Chapter-11

Sound

There are different forms of energy like mechanical energy, electric energy, heat, light energy, nuclear energy etc. One more form of energy is the sound energy. We hear sound from different sources in our day-to-day life. The sensation generated in our ears by the sound vibrations help us to hear voices.

Activity 11.1 : Can you hear sound on striking the prong of a tuning fork on a rubber pad? We will observe that on striking on a rubber pad the prong of the tuning fork starts vibrating. If this vibrating fork is brought near a ball suspended with a thread even the ball starts vibrating as shown in fig. 11.1.

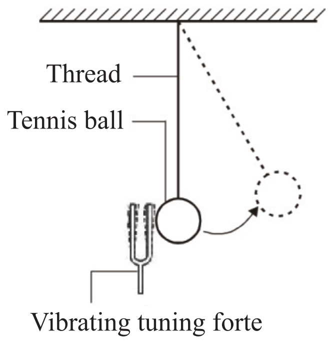

Fig. 11.1 :
The vibrating tuning fork touching a suspended ball

Activity 11.2 : Various musical instruments and their part which vibrate to produce sound

Musical Instrument	Part that vibrates
Gitar, Sitar	Wire
Flute	The air inside the flute
Drum	Screen
Hormonium	Reeds activated by air

Similarly the school bell rings when we strike it with a hammar which generates vibrations and hence sound. The above observations make it clear that sound is produced by the vibrations generated.

11.1 Propagation of sound :

The substance through which the vibrations of objects pass is known as the medium. Sound can propagate in all three medium solid liquid and gas. When something vibrates the particles of the medium transfer their energy to the nearby particles of the medium by vibrating. As a result the neighbouring particles start vibrating and similarly pass on their energy to their neighbouring particles. Thus the sound (energy) reachs our ears passing in the form of vibrations from particle to particle. In the ear these vibrations or disturbances generate stimuli because of which we are able to hear the sound. In sound propagation, only the vibrations are propagated. The total displacement of the particles of the medium remains zero.

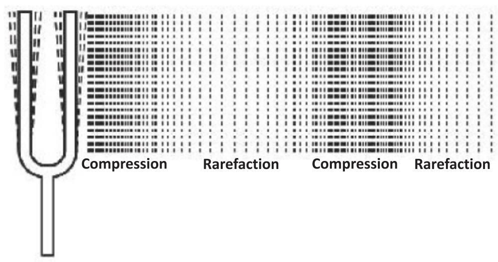

Fig. 11.2 :
Series of compression and rarefaction in sound propagation

Air is the most normal medium for sound propagation. As shown in fig. 11.2 the vibrating body pushes air to cause compression. When the vibrating body moves back rarefaction is generated. These compressions and rarefactions form the sound waves which propagate in the medium. Compression is an area of high pressure and rarefaction is the area of low pressure.

Sound needs medium to travel :

Sound is a mechanical wave and a medium like- air, water, iron etc. is required for its propagation. It cannot move in vacuum. This can be observed by a simple experiment.

Activity 11.3 : An electric bell is suspended in a bell jar and its sound is heard when we press the switch from outside. Now, vacuum is created in the jar with the help of a suction pump. As the amount of air in the bell jar decreases, the sound of the bell also reduces. When there is the condition nearing vacuum the sound of the bell stops being heard.

From this activity it is clear that a medium is required for the propagation of sound. This is the reason why we will not hear what our friend speak on the moon because there is no atmosphere on moon.

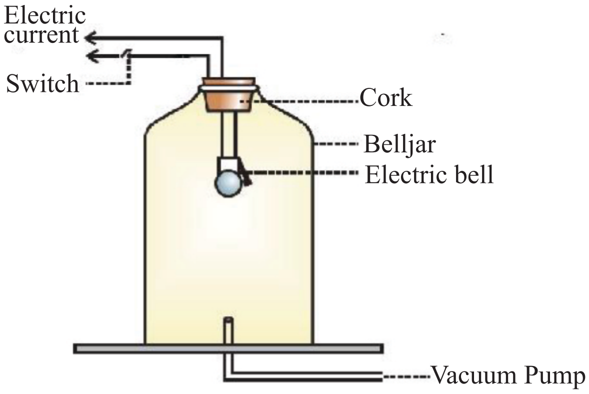

Fig. 11.3 The bell jar experiment

Nature of sound waves :

Waves can be of two types depending upon the direction of vibration and propagation :

(i) Transverse waves : The waves in which the vibrations are vertical to the direction of propagation are known as transverse waves. Examples - light waves, energy transmitted in a stretched rope etc.

