Chapter = 11

SOUND

SOUND WAVES

Definition: - The sensation felt by our ears is called sound. OR
The sensation produces in our ears due to vibrating body is known is sound. OR
It is a form of energy which is transferred from one place to another due to compressional waves.

Cause: - Vibrations

Nature: - Mechanical waves

Wave form:- Longitudinal waves (Compressional waves).

Requirement:- Three things are necessary for hearing sound.

Effect:- When sound falls on the ear membrane it produces the sensation of hearing.

Factors: - The speed of sound in a medium depends the following the factors.

(i) Elasticity of the medium (Velocity ∝ Elasticity) .

(ii) Density of the medium (Velocity ∝ $\frac{1}{Density}$).

Example:- In guitar, sound is produced due to vibrations of its string as shown in figure.

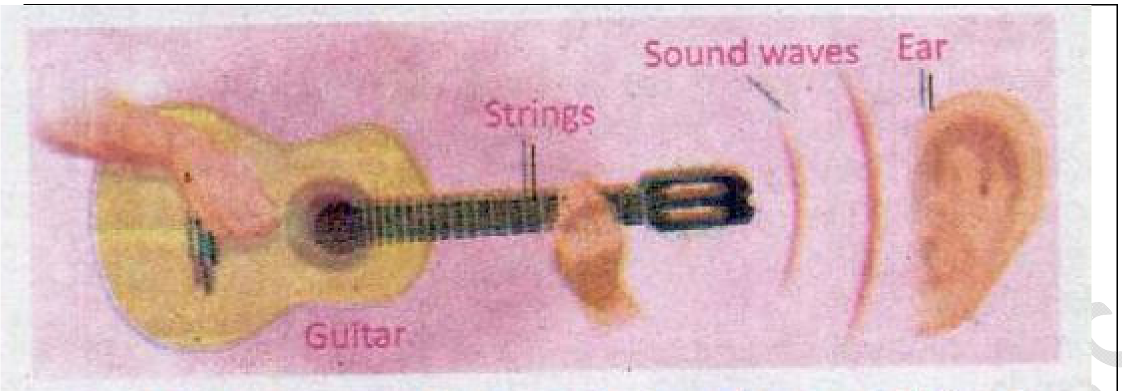


Fig. : Vibrations of guitar strings produce sound waves

Note: - The speed of sound in

- Air is 330 m/s.
- Water is 1450 m/s.
- Iron is 5130 m/s.
- The speed of sound in air increases with increase in the temperature of air.

Speed of sound in solid > Speed of sound in liquids > Speed of sound in gases

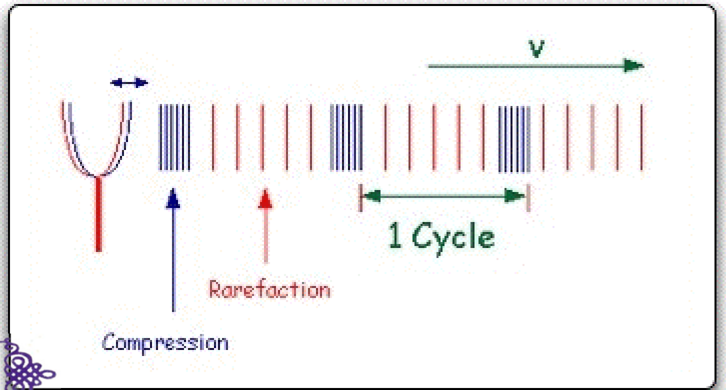
PRODUCTION OF SOUND

Sound waves can be generated by creating vibrations in a body, without vibrating body sound cannot be produced.

For examples: -

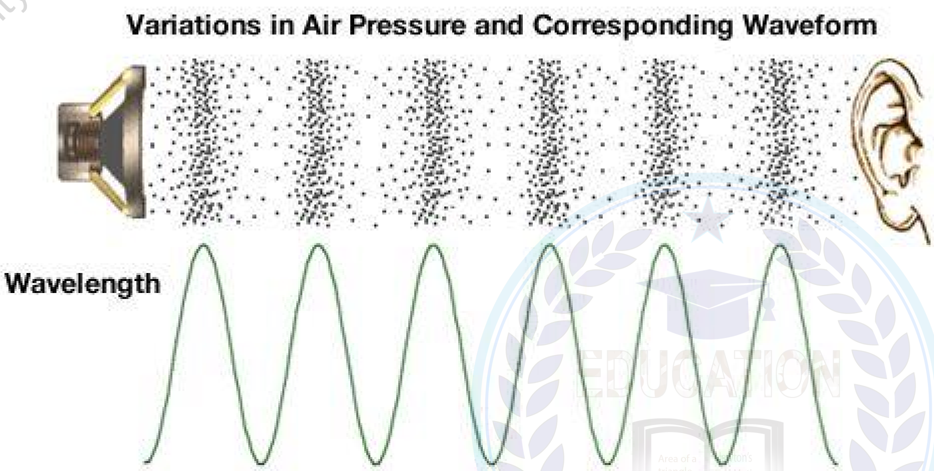
(i) Sound can be produced by striking a vessel with a spoon. The vibrations of the vessel can be judged by touching the vessel with hand.

(ii) Sound can be produced in the laboratory by striking the tuning fork with rubber pad. The vibrations of the tuning fork can be observed by touching the prongs of the tuning fork.



