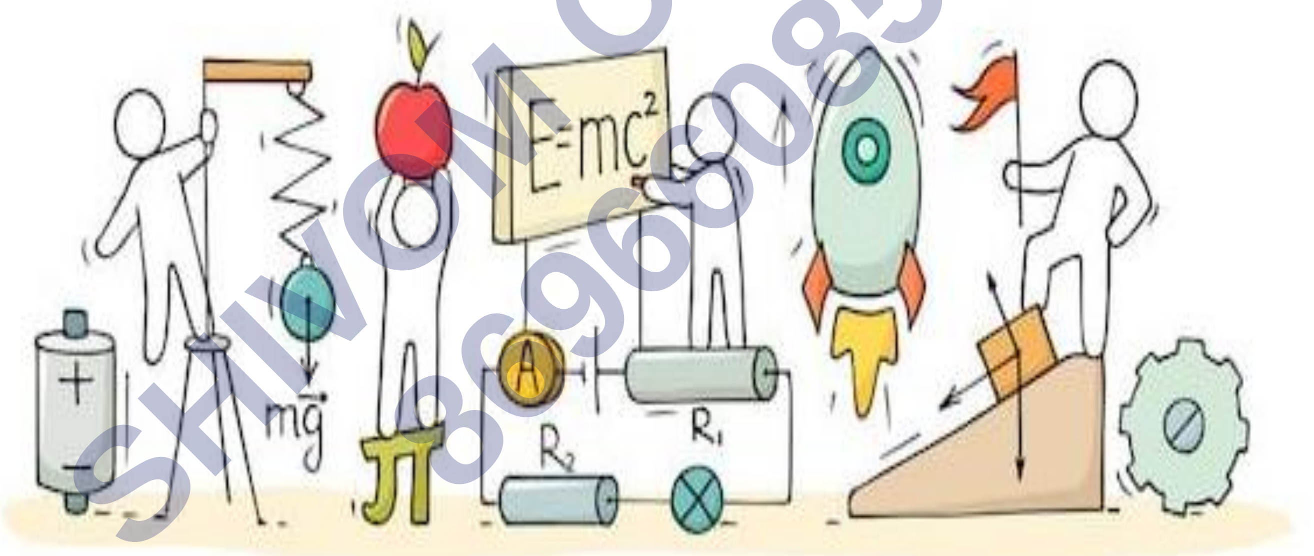
PHYSICS

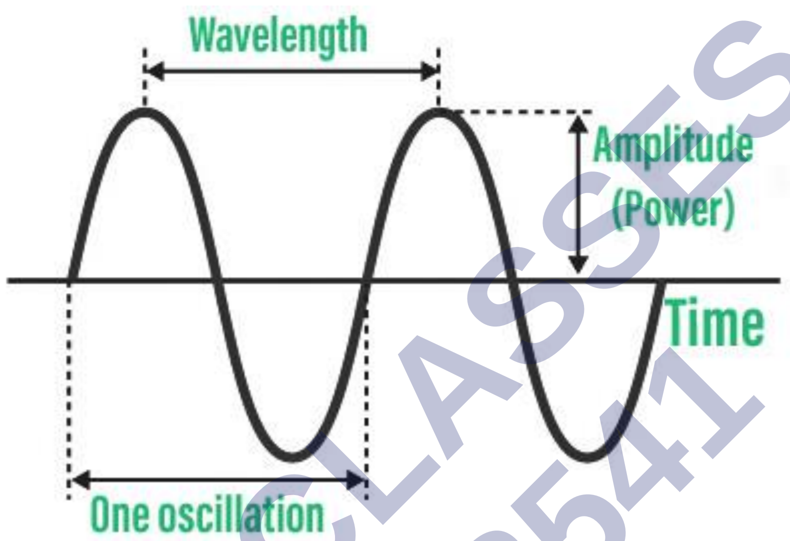
Chapter 12: Sound



Sound

- Sound is a form of **mechanical energy** which produces the sensation of **hearing**.
- It is produced due to **vibrations** of different objects. It travels in the form of waves.
- Sound is a form of energy which produces a sensation of hearing in our ears.

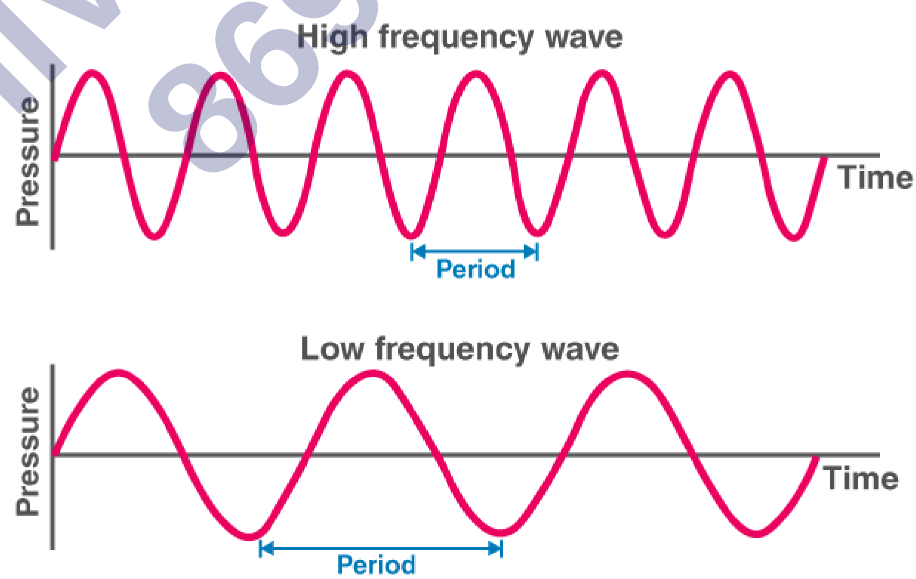
Introduction to waves



A wave is a disturbance in a medium which moves from one point to another and carries energy without a net movement of particles. It may take the form of elastic deformation or a variation of pressure.

E.g: Rubber cork on the water that goes up and down when a rock falls in the water creates a ripple.

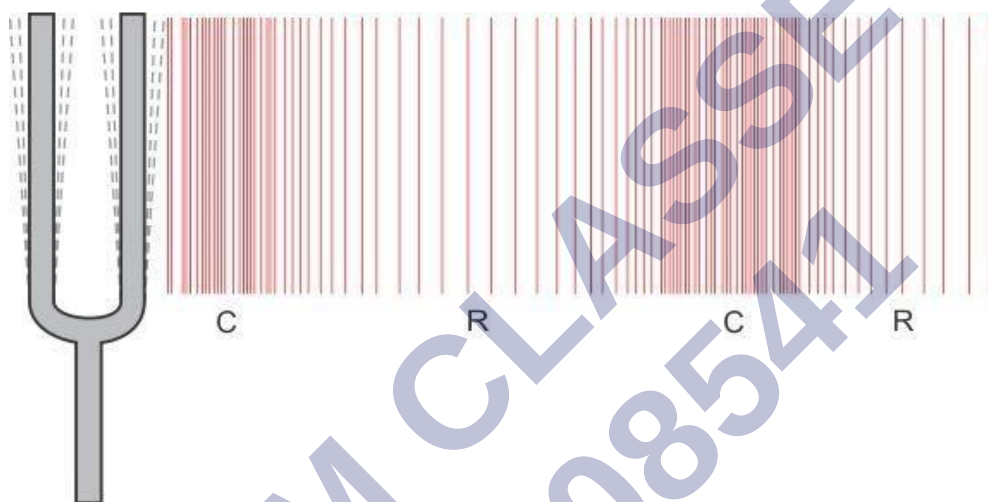
Propagation of Sound



Propagation of sound

- A material medium is necessary for the propagation of sound. It can be solid, liquid or gas.

