

11.13 If the pitch of the sound is increased what are the changes in the following.

- a) The frequency
- b) The wavelength
- c) The wave velocity
- d) The amplitude of wave

According to wave equation $V=f\lambda$. If there is an increase in the pitch then there will also be increase in frequency, wavelength decrease, wave velocity will increase? There will be no change in the amplitude of wave.

11.14 If we clap or speak in front of a building while standing at a particular distance, we rehear our sound after sometime. Can you explain how does this happen?

It is due the reflection of sound. When sound is incident on the surface of a medium it bounces back into the first medium. This is known as reflection of sound or echo.

11.15 How can you find the speed of sound by echo method? What factors can affect the accuracy of this method?

See question no. 11

11.16 What is the audible frequency range for human ear? Does this range vary with the age of people? Explain.

See Question no. 14

11.17 Explain that noise is a nuisance.

See Question no. 12

11.18 Describe the importance of acoustic protection.

See Question no. 13

11.19 What are the uses of ultrasound in medicine?

See Question no. 15

CONCEPTUAL QUESTIONS

11.1 Why two tin cans with a string stretched between them could be better way to communicate than merely shouting through the air?

Ans: Two tin cans with a string stretched between them could be better way to communicate than merely shouting through the air because sound travel faster in solids as compared to gases (air).

11.2 We can recognize persons speaking with the same loudness from their voice. How is this possible?

Ans: We can recognize persons speaking with the same loudness from their voice due to quality of their sound which is defined as:

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

11.3 You can listen to your friend round a corner, but you cannot watch him/her. Why?

Ans: The sound travel through medium in all directions and shows diffraction about the corner therefore we can listen to our friend around a corner due to diffraction but we can not watch him.

11.4 Why must the volume of a stereo in a room with wall-to-wall carpet be tuned higher than in a room with a wooden floor?

Ans: The volume of a stereo in a room with wall-to-wall carpet be tuned higher because maximum absorption of sound takes place through the porous and rough, material of carpet. But through flat surfaces and wooden floor maximum reflection is taking place so low sound is required to make clear sensation.

11.5 A student says that the two terms speed and frequency of the wave refer to the same thing. What is your response?

Ans: No, speed and frequency are two different terms which can be differentiated as follows.

Speed	Frequency
• The distance covered by the body in unit time • SI unit of speed is ms^{-1}.	• Number of waves passing through the point in one second is called frequency. • SI unit of frequency is Hz.

11.6 Two people are listening to the same music at the same distance. They disagree on its loudness. Explain how this could happen?

Ans: Two people are listening to the same music at the same distance. They disagree on its loudness. Because loudness also depends upon the physical condition of the ears of the listener. A sound appears louder to a person with sensitive ears than to a man with defective ears.

11.7 Is there any difference between echo and reflection of sound? Explain.

Ans: Yes, there is a difference. The reflection can take place at any distance from the denser medium at any time. But echo can be heard after 0.1 second, when distance between listener and reflecting surface is 17 m.

11.8 Will two separate 50dB sound together constitute a 100dB sound? Explain.

Ans: Yes, when two same sound of same loudness and are coherent (same wavelength) each of 50dB will constitute 100dB sound.

11.9 Why ultrasound is useful in medical field?

Ans: Ultrasound has high frequency (above 20,000Hz) and it carry more energy than the audible sound. According to relation $v = f\lambda$, the wavelength of ultrasonic waves is very small. Due to these characteristics ultrasonics are utilized in medical field.

INFORMATION BASED QUESTIONS AND THEIR ANSWERS

Self Assessment (Page 22)

Q.1 Explain how sound is produced by a school bell?

Ans. When hammer strike the school bell, it starts vibrating and hence produces sound.

Self Assessment (Page 22)

Q.2 Why are sound waves called mechanical waves?

Ans. Sound waves travel in the form of compressions and rarefactions due to the vibrations of the particles of the medium about their mean positions. In other words, sound waves require material medium for their propagation and hence are called mechanical waves.