(ii) Longitudinal waves : The waves in which the vibrations are in the direction of the propagation are known as longitudinal waves examples : waves generated in a spring, sound waves etc.

Sound waves are the longitudinal waves. We can understand the propagation of longitudinal waves by the following activity.

Activity 11.4 : A spring (slinky) is held in the two hands as shown in the fig. 11.4. Now stretch one of its end and then give it a sharp push towards the other end. If a dot is marked on this it is observed that the dot moves in the parallel direction i.e. to and fro of the direction of the disturbances i.e. vibrations.

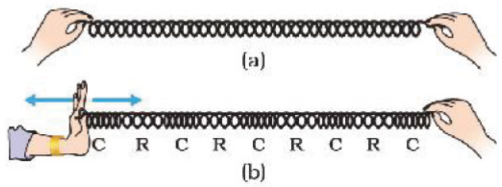

Fig. 11. 4
Longitudinal wave in a slinky (pre compressed helical spring)

The regions where the coils come close to each other are known as compressions (c) while the regions where the coils are away from each other are known as rarefactions (R). The waves of the propagation of disturbances in the slinky are known as longitudinal waves. In these waves the displacement of the particles of the medium is in the direction of the propagation of disturbances i.e. parallel.

11.2 Characteristics of a sound wave :

There are three characteristics features of a sound wave :

(i) Frequency
(ii) Amplitude
(iii) Speed

The sound wave has been graphically represented in fig. 11.5. Here the distance of propagation has been shown along x-axis and the average value of the pressure of the medium at the given point of the time is shown along the y-axis.

On studying the various points on the graph we observe that points 1, 5, 9, etc. are the regions of maximum pressure while at the points 3, 7, 11 the pressure is the least. The points of high pressure are the regions of compression of sound propagation while the points of low pressure are the rarefaction regions. The distance between two consecutive compressions or two consecutive rarefactions is known as the wave length. It is generally denoted by λ.

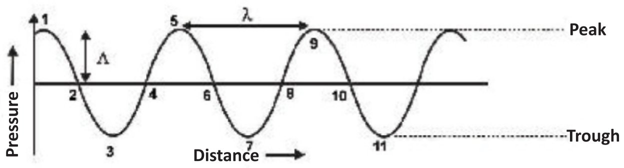

Fig. 11.5 : Graphical representation of the sound wave

Frequency : "The number of vibrations or oscillations occurring in unit time is known as the frequency of the sound wave". It is denoted by υ and it's SI unit is Hertz (Hz).

Time period : "The time taken by two consecutive compressions or rarefactions to pass a particular point is known as the time period of the wave." In other words the time taken by the particles of the medium to complete one oscillation is known as the time period. It is represented by T and its SI unit is second (s).

The relation between the frequency and the time period is

$$\text{frequency} = \frac{1}{\text{Time period (T)}} \quad .....(11.1)$$

Amplitude : The maximum displacement of the disturbance of the medium from the equilibrium position is known as the amplitude. It is represented by A.

Velocity and Wave Equation : In a wave, the distance travelled in one second by a point (like compression or rarefaction) is known as the wave velocity.

$$\text{We know that velocity} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Therefore } V = \frac{r}{T} = \lambda\upsilon \quad ......(11.2)$$

This equation is known as the wave equation and it is true for all types of waves. The velocity of the wave depends on the medium and remains constant in a medium. When the frequency of a wave in any medium increases, the wave length will decrease.

Intensity :

1. The sound energy passing a unit area in one second is known as the intensity of the sound.
2. The sound intensity can be measured.
3. Sound intensity is related to its energy.