- The disturbance which moves through a medium when the particles of the medium set the neighbouring particles into motion is known as a **wave**.
- A sound wave can be considered the propagation of pressure or density variations in the medium, i.e. it propagates in a medium as a series of compressions and rarefactions.
- A region of compressed air (increased density or pressure) is called a **compression** (C) and that of rarefied air (decreased density or pressure) is called a **rarefaction** (R).
- A vibrating object produces a series of compressions and rarefactions in the medium.



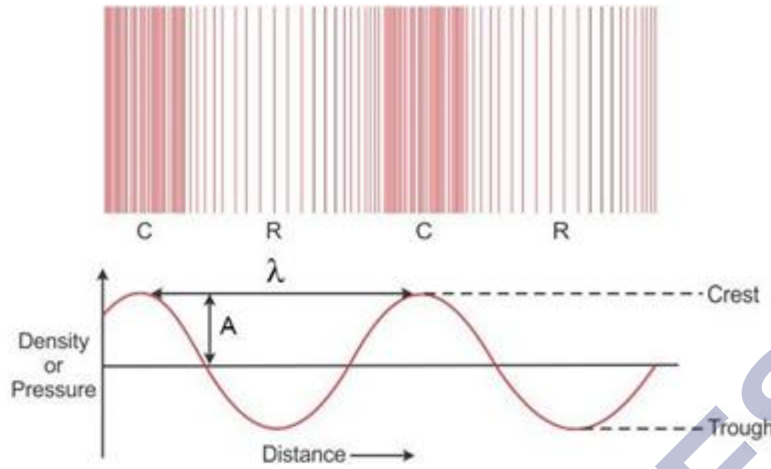
Example: When the prongs of a tuning fork move forward, compression is formed, and when the prongs move backwards, rarefaction is formed.

- As sound propagates, it is the sound energy which travels in the medium and not the particles of the medium.
- Sound waves are **longitudinal waves** as the particles of the medium through which the wave propagates vibrate in a direction parallel to the direction of propagation of waves.

There are many types of waves like mechanical waves, electromagnetic waves, matter waves.

Mechanical Wave:

Mechanical wave is periodic disturbances which require material medium like solid, liquid and gas for its propagation.

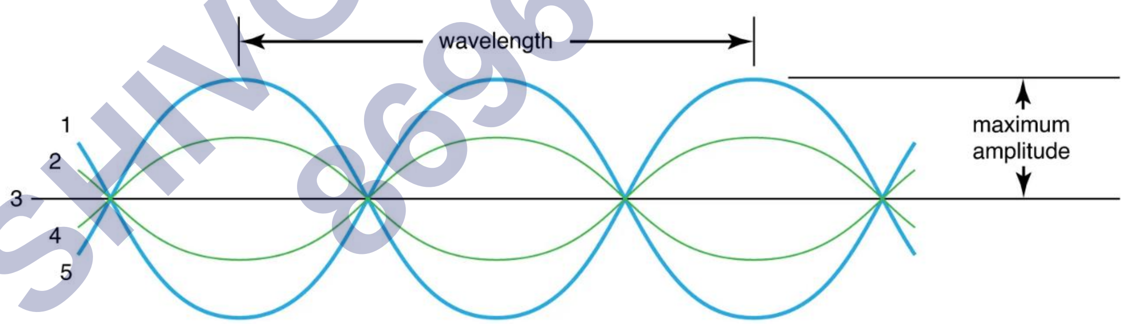


Some examples of mechanical waves includes

- Sound waves
- Water waves
- Waves produced in stretched string
- Waves produced in slinky or a long string

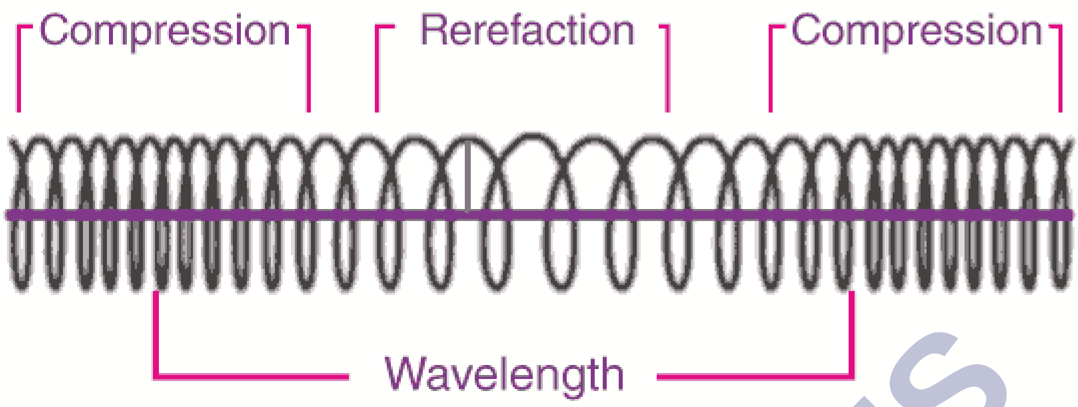
There are two types of mechanical waves

Transverse wave: In these waves the individual particles of the medium move in a direction perpendicular to the direction of propagation of the disturbance. The particles do not move from one place to another, but they simply oscillate back and forth about their position of rest



Longitudinal wave: In these waves the individual particles of the medium move in a direction parallel to the direction of propagation of the disturbance. The particles do not move from one place to another, but they simply oscillate back and forth about their position of rest

Sound waves are longitudinal waves as in sound waves, particles moves in a direction parallel to the direction of propagation of the disturbance.



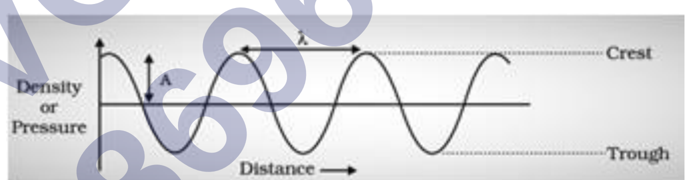
Introduction to sound waves

Sound needs a medium to propagate. The matter or material through which sound propagates is called a medium. When particles vibrate about their mean positions, it pushes a region of compressed air, creating a region of high pressure, followed by a region of low pressure as the particle retreats to its mean position. The sound wave propagates by compressions and rarefactions of particles in a medium. Sound propagation can be visualised as the propagation of pressure variations in the medium.

Characteristics of Sound Waves

Wavelength

The distance between two successive crests or troughs (or) successive compressions and rarefactions is called as wavelength (λ). The SI unit of wavelength is metre (m).



Time period

Time taken by two consecutive compressions or rarefactions to cross a fixed point is called a Time period (T). The SI unit of time in seconds (s).

Frequency

The number of compressions or rarefactions per unit time is called frequency (**ν**).

The SI unit of frequency is Hertz. The SI unit is Hertz (s−1)

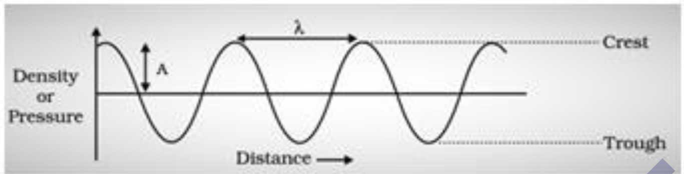
$$v = \frac{1}{T}$$

Speed (v), wavelength (λ) and frequency (**ν**) are related as v=λ**ν**

Amplitude

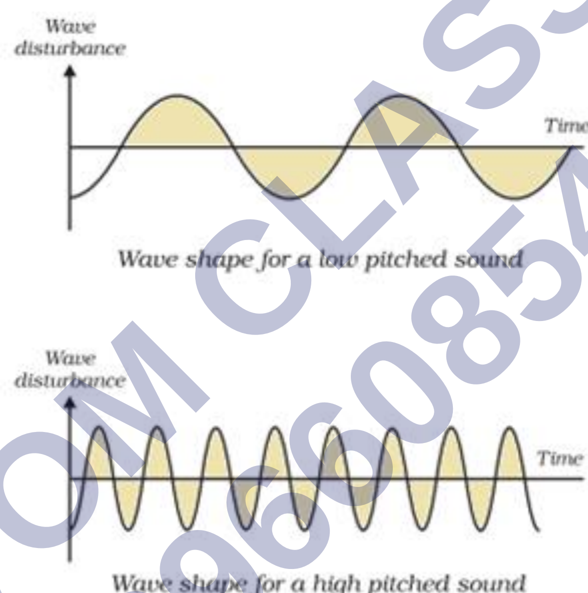
The magnitude of disturbance in a medium on either side of the mean value is called an amplitude (A).