Self Assessment (Page 22)

Q.3 Suppose you and your friend are on the moon. Can you be able to hear any sound produced by your friend?

Ans. As there is no material medium on the moon for the propagation of sound waves, hence we can not hear any sound produced by our friend on the moon.

Quick Quiz (Page 24)

Q.4 Why the voice of women is more shrill than that of men?

Ans. Voice of women is more shrill than that of men due to high frequency and pitch.

Quick Quiz (Page 24)

Q.5 Which property of sound waves determines its (a) loudness (b) pitch?

Ans. (a) Amplitude of sound wave determines its loudness.

(b) Frequency of sound wave determines its pitch.

Quick Quiz (Page 24)

Q.6 What would happen to the loudness of sound with increase in its frequency?

Ans. Loudness of sound does not depend upon the frequency of sound.

EXERCISE MULTIPLE CHOICE QUESTIONS FROM TEXT BOOK

1. Which is an example of a longitudinal wave?
☒ (a) Sound wave (b) Light wave (c) Radio wave (d) Water wave
2. How does sound travel from its source to your ear?
☒ (a) By changes in air pressure (b) By vibrations in wires or strings
 (c) By electromagnetic wave (d) By infrared waves
3. Which form of energy is sound?
 (a) Electrical ☒ (b) Mechanical (c) Thermal (d) Chemical
4. Astronauts in space need to communicate with each other by radio links because
 (a) Sound waves travel very slowly in space (b) Sound waves travel very fast in space
☒ (c) Sound waves cannot travel in space (d) Sound waves have low frequency in space
5. The loudness of a sound is most closely related to its
 (a) Frequency (b) Period (c) Wavelength ☒ (d) Amplitude
6. For a normal person, audible frequency range for sound wave lie between
 (a) 10 Hz and 10 kHz ☒ (b) 20 Hz and 20 kHz (c) 25 Hz and 25 kHz (d) 30 Hz and 30 kHz
7. When the frequency of a sound wave is increased, which of the following will decrease?
 (I) Wavelength (II) Period (III) Amplitude
 (a) I only (b) III only ☒ (c) I and II only (d) I and III only