PROPAGATION OR TRANSMISSION OF SOUND

Sound waves are mechanical waves and require a material medium for its propagation. It moves in the form of compressions and rarefactions. The energy of vibrations produced is transmitted through this way from particle to particle in the medium. The medium could be solid, liquid, gas.



Note: - Sound cannot travel through vacuum because of mechanical nature.

DETECTION OF SOUND

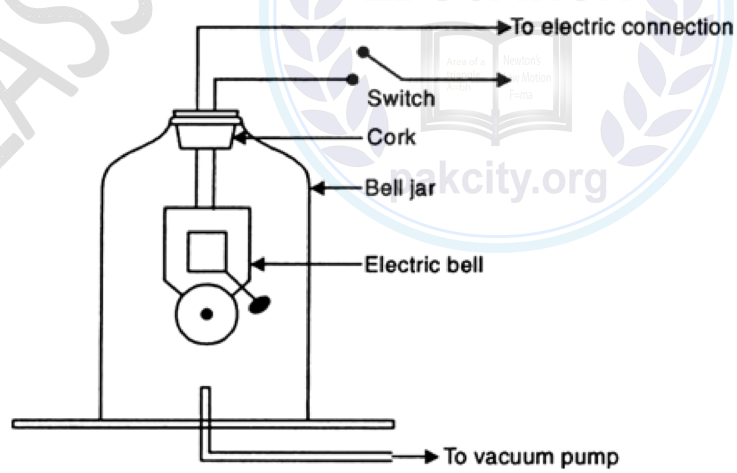
The receiving of sound requires a hearing device to detect the sound. Ear is a natural device which converts sound waves into sensation of hearing. Artificial devices are also uses to detect sound.

For example:- When sound waves fall on ear, its energy will set the ear membrane into vibrations and hence the sensation of hearing is produced.

NOTE:- Microphone detect sound by converting it to electrical signals. The persons impaired of hearing detects the sound with artificial hearing devices.

SHOW THAT THE SOUND CANONT PASS THROUGH VACUUM

Experimental demonstration:- An electric circuit consisting of a battery, a switch and an electric bell which is placed inside a glass jar and stand on the platform of an evacuating pump. The switch of the bell is pressed to close the circuit. Sound is heard, when there is air within the bell jar. If air is now gradually pumped out of the bell jar. The intensity of sound goes on decreasing and no sound is heard when the air is completely removed from the bell jar.



CHARACTERISTICS OF SOUND

Sounds of different objects can be distinguished on the basis of different characteristics which are given below.

(1) Pitch of sound
(2) Loudness of sound
(3) Quality of sound
(4) Intensity of sound.

(1) PITCH OF SOUND

Definition:- A characteristic of sound due which we can differentiate between a shrill and grave sound is called pitch. OR
The perception of the frequency of a sound is known as pitch of sound.

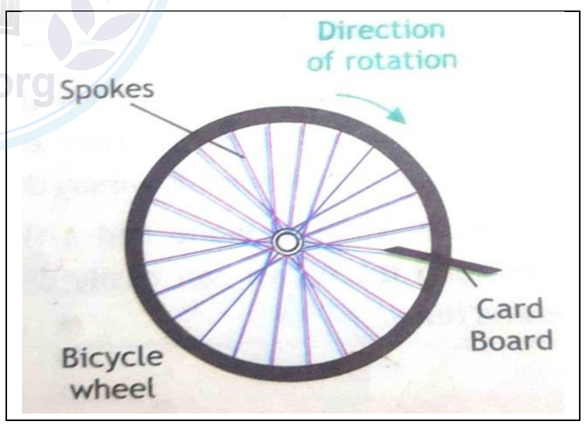
Factor:- Pitch of the sound depends on the frequency of the source. Greater the frequency greater is the pitch and shrill sound is produced.

For example :- Sound of the birds, cats, children and women are of high frequency hence shriller Smaller the frequency smaller will be the pitch and a grave sound is produced.

For example : - Sound of the dogs, frogs and men have low frequency and hence grave sound is produced.

SHOW THAT PITCH OF SOUND INCREASES WITH THE INCREASE OF FREQUENCY

Support a bicycle on its stand and rotate its rear wheel. Hold a piece of cardboard in your hand with its free end touching the spokes of the rotating wheel. The sound will produced, as you increase the speed of rotation the spokes touching per unit time to the cardboard will increase, which will the frequency. As a result,



sound produced will become shriller (of a higher pitch).

NOTE:- Pitch is like colour in light, both depends on the frequency.

(2) LOUDNESS OF SOUND

Definition: - The magnitude of auditory sensation produced by sound is known as loudness of sound. OR
The perception of sound intensity is known as loudness of sound. OR
It is the characteristics of sound by which louder and fainter sounds can be distinguished.
Representation: - It is represented by **"L".**
Explanation: - When we talk to our friends, our vice is low, but when we address a public gathering our vice is loud.
Factors affecting loudness: - Loudness of sound depends upon various factors which are given below.
(i) Area of vibrating body
(ii) Amplitude of vibrating body
(iii) Distance from the vibrating body
(i)Area of vibrating body:- Greater the area of vibrating body grater will be the loudness and vice versa.
For example: - The school bell produces a loud sound as compared to the house bell. Because the area of vibration of the school bell is greater than the bell used in houses .
(ii) Amplitude of vibrating body:- Greater the amplitude of vibration greater will be the loudness and vice versa.
For example:- A drum produces loud sound when its membrane is struck strongly whereas the sound is faint when the membrane is struck gently.
(iii)Distance from the vibrating body:-The loudness of sound increases when the distance from the vibrating body decreases. Similarly, loudness of sound decreases when the distance from the vibrating body increases.