As shown in the figure below, the unit of amplitude will be the density or pressure. Distance between mean position and crest (maximum displacement).



Pitch

The number of compressions or rarefactions per unit time. Directly proportional to frequency.



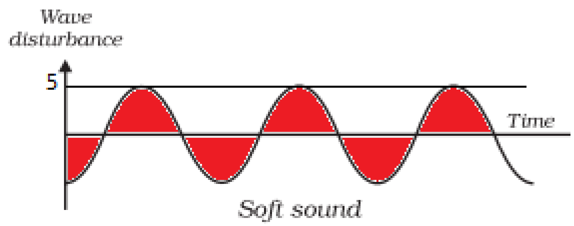
Representation of low and high pitch

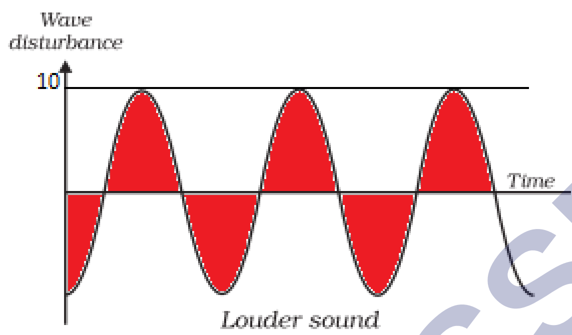
Volume

Volume or loudness of a sound depends on the amplitude. The force with which an object is made to vibrate gives the loudness.

Higher force → higher amplitude → louder sound

The amount of sound energy flowing per unit time through a unit area is called the intensity of sound.





The Intensity of Sound

Note and Tone

A sound of a single frequency is called a tone. A sound produced with a mixture of several frequencies is called a note.

Quality of sound

The richness or timber of sound is called the quality. Sound with the same pitch and loudness can be distinguished based on the quality. Music is pleasant to the ears while noise is not. But they both can have the same loudness and pitch.

Speed of sound

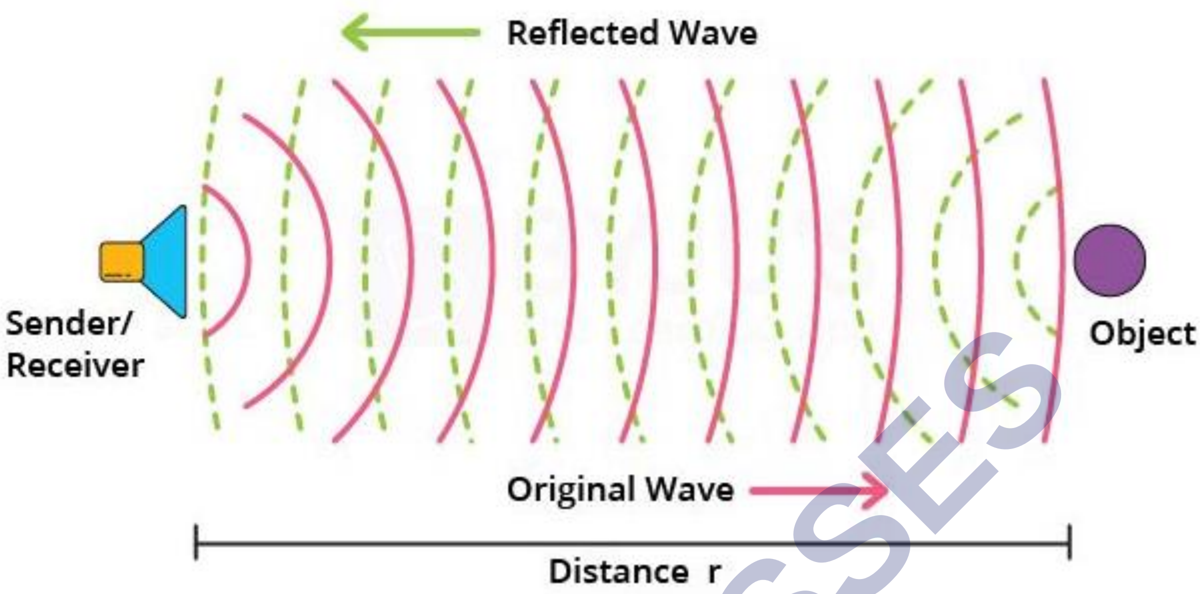
Sound travels through different media with different speeds. Speed of sound depends on the properties of the medium: pressure, density and temperature

Speed of sound: Solids > Liquids > Gases

Speed of sound in air = 331 m/s at 0^0C and 344 m/s at 22◦ C

When a source emits sound with a speed greater than the speed of sound in air, it creates a sonic boom which produces shockwaves with lots of energy. They produce a very loud noise which is enough to shatter glass and damage buildings.

Reflection of Sound Waves



Like light, sound also follows laws of reflection, it bounces off the surface of solid and liquid.

Echo

The phenomenon where a sound produced is heard again due to reflection is called an echo.

E.g: Clapping or shouting near a tall building or a mountain.

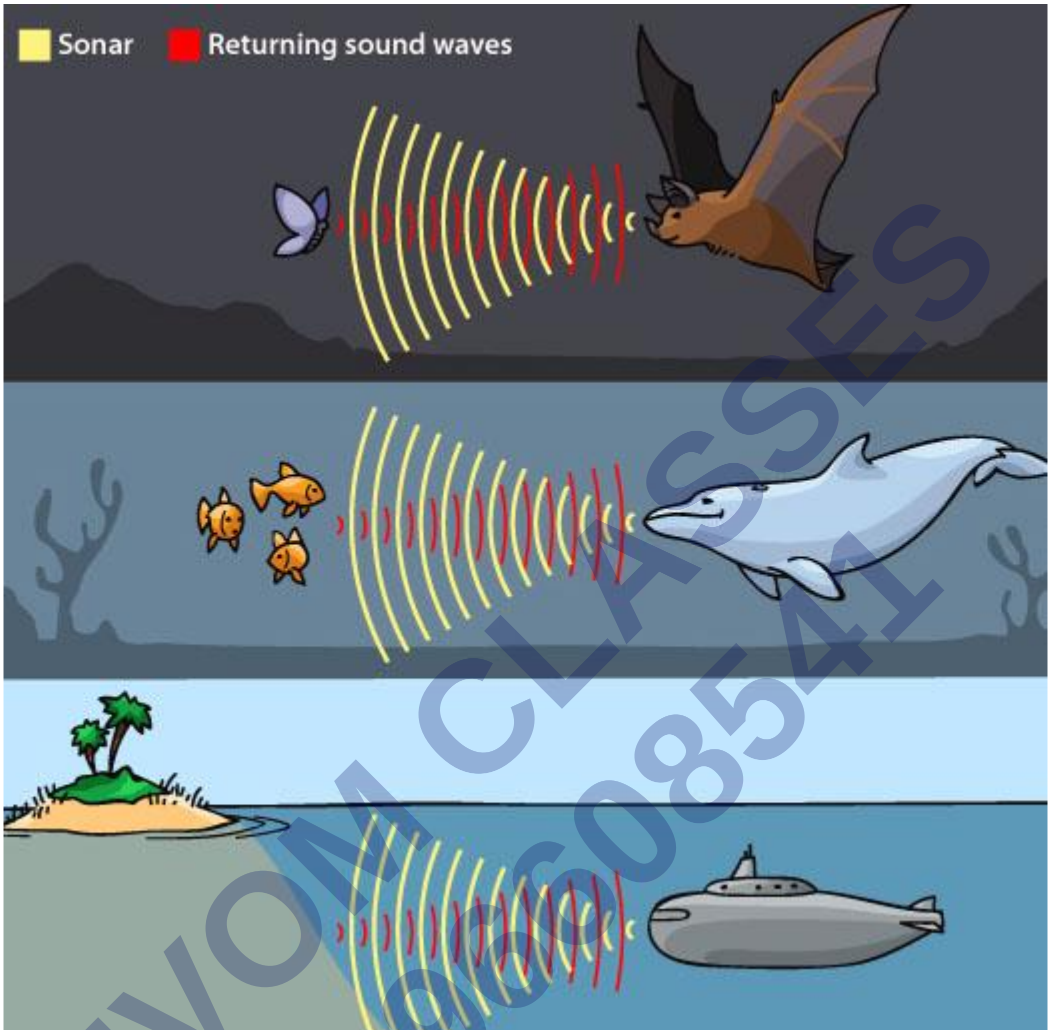
To hear distinct echo sound, the time interval between original and reflected sound must be at least 0.1s. As sound persists in our brain for about 0.1s. Minimum distance for obstruction or reflective surface to hear an echo should be 17.2 m. Multiple echoes can be heard due to multiple reflections.