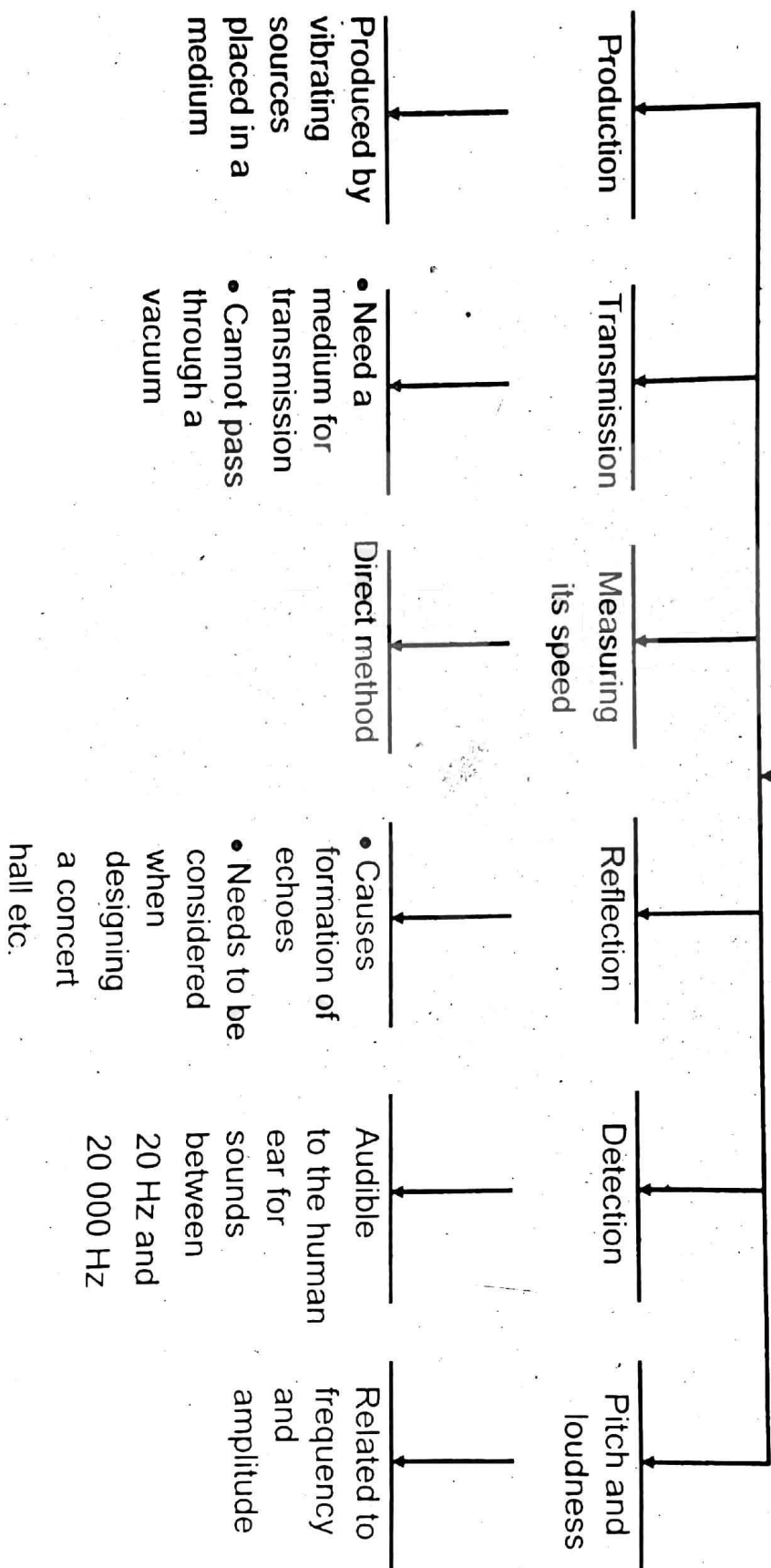
ANSWER KEY

1	2	3	4	5	6	7
a	a	b	c	d	b	c

SOUND

CONCEPT MAP

SOUND



TOPICAL MULTIPLE CHOICE QUESTIONS

11.1 Sound Waves:

1. The study of sound is called
(a) Acoustic (b) Optics (c) Electrostatics (d) All of these
2. Sound is produced by _____.
(a) Propagation (b) Vibration (c) Both of these (d) None of these
3. Sound can travel only in presence of
(a) Medium (b) vacuum (c) Air (d) Both a and c
4. Sound is _____ Wave
(a) Electromagnetic (b) Transverse (c) Longitudinal (d) None of these

11.2 Characteristics of Sound:

5. Characteristic by which We can distinguish between two sounds of same loudness and pitch is called _____.
(a) Loudness (b) Pitch (c) Quality (d) intensity of sound
6. Pitch of sound depends on
(a) Amplitude (b) Frequency (c) Time period (d) Displacement
7. Distance between two consecutive compressions and rarefactions is the _____ of sound wave.
(a) Amplitude (b) Frequency (c) Wave Length (d) none of these
8. Loudness of sound depends on
(a) Amplitude of vibrating body (b) Area of vibrating body
(c) Distance of vibrating body (d) All of these
9. _____ is the characteristic of sound by which we can distinguish between a shrill and a grave sound.
(a) Pitch (b) loudness (c) Intensity (d) Quality
10. Frequency of silent whistle Lies between _____.
(a) 20,000Hz - 25,000Hz (b) 20,000Hz - 35,000Hz
(c) 20Hz - 20,000Hz (d) 15,000Hz - 40,000Hz
11. The intensity of sound depends on the _____ of sound.
(a) Time period (b) frequency (c) Amplitude (d) None of these
12. Intensity is a _____ quantity.
(a) Vector (b) Scalar (c) Physical quantity (d) None of these
13. Intensity of faintest sound is
(a) 10^{12} Wm^{-2} (b) 10^{-12} Wm^{-2} (c) 10^{-8} Wm^{-2} (d) 10^{-9} Wm^{-2}

