3: Take two identical plastic pipes of suitable length, as shown in Fig. 11.10. (We can make the pipes using chart paper).

- Arrange the pipes on a table near a wall.
- Place a clock near the open end of one of the pipes and try to hear the sound of the clock through the other pipe.
- Adjust the position of the pipes so that you can hear the sound of the clock clearly.
- Now, measure the angles of incidence and reflection and see the relationship between the angles.

Interesting information

A blue whale's 180 dB rumble is the loudest animal sound ever recorded. Whale sounds also appear to be a part of a highly evolved communication system. Some whales are thought to communicate over hundreds and may be thousands of kilometres. This is possible, in part, because sound waves travel five times faster in water than in air. In addition, the temperature characteristics of ocean water — decrease in temperature with depth — create a unique sound phenomenon.

Do you know?

Elephants use low frequency sound waves to communicate with one another. Their large ears enable them to detect these low frequency sound waves, which have relatively long wavelengths. Elephants can effectively communicate in this way, even when they are separated by many kilometres.

- Lift the pipe on the right vertically to a small height and observe what happens.

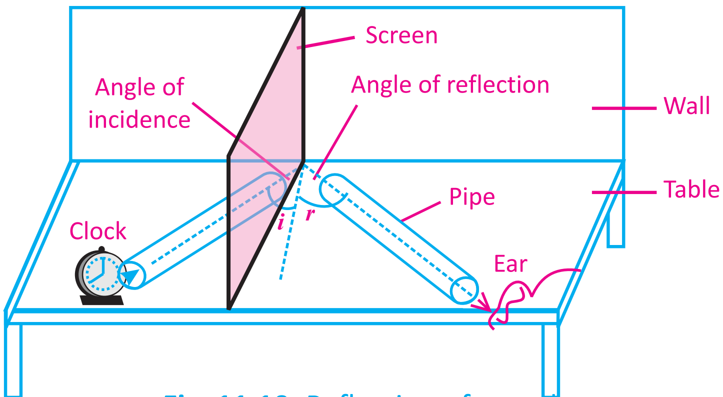
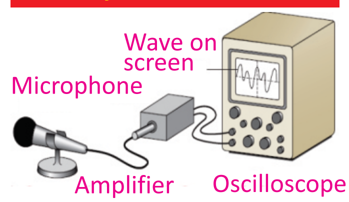


Fig. 11.10: Reflection of sound

For your information



By using an oscilloscope, you can "see" sound waves.

11.4 SPEED OF SOUND

Sound waves can be transmitted by any medium containing particles that can vibrate. They cannot pass through vacuum. However, the nature of the medium will affect the speed of the sound waves. In general, the speed of sound in a liquid is five times that in gases; the speed of sound in solid is about fifteen times that in gases. The speed of sound in air is affected by changes in some physical conditions such as temperature, pressure and humidity etc.

The speed of sound in air is 343 m s^{-1} at one atmosphere of pressure and room temperature (21°C). The speed varies with temperature and humidity. The speed of sound in solids and liquids is faster than in air. Following relation can be used to find the speed of sound:

$$v = f\lambda \quad .... (11.6)$$

where v is the speed, f is the frequency and λ is the wavelength of sound wave.

Table 11.1
Speed of sound in various media

Medium	Speed (m s^{-1})
Gases	
Air(0°C)	331
Air (25°C)	346
Air(100°C)	386
Hydrogen (0°C)	1290
Oxygen (0°C)	317
Helium (0°C)	972
Liquids at 25°C	
Distilled water	1498
Sea water	1531
Solids 25°C	
Wood	2000
Aluminium	6420
Brass	4700
Nickel	6040
Iron	5950
Steel	5960
Flint Glass	3980

Example 11.2: Calculate the frequency of a sound wave of speed 340 m s^{-1} and wavelength 0.5 m.

Solution: Given that; speed of waves $v = 340$ m s^{-1}

Wavelength $\lambda = 0.5$ m
Using the formula $v = f\lambda$
Putting the values

$f = 340 \text{ m s}^{-1} / 0.5 \text{ m} = 680$ Hz

Measuring Speed of Sound by Echo Method

Apparatus: Measuring tape, stopwatch, flat wall that can produce a good echo.