Loudness :

1. The measure of the sensitivity of ears is known as the loudness of the sound.
2. Loudness of the sound cannot be measured.
3. Loudness of sound depends more on the sensitivity of our ears as compared to the wave energy.

Some facts regarding the characteristics of sound are as under :

1. Pitch is the property of sound because of which it is shrill or heavy. Pitch cannot be measured but can be experienced.
2. Pitch depends on the frequency of the sound. The pitch of the high frequency sound is high. This sound is shrill to hear. On the other hand the pitch of low frequency sound is low and is the heavy sound.
3. The pitch of buzzing mosquito is high while that of the roar of a lion is low.
4. Loudness is the property of sound on the basis of which it is loud or soft to listen. The loudness of soft or quiet sound is less while that of the loud sound is more.
5. The loudness of sound depends on the medium of sound propagation as well as the sensitivity of the ears. The same sound can be loud for one person while for the other it may be soft.
6. Quality or timbre is characteristic of sound on the basis of which two sounds having the same pitch and loudness can be distinguished from each other.

Example 11.1 : The frequency of a sound is 4 KHz and its wavelength is 17.5 cm. What will be the time taken by it to move by a distance of 3.5 km?

Solution : Frequency $\upsilon = 4\text{ KHz} = 4000\text{ Hz}$

$$v = \lambda\upsilon = 0.175\text{ m} \times 4000\text{ Hz}$$
$$700\text{ m/s.}$$

The wave has to cover a distance of 3.5 km, so the time taken by it will be

$$t = \frac{d}{v} = \frac{3.5\times1000\text{ m}}{700\text{ ms}^{-1}} = \frac{35}{7} = 5\text{s}$$

Thus, the sound will take 5 seconds to cover the distance of 3.5 km.

Example 11.2 : In a given medium the frequency of the sound wave is 220 Hz and its velocity is 440m/s.Calculate the wave length of this wave.

Solution :

Frequency of the wave $\upsilon = 220$ Hz

Wave velocity = 440 m/s

Formula :

$$V = \lambda \upsilon$$

$$\lambda = \frac{V}{\upsilon} = \frac{440}{220} = 2\text{m}$$

11.3 Speed of sound in different media :

Speed of sound depends upon the properties of the media including its temperature. The speed of sound is more in solid and less in gaseous media. The speed of sound increases with the increase in temperature. Normally, the speed of sound at 0ºC is 330 m/s. Table 11.1 shows the speed of sound in different media.

Table 11.1

Speed of sound in different media at 25ºC

State	Substance	Speed (m/s)
Solid	Aluminium	6420
	Nickel	6040
	Steel	5960
	Iron	5950
	Brass	4700
Liquid	Water (Marine)	1531
	Water (distilled)	1498
	Ethanol	1207
	Methanol	1103
Gas	Hydrogen	1284
	Helium	965
	Air	346
	Oxygen	316
	Sulphur-di-oxide	213

11.4 Reflection of sound :

Like light, sound is also reflected by the surface of a solid or liquid and follows the same laws of reflection as the light does. These laws are :

(1) The angle between the direction of the incidence of the sound and the perpendicular drawn on the point of incidence of the sound on the reflecting surface is the same as the angle of the direction of reflection and the perpendicular i.e. angle of incidence is equal to the angle of reflection.

(2) Incidence sound, reflected round and the perpendicular lie on the same plane.

Activity 11.5 : Two similar pipes are arranged near a wall, on a table, as shown in fig. 11.6 place a clock or some other source of sound at the open end of one of the pipes. Try to listen to this sound by placing your ear at the open end of the other pipe. Adjust the angle of the second pipe to hear the sound clearly. Now measure the angles of these pipes with the perpendicular drawn.

