SOUND

Introduction

Sound is a form of energy that produces the sensation of hearing in our ears. The speed of light high 3×10^8 meters per second (30 crore metres per second) and the speed of sound in the air under normal conditions is 344 metres per second. So, the light travels almost instantaneously, whereas sound takes some time.

How is sound Produced

In all the activities described above we notice that sound is produced by vibrations. Thus, all vibrating bodies produce sound.

In some cases, the vibrations are easily visible to our naked eyes but in some cases they can only be felt and not seen.

How does Sound Propagate

When a person speaks, the molecules in the air near his mouth are disturbed. Due to this, these molecules start vibrating to-and-fro about their mean positions. These vibrating molecules then disturb the nearby molecules. This process continues until the molecules in the air next to the listener's ear start vibrating. These vibrating molecules then cause vibrations in the diaphragm of the listener's ear and the sound is heard.

Vibrations or Oscillations

In the previous section, you have learnt that a vibrating body produces sound.

◆ Rapid to-and-fro movements of a body about its mean position are called vibrations.

◆ Slower vibrations are called oscillations.

◆ The to-and-fro motion of a body on the same path with its mean position in the middle is called Oscillatory motion.

Have you carefully watched a child on a swing ? The swing repeats its updown and forward-backward motion in a regular fashion. The swing moves to-and-fro on the same path with its mean position in the middle. The motion like that of a swing is called oscillatory motion.

Some examples of oscillatory motion are :

(a) motion of the pendulum of a wall clock,

(b) vibrating string of a musical instrument.

(c) motion of the heart muscles in a healthy person.

When a body underoges an oscillatory motion, it passes through a particular position at regular intervals of time. Therefore, oscillatory motion is a periodic motion.

◈ **Oscillation**

The movement of a body from one extreme position to the other and back is called an oscillation. In the figure shown in the activity 5, the movement of the bob from B to C and back to B is one complete oscillation.

Also, the motion of the bob from A to B, B to C and then from C to A is one complete oscillation.

❖ **Amplitude of Oscillation (A)**

The maximum displacement of a body from its mean position is called the amplitude of oscillation. Thus, in the figure shown in the activity 5, the displacement AB or AC is called amplitude of the oscillating bob. Amplitude is denoted by A.

For a body oscillating in the air, the amplitude of oscillation gradually decreases due to the air-resistance.

❖ **Time period (T)**

The time taken to complete one oscillation is called its time period. Time period is denoted by T. In the figure (see activity 5), the time taken by the bob to travel from B to C and back to B is called is its time period.

As long as the amplitude of oscillation is small, the pendulum takes equal intervals of time to complete each oscillation.

❖ **Frequency of Oscillation**

The number of oscillations made by an oscillating body in one second is called the frequency of oscillation.

Frequency (v) is related to the time period (T) by the relationship,

Frequency, $v = 1/T$

The unit of frequency of oscillation is hertz (Hz).

1 Hz = 1 cycle per second

Audible and Inaudible Sound

The human ear can hear the sounds having frequencies between 20 Hz to 20000 Hz. This is called the audible range. Thus, the audible range of a normal human ear is 20 to 20000 Hz.

◆ The sound in the audible range (20 to 20000 Hz) is called sonic sound. An infant (about 1 year old) can hear sounds up to 35000 Hz. This limit gradually comes down to 20000 Hz for an adult.

◆ The sound of frequencies greater tha 20,000 Hz is called ultrasonic sound.

◆ The sound of frequencies lower than 20 Hz is called subsonic or infrasonic sound.

Less than 20 Hz	20 Hz to 20000 Hz	Greater than 20000 Hz
subsonic sound	**sonic sound**	**ultrasonic sound**

Ultrasonic Sound and Animals

Certain animals such as dog, leopard, monkey and deer can hear ultrasonic sounds. Certain birds like bat can produce sounds of very high frequencies. A bat is able to locate any obstacle or its prey in its path due to reflection of the ultrasonic wave from the object. Dolphins use ultrasonic sound to locate their prey.

❖ **Technological / Industrial Applications of Ultrasonic Sound**

Ultrasonic waves have short wavelength.

These short wavelength sound waves can be reflected back from the smaller objects. Thus, ultrasound can detect or 'see' smaller objects (< 1 cm size). The ultrsonic waves do not get scattered.