Procedure:

1. Use the tape to measure a distance of 50 metres from the wall.
2. Now clap your hands in front of the wall at a distance of 50 metres and check if you can clearly hear an echo from the wall. Make sure the echo is not coming from any other wall in the area. The time taken by the sound to travel 100 metres is the time difference between the clap and the echo.
3. Now restart the clapping and start the stopwatch at the first clap. Count the number of claps, and stop the clapping and the stopwatch when you hear the echo of the 10th clap (say).
4. Now find the average time for 10 claps. After calculating the time interval t between claps and using the formula $S = vt$, we can calculate the speed of the sound.

Example 11.3: Flash of lightning is seen 1.5 seconds earlier than the thunder. How far away is the cloud in which the flash has occurred? (speed of sound = 332 m s^{-1}).

Solution: Given that, time $t = 1.5$ s, speed of sound $v = 332 \text{ m s}^{-1}$.
Therefore, distance of the cloud $S = vt = 1.5 \text{ s} \times 332 \text{ m s}^{-1} = 498$ m.

Do you know?

The speed of sound in air was first accurately measured in 1738 by members of the French Academy. Two cannons were set up on two hills approximately 29 km apart. By measuring the time interval between the flash of a cannon and the "boom", the speed of sound was calculated. Two cannons were fired alternatively to minimize errors due to the wind and to delayed reactions in the observers. From their observations, they deduced that sound travels at about 336 m s^{-1} at 0°C.

11.5 NOISE POLLUTION

We enjoy the programmes on radio or television by hearing sounds of different qualities. In musical programmes, we hear sound produced by musical instruments such as flute, harmonium, violin, drum etc. Sound of these instruments has pleasant effect on our ears. Such sounds which are pleasant to our ears are called musical sounds. However, some sounds produce unpleasant effects on our ears such as sound of machinery, the slamming of a door, and sounds of traffic in big cities. Sound which has jarring and unpleasant effect on our ears is called noise. Noise corresponds to irregular and sudden vibrations produced by some sounds.

Noise pollution has become a major issue of concern in big cities. Noise is an undesirable sound that is harmful for health of human and other species. Transportation equipment and heavy machinery are the main sources of noise pollution. For example, noise of machinery in industrial areas, loud vehicle horns, hooters and alarms. Noise has negative effects on human health as it can cause conditions such as hearing loss, sleep disturbances, aggression, hypertension, high stress levels. Noise can also cause accidents by interfering with communication and warning signals.

A safe level of noise depends on two factors: the level (volume) of the noise; and the period of exposure to the noise. The level of noise recommended in most countries is usually 85-90 dB over an eight-hour workday. Noise pollution can be reduced to acceptable level by replacing the noisy machinery with environment friendly machinery and equipments, putting sound-reducing barriers, or using hearing protection devices.

Activity 11.4: Develop an action plan to help you address any problem(s) with noise in your workplace considering the following points:

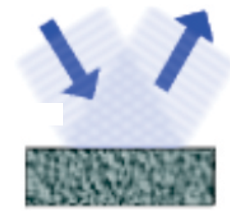
1. Describe the problem(s).
2. What are the sources of the problem(s)?
3. Who are the people being affected?
4. Your suggestions for the solution.

11.6 IMPORTANCE OF ACOUSTICS

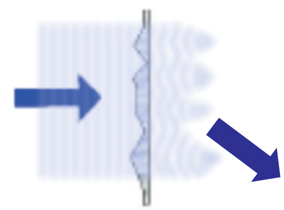
The technique or method used to absorb undesirable sounds by soft and porous surfaces is called acoustic protection.