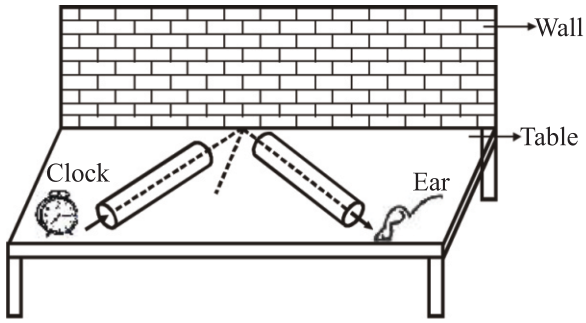

Fig. 11.6 Reflection of Sound

We find that

(1) The sound is heard with utmost clarity when the angles made by the two with the perpendicular are equal i.e. $\angle i = \angle r$.

Echo : If we shout loudly in front of any proper reflecting object - like a building, well, hill etc. we will hear our own voice after some time. This is known as the echo. To hear a clear echo there should be a time interval of atleast 0.1 sec between the original sound and the reflected sound. If the speed of sound at room temperature is 350m/s then to listen to a clear echo the distance of the barrier should be half of the total distance i.e. $\frac{1}{2}$ of $(350\times0.1) = \frac{1}{2}\times 35 = 17.5$ m. More than one echos can be heard because of repeated reflections of the sound

11.5 Reverberation :

The sound produced in an auditorium or a large hall is repeatedly reflected by its walls causing persistence of the sound after its source has stopped. This repeated or multiple reflection, which results in the persistence of the sound, is known as reverberation.

11.6 Uses of Multiple Reflection of Sound:

(1) Loudspeaker, horns and musical instruments like shahnai are designed in a manner that the sound spreads in all the directions. The sound waves produced by them are reflected many times and then are send towards the listener.

(2) Stethoscope is an important instrument in medical research which is used by the doctors to listen to the sound of heart and lungs. In it the sound reaches to the doctor's ears by multiple reflections.

(3) The roof of the concert halls, seminar rooms and cinema halls is curved so that the sound reaches to all parts of the hall after reflection.

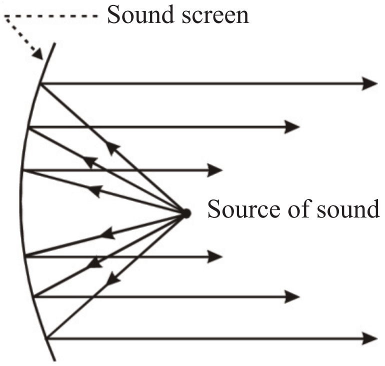

Fig. 11.7 Sound screen used in large halls.

Range of Hearing :

Sound waves on the basis of the range of their frequency can be of the following types :

(1) Audible sound waves : The sound waves which can be heard by our ears are known as audible sound. The frequency of these waves lies between 20 Hz and 20 KHz. These are known as the lowest and highest limits of the audibile frequency. These waves are produced by the resonance air column, tuning fork, violin etc.

(2) Infra sound waves : The sound waves of frequency less than 20Hz are known as the infra sound waves. These waves cannot be heard. They are produced at the time of earth quake, volcanic erruptions and in animals like whale, elephant etc.

(3) Ultra sound : The sound whose frequency is more than 20,000 Hz (20KHz) are known as the ultra sound waves. They can be produced by the vibrations of the quartz crystal. Animals like bat, cat, dog etc. and some birds and insects use ultra sound waves for signaling. They are used to measure the depth of the oceans, in medical science and to remove fog at Airports. In air the wave length of these waves is less than 1.6 cm.

Applications of Ultrasound :

Ultra sound are high frequency waves. Ultra sound is extensively used in the field of medical science and in industries. Some of its uses are as follows:

(i) Ultra sound is used to find out the cracks and other defects in metallic blocks. Ultra sounds are passed through the metallic blocks and indicators are used to detect the transmitted waves. If there is any defect the ultrasound waves are reflected which indicates defect in the block.

(ii) Ultrasound are used to clean the objects which are not reachable. The objects to be cleaned are placed in the cleansing solution and ultrasound waves are passed. The particles of dust, grease and dirt separate and fall apart due to the high frequency.

(iii) Ultrasound waves are reflected from various parts of the heart and an image is formed. This is known as the electrocardiogram (ECG).