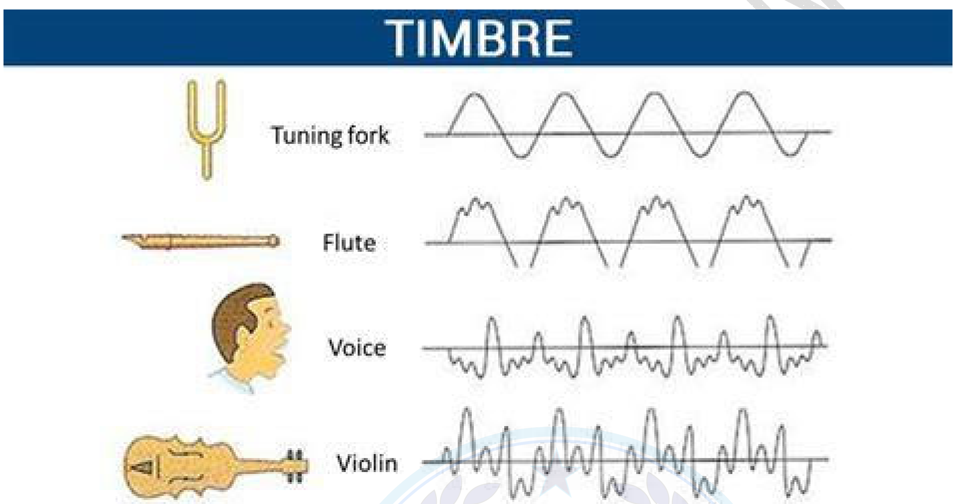
QUALITY OF SOUND

Definition: - A characteristic of sound by which two sounds of same loudness and same pitch are differentiated which is produced by two different instruments is called quality of sound. OR

The characteristic of sound by which we differentiate between two sounds of the same loudness and pitch is called quality of sound.

Other Name:- It is also called timber.

For example: - We can differentiate the sound of a violin, a flute and a sitar that are being played simultaneously at the same time during a song.



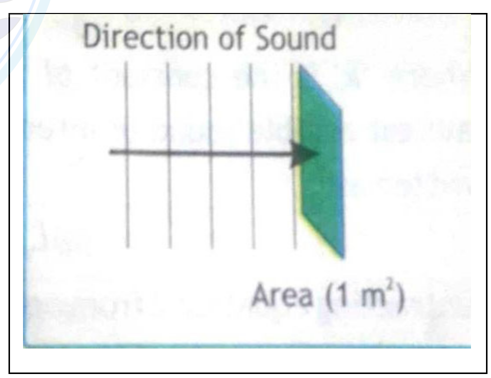
(3) SOUND INTENSITY

Definition: - The energy carried by sound waves per unit time per unit area placed perpendicular to the direction of propagation of waves.

OR

Intensity is a measure of the amount of the sound energy reaching a unit area in unit time. OR

The power per unit area is known as intensity of sound.



Representation: - It is represented by **"I"**.

Mathematically :- $I = \frac{E}{t \times A} = \frac{P}{A}$

Unit: - The unit of intensity of sound is watt per meter square (W/m^2).

Other Unit: - Pico watts per square metre (pW/m^2).
Note that 1.0 pW is 1.0 x 10^{-12} W.
Note: **-** Greater the intensity of sound greater will be the loudness and vice versa.
Explanation:
(i) It is a scalar quantity.
(ii) It is independent on the condition of the ear.
(iii) It is purely physical quantity.
Measurement: - It is measured with the help of decibel scale.
Examples:
(i) The intensity of faintest audible sound is 10^{-12} Wm^{-2}.
(ii) The intensity of loudest sound is $1Wm^{-2}$.

WEBER FECHNER LAW

Purpose:-To show the relation between loudness and intensity of sound.
Statement:- "The loudness (L) of a sound is directly proportional to the logarithm of intensity(I)"
Mathematically :- Loudness ∝ logarithm of intensity

$$L \propto \log I$$

$$L = \text{constant} (\log I)$$

$$L = K (\log I) \qquad \text{constant} = K$$

$$L = k \log I \text{ .... (i)}$$

Equation (i) represents the mathematical form of weber Fechner law.
In Equation (i) "K" is known as constant of proportionality and it value depend upon the system of units.

INTENSITY LEVEL

Definition: - The difference in loudness of two sounds where one sound is faintest audible sound is known as intensity level.

Other Name:- It is also known as sound level. Symbol:- It is denoted by "β" (Beta).