Reflection of sound is more prominent if the surface is rigid
and smooth, and less if the surface is soft and irregular. Soft,

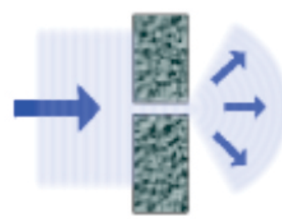
Physics insight



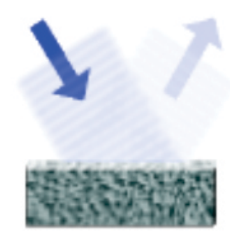
Reflection



Refraction



Diffraction



Absorption

Sound displays all the properties of waves when it interacts with materials and boundaries.

porous materials, such as draperies and rugs absorb large amount of sound energy and thus quiet echoes and softening noises. Thus by using such material in noisy places we can reduce the level of noise pollution. However, if the surface of classrooms or public halls are too absorbent, the sound level may be low for the audience. Sometimes, when sound reflects from the walls, ceiling, and floor of a room, the reflecting surfaces are too reflective and the sound becomes garbled. This is due to multiple reflections called reverberations. In the design of lecture halls, auditorium, or theater halls, a balance must be achieved between reverberation and absorption. It is often advantageous to place reflective surfaces behind the stage to direct sound to the audience.

Generally, the ceilings of lecture halls, conference halls and theatre halls are curved so that sound after reflection may reach all the corners of the hall (Fig 11.11). Sometimes curved sound boards are placed behind the stage so that sound after reflection distributed evenly across the hall (Fig. 11.12).

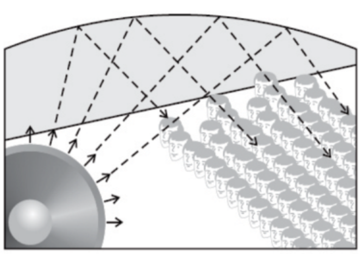


Fig. 11.11: Curved ceiling of a conference hall

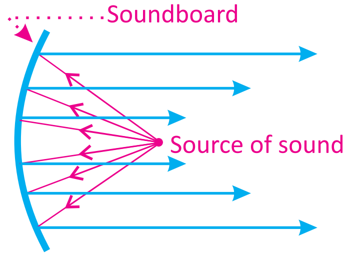
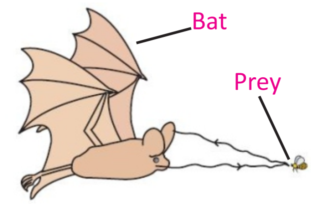


Fig. 11.12: Soundboard used in a big hall

For your information

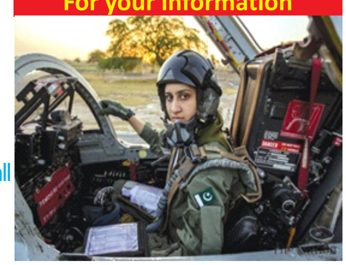


The phrase "blind as a bat" is a false statement. Bats have some vision using light, but when placed in pitch-black rooms crisscrossed with fine wires, they can easily fly around and unerringly locate tiny flying insects for food. We usually assume that vision requires light but both bats and dolphins have the ability to "see" using sound waves. Research in science and technology has developed "eyes" that enable humans also to see using sound waves.

11.7 AUDIBLE FREQUENCY RANGE

We know that sound is produced by a vibrating body. A normal human ear can hear a sound only if its frequency lies between 20Hz and 20,000 Hz. In other words, a human ear neither hears a sound of frequency less than 20 Hz nor a sound of frequency more than 20,000 Hz. Different people have different range of audibility. It also decreases with age. Young children can hear sounds of 20, 000 Hz but old people cannot hear sounds even above 15, 000 Hz.

For your information



Pilots wear special headphones that reduce the roar of an airplane engine to a quiet hum.

The range of the frequencies which a human ear can hear is called the audible frequency range.

11.8 ULTRASOUND

Sounds of frequency higher than 20, 000 Hz which are inaudible to normal human ear are called ultrasound or ultrasonics.

Tidbits

Bats can hear frequencies up to 120,000 Hz. Other animals cannot hear such high-pitched sounds. Mice can hear frequencies up to 100,000 Hz, dogs up to 35,000 Hz, and cats up to 25,000 Hz. Humans hear sounds only upto about 20,000 Hz, but children can usually hear higher-frequency sounds than adults.