(iv) Ultrasound is also used in the ultrasound sonography. In it images of various organs like liver, gall bladder, uterus, kidney etc. are obtained using ultrasound waves. Ultrasonography is made use of to examine the embryo during pregnancy and to detect any irregularities. This technique is used to detect tumours.

(v) Ultrasound is also used to break the kidney stone into minute pieces so that they come out along with the urine.

Bats emit ultrasound waves while flying at night and to find food and then detects the reflected waves. Bats cannot see so they generate high pitch ultra sound vibrations which are reflected on striking the barriers or insects other prey. These are then detected by bat's ears and it comes to know about their position.

11.7 : Sonar

This is a device in which ultrasound is made use of to determine the distance, direction and speed of objects present in the water. The English synonym of the word SONAR is Sound Navigation and Ranging.

Mechanism : In sonar, there is a transmitter and a detector and it is put on the boat or ship as shown in fig. 11.8. The ultrasound waves generated by the transmitter travels in water and after colliding with the object or sea floor are reflected. These reflected rays are detected by the detector which converts them into electric signals. The distance of the object from which the sound waves are reflected can be calculated by knowing the speed of sound (in water) and the time interval between transmission and detection of the ultrasound.

Suppose the time interval between transmission and detection of ultrasound signals is t and the speed of sound in marine water is v and if the object is at a depth d then the distance travelled from the ship to the object and back to the ship will be 2d.

Then $2d = v \times t$.

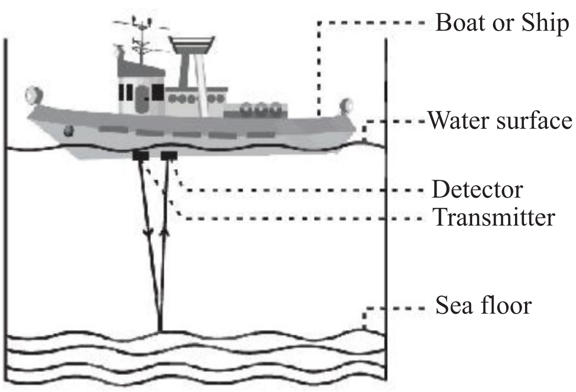

Fig. 11.8 Sonar

11.8 Structure of Human Ear :

We listen with our ears. Ear converts the variations of the pressure in air due to audible frequencies, into signals that reach the brain via the auditory nerves.

The structure of ear is shown in fig. 11.9. The outer ear is known as the 'pinna'. It collects the sound from the surroundings and send them to the auditory canal. On the end of the auditory canal there is a thin membrane called the ear drum. When the compression due to sound reaches the membrane the pressure on the outside of the membrane increases and pushes the ear drum inwards and at the time of rarefaction the membrane moves toward outside. Thus vibrations are generated on the ear drum.

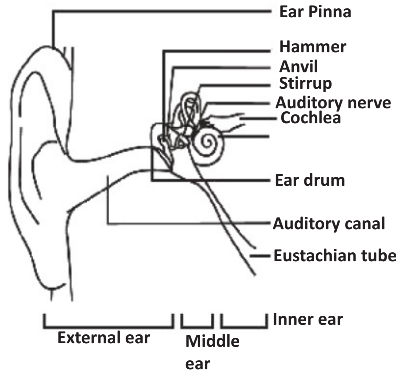

Fig. 11.9 Structure of ear

Three bones - the hammer, anvil and stirrup magnifies these vibrations manifold. The middle ear conducts these changes in pressure to the inner ears. The cochlea in the inner ear converts these pressure variations into electric signals and send them to the brain. The brain then interprets them in the form of sound.