Explanation:- If "I" and "I_0" represent the intensities of two sounds having loudness "L" and "L_0" respectively then

$$L = k \log I \quad \text{.............................} \quad (i)$$

$$L_0 = k \log I_0 \quad \text{...........................} \quad (ii)$$

For intensity level :- Subtracting equation (ii) form equation (i) we get

$$L - L_0 = K \log I - K \log I_0 \quad \text{.......} \quad (iii)$$

As $L - L_0$ = intensity level = β then equation (iii) becomes

$$\text{Intensity level} = \beta = K \log I - K \log I_0$$

$$\beta = K (\log I - \log I_0) \qquad \text{take K common}$$

$$\beta = K \log \frac{I}{I_0} \quad \text{...........} \quad (iv) \qquad \log a - \log b = \log (\frac{a}{b})$$

If K = 1 then equation (iv) becomes

$$\beta = (1) \log \frac{I}{I_0}$$

$$\beta = \log \frac{I}{I_0} \text{ (bels)} \text{.................} \quad (v)$$

Unit:-Bel and decibel are units of intensity level.

i. Bel is big unit

ii. Decibel is small unit

iii. 1bel = 10dB Then the equation (v) becomes.

$$\beta = \log \frac{I}{I_0} \text{ (10 dB)} \quad \text{OR} \quad \beta = 10 \log \frac{I}{I_0} \text{ (dB)} \quad \text{.......................} \quad (vi)$$

DIFFERENCE BETWEEN LOUDNESS AND INTENSITY OF SOUND

LOUDNESS OF SOUND	INTENSITY OF SOUND
The perception of sound intensity is known as loudness of sound.	The power per unit area is known as intensity of sound.
It is denoted by "L".	It is denoted by "I".
It has no unit.	Its unit is w/m^2.
It depends upon the condition of ears.	It does not depends upon the condition of ears.
It is the magnitude of sensation.	It is a physical quantity.

MUSIC AND N0ISE

MUSICAL SOUND

Definition: - A sound which produces a pleasing sensation in the ear is known as musical sound.

Explanation: -

(i) Musical sound composed of regular and uniform vibrations.

(ii) It has definite periodicity.

(iii) It has definite amplitude.

(iv) It has regular change in its loudness.

Examples: -

(i) Sound produced by piano.

(ii) Sound produced by violins.

(iii) Sound produced by sitar etc.

NOISE

Definition: - A sound which produces an un-pleasant sensation in the ear is known as noise.

Explanation: -

(i) Noise is composed of irregular and disordered vibrations.

(ii) It has a short duration having no periodicity.

(iii) It has no definite amplitude.

(iv) It has shape and irregular changes in its loudness.

Examples:-

(i) Sound produced by horn system.

(ii) Sound produced by low flying aircraft.

(iii) Sound produced by industrial machinery etc.

SPEED OF SOUND WAVES

Definition:- The distance traveled by per unit time by sound waves is known as speed of sound waves.

Symbol:- It is denoted by "V".

Mathematical Form:-

$$\text{Speed} = \frac{Distace}{time}$$

$$V = \frac{S}{t}$$

Unit: - Its SI unit is meter per second (m/s).

Explanation: - As we know that the speed of sound depends upon the material through it is passing. The sound can be transmitted through any medium gas, liquid or solid.

Speed of sound in solid > Speed of sound in liquids > Speed of sound in gases

SPEED OF SOUND IN AIR

The speed of sound in air depends upon the density of air and its compressibility (how easy it is to squeeze).

As we know that

(1) Speed of sound ∝ $\frac{1}{\sqrt{Density}}$.

$$V \propto \frac{1}{\sqrt{\rho}} \quad \text{.. (i)}$$

(2) Speed of sound ∝ $\sqrt{Temperature}$

$$V \propto \sqrt{T} \quad \text{.. (ii)}$$

Explanation:- When the temperature of air increases, its density decrease and as a result the speed of sound increases. The speed of sound in dry air at 0 ^{0}C is 331 m/s. For each 1 ^{0}C rise in temperature, the speed of sound increases approximately by 0.6 m/s.

Mathematically: - V = 331 + 0.6 T .... (iii)

In equation (iii) T is the temperature in ^{0}C and this equation is used to calculate the speed of sound in air for given value of temperature (T).

Example:- Find the speed of sound in air at 20 ^{0}C ?

Given data:- Temperature = T = 20 ^{0}C.

Required data:- Speed of sound in air at 20 ^{0}C = V = ?

Solution:-

Formula:- As we know that

V = 331 + 0.6 T .... (A)

Calculation:- By putting values in equation we get

V = 331 + 0.6 T = 331 + 0.6 x 20 = 331 + 12 = 343 m/s.

Result: - So the speed of sound in air at 20 ^{0}C = V = 343 m/s.

NOTE:- The general wave equation also applies to sound waves as

$$V = f\lambda \quad \text{.................................... (iv)}$$

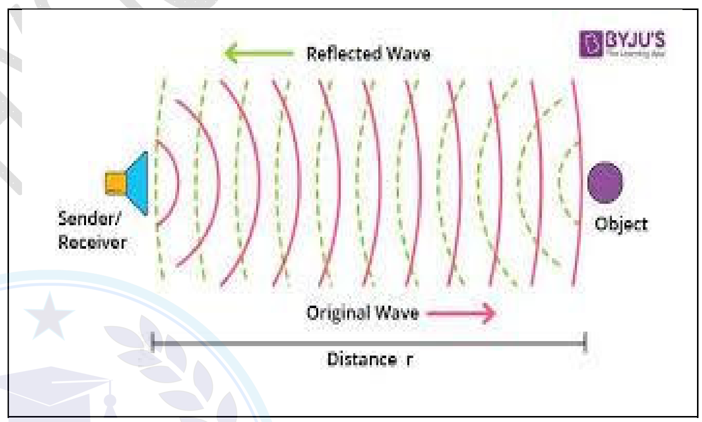
From equation (iv) it should be noted that wide range of frequencies observed in sound, and the speed of sound is the same for all frequencies. Thus in the relation (iv) the speed "V" remains fixed.