Some important technological and industrial uses of ultrasonic waves are described below :

◆ Ultrasonic waves are used to drive away rats, cockroaches etc.

◆ Ultrasonic waves are used for detecting any deformity in the unborne baby.

◆ Ultrasonic waves are also used for determining the depth of sea.

◆ Ultrasonic waves are also used for detecting the presence of submarines, icebergs, sunken ships etc., in the sea. This technique is called by the name SONAR (Sound Navigation and Ranging).

Sound Needs a Medium to Propagate

You have learnt that vibrations produce sound. To produce vibrations, we need a material body. Therefore, we can say that a medium is needed for sound to travel.

Speed of Sound

Sound travels at different speeds in different media .

Medium	Air (dry)	Water	Steel
Speed of sound at 0°C	330 m/s	1500 m/s	6000 m/s

As per definition,

$$\text{Speed of sound} = \frac{\text{Distance travelled by the sound}}{\text{Time taken}}$$

Reflection of Sound

Like light, sound also gets reflected from a hard surface.

◈ **Echo**

When sound waves strike a hard surface, they get reflected.

In a small room, the sound that reacthes us directly and the one which gets reflected from the walls, reach our ears almost at the same time. As a result, we hear only one sound.

When the sound gets reflected from a surface which is far away, we hear two sounds. The first sound is the sound which reaches us directly from the source. The second sound is the sound which reaches us after suffering reflection from the far off surfaces.

The sound which is received after reflection from a far off object is called an echo.

An echo is produced only when the listener is at a distance of 11 metres or more from the reflecting surface.

◈ **Applications of Echo-sounding**

Determining the distance of a sound-reflecting surface by producing echo is called echo-sounding. This method is also called Sound Navigation and Ranging (SONAR).

Echo-sounding (or Sonar) is used

◆ for determining the depth of a sea

◆ by ships to detect submarines

◆ by bats and dolphins to locate any obstacle in their path.

To measure the depth of a sea, pulse of ultrasonic sound (high frequency sound) waves are sent down into the sea from a ship. These pulses after suffering reflection from the sea-bed are received back on the ship. The time taken by the sound to travel down and return back to the ship is measured. By knowing the speed of sound in the sea water, the depth of the sea at that place can be determined.

$$\text{Depth of the sea} = \frac{1}{2} \times \text{Total distance travelled by the sound pulse}$$

or $$\text{Depth of the sea} = \frac{1}{2} \times \text{Speed of sound in sea water} \times \text{Total time taken}$$

Ex.   A ship out a sound wave and receives an echo after 1 second. If the speed of sound in water is 1500 m/s. What is the depth of the sea at that point ?

Sol.   Given :

Total time taken by the sound wave = 1s

Speed of sound in the sea water = 1500 m/s

Then, depth of the sea = $\frac{1}{2}$ × Speed of sound × Total time taken

or, depth of the sea = $\frac{1}{2}$ × 1500 m/s × 1s = 750 m

Characteristics of Sound

A sound is characterised by the following characterisitcs :

1. Loundness
2. Pitch
3. Quality or tone

◈ **Loudness**

Loudness of a sound depends on the amplitude of the vibration producing that sound. Greater is the amplitude of vibration, louder is the sound produced by it.

The loudness of a sound also depends on the quantity of air that is made to vibrate. Loudness of sound is measured in decibel (dB) unit.

◈ **Pitch**

The shrillness of a sound is called its pitch. The pitch of a sound depends upon its frequency. Higher the frequecy of a sound, higher is its pitch.

The voice of a child or a women has higher frequency than the voice of a man.

That is why, the voice of a child or a woman is more shrill as compared to the voice of a man.

The stretched membrane of a tabla or mridangam produces sound of a higher frequency (or of higher pitch).

◈ **Quality**

Quality of a sound is also called its tone. We can easily distinguish between the sounds produced by different sources. Let us see how does it become possible. A tuning fork produces the sound of a single frequency. Most other instruments usually produce sounds (called notes) which consist of a basic or fundamental frequency and a number of overtones or harmonics of different loudness.

Different instruments, depending on their shape and size, produce different number of harmonic of different relative loudness. As a result, the sound produced by an instrument can be distinguished from that produced by other instruments.