Sonar and Radar

SONAR – Sound Navigation And Ranging.

It is a technique that uses sound or ultrasonic waves to measure distance. The human range of hearing is 20Hz- 20kHz.

What are Ultrasonic sounds?



Ultrasonic sounds are high-frequency sound having a frequency greater than 20kHz (inaudible range).

Applications of Ultrasound

(i) Scanning images of human organs

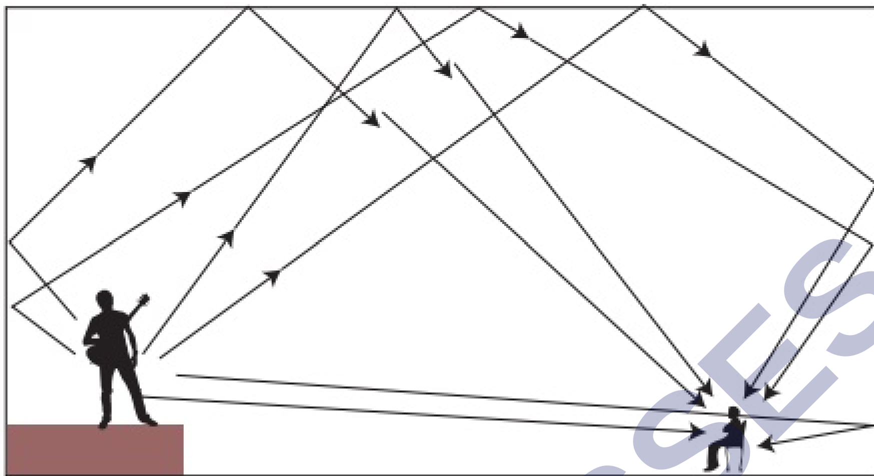
(ii) Detecting cracks in metal blocks

(iii) Cleaning parts that are hard to reach

(iv) Navigating, communicating or detecting objects on or under the surface of the water (SONAR).

Sonar consists of a transmitter and detector mounted on a boat or ship. The transmitter sends ultrasonic sound waves to the seabed which gets reflected back and picked up by the detector. Knowing the speed of sound in water, distance can be measured using: $2d = v \times t$. This method is called echolocation or echo ranging.

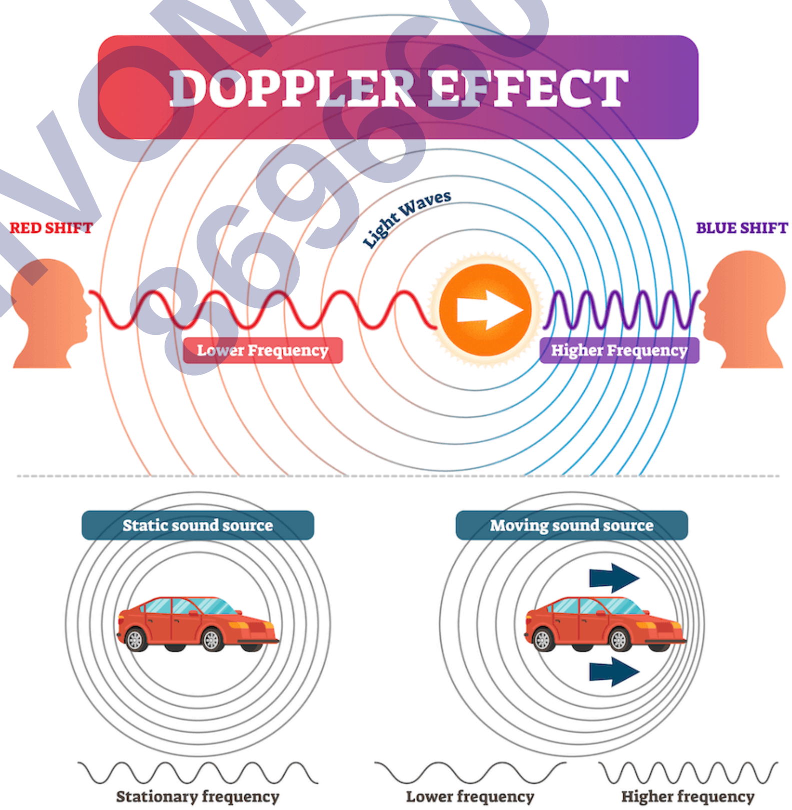
Reverberation



Persistence of sound because of multiple reflections is called reverberation. Examples: Auditorium and a big hall.

Excessive reverberation is undesirable and to reduce this, halls and auditoriums have sound-absorbing materials on the walls and roofs. E.g: Fibreboard and rough plaster.

Doppler's effect



If either the source of sound or observer is moving, then there will be a change in frequency and wavelength for the observer. The frequency will be higher when the observer moves towards the source and it decreases when the observer moves away from the source.

Example: If one is standing on a street corner and an ambulance approaches with its siren blaring, the sound of the siren steadily gains in pitch as it comes closer and then, as it passes, the pitch suddenly lowers.

Variations in Pressure and Density of a Medium due to Sound Waves

- The variations of pressure and density when a sound wave moves in a medium are as shown below:
- The portion of the medium where density (or pressure) has a value larger than its average value is called a **crest**.
- The portion of the medium where density (or pressure) has a value smaller than its average value is called a **trough**.
- The magnitude of maximum disturbance in the medium on either side of the mean position is called the **amplitude** (A).
- When a sound propagates through a medium, the density of the medium oscillates between a maximum value and a minimum value.
- The change in density (or pressure) from the maximum value to the minimum value and again to the maximum value is called an **oscillation**.
- The number of complete oscillations per second is called the **frequency** (ν) of the sound wave. Its unit is **hertz** (Hz).
- The time taken for one complete oscillation in the density (or pressure) of the medium is called the

  time period (T) of the wave.
- The distance between two consecutive compressions or two consecutive rarefactions is called **wavelength** (λ) of the wave. Its SI unit is **metre** (m).
- Frequency (ν) and time period (T) are related as

$$\nu = \frac{1}{T}$$

- **Speed of sound** is the distance travelled by the sound wave per unit time.

$$\text{Speed, } v = \frac{\text{Distance } (\lambda)}{\text{Time } (T)}$$

- The relation between the speed of sound wave (v), its frequency (υ) and wavelength (λ) is $v = \upsilon \lambda$