For example if the frequency of a wave is doubled, its wavelength is halved, so that the speed "V" stays the same.

REFLECTION OF SOUND WAVES AND ECHO

REFLECTION OF SOUND

Definition: - The bouncing back of sound when it strikes a hard surface is known as reflection of sound.



Requirement for reflection of sound: -
Hard surfaces like walls, metal sheets and plywood etc reflect sound waves.

Practical Applications of reflection of sound :- The reflection of sound is utilized in

(i) Megaphone
(ii) Sound boards
(iii) Ear trumpet
(iv) Whispering gallery
(v) Sonar to find the depth of sea.

ECHO

Derivation and meaning :- It is a Greek word which means "**To Resound**" OR Reflected sound.

Definition: - The repetition of a sound by reflection of sound waves from a surface is known as echo. OR

The rehearing of sound after reflection is known as Echo. OR

A reflected sound that can be distinguished from the original is known as echo.

Cause: - Reflection of sound.

Time duration: -To hear a clear echo time interval between our sound and the reflected sound must be at least 0.1 sec.

Distance:-The least distance between the obstacle and source of sound is 17 m.

Explanation:-When a person shouts in a big empty hall, we first hear his original sound after a little while , we hear the reflected sound of the shout. This reflected sound is an echo. Thus when we hear an echo, we are actually hearing a reflected sound.

CALCULATE THE MINIMUM DISTANCE FOR ECHO TO BE HARD

As we know that

Speed of sound at room temperature of 20 ^{0}C = V = 343 m/s

In case echo the sound covers a distance "S" twice S = 2S

The time interval in which sound waves covers "2S" = Δt = 0.1 sec

Formula:- $V = \frac{2\,S}{\Delta\,t}$ OR $S = \frac{V\,\Delta t}{2}$ .... (1)

Calculation: - By putting values in equation (1) we get

$$S = \frac{V\,\Delta t}{2} = \frac{343 \times 0.1}{2} = \frac{34.3}{2} = 17.15 \text{ m.}$$

RESULT: - So the minimum distance required for an echo to be heard when the speed sound is 343 m/s is 17.15 m.

The change in temperature can effect this distance because the speed of sound changes with temperature.

DIFFERENCE BEWEEN ECHO AND REVRBRATION

ECHO	REVERBRATION
The rehearing of sound after reflection is known as Echo.	The sound due to multiple reflections is known as reverberation.
To hear a clear echo time interval between our sound and the reflected sound must be at least 0.1 sec.	For reverberation the time interval between our sound and the reflected sound must be less than 0.1 sec.
The least distance between the obstacle and source of sound is 17 m.	The least distance between the obstacle and source of sound is less than 17 m.
It can be heard both in open and closed spaces.	It is usually experienced in closed spaces with multiple reflecting objects.
Echo is a single reflection of a sound wave off a surface.	Reverberation is the sound or the pattern created by the superposition of such echoes.

ACOUSTICS

<u>Definition:</u> - The study of production, propagation and properties of sound as well as the application of the result of scientific study of sound in the design of buildings, halls, rooms etc is called acoustics. **OR**

The scientific study of waves, vibrations and sound is known as acoustic.

<u>Factors of acoustics</u>: - The acoustics of a room depends upon various factors which are given below.

(i) Shape of the room.

(ii) The contents of the room.

(iii) The composition of the walls, ceiling and the floor.

Example: - The halls or big rooms which are built on the basis of acoustics, sound is clearly heard everywhere in these places. But if these places are built without the application of acoustics, then a loud will heard at some spots and low sound at other spots in these places.

Application: -

Acoustic protection:-

Definition: - The technique or method used to absorb un-desirable sounds by soft and porous surfaces is known as acoustic protection.

There are some factors that affect the clear cut hearing of sound in big halls and rooms. The elimination of such factors from the halls and rooms is called acoustic protection.

Explanation: - The factors that affect the acoustic of rooms and halls are given below.

(i) Echo :- The reflection of sound from a hard surface is called echo. Due to echo the original sound cannot be heard clearly. Echo can be avoided by placing sound absorbing materials in the walls of the halls and rooms.

(ii) Reverberation:- The presence of sound after the sounding source has stopped is known as reverberation. It causes a general confusion of the sound impression on the ear. To avoid this we use sound absorbing materials like carpet curtain, wood etc.

(iii) Focusing of sound at certain spots :- The curved wall causes the sound waves to be focused at certain spots. Due to this sound at other places cannot be heard clearly. To avoid this we should construct flat walls.

NOISE POLLUTION

Noise:- The word noise means un-wanted sound.

Definition:- The excessive displeasing sounds which disrupt the activity of human, animals and plants in the environment are called Noise pollution.

Unit:- It is measured in decibel (dB).

Explanation: -

Sources of noise pollution:- There are many sources which causes Noise pollution.

i. The horn of vehicles

ii. The machinery used in construction,

iii. The low flying aircrafts

iv. wood cutting machine etc.

Harmful effects: - Noise is nuisance because of its harmful effects on the human beings, animals and plants. Some harmful effects are mentioned below:

(i) It causes temporary or permanent deafness.

(ii) it reduces the working efficiency.

(iii) it increases the rate of errors which causes accidents.

(iv) it causes dangerous diseases like blood cancer, blood pressure, heart problems and mental illness.

(v) it effects the normal growth of plants.

Control of noise pollution:-

i. Sound insulation
ii. Sound absorption
iii. Vibration damping
iv. Public education and awareness.