11.9 Radar [Radio Aim Detecting and Ranging]:

Radar is a scientific equipment. It was invented by Taylor and Leo C Young in 1922. This instrument is used in detection of air crafts moving in space and to determine their position. It makes use of radio waves to find out distant objects, their location i.e. direction and distance. Radar can locate things situated at distances much more than can be perceived by our eyes and can identify their exact location. Nothing like fog, smog, rains, snowfall, smoke or darkness can hinder its functioning. However, radar cannot compete with our eye, as it cannot know the colour and minute details of the object. There is only a sense of presence of the object. Objects that are odd from the background and large objects like ships on the sea surface, high flying air-crafts, islands, sea shore etc. can be detected easily by the Radar. In 1886 Heinrich Hertz, the inventor of radio waves, had proved that radio waves could be reflected from the solid objects. In 1925 the reflection of radio pulse had been made use of to detect the distances and by 1939 many instruments working on the principle of Radar had been formed. But radar was used on large scale from Second World War onwards.

Fig. 11.10 Radar

Method for Position Location :

Radio waves are transmitted from radar and the time taken by them to return , on being reflected from the distant object is measured. The velocity of radio waves is 1,86,999 miles per second. Therefore the distance of the object can be easily calculated on knowing the time taken. The exact location of the reflector, that is, the target object is known by the high direction sensing antenna on the Radar. The actual position of the object becomes known by knowing the distance and direction. The transmitter of the radar emits momentary but intense pulses of radio waves at regular intervals. The receiver receives the reflected waves from outer objects, if present, in the time interval between the two pulses. The exact timing of reception of reflected waves is known by the electric circuits and the distance is then known instantly by the indicators marked in proportion to time. One microsecond (10 lakh part of a second) refers to 164 yards and 19.75 microsecond means a distance of 1 mile. Some radars can sense the presence of objects upto the distance of 199 miles. Good instruments measure the distances with an accuracy of 15 yards and the variation in distance does not influence the measurement much. The angle of the height or the direction of the target object can be measured to an accuracy of 9.96 part of a degree. The position is clearly observed in the Cathode-ray-tube of Radar.

Knowledge of direction :

The antenna is rotated or is moved to and fro to know the target. When the antenna is in the direction of the target the image of the target is seen on the cathode ray tube screen. This image is known as the pip. Pip is most clear when the antenna is in its direction. The antenna of the radar are highly direction oriented. They concentrate the radio waves into screwed beams and special type of reflectors in the instrument condense these beams. Waves with very small wave length i.e. those having high frequency are used for the functioning of the radar. An instrument known as the multi cavity magneton is required for the production of these beams. Functioning of modern radars is not possible without this multi cavity magneton.

Components of a Radar :

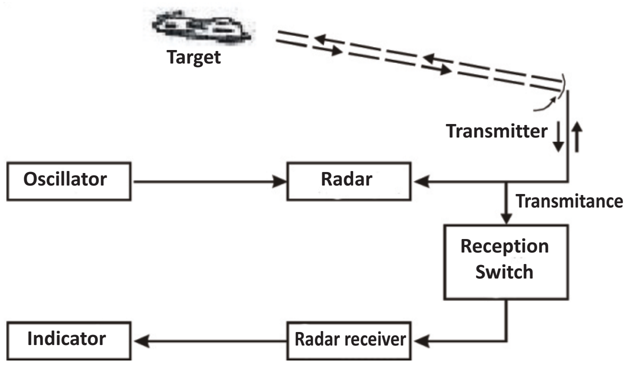

Fig. 11.11 : Components of a Radar and its functioning

Modulator : The essential impulse of high electric power provided to the Radio frequency Oscillator is obtained from the modulator.

Radio frequency Oscillator generates the high frequency power impulses from which the radar signals are formed. Antenna transmits these impulses to the sky and receives them back.

Receiver detects the radio waves that returns .

Indicator provides information gathered by the antenna to the radar operator.

Synchronisation and **measurement of range** is done by the modulator and the indicator.

These are just the basic components of the radar, the details however are modified and fine tuned according to the purpose for which the radar has to be used.

Use of Radar :

The sudden attacks during wars has become nearly impossible because of radar. It pre informs the arrival of ships, aircrafts and rockets. The presence of radar on aircraft informs of the other arriving aircrafts. Because of this instrument the fighter planes successfully reach their target and return. With the help of radar it is possible to know what is happening in all the directions, in the sky, on the ground in a radius of 299 miles, from the central controlling point. We can come to know of the presence of boats on the sea and other ships, whether it is day or night. They also help in shooting missles on enemy ships.