Sound, travels as a wave

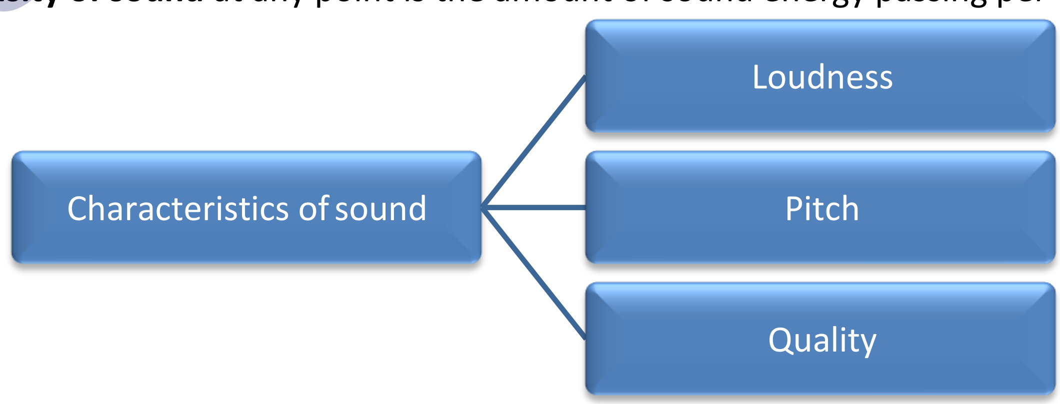
- From the previous section we have already established that sound is produced by vibrating objects. Term vibration refers to the rapid to and fro motion of an object.
- If we throw a piece of stone in a pond of still water then expanding circle of ripples or water waves are formed over the surface of water. These water waves moves on an outward direction on the surface of water.
- This happens because when stone hits water surface it disturbs the particles of water surface. As a result water particles began to vibrate about their means positions.
- These vibrating particles collide with the neighboring particles and make them vibrate.
- This process continues and the disturbance travels through the water.
- The disturbance travel in water due to the repeated periodic motion of the particles of water about their mean positions.

Speed of Sound in Different Media

- Speed of sound is **finite** and is **much less than the speed of light**.
- Speed of sound in solids > speed of sound in liquids > speed of sound in gases
- The speed of sound increases with increase in **temperature**.

Characteristics of Sound

- Sounds can be distinguished from each other by three characteristics—loudness (intensity), pitch (frequency) and quality (timbre).
- The **intensity of sound** at any point is the amount of sound energy passing per unit time per unit



area in a direction perpendicular to the area. Its unit is watt/metre^2 (W/m^2).
- The physiological response of the ear to the intensity of sound is called **loudness**. It is

determined by the **amplitude** of the wave.

- **Pitch** is the physiological sensation which helps in distinguishing a shrill sound from a flat sound. It is determined by the **frequency** of the wave.
- **Quality (timbre)** distinguishes one sound from another sound of the same pitch and loudness. It is determined by the **wave form** of the sound.
- A sound of single frequency is called a **tone**.
- The sound produced by a mixture of several frequencies is called a **note**.

Reflection of Sound

- The laws of reflection for sound are the same as those for light.
- The repetition of sound caused by reflection of sound waves from an obstacle is known as an **echo**.
- The time interval between the original sound and the reflected one must be at least 0.1 s for an echo to be heard distinctly.
- **Multiple echoes** are heard when sound is repeatedly reflected from several obstacles at suitable distances.
- The phenomenon of persistence or prolongation of audible sound after the source has stopped emitting it is called **reverberation**.

Uses of Multiple Reflection of Sound

- In megaphones, horns, musical instruments and stethoscopes, the mechanism of multiple reflection of sound is used.

Sound needs a medium to travel

- Sound cannot travel through vacuum.
- This is because when sound travels from one place to another then energy is transferred from one particle to another particle of the medium.
- This means that sound needs a material medium like solid, liquid or gas for its propagation.
- Visit this link for demonstration that shows sound waves cannot travel through vacuum.

Range of Frequencies

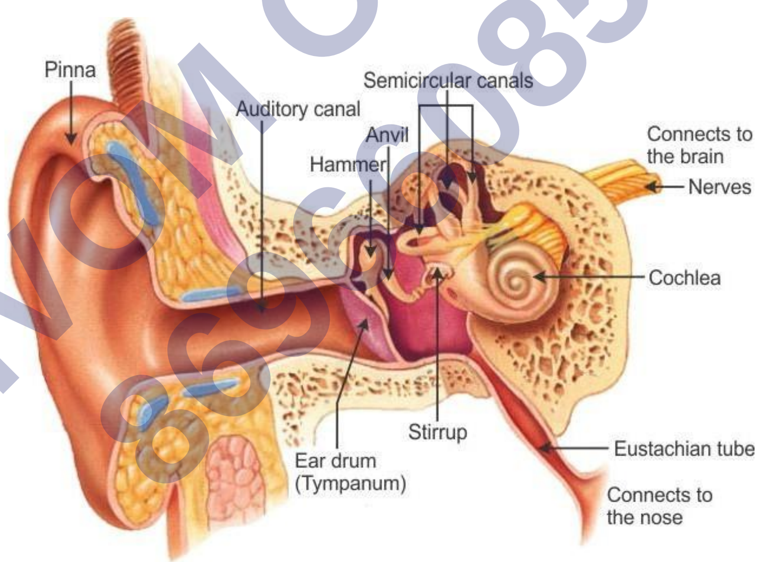
Audible range	• 20 Hz to 20,000 Hz
Ultrasound	• Above 20 kHz
Infrasound	• Below 20 Hz

Applications of Ultrasound

- Ultrasound finds **applications** in industry, medical science and communication (SONAR).
- SONAR stands for **Sound Navigation And Ranging**. It is used to measure the distance, direction and speed of objects under the sea. It is also used in ship-to-ship communication.

Human Ear

The human ear can be divided into three parts:



- ✓ The **outer ear** which collects the sound waves.
- ✓ The **middle ear** which amplifies the sound waves about 60 times.
- ✓ The **inner ear** which converts the amplified sound energy into electrical energy and conveys it to the brain as nerve impulses for interpretation.

Range of Hearing

- Audible sounds are those that can be heard while inaudible sounds are those that cannot be heard.
- Human can hear sounds with frequency between 20Hz and 20,000Hz.

- Low frequency sounds which cannot be hear are called infrasonic.
- Rhinoceroses communicate using infrasound of frequency as low as 5 Hz. Whales and elephants produce sound in the infrasound range. It is observed that some animals get disturbed before earthquakes. Earthquakes produce low-frequency infrasound before the main shock waves begin which possibly alert the animals
- Objects that vibrate at frequencies of above 20,000Hz produce sound which also cannot be heard by us. Such sounds are called.

ultrasonics

Ultrasound is produced by dolphins, bats and porpoises.

Human Ear Parts

The human ear parts are explained below:

External Ear

The external ear is further divided into the following parts:

Auricle (Pinna)

The auricle comprises a thin plate of elastic cartilage covered by a layer of skin. It consists of funnel-like curves that collect sound waves and transmits them to the middle ear. The lobule consists of adipose and fibrous tissues supplied with blood capillaries.

External Auditory Meatus

It is a slightly curved canal supported by bone in its interior part and cartilage in the exterior part. The meatus or the canal is lined with stratified epithelium and wax glands.

Tympanic Membrane

This membrane separates the middle ear and the external ear. This part receives and amplifies the sound waves. Its central part is known as the umbo.

Middle Ear

The middle ear comprises the following parts:

Tympanic Cavity

It is a narrow air-filled cavity separated from the external ear by tympanic membrane and from inner ear by the bony wall. The tympanic cavity has an auditory tube known as the eustachian tube in its anterior wall.

Eustachian Tube

The eustachian tube is a 4cm long tube that equalizes air pressure on either side of the tympanic membrane. It connects the tympanic cavity with the nasopharynx.

Ear Ossicles

These are responsible for transmitting sound waves from the eardrum to the middle ear. There are three ear ossicles in the human ear:

Malleus: A hammer-shaped part that is attached to the tympanic membrane through the handle and incus through the head. It is the largest ear ossicle.