Noise–A Health Hazard

Loud and harsh sound is called noise. Noise is produced by irregular vibrations.

The disturbance caused by an undesirated loud sound of different kinds is called noise pollution. Noise pollution is caused by motors, trains, aeroplanes, radio, T.V. and loudspeakers etc.

❖ Effect of Noise Pollution

Noise pollution may cause,

- ◆ Hearing loss – prolonged exposure to high noise level can lead to los of hearing.
- ◆ Fatigue
- ◆ High blood pressure
- ◆ Extreme emotional behaviour.

❖ Ways to Reduce Noise Level

Noise level can be reduced by the following activities :

- ◆ Setting up of industry away from the resisdential areas and planting more trees.
- ◆ Restricted use of loudspeakers, amplifiers, and upto horns.
- ◆ Using soft/carpeted floors, curtains and sound absorbers such as cork thermocole indoor can reduce the noise level.

The Human Ear

Sound waves from outside are collected by the outer ear and reach the eardrum. When the sound waves strike the eardrum, it starts vibrating. These vibrations are passed on to the oval window by three bones (called the hammer, anvil and stirrup) which act as a lever with the pivot at point P. They magnify the force of the vibrations. The oval window has a smaller area than the eardrum. So this increases pressure on the oval window and on the liquid in the cochlea.

The vibrations of the liquid in the cochlea affect thousands of auditory nerves which send message to the brain.

Our ears are very delicate and frangile organs. Proper care must be taken to keep them in healthy state.

Some suggestions to keep the ears helathy are given below :

- ◆ Never insert any pointed objet into the ear. It can damage the eardrum and make a person deaf.
- ◆ Never shout loudly into someone's ear.
- ◆ Never hit anyone hard on his/her ear.

EXERCISE - 1

VERY SHORT ANSWER TYPE QUESTION

Q.1 Define vibration.

Q.2 How is sound produced ?

Q.3 Can sound travel in vacuum ?

Q.4 What is meant by oscillatory motion ?

Q.5 Define frequency.

Q.6 Define 1 hertz.

Q.7 Define amplitude.

Q.8 What is audible range of sound ?

Q.9 Name the equipment which works at frequencies greater than 20,000 Hz.

Q.10 What is noise ?

Q.11 What is meant by base loudness level ?

Q.12 In which unit loudness is expressed ?

Q.13 Name the SI units of (i) time period (ii) frequency.

Q.14 In which state of matter does sound travel the (i) slowest (ii) faster ?

Q.15 What happens to sound when it strikes a surface ?

Short Answer Type Question

Q.16 The sound from a mosquito is produced when it vibrates its wings at an average rate of 500 vibrations per second. What is the time period of the vibration ?

Q.17 How can we control the sources of noise pollution ?

Q.18 What is relation between loudness of sound and amplitude ?

Q.19 The frequency of a given sound is 1.5 KHz. How many vibrations is it completing in one second ?

Q.20 Which characteristic of a vibrating body determines (a) loudness (b) pitch of the sound produced by it.

Q.21 Why do we hear the thunder a little after we see the flash of lightning ?

Q.22 Why do we not hear echoes in our ordinary surroundings ?

Q.23 What are vocal cords ? What is their function?

Q.24 How is that you can hear a friend talking in another room without seeing him ?

Q.25 List sources of noise pollution in your surroundings.

Q.26 What are the effects of noise pollution ?

Q.27 A pendulum oscillates 40 times in 4 seconds. Find its time period and frequency.

Q.28 Your parents are going to buy a house. They have been offered one on the roadside and another three lanes away from the roadside. Which house would you suggest your parents should buy ? Explain your answer.

Q.29 How can the noise pollution be controlled in residential area ?

Q.30 Can you hear the sound on the moon? Explain.

Long Answer Type Questions

Q.31 Lightning and thunder take place in the sky at the same time and at the same distance from us. Lightning is seen earlier and thunder is heard later. Can you explain why ?

Q.32 (a) What is SONAR ?

(b) What is the basic principle of its working?

(c) Explain its use.

Q.33 What is the use of ultrasound in medicine and industry ?

Q.34 (a) Name the properties of sound which is

(i) similar to the property of light.

(ii) different from that of light

(b) Why do some people have hearing impairment ? How do they communicate with others ?