AUDIABLE FREQUENCY RANGE

Definition:- The range of frequency from 20 Hz to 20,000 Hz is known as the audible frequency range. **OR**

The range of frequencies which a human ear can hear is known as audible frequency range.

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

Non-audible frequency range:-The range of frequencies which a human ear cannot hear is known as non-audible frequency range.

Types of non- audible sounds:- On the base of non- audible frequency range non-audible sounds are divided into two types which are given below.

1. Infra-sounds
2. Ultra-sounds

INFRA-SOUND

Definition: -

The sound having frequency less than 20 Hz are known is infrasonic.

Other names: -They are also called infrasonic sounds.

Explanation: -

I. They have large wavelength range.
II. They have low intensity.
III. They cannot pass through the sea water.

Examples: -

i.The sound produced by earth quakes is infrasonic.

ii.The sound produce by simple pendulum is infrasonic.

ULTRA-SOUND

Meaning :-

Definition: - The sound having frequency greater than 20,000Hz (20 kHz) are known as ultrasonic.

Other name: - They are also called ultrasonic sounds.

Explanation: -

i. They have small wavelength range.
ii. They have high intensity.
iii. They can pass through the sea water.

Examples: -

The sound produced by bats is ultrasonic etc.

Note:- A human ear cannot hear these sounds because such sounds cannot vibrate the membrane of ear.

Practical applications of ultrasound are as under;

(i) Ultrasound is used in "sonar" to measure the depth of the sea (ocean), and to locate underwater objects like the shoals of fish, submarine, etc.
(ii) Ultrasound is used to investigate injury inside the human body.
(iii) Ultrasound is used in the treatment of muscular pain.
(iv) Ultrasound is used in industry for detecting flaws in metal blocks or sheets without damaging them.

(v) Ultrasound is used for finding the level of a liquid in a metal tank without opening it.

CONCEPTUAL QUESTIONS

Question #01: Why the waves produced by a simple pendulum are not heard?

Ans:-Statement: - The waves produced by a simple pendulum are not heard.
Reason: - Because waves produced by simple pendulum are infrasonic in nature.
Explanation: - As we know that the Humans can hear only sound of those material whose frequency is 20Hz to 20000Hz. If the frequency of the body is less or greater than this human ears are unable to perceive sound. But the frequency (f) of the waves produced by a simple pendulum is less than 20 Hz, so such waves cannot be detected by the human ear and hence cannot be heard. So if the frequency of pendulum is less or greater than this range you cannot hear the sound produced by it.

Conclusion:- So as a result we can conclude that the waves produced by a simple pendulum are not heard.

Q # 02:- If a ringing bicycle bell is held tightly by hand, it stops producing sound. Why?

Ans:- Statement:- If a ringing bicycle bell is hold tightly by hand it stops producing sound.
Reason: - Because the vibrations of bell stops.
Explanation:- As we know that the sound can be produced by vibrating body. When an

object starts vibrations continuously through a very small distance sound is produced. When we hold the bell tightly, we are not allowing the bell to vibrate with an audible frequency. Therefore we cannot hear the bell.

Conclusion: - So as a result we can conclude that if we hold a ringing bicycle bell tightly by hand, it stops producing sound.

Q # 03:- Why is the intensity of an echo less than that of the original sound?

Ans:- Statement:- The intensity of an echo is always less than that of the original sound.

Reason: - It is because the loss of energy of the original sound after reflection from some surface. Less energy = Less loud

Explanation:- As we know that sound is a form of energy and an echo is based on reflection. When Sound waves strike the surface of a wall or other objects a part of its energy is absorbed and the rest is reflected. So the reflected wave possess less energy and becomes less intense.

Conclusion:- So as a result we can conclude that the intensity of an echo less is than that of the original sound.

Q # 04: In which medium air or water an echo is heard sooner? And why ?

Ans:-Statement:- In medium water an echo is heard sooner as compare to air.

Reason: - Water is more elastic than air.

Explanation: - As we know that the speed of sound in different media is different. Its speed depends upon the elasticity of the medium i-e Speed of sound ∝ Elasticity of medium. In more elastic medium the speed of sound is greater. The elasticity of water is more than the elasticity of air. Therefore the speed of sound in water is greater than in air.

Conclusion: - So as result we can conclude that In medium water an echo is heard sooner as compare to air.

Q # 05:- why a sound cannot be heard on moon?

Ans:-Statement:- A sound cannot be heard on moon.
Reason:- Because Sound waves are mechanical in nature.
Explanation:- As we know that sound is a form of wave motion .The sound waves are mechanical waves .The mechanical wave requires a material medium for their propagation. The material medium could be: Solid, liquid or gas. But there is no material medium in the atmosphere of the moon through which sound can pass.
Conclusion:- As a conclusion we find that sound cannot be heard on moon .

Q # 6:- If a person places his ear on rails of railroad for determination of the coming train. Why is this done and how it work?

Ans:- Statement:- A person places his ear on rails of railroad for determination of the coming train even if it is quite far away.
Reason:- It is because that the sound waves travel very fast in solids than in air.

Explanation:- As we know that

$$V = \sqrt{\frac{Elastic\ Modulus}{Density}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

From equation (1) the speed of sound depends upon the elasticity of the medium. Greater the elasticity of the medium greater will be the speed of sound. The speed of sound in solids is much greater than in air because the solids are more elastic than air (gases).