Incus: An anvil-shaped ear ossicle connected with the stapes.

Stapes: It is the smallest ossicle and also the smallest bone in the human body.

Inner Ear

It comprises two parts:

Bony labyrinth

Membranous labyrinth

Bony Labyrinth

The bony labyrinth comprises a vestibule, three semi-circular canals, and spirally coiled cochlea. It is filled with perilymph.

Membranous labyrinth

The bony labyrinth surrounds the membranous labyrinth. It comprises sensory receptors responsible for balance and hearing. The membranous labyrinth is filled with endolymph and comprises three semi-circular ducts, cochlear duct, saccule and utricle. The sensory receptors include cristae, an organ of corti, and ampullaris maculae.

Function of Ear

Following are the important function of the ear:

Hearing

The mechanism of hearing involves the following steps:

- The sound waves pass through the auditory canal and reach the eardrum.
- The vibrations produced pass through the tympanic membrane to the tympanic cavity.
- The ear ossicles in the tympanic cavity receive the vibrations and the stapes pushes the oval window in and out.
- This action is passed on to the organ of corti, the receptor of hearing, that contains tiny hair cells that translate the vibrations into an electrical impulse that are transmitted to the brain by sensory nerves.

Balance

The eustachian tube and the vestibular complex are the important parts of the ear responsible for the balance.

- The eustachian tube equalizes the air pressure in the middle ear and maintains the balance.
- The vestibular complex contains receptors that maintain body balance.

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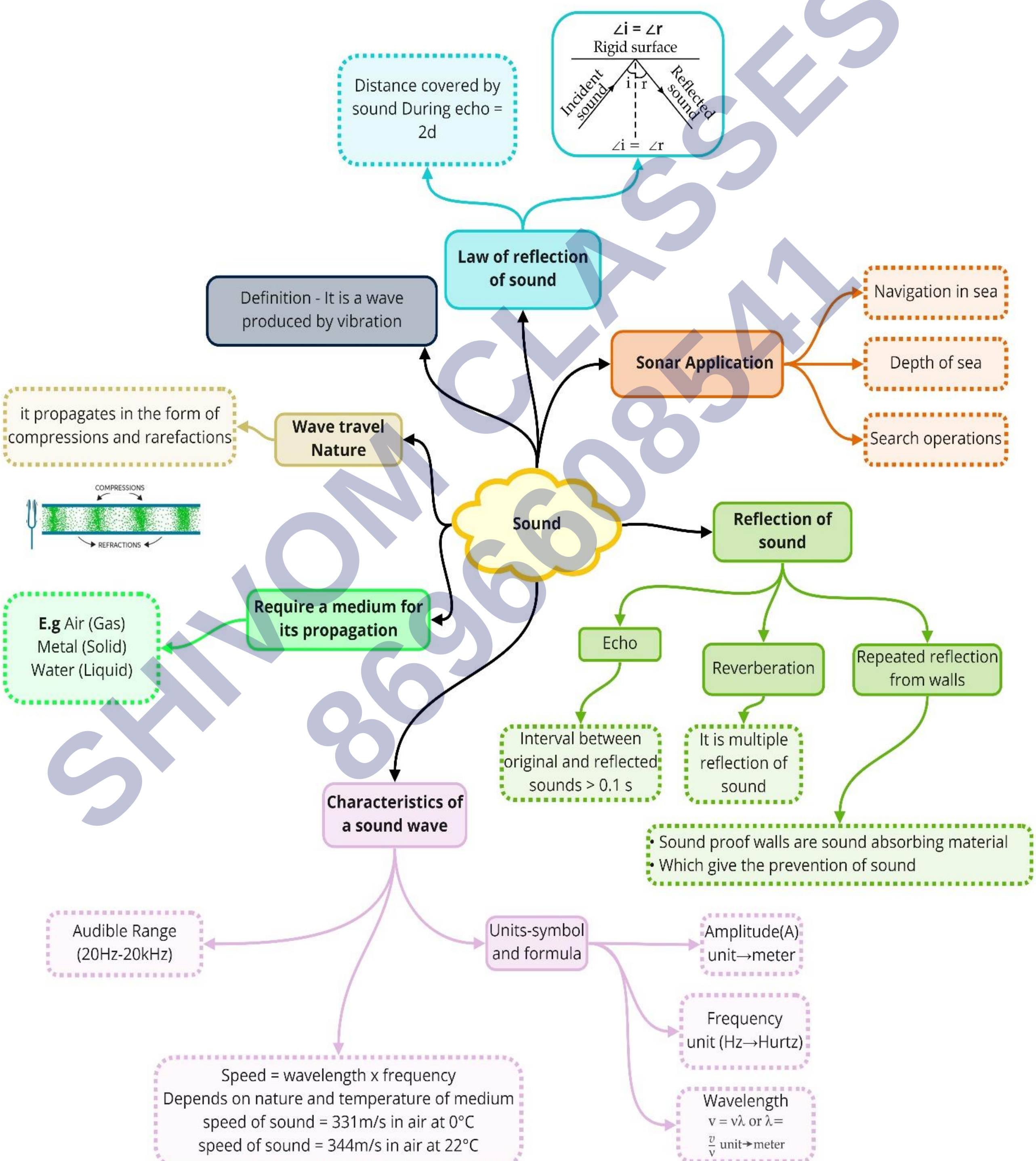


Important Question

➢ Multiple Choice Questions:

1. Note is a sound

(a) of mixture of several frequencies

(b) of mixture of two frequencies only

(c) of a single frequency

(d) always unpleasant to listen

2. A key of a mechanical piano struck gently and then struck again but mush harder this time. In the second case

(a) sound will be louder but pitch will not be different

(b) sound will be louder and pitch will also be higher

(c) sound will be louder but pitch will be lower

(d) both loudness and pitch will remain unaffected

3. In SONAR, we use

(a) ultrasonic waves

(b) infrasonic waves

(c) radio waves

(d) audible sound waves

4. Sound travels in air if

(a) particles of medium travel from one place to another

(b) there is no moisture in the atmosphere

(c) disturbance moves

(d) both particles as well as disturbance travel from one place to another.

5. When we change feeble sound to loud sound we increase its

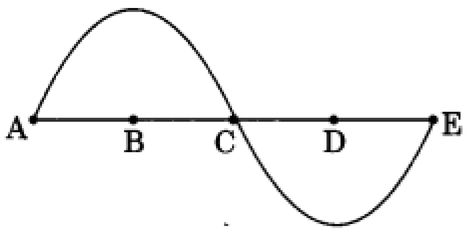
(a) frequency

(b) amplitude

(c) velocity

(d) wavelength

6. In the curve half the wavelength is



(a) AB

(b) BD

(c) DE

(d) AE

7. Earthquake produces which kind of sound before the main shock wave begins

(a) ultrasound

(b) infrasound

(c) audible sound

(d) none of the above

8. Infrasound can be heard by

(a) dog

(b) bat

(c) rhinoceros

(d) human beings

9. Before playing the orchestra in a musical concert, a sitarist tries to adjust the tension and pluck the string suitably. By doing so, he is adjusting

(a) intensity of sound only

(b) amplitude of sound only

(c) frequency of the sitar string with the frequency of other musical instruments

(d) loudness of sound

➢ Very Short Question:

1. What are longitudinal waves?

2. What are transverse waves?

3. Define wavelength. What is its symbol and its SI unit?

4. Define frequency. What is its symbol and its SI unit?

5. What is one hertz?

6. Define amplitude. What is its symbol and its SI unit?

7. What is ‘audible’ sound?

8. What do you mean by an echo?

9. What do you understand by the terms “compression” and rarefaction?

A region of low pressure of a medium when a sound wave travels through it is called rarefaction.