During times of peace also the radar have many uses. They have made boat, ship or air craft monitoring more safe because the drivers are able to view the hills, glaciers and other hurdles from a distance. Radar helps the airplanes to know their exact height from the earth surface and facilitates landing at airports during night. On 19th January 1946 the United States of America's troop first established contact with the moon by means of radar. The radio signals had to cover a distance of 4,59,999 miles to contact moon and it took a time of 2.4 seconds.

Important points

1. The motion of a particle which is repeated continuously after a definite time is known as recurrent motion.
2. The recurrent motion of a particle to and fro from a point in a simple line is known as the vibrational motion or oscillatory motion.
3. On the basis of the type of vibrations of the particles of the medium, waves can be of two types :

   (i) Transverse waves (ii) Longitudinal waves
4. Sound is produced because of vibration of different objects. Sound waves are longitudinal waves.
5. Sound travels in a medium in the form of consecutive compression and rarefaction.
6. The distance between two consecutive compressions or two consecutive rarefactions is known as wave length. It is represented by λ.
7. Time period (T) is the time taken by a wave for a complete oscillation of the disturbance of the medium.
8. Frequency (υ) is the total number of oscillations in a unit time. $\upsilon = 1/T$
9. The speed of a wave is equal to the product of its frequency and wave length i.e. $v = \upsilon\lambda$.
10. Intensity of the sound is 'amount of sound energy passing a unit area in one second.'
11. The speed of sound basically depends upon the nature of the medium of propagation and its temperature.
12. The direction of incidence of sound on a reflector (wall etc.) makes an angle with the perpendicular drawn at the point of incidence, which is always equal to the angle made by the perpendicular with the direction of the transmitted sound wave. The direction of incidence of the wave, that of transmitted wave and the perpendicular all three lie in the same plane.
13. A minimum time interval of 0.1 second between the original sound and the reflected sound, is essential, for hearing the echo, clearly.
14. Sound has three properties :

    (i) Pitch (b) Loudness

    (iii) Quality
15. The range of sound audible to human ears it 20 Hz to 20KHz.
16. The sounds of frequency less than 20 Hertz are known as infra sound while those having frequency more that 20 KHz are known as ultra sonic.
17. Ultra sonic sound has many uses in medicine and industries.
18. Sonar is a device used to measure the depth of sea or to detect some visible object under water.

19. Ultra sonic waves are used in Sonar.
20. Tone is the sound generated by the mixture of many frequencies.
21. Radar is used to detect the air-crafts moving in the space and to determine their position.

Important Questions

Objective type :

1. The wave having compression and rarefaction is known as :
(a) Transverse wave
(b) Longitudinal wave
(c) Light wave
(d) Ultra violet waves
2. The relation between velocity v, wavelength λ and frequency υ is :
(a) $v = \upsilon\lambda$ (b) $\lambda = v\upsilon$
(c) $\upsilon = v\lambda$ (d) $v = \lambda/\upsilon$
3. Longitudinal waves can be generated in :
(a) solid and gas
(b) solid and liquid
(c) gas and liquid
(d) solid, liquid and gas
4. The vibration of the particles of the medium in longitudinal waves is :
(a) In the direction of the wave
(b) Vertical to the direction of the wave
(c)The particles do not vibrate
(d) at an angle of 60^o to the direction of waves
5. The speed of sound is maximum in :
(a) air (b) solid
(c) water (d) Both water and solid
6. The time period of the hour-hand of a clock is :
(a)1 hour (b) 24 hours
(c) 12 hours (d) None of the above
7. If the speed of a wave is 350 m/s and its wave-length is 50 cm then the frequency of the wave will be :
(a) 13500 Hz (b) 700 Hz
(c) 400 Hz (d) 300 Hz
8. The number of complete oscillations made in one second is known as :
(a) Amplitude (b) Speed
(c) Time period (d) Frequency
9. The time period of a vibrating body is 0.02 s. The frequency of vibrations will be :
(a) 100 Hz (b) 20 Hz
(c) 50 Hz (d) 1 Hz
10. The time period of the seconds-hand of a watch is :
(a) 1 minute (b) 1 hour
(c) 12 hours (d) 24 hours
11. The limit of audibility is :
(a) 200 Hz to 20,000 Hz
(b) 20 Hz to 20,000 Hz
(c) 2 Hz to 20 Hz
(d) more than 20,000 Hz
12. To listen to the echo the sound should reach our ears at least after :
(a) 0.1 s (b) 0.5 s
(c) 1 s (d) 2 s
13. The frequency of the waves used for ultrasonography is :
(a) 20 Hz
(b) Less than 20 Hz
(c) From 20 Hz to 20,000 Hz
(d) More than 20,000 Hz
14. Unit of amplitude is :
(a) m (b) m/s
(c) Hz (d) None of the above
15. The velocity of sound in vacuum is :
(a) 3×10^8 m/s
(b) 330 m/s
(c) Sound cannot move in vacuum
(d) None of the above