14. Intensity of loudest audible sound is _____.
 (a) 10^{-12}Wm^{-2} (b) 1Wm^{-2} (c) 20Wm^{-2} (d) All of these
15. Intensity of whispering
 (a) 10^{-5}Wm^{-2} (b) 10^{-8}Wm^{-2} (c) 10^{-9}Wm^{-2} (d) 10^{-12}Wm^{-2}
16. The loudness of sound is directly proportional to logarithm of intensity, this Law is called _____.
 (a) Weber Fechner Law (b) Law of Gravitation
 (c) Intensity Level (d) Echo
17. Voice of Child is _____.
 (a) Grave (b) Shrill (c) Faint (d) Loud
18. I bell is equal to
 (a) 20dB (b) 10dB (c) 100dB (d) 50dB
19. The amplitude of 100 dB sound is _____.
 (a) 1000 (b) 10,000 (c) 100,000 (d) 1001000
20. By using an _____ we can see sound wave.
 (a) Electroscop (b) Stroboscope (c) Gastroscope (d) Oscilloscope

11.3 Reflection (ECHO) of Sound:

21. Echo of sound is
 (a) Refraction (b) Reflection (c) Diffraction (d) Interference
22. The sensation of sound persists in our brain about _____.
 (a) 1s (b) 0.1s (c) 0.01s (d) 2s
23. For hearing distinct echoes, the minimum distance of obstacle from source of source of sound must be
 (a) 34m (b) 17m (c) 38m (d) 16m

11.4 Speed of Sound:

24. The speed of sound in solid is about _____ times that in gases.
 (a) 5 (b) 15 (c) 20 (d) 10
25. The speed of sound in air at a2 atm pressure and at room temperature (21°C) is
 (a) 320ms^{-1} (b) 360m/s (c) 343ms^{-1} (d) None of these
26. The speed of sound varies with _____.
 (a) Temperature (b) Humidity (c) both a and b (d) None of these
27. The speed of sound in solid is _____ than liquid and air
 (a) Greater (b) Smaller (c) Equal (d) None of these
28. Bats can hear Frequencies up to 120,000Hz
 (a) 10,000Hz (b) 120,000Hz (c) 12,00,000Hz (d) 120,00,000Hz

29. Mice can hear frequencies up to
 (a) 35,00Hz (b) 35,000Hz (c) 45,00Hz (d) 100,000 Hz
30. Compressions are places Where air is slightly _____ than the surrounding air
 (a) Less (b) Higher (c) Equal (d) None of these
31. Rarefactions are places where air is slightly _____ than the surrounding air
 (a) Less (b) Higher (c) Equal (d) None of these
32. The speed of sound in air was first accurately measured in _____
 (a) 1838 (b) 1738 (c) 1638 (d) 1938