Conclusion:- As conclusion we find that a person places his ear on rails of railroad for determination of the coming train even if it is quite far away.

Q # 07: When you watch a thunderstorm you see the lightning first and you hear the thunder afterward . Why is the thunder delayed ?

Ans:- Statement:- In a thunderstorm we always see lightning before we hear the thunder. **Reason**:- It is because
(i) The speed of light is very greater than the speed of sound. **OR**
(ii) Light travels faster than sound

Explanation:- As we know that Light and sound are different in nature. Light travels much faster than sound. The speed of sound through air is about 340 meters per second. The speed of light in vacuum (Air) is 3 x 10^8 meters per second. The speed of light is about one million times faster than the speed of sound.

Conclusion:- As conclusion we can find that In a thunderstorm we always see lightning before we hear the thunder.

Q # 08: If the speed of sound is depended on frequency, would music from marching band be enjoyed?

Ans:- Statement:- No, If the speed of sound is depended on frequency, the music from marching band will not be enjoyed.

Reason: -

Explanation:- As we know that

$$V = f\lambda \text{ .... } (1)$$

From equation (iv) it should be noted that wide range of frequencies observed in sound, and the speed of sound is the same for all frequencies. Thus in the relation (iv) the speed "V" remains fixed. For example if the frequency of a wave is doubled, its wavelength is halved, so that the speed "V" stays the same.

If the speed of sound depends upon the frequency of sound, then the sound of different instruments will be heard at different speeds because high frequency sound will travel faster than low frequency sounds.

Conclusion:- As conclusion we find that If the speed of sound is depended on frequency, the music from marching band will not be enjoyed.

Q#09: Why does your voice sound fuller in the shower?

Ans: - Statement:- Our vice sound is fuller and richer in the shower.

Reason: - It is because of echo and reverberation effect.

Explanation: - As we know that as we know that the shower are made up tiles or hard non-absorbent surfaces. Due to which the multiple reflections of sound waves from these walls occurs. These multiple reflections enrich the sound and making one's voice louder and more powerful because of echo and reverberation effect.

Conclusion: - As conclusion we find that our vice sound is fuller and richer in the shower.

Q # 10: Why is it so quiet after a snowfall ? pakcity.org

Ans:- Statement:- It is so quiet after a snowfall.

Reason:- Because fluffy snow has ability absorb the sound waves.

Explanation:- When the ground has a thick layer of fresh, fluffy **snow** , it acts as a sound absorber, dampening sound waves much like commercial sound absorbing products**.** Snow's has ability to absorb sound is comparable to many of the foams and fibers used inside cars and buildings to reduce the noise.

Conclusion: - As conclusion we find that it is so quiet after a snowfall.

NUMERICAL QUESTIONS

Pb# 01:-The sound intensity 3 m from a jackhammer is 8.20×10^{-2} Wm^{-2}. What is the sound intensity level in decibels? (Use the usual reference level of $I_o = 1.00 \times 10^{-12}$ Wm^{-2}).

ANSWER:- GIVEN DATA:- Distance= d= 3m Intensity= I= 8.20×10^{-2} W/m^2 Faintest intensity= I_0= = 1.00×10^{-12} W/m^2 **REQUIRED DATA:-** Sound level= β= ? **SOLUTION:-** **FORMULA:-** $\beta = 10 \text{ Log } \frac{I}{I_0}$ .... (1)	**CALCULATION:-** By putting values in eq (1) $\beta = 10\text{Log } \frac{8.20 \text{ x} 10^{-2}}{1.00 \text{ x } 10^{-12}}$ =10 Log $8.\ 2 \times 10^{10}$ $\beta = 10\times$ Log (8.2 x 10000000000) β = 10 x 10.9138 = 109.1 dB **RESULT:-** **Intensity level=**109.1dB

Pb# 02:A ship is anchored where the depth of water is 120 m. An ultrasonic signal sent to the bottom of the lake returns in 0.16 s. What is the speed of sound in water?

ANSWER:- GIVEN DATA:- Distance =d=120m Time= T=0.16sec In case of echo = t = $\frac{T}{2}$ = $\frac{0.16}{2}$ = 0.08 sec **REQUIRED DATA:-** Speed = V =? **SOLUTION:-** **FORMULA:-** V = $\frac{d}{t}$	**CALCULATION:-** $V = \frac{d}{t} = \frac{120}{0.08} = 1500$ m/sec **RESULT:-** 1500 m/sec

Pb# 03:A gunshot from a 0.22 rim fire rifle has an intensity of about I = (2.5 ×10^{13}) I$_o$. Do we need to wear ear protection? (Considering that prolonged exposure to sounds above 85 decibels can cause hearing damage or loss).

ANSWER:- GIVEN DATA:- Intensity = I= 2.5x10^{13} I$_0$ W/m^2 Intensity level limit = 85dB **REQUIRED DATA:-** (i)Sound level of rim fire rifle = β =? (ii) Ear protection= ? **SOLUTION:-** **FORMULA:-** $\beta = 10 \text{ Log } \frac{I}{I_0}$	**CALCULATION:-** $\beta = 10 \text{ Log } \frac{(2.5 \text{ x}10^{13})I_0}{I_0} = 10\log 2.5 \text{ x}10^{13}$ β= 10 x 13.9 = 133.39 dB **RESULT:-** β= 133.39 dB. **(ii)Given intensity level limit is** 85dB. But resultant **intensity level limit is** 133.39dB which is too greater than 85dB. So we will be need to wear ear protection

Pb#04: What sound intensity level in dB is produced by earphones that create an intensity of 4.00 × 10^{-2} Wm^{-2}? (Use the usual reference level I$_o$ = 1.00 × 10^{-12} Wm^{-2}).