Very short answer type :

1. Longitudinal waves can be generated in which type of medium?
2. The sound waves produced in iron are of which type?
3. The sound waves produced in air are of which type?
4. If a wire tied between two pegs is stretched vertically to its length and is left, then which type of wave will be produced in the wire.
5. What is the SI unit of wave length?
6. What is the SI unit of frequency?
7. Which type of waves will be generated if a freely hanging slinky is stretched and is left?
8. What is the type of movement of the hands of a clock?
9. Define wave length.
10. Define frequency.
11. What is a Radar?

Short answer type questions :

1. What is essential for production of sound?
2. What do you understand by motion of a wave?
3. What are longitudinal waves?
4. What is required for the propagation of waves?
5. What is transferred during wave propagation from one point to another? Energy or some physical mass?
6. Give two examples of longitudinal waves.
7. Are waves generated by a bullet fired from a gun or a stone hurled from a catapult?
8. Write the method of 'position location' by a radar and the uses of radar.
9. What is the difference between the longitudinal and the transverse waves?

Essay type Questions :

1. Define the following :
   (i) Amplitude (ii) Frequency
   (ii) Time period (iv) Wave-length
2. Write the relation between :
   (i) Time period and frequency
   (ii) Frequency, wavelength and velocity
3. Answer the following :
   (i) What is the distance travelled by the wave when the particle of medium completes one oscillation?
   (ii) The sound waves in air are transverse or longitudinal?
   (iii) Write the names of the wave/waves which can be generated in a long slinky.
   (iv) Give two examples of each : the longitudinal waves and the transverse waves.
   (v) Name the physical quantity whose unit is Hz.
4. Write the uses of ultrasound.
5. Write the extended form of SONAR. How will you determine the depth of sea by using reverberation range?
6. Explain, with the help of a suitable diagram, the working of the human ear.
7. Write the laws of reflection of sound. Describe an activity to verify them.
8. What is ultrasound? How can it be used to detect the defects in metallic blocks?
9. Elucidate the components of a radar and their functions.

Numerical Questions :

1. An object is vibrating 6600 vibrations per minute. If the velocity of sound in air is 330 m/s then find :
   (i) Time period (ii) Frequency
   (iii) Wave length
2. The time period of a body is 0.004 s. Find its frequency.
3. The distance between two adjacent crests of a wave is 30 cm and its frequency is 450 Hz. Then determine the velocity of the wave.
4. A wave of frequency 256 Hz is propagating at a speed of 330m/s. What will be the speed of a wave having frequency of 512 Hz, in the same medium?

Answer Key

1. (b)	2. (a)	3. (b)	4. (a)	5. (b)
6. (c)	7. (b)	8. (d)	9. (c)	10. (a)
11. (b)	12. (a)	13. (d)	14. (a)	15. (c)

Answer for the numeric questions

1. (i) 1/110 seconds
   (ii) 110 Hz
   (iii) 3m
2. 250 Hz
3. 135 m/s
4. 330 m/s