11.5 Noise Pollution:

33. Such sound Which are pleasant to our ears are called _____
 (a) Musical Sound (b) Noise (c) Both a and b (d) None of these
34. Such sounds which are unpleasant to our ears are called _____.
 (a) Musical Sound (b) Noise (c) Both a and b (d) None of these
35. Corresponds to irregular and sudden vibrations produced by some sound
 (a) Noise (b) Musical Sound (c) Notes of tuning fork (d) None of these
36. The Level of noise recommended in most of countries is
 (a) 75-80dB (b) 85-90dB (c) 95-100dB (d) 115-120dB
37. The method used to absorb undesirable sound by soft and porous surface is called
 (a) Acoustics (b) Echos (c) Intensity (d) Pitch
38. Multiple reflections called
 (a) Acoustics (b) reverberations (c) Vibration (d) All of these
39. We hear sound produce by musical instrument such as
 (a) Flute (b) Violin (c) Harmonic (d) All of these
40. For a normal person audible frequency range for sound wave lie between
 (a) 10^{th} and 10 KHz (b) 20 Hz and 20KHz (c) 25Hz and 25 KHz (d) 30Hz and 30 KHz
41. Noise correspond _____ vibration
 (a) Irregular (b) Sudden (c) Both 'a' and 'b' (d) Slowly slowly
42. Noise has negative effects on human health it cause except
 (a) Aggression (b) Hypertension (c) High stress level (d) Fever/flue
43. Which are the acoustic protection except
 (a) Lecture Halls (b) Auditorium (c) Theater halls (d) Kitchen

11.6 Audible Frequency Range:

44. Audible frequency range is
 (a) 200Hz-2000Hz (b) 15Hz-15000Hz (c) 20Hz-20KHz (d) 20Hz-15000Hz
45. Old people cannot hear sound even above
 (a) 20, 00Hz (b) 15 KIHz (c) 15,000 Hz (d) Both (b) and (c)
46. Which bird fly easily between wires in the black room
 (a) Sparrow (b) Bat (c) Cow (d) Parrot
47. The range of the frequency which human, ear can hear is called
 (a) Audible frequency range (b) Ultrasonic waves
 (c) Transonic waves (d) None of these

11.7 Ultrasound:

48. Ultrasonics are used to measure the depth of Water by
 (a) Acoustics (b) Echo Method (c) Sound Level (d) Diffraction
49. _____ Waves carry more energy and higher frequency than sound waves
 (a) Ultrasonics (b) Infrasonic (c) Audible sound (d) All of these
50. Ultrasonics are used to locate under-water depth the technique is called
 (a) Acoustics (b) Reverb ration (c) Sonar (d) Infrasonics
51. Sound waves with frequency less than 20Hz are called _____.
 (a) Ultrasonic (b) Infrasonics (c) Notes (d) Acoustic
52. Ultrasound is the frequency of sound higher than
 (a) 20Hz (b) 20KHz (c) 15,000 Hz (d) 25,000 Hz
53. Infrasonic is the frequency of sound less than
 (a) 20Hz (b) 20 KHz (c) 15,000 Hz (d) 25,000 Hz
54. According to wave equation $v = f\lambda$ the wavelength of ultra sonic waves are
 (a) Very small (b) Very big (c) Both "a" and "b" (d) None of these
55. Powerful ultrasound is now being used to remove blood clot from
 (a) Capillaries (b) Arteries (c) Convoluted tubule (d) None of these
56. By which waves small cracks can appear
 (a) Ultrasonics (b) Infrasonic (c) NOTSE (d) Sound frequency
57. By ultrasonic waves are destroyed
 (a) Germs (b) Bacteria (c) Fungus (d) Both "a" and "b"
58. When the frequency of a sound wave is increased which of following decrease
 (a) Wave length (b) Period (c) Amplitude (d) Both a and b
59. Bats can hear frequency up to
 (a) 120, 000Hz (b) 2,000 Hz (c) 20, 000 Hz (d) 15,000 Hz
60. Researcher in _____ observed giraffes to stop and wait for the others that were out of sight
 (a) 1898 (b) 1993 (c) 2013 (d) None of these

ANSWER KEY

Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans
1	a	11	d	21	b	31	a	41	c	51	b
2	b	12	c	22	b	32	b	42	d	52	b
3	d	13	b	23	b	33	a	43	d	53	a
4	c	14	b	24	b	34	b	44	c	54	a
5	c	15	c	25	c	35	a	45	c	55	b
6	b	16	a	26	c	36	b	46	b	56	a
7	c	17	b	27	a	37	a	47	a	57	d
8	d	18	b	28	b	38	b	48	b	58	d
9	a	19	c	29	d	39	d	49	a	59	a
10	a	20	d	30	b	40	b	50	c	60	b

SHORT QUESTIONS

11.1 Sound Waves

11.2 Characteristics Of Sound

11.3 Speed Of Sound

Q.1. What is sound wave? How sound is produced?