Uses of Ultrasound

- Ultrasonic waves carry more energy and higher frequency than audible sound waves. Therefore, according to the wave equation $v = f\lambda$, the wavelength of ultrasonic waves is very small and is very useful for detecting very small objects.
- Ultrasonics are utilized in medical and technical fields.
- In medical field, ultrasonic waves are used to diagnose and treat different ailments. For diagnosis of different diseases, ultrasonic waves are made to enter the human body through transmitters. These waves are reflected differently by different organs, tissues or tumors etc. The reflected waves are then amplified to form an image of the internal organs of the body on the screen (Fig.11.13). Such an image helps in detecting the defects in these organs.

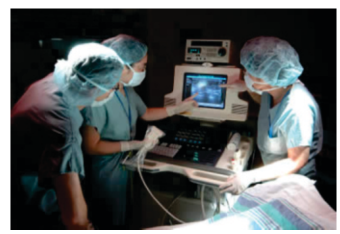


Fig. 11.13: Doctors are taking ultrasound test of a patient with an ultrasound machine

- Powerful ultrasound is now being used to remove blood clots formed in the arteries.
- Ultrasound can also be used to get the pictures of thyroid gland for diagnosis purposes.
- Ultrasound is used to locate underwater depths or is used for locating objects lying deep on the ocean floor, etc. The technique is called *SONAR*, *(sound navigation and ranging)*. The sound waves are sent from a transmitter, and a receiver collects the reflected sound (Fig.11.14). The time-lapse is calculated, knowing the speed of sound in water, the distance of the object from the ocean surface can be estimated.

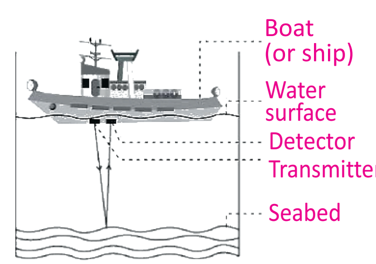


Fig. 11.14: Ultrasonics are used to measure the depth of water by echo method

- SONAR ranging is also used to see the shape and the size of the object.

Cracks appear in the interior of moving parts of high speed heavy machines such as turbines, engines of ships and airplanes due to excessive use. These cracks are not visible from outside but they can be very dangerous. Such cracks can be detected by ultrasonics. A powerful beam of ultrasound is made to pass through these defective parts. While passing, these waves are reflected by the surface of these cracks and flaws. The comparison of the ultrasonic waves reflected from cracks and from the surfaces of these parts can give a clue of the existence of the cracks.

- Germs and bacteria in liquids can also be destroyed by using high intensity ultrasonic waves.

SUMMARY

- Sound is produced by a vibrating body. It travels in the medium from one place to another in the form of compressional waves.
- Loudness is a feature of sound by which a loud and a faint sound can be distinguished. It depends upon the amplitude, surface area and distance from the vibrating body.
- Sound energy flowing per second through unit area held perpendicular to the direction of sound waves is called the intensity of sound. bel is unit of the intensity level of sound, where 1 bel = 10 decibels
- Pitch of the sound is the characteristics of sound by which a shrill sound can be distinguished from a grave one. It depends upon the frequency.
- The characteristics of sound by which two sound waves of same loudness and pitch are distinguished from each other is called the quality of sound.
- The sounds with jarring effect on our ears are called noise and the sounds having pleasant effect on our ears are called musical sounds.
- Noise pollution has become a major issue of concern in some big cities. Any form of sound which disturbs the normal functioning of any natural ecosystem or some human community is the cause of noise pollution.
- Noise pollution can be reduced to acceptable level by replacing the rusty noisy machinery with environment friendly machinery and equipments, putting sound-reducing barriers, or using hearing protection devices.
- The technique or method used to absorb undesirable sound energy by soft and porous surfaces is called acoustic protection. This can be done by using soft, rough and porous materials.