EXERCISE - 2

SINGLE CORRECT ANSWER TYPE QUESTIONS

Q.1 Sound cannot travel through
(A) air   (B) water
(C) iron   (D) vacuum

Q.2 The audible range of frequency is
(A) 200-2000 Hz   (B) 20-20000 Hz
(C) 20-23000 Hz   (D) 220-20000 Hz

Q.3 A tightended string of instrument produces sound of .... frequency.a
(A) lower   (B) higher
(C) same   (D) none of these

Q.4 An object produces a sound of 15 Hz. Which of the following is correct ?
(A) this sound can be heard by us
(B) this sound cannot be heard by us
(C) it does not produce sound
(D) this sound can be heard only through solids

Q.5 A mosquito produces sound by vibrating its...
(A) wings   (B) vocal cords
(C) legs   (D) body

Q.6 Violin is a musical instrument with ....
(A) stretched bow
(B) stretched string
(C) stretched membrane
(D) none of these

Q.7 Loudness is the measure of .... of a sound.
(A) shrillness   (B) heaviness
(C) Length   (D) Pitch

Q.8 The level of normal conversation is about..... dB.
(A) 40-60   (B) 100-200
(C) below 60   (D) 60-100

Q.9 Late Ustad Bismillah Khan was a famous.... player.
(A) Flute   (B) Table
(C) Guitar   (D) Shehnai

Q.10 The frequency of a sound wave is
(A) Directly propertional to time period
(B) Inversely proportional to time period
(C) Equal to the time period
(D) Has no relation with time period

Q.11 The maximum distance of a vibrating body from its mean position is called its –
(A) Frequency   (B) Quality
(C) Amplitude   (D) Pitch

Q.12 The loudness of a sound depends upon its–
(A) Amplitude   (B) Frequency
(C) Pithc   (D) None of these

Q.13 The pitch of a sound depends upon its –
(A) Amplitude   (B) Frequency
(C) Quality   (D) None of these

Q.14 Two wires A and B of equal length differ only in their thickness. A is thinner than B. If both are plucked with same force, then–
(A) A will produce sound of higher pitch than B
(B) A will produce sound of lower pitch tha B
(C) Both will produce sounds of equal pitch
(D) None of these

Q.15 Which of the following are used in dishwasher or to wash the machines ?
(A) Infra-sonic waves
(B) Ultra-sonic waves
(C) Both (A) and (B)
(D) Neither (A) nor (B)

Q.16 Which of the following sounds has the greatest frequency ?
(A) man's voice
(B) woman's voice
(C) boy's voice
(D) all have the same frequency

Q.17 The sound waves travel the slowest in –
(A) Dry air   (B) Moist air
(C) Liquid water   (D) Ice

Q.18 For an echo to be distinguishable from sound, the minimum time difference is –
(A) 1 sec   (B) 0.1 sec
(C) 0.01 sec   (D) 10 sec

Q.19 Which of the following is the correct group of wind instruments –
(A) Violin, drum, nadaswaram
(B) Shehnai, flute, nadaswaram
(C) Shehnai, flute, cymbals
(D) Gongs, jaltarang, shehnai

Q.20 Sound cannot be associated with
(A) hearing   (B) frequency
(C) wave   (D) sunlight

Q.21 Sound is caused due to
(A) propagation of light
(B) vibrations
(C) change in physical state
(D) clouds

Q.22 The minimum distance required to produce a distinct echo is
(A) 10 m   (B) 11 m
(C) 15 m   (D) 17 m

Q.23 Which of the following is not a stringed instrument ?
(A) Sitar   (B) Tabla
(C) Violin   (D) Guitar

Q.24 Sound travels in air at 0°C with a velocity of about
(A) 300 m/s   (B) 330 m/s
(C) 360 m/s   (D) 380 m/s

Q.25 Velocity of sound in water is about
(A) 340 m/s   (B) 420 m/s
(C) 1000 m/s   (D) 1500 m/s

Q.26 If a pendulum has a time period of 3 second, then its frequency is
(A) 3 Hz   (B) 0.5 Hz
(C) 3 s   (D) 0.33 Hz

ANSWER KEY
EXERCISE-1

VERY SHORT ANSWER TYPE QUESTION

Sol.1 Vibration is the to and fro or back and forth motion of an object.

Sol.2 Sound is produced by a vibrating body.