10. What do you understand by the pitch of a sound?

➢ Short Questions:

1. State law of conservation of energy and law of conservation of mechanical energy.

2. Define (a) 1 joule (b) 1 watt.

3. Write down SI unit of the following quantities.

(a) work

(b) kinetic energy

(c) potential energy

(d) power

4. What is the sequence of energy change that takes place in the production of electricity from adam?

5. A light and a heavy object have the same momentum. Find out the ratio of their kinetic energies. Which one has larger kinetic energy?

6. Why a man does not do work when he moves on a level road while carrying a box on his head?

7. If an electric iron of 1200 W is used for 30 minutes every day, find electric energy consumed in the month of April.

8. What is work done by a force of gravity in the following cases?

(a) Satellite moving around the Earth in a circular orbit of radius 35000 km.

(b) A stone of mass 250 g is thrown up through a height of 2.5 m.

➢ Long Questions:

1. State the conditions for positive, negative, and zero work. Give at least one example of each.

2. Give a reason for the following:

(a) A bullet is released on firing the pistol.

(b) An arrow moves forward when released from the stretched bow.

(c) Winding the spring of a toy car makes it to run on the ground.

(d) Falling water from a dam generates electricity.

(e) Winding the spring of our watch, the hands of the watch movement.

3. State the law of conservation of energy. Show that the energy of a freely falling body is conserved.

➢ Assertion Reason Questions:

1. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

   c. Assertion is true but Reason is false.

   d. Both Assertion and Reason are false.

   Assertion: When any objects vibrates that time it produces sound.

   Reason: Vibration means a kind of rapid to and from motion of an object.

2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

   c. Assertion is true but Reason is false.

   d. Both Assertion and Reason are false.

   Assertion: When any objects vibrates that time it produces sound.

   Reason: vibration is the process in which two objects strikes on each other.

➢ Case Study Questions:

1. Sound is produced by vibrating objects. The matter or substance through which sound is transmitted is called a medium. It can be solid, liquid or gas. Sound moves through a medium from the point of generation to the listener. When an object vibrates, it sets the particles of the medium around it vibrating. The particles do not travel all the way from the vibrating object to the ear. Sound waves are characterized by the motion of particles in the medium and are called mechanical waves. When a vibrating object moves forward, it pushes and compresses the air in front of it creating a region of high pressure; this region is called a compression(C).When the vibrating object moves backwards, it creates a region of low pressure called rare faction (R). Hence sound is longitudinal wave.

(i) Sound waves are:

(a) Mechanical waves

(b) Electromagnetic wave

(c) Transverse waves

(d) None of these

(ii) Sound travel in medium with:

(a) Compression and rare fraction

(b) Crest and trough

(c) Both can be possible

(d) None of these

(iii) Compression is the region of:

(a) High pressure

(b) Low pressure

(c) Medium pressure

(d) None of these

(iv) What is sound and how is it produced?

(v) Why sound wave is called as longitudinal wave?

2. The individual particles of the medium move in a direction parallel to the direction of propagation of the disturbance. The particles do not move from one place to another but they simply oscillate back and forth about their position of rest. This is exactly how a sound wave propagates; hence sound waves are longitudinal waves. There is also another type of wave, called a transverse wave. In a transverse wave particles do not oscillate along the direction of wave propagation but oscillate up and down about their mean position as the wave travels. Thus, a transverse wave is the one in which the individual particles of the medium move about their mean positions in a direction perpendicular to the direction of wave propagation.

(i) Sound waves are:

(a) Transverse waves

(b) Longitudinal wave

(c) Both a and b

(d) None of these

(ii) Light is:

(a) Transverse waves

(b) Longitudinal wave

(c) Both a and b

(d) None of these

(iii) In case of Longitudinal waves:

(a) The particles do not move fromone place to another but they simply oscillateback and forth about their position of rest

(b) The particles move fromone place to another

(c) The particles move up and down.

(d) None of these

(iv) When stone is dropped in water; waves are generated of which types?

(v) Differentiate between longitudinal wave and transverse waves.

✓ Answer Key-

➢ Multiple Choice Answers:

1. (c) of a single frequency
2. (a) sound will be louder but pitch will not be different
3. (c) radio waves
4. (d) both particles as well as disturbance travel from one place to another.
5. (b) amplitude
6. (b) BD
7. (a) ultrasound
8. (c) rhinoceros
9. (c) frequency of the sitar string with the frequency of other musical instruments

➢ Very Short Answers:

1. Answer: A wave in which the particles of the medium vibrate back and forth in the 'same direction' in which the wave is moving, is called as a longitudinal wave.
2. Answer: A wave in which the particles of the medium, vibrate up and down 'at right angle' to the direction in which the wave is moving, is called a transverse wave.
3. Answer: The distance between two consecutive compressions (C) or two consecutive rarefactions (R) is called the wavelength. The wavelength is denoted by (Greek letter 'lambda'). Its SI unit is the meter (m).
4. Answer: The number of complete waves (or cycles) produced per second is called a

frequency of sound waves. It is denoted by f. The SI unit of frequency is hertz (Hz).

5. Answer: A vibrating body producing 1 wave per second is said to have a frequency of 1 Hz.
6. Answer: The magnitude of the maximum disturbance in the medium on either side of the mean value is called the amplitude of wave. It is denoted by A. The SI unit is the metre (m).
7. Answer: The sound which we are able to hear is called 'audible' sound. The audible range of sound for human beings extends from about 20 Hz to 20000 Hz.
8. Answer: The repetition of sound caused by the reflection of sound waves is called an 'echo'.
9. Answer: A region of high pressure of a medium when a sound wave travels through it is called compression.

   A region of low pressure of a medium when a sound wave travels through it is called rarefaction.
10. Answer: Pitch of a sound is the characteristic of sound that depends on the frequency received by a human ear.

➢ Short Answers:

Answer: The sensation felt by our ears is called sound. A sound is a form of energy which makes us hear. When an object is set into vibrations, the sound is produced. For example, the vibrating diaphragm of a drum produces sound, the vibrating string of a guitar produces sound, the vibrating diaphragm of speakers of a radio produce sound, the vibrating end of a drilling machine produces sound, etc.

Answer: The conditions to hear an echo are:

i. Echo can be heard only if it is produced at least $\frac{1}{10}$th of a second (0.1 s) after the original sound.

ii. The speed of sound in air is 344 m/s. Let us calculate the minimum distance from the reflecting surface, which is necessary to hear an echo.

$$\text{Speed} = \frac{\text{distance travelled}}{\text{Time taken}}$$

$$\text{Thus,} \quad 344 = \frac{\text{distance travelled}}{\frac{1}{10}}$$

∴ Distance travelled = 344 x $\frac{1}{10}$ = 34.4 metres

Thus, the distance travelled by the sound in $\frac{1}{10}$th of a second is 34.4 m. This means that the minimum distance between the source of the sound and the listeners should be 17.2 metres.

iii. Echo can be heard only if the reflecting surface is large.

Answer: Bats search out prey and fly in the dark night by emitting and detecting reflections of ultrasonic waves. The high-pitched ultrasonic squeaks of the bat are reflected from the obstacles or prey and returned to bat's ear. The nature of reflections tells the bat where the obstacle or prey is and what it is like.

Answer: A certain amount of reverberation improves the quality of sound of orchestral and choral music. However excessive reverberation makes the speech or music indistinct.

Answer: A megaphone works on the principle of reflection of sound. In this instrument, a tube followed by a conical opening reflects sound successively to guide most of the sound from the source in the forward direction towards the audience.

Answer:

Given,

velocity of sound, υ = 340 m/s

1. v = 256 Hz

using, $\upsilon = \lambda v$

$\lambda = \frac{\upsilon}{\lambda} = \frac{340}{256} = 1.33\text{m}$

2. λ = 0.85

using, $u = \lambda v$

$\lambda = \frac{\upsilon}{\lambda} = \frac{340}{0.85} = 400\text{Hz}$

7. 30 waves pass through a point in 3 seconds. If the distance between two crests is 2 m. Calculate

(a) frequency

(b) wavelength.