ANSWER:- GIVEN DATA:- Intensity= I= 4.00 x 10^{-2} W/m^2 Reference intensity= I_0= 1.00 x 10^{-12} W/m^2 **REQUIRED DATA:-** Sound level= β=? **SOLUTION:-** **FORMULA:-** $\beta = 10 \text{ Log } \frac{I}{I_0}$ ………… (1) **CALCULATION:- By putting values in equation (1) we get.**	$\beta = 10 \text{ Log } \frac{4.00 \times 10^{-2}}{1.00 \times 10^{-12}} = 10 \text{ Log } 4.00 \times 10^{10}$ β = 10 Log (4 x 10000000000) β = 10 x log (40000000000) β = 10 x 10.6 β = 106 dB **RESULT:-** β = 106 dB

Pb#05:What is the speed of sound in air at -20°C?

ANSWER:- GIVEN DATA:- Temperature=T= -20^0C Speed of sound in air =V= 331m/sec **REQUIRED DATA:-** Speed of sound in air at -20^0C =V_t=? **SOLUTION:-**	**FORMULA:-** V_t= V+0.6T **CALCULATION:-** V_t= 331+0.6 x -20 = 331 + (-12) V_t= 331 -12 = 319 m/s. **RESULT:-** Speed of sound in air at -20^0C =V_t= 319 m/s.

Pb# 06: Army man wearing binoculars see the flash from enemy tank fire 5 s before the fire is heard, he records 26°C temperature on his personal thermometer. What is the distance of the tank from him?

GIVEN DATA:-
Time = t = 5 sec
Temperature = T = 26^0
REQUIRED DATA:-
Distance of tank = S = ?
SOLUTION:- As we know that
FORMULA:- $V_t = \frac{S}{t}$ OR $S = V_t\, t$ .... (i)
As $V_t = 331+0.6T$

Then eq(i) becomes
$S = (V_t = 331+0.6T)\, t$ .... (ii)
CALCULATION:-
By putting values in equation (ii) we get
$S = (331+0.6\times 26) \times 5 = (331 + 15.6) \times 5$
$S = 346.6 \times 5 = 1733$ m $= 1.7 \times 10^3$=1.7km
RESULT:-
Distance of tank = S = 1.7km

Bb# 07: Calculate the wavelengths of sounds at the extremes of the audible range, 20 Hz and 20,000 Hz, at normal room temperature of 20°C?

ANSWER:-
GIVEN DATA:- Frequency $=f_1=$ 20Hz
Frequency $=f_2=$ 20,000Hz
Speed of sound=v=330 m/sec
Room temperature=T= 20 ^{0}C
REQUIRED DATA:-
(a) Wavelength of $f_1 = \lambda_1$=?
(b) Wavelength of $f_2 = \lambda_2$=?
SOLUTION:- As we know that
(a) For Wavelength of $f_1 = \lambda_1$:-
FORMULA:- $\lambda_1 = \frac{v}{f_1}$ ....(1)
As V = 331 + 0.6 T then eq (2) becomes
$\lambda_1 = \frac{331 + 0.6\,T}{f_1}$ .... (2)
CALCULATION:-
By putting values in eq (2)we get

$\lambda_1 = \frac{331+0.6\times 20}{20} = \frac{331+12}{20} = \frac{342}{20}$
λ_1= 17m

(b)Wavelength of $f_2 = \lambda_2$:-
FORMULA:- $\lambda_2 = \frac{331 + 0.6\,T}{f_2}$ .... (3)
CALCULATION:-
By putting values in eq (2) we get
$\lambda_2 = \frac{331+0.6\times 20}{20{,}000} = \frac{331+12}{20{,}000} = \frac{342}{20{,}000}$
λ_2 = 0.017m = 1.7 cm

RESULT:- (a) λ_1 = 16.5m
(b) λ_2 = 1.7cm

Pb# 08: Ishfaq stands between two high rise buildings A and B, such that he is at 33 m distance from building A. When he blows the whistle, he hears the first echo after 0.2 s and second echo after 0.8 s. Calculate (a) the speed of sound and (b) distance of building B from him.

ANSWER:- GIVEN DATA:-

Distance between Ishfaq and building A = S_1= 33m

First echo = t_1=0.2sec

Second echo = t_2=0.8sec

REQUIRED DATA:- (a) Speed of sound =V= ?

(b) Distance between Ishfaq and building "B" = S_2=?

SOLUTION:- (a) For speed of sound = v :- In case of echo

FORMULA:- v = $\frac{2S_1}{t_1}$ .... (1)

CALCULATION:- By putting values in eq 1 we get

$$v = \frac{2\times33}{0.2} = \frac{66}{0.2} = 330 \text{ m/sec}$$

(b) For distance between Ishfaq and building "B" = S_2:-

FORMULA:- S_2 = $\frac{Vt_2}{2}$........................ (2)

CALCULATION:- By putting values in eq 2 we get

$$S_2 = \frac{330 \times 0.8}{2} = \frac{264}{2} = 132 \text{ m}$$

RESULT:- (a) V= 330 m/sec (b) S_2 = 132 m