Sol.3 No, sound cannot travel in vacuum.

Sol.4 The to and fro motion of an object is known as oscillatory motion.

Sol.5 The number of oscillations per second is called the frequency of oscillation.

Sol.6 A frequency of 1 hertz means one oscillation per sound.

Sol.7 The maximum distance to which a vibrating body moves on either side of its mean position is called the amplitude of vibration.

Sol.8 The range of the sound which can be heard by human ear is known as audible sound.

Sol.9 Ultrasound equipment.

Sol.10 Unpleasant soundes are called noise.

Sol.11 The base loudness level is defined as that loudness of sound that the human ear can just perceive.

Sol.12 Loudness is expressed in a unit called decibel (dB).

Sol.13 (i) Second

(ii) Hertz

Sol.14 (i) Air

(ii) Solids

Sol.15 Sound gets reflected on striking a surface.

Short Answer Type Question

Sol.16 Time taken for 500 vibrations = 1 second

Time taken for 1 vibrations = 1/500 second.

Time period = 1/500 second.

Sol.17 We can control noise pollution by designing and installing silencing devices in machines.

Sol.18 Loudness of sound is proportional to the square of the amplitude of vibrations producing the sound.

Sol.19 Frequency $= \dfrac{\text{No. of vibrations}}{\text{time}}$

No. of vibrations = Frequency × time

$= 1.5 \times 1000 \times 1$

$= 1500$ vibrations

Sol.20 (a) Amplitude

(b) Frequency.

Sol.21 We hear the thunder a little after we see the flash of lightning because the speed of sound is less than the speed of light.

Sol.22 We do not hear echoes in our ordinary surroundings because the distance to hear echo should be more than 17 m.

Sol.23 The larynx has a pair of membranes known as vocal cords stretched across their length. The vocal cords vibrate and produce sound.

Sol.24 Sound can travel in all directions and around corners. Light cannot travel around corners. Therefore, we can hear a friend talking in another room but cannot see him.

Sol.25 The major sources of noise pollution are sounds of vehicles, explosions, machines, loudspeakers.

Sol.26 Due to noise pollution a person may suffer from lack of sleep, hypertension and anxiety. If a person is exposed to noise continuously he may get temporary or permanent deafness.

Sol.27 40 vibrations in 4 seconds.

10 vibrations in 1 seconds.

$\therefore$ Frequency = 10 vibrations/sec. or 10 Hz.

$\therefore$ Time period = 1/10 sec.

Sol.28 I would advise my parents to buy the house three lanes away from the roadside because there the noise from automobiles would be much less.

Sol.29 (a) The noisy operations must be conducted away from residential areas.

(b) Noise producing industries should be set away from such areas.

(c) Use of automobile horns be minimized.

(d) TV and music systems should be run at lower volumes.

Sol.30 We cannot hear the sound on the moon because sound requires a material medium to travel. On the moon there is no atmosphere and sound cannot travel in vacuum.

Long Answer Type Question

Sol.31 The speed of light is more that the speed of sound. Therefore, even though thunder and lightning take place simultaneously, we see the lightning earlier.

Sol.32 (a) SONAR refers to Sound Navigation and Ranging.

(b) The principle of reflection of sound is used in SONAR.

(c) SONAR is used to measure the depth of the ocean. Ultrasonic waves are sent from the ship down into the sea. They are received back after reflection from the sea bed. The depth is calculated by noting the time period.

Sol.33 Use of ultrasound in medicine :

(a) for scanning and imaging the body for stones, tumour and foetus.

(b) for relieving pain in muscles and joints.

Use of ultrasound in industry :

(a) for detecting finer faults in metal sheets.

(b) in dish washing machines where water and detergent are vibrate with ultrasonic vibrators.

(c) for homogenising milk in milk plants.

Sol.34 (a) (i) The property of sound similar to light is that in both reflection takes place.

(ii) Sound can travel around corners but light cannot.

(b) Some people suffer from hearing impairment because their ear drum is damaged or absent. This can be from birth or may occur later on. Such people communicate with "sign language". They can also use "hearing aids".

EXERCISE-2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	B	B	B	A	B	C	A	D	B	C	A	B	A	B
Ques.	16	17	18	19	20	21	22	23	24	25	26				
Ans.	B	A	B	B	D	B	D	B	C	D	D				