Answer:

30 waves in 3 seconds

$\upsilon = \frac{30}{3} = 10\text{Hz}$

∴ λ = 2m.

8. What is the reflection of sound? State the laws of reflection.

Answer: The bouncing back of sound from a hard surface is called a reflection of sound. The laws of reflection are:

i. The incident sound wave, the reflected sound wave and the normal at the point of incidence, all lie in the same plane.

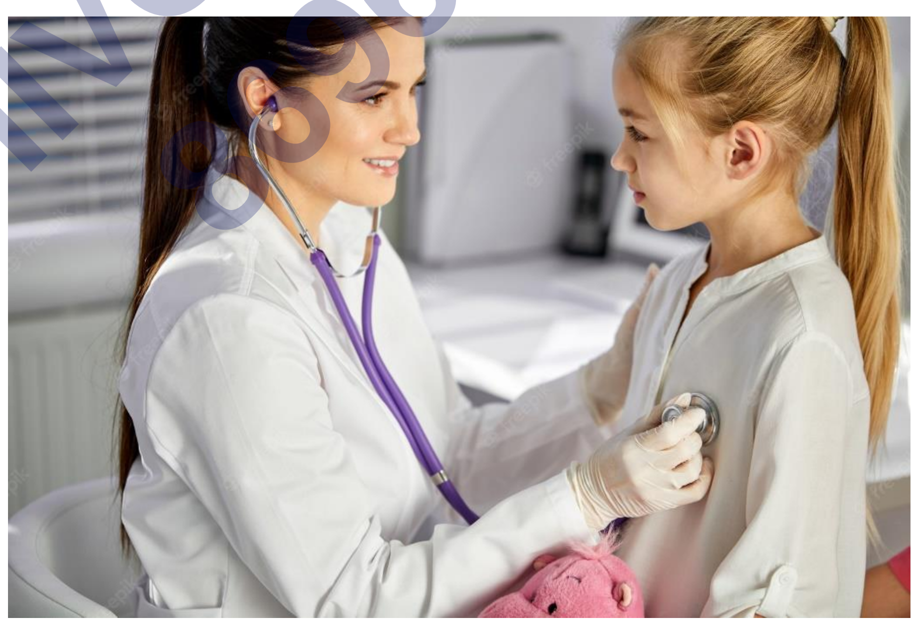
ii. The angle of incidence of sound is always equal to the angle of reflection of sound.

➢ Long Answers:

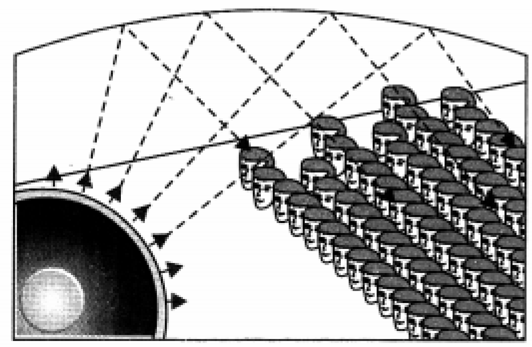
1. Answer:

i. Megaphone and a bulb horn: Megaphones or loudhailers, horns, musical instruments such as trumpets and she Hana is, are all designed to send sound in a particular direction without spreading it in all directions, as shown in the figure. In these instruments, a tube followed by a conical opening reflects sound successively to guide most of the sound waves from the source in the forward direction towards the audience.

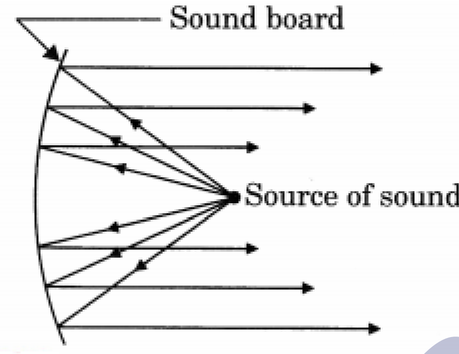
ii. Stethoscope: Stethoscope is a medical instrument used for listening to sounds produced within the body, chiefly in the heart or lungs. In stethoscopes, the sound of the patient's heartbeat reaches the doctor's ears by multiple reflections of sound, as shown in the figure.



iii. Soundboard: Generally the ceiling of concert halls, conference halls and cinema halls are curved so that sound after reflection reaches all corners of the hall, as shown in the figure. Sometimes a curved soundboard may be placed behind the stage so that the sound, after reflecting from the soundboard, spreads evenly across the width of the hail (Fig).



Curved ceiling of a conference hall



Sound board used in a big hall

2. Answer:

Ultrasounds are high-frequency waves. Ultrasounds are able to travel along well-defined paths even in the presence of obstacles. Ultrasounds are used extensively in industries and for medical purposes.

i. Ultrasound is generally used to clean parts located in hard-to-reach places, for example, spiral tube, odd-shaped parts, electronic components, etc. Objects to be cleaned are placed in a cleaning solution and ultrasonic waves are sent into the solution. Due to high frequency, the particles of dust, grease and dirt get detached and drop out. The objects thus get thoroughly cleaned.

ii. Ultrasounds can be used to detect cracks and flaws in metal blocks. Metallic components are generally used in the construction of big structures like buildings, bridges, machines and also scientific equipment. The cracks or holes inside the metal blocks, which are invisible from outside reduces the strength of the structure.

Ultrasonic waves are allowed to pass through the metal block and detectors are used to detect the transmitted waves. If there is even a small defect, the ultrasound gets reflected back indicating the presence of the flaw or defect.

iii. Ultrasonic waves are made to reflect from various parts of the heart and form the image of the heart. This technique is called 'echocardiography'.

vi. An ultrasound scanner is an instrument which uses ultrasonic waves from getting images of internal organs of the human body. A doctor may image the patient's organs such as liver, gall bladder, uterus, kidney, etc. It helps the doctor to detect abnormalities, such as stones in the gall bladder and kidney or tumours in different organs.

In this technique, the ultrasonic waves travel through the tissues of the body and get reflected from a region where there is a change of tissue density. These waves are then converted into electrical signals that are used to generate images of the organ.

These images are then displayed on a monitor or printed on a film. This technique is called 'ultrasonography'. Ulträsonography is also used for examination of the foetus during pregnancy to detect congenital defects and growth abnormalities.

v. Ultrasound may be employed to break small 'stones' formed in the kidneys into fine grains. These grains later get flushed out with urine.

➢ Assertion Reason Answer:

1. (b) Both Assertion and Reason are correct, and reason is not the correct explanation for assertion.
2. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

➢ Case Study Answers:

1.

(i) (a) Mechanical waves

(ii) (a) Compression and rare fraction

(iii) (a) High pressure

(iv) Sound is vibrations created by object. When body vibrates, it forces the adjacent particles of the medium to vibrate. This results in disturbance in the medium, which travels as waves an reaches the ear hence sound is produced.

(v) The vibration of medium that travels parallel to direction of wave or along in the direction of the wave is called longitudinal wave. The direction of particles of medium vibrates parallel to direction of propagation of disturbance. Therefore a sound is called longitudinal waves.

2.

(i) (b) Longitudinal wave

(ii) (a) Transverse waves

(iii) (a) The particles do not move from one place to another but they simply oscillate back and forth about their position of rest

(iv) When stone is dropped in water. Waves are generated where water particles are moving up and down and propagated away from dropping point .hence this is sign of transverse waves. Hence transverse waves are produced when stone is dropped in water.

(v) Following are differentiated points:

No	Longitudinal waves	Transverse waves
1	The medium, in the case of a longitudinal wave, moves in the same way to wave direction	The medium, in case of a transverse wave, moves perpendicular to wave direction
2	This wave is made up of	This wave is made up of crests and

	compressions and rarefactions	troughs
3	example of a longitudinal wave is sound wave	An example of a transverse wave is the Light