Sound Wave

A sound wave is a pattern of disturbance caused by the movement of energy traveling through medium as it propagate away from source of sound.

Like other waves sound is also produced by vibrating bodies. Due to vibration of bodies the air around them also vibrates and the air vibration produces sensation of sound in our ear.

Q.2. Ans: What is tuning fork?

Ans: It is a U-shaped body having two metal prongs with a stem at the bottom and is used for producing sound of particular frequency.



Q.3. Why medium is required for the propagation of sound waves?

Ans: Sound waves are compressional waves in nature. That is the type of mechanical waves and we know that mechanical waves require medium for their propagation. So we can say material medium is necessary for the propagation of sound from one point to another. This material medium can be a gas, a liquid or a solid.

Q.4. Define loudness of sound and what are the factors affecting it?

Ans: Definition

"The characteristic of sound by which a loud and faint sound can be distinguished is called loudness of sound".

Factors affecting loudness of Sound

Following are the factors that affect the loudness of sound.

- Amplitude of vibrating body
- Area of vibrating body
- Distance from vibrating body
- Physical condition of ear

Q.5. Define pitch of the sound

Ans: The characteristic of sound by which a shrill sound can be distinguished from a grave one is called the pitch of the sound.

Dependence on Frequency

It depends upon the frequency, the greater the frequency, the higher the pitch and lower the frequency, the lower the pitch.

Q.6. Define the quality of sound with an example.

Ans: "The characteristic of sound by which two sounds of same loudness and pitch are distinguished from each other is called the quality of sound".

Example

Sounds of flute and piano of given loudness and pitch can be distinguished because the quality of their notes is different.

Dependence:

It depends upon the waveform of the sound waves. The loudness and pitch of these two sounds are the same but their waveforms are different. So their quality is different and can be distinguished from each other

Q.7. What is intensity of sound?

Ans:

Intensity of sound

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

Unit

The unit of intensity of sound is watt per square meter (Wm^{-2}). Intensity is a physical quantity and can be measured accurately.

Intensities of Faintest and Loudest sound

The intensity of faintest sound is 10^{-12} Wm^{-2} and the intensity of the loudest sound, which can be heard without pain, is 1 Wm^{-2} .

Q.8. State Weber Fechner Law

Ans: Weber Fechner Law

It has been proved experimentally that loudness (L) of a sound is directly proportional to the logarithm of intensity.

Mathematically:

$$L \propto \log I$$

$$L = K \log I$$

Where L is loudness of sound, K is proportionality constant and I is intensity of sound.

Q.9. Intensity Level or Sound Level

Ans. The difference between the loudness of any unknown sound and faintest sound ($L - L_0$) is called the intensity level or sound level.

Mathematically:

$$\text{Sound level} = K \log \frac{I}{I_0}$$

Where I is intensity of unknown sound, K is proportionality constant and I_0 is intensity of the faintest sound.

Q.10. Define SI unit of sound level (Bel)

Ans. Bel:

If the intensity of any unknown sound is 10 times greater than the intensity I_0 of the faintest audible sound i.e. $I = 10I_0$ then the intensity level of such sound is taken as unit, called Bel. The value of K becomes 1.

Mathematically:

$$\text{Sound Level} = K \log \frac{I}{I_0} (\text{Bel})$$

By substituting $K = 1$, equation becomes

$$\text{Sound Level} = \log \frac{I}{I_0} (\text{Bel})$$

Q.11. Find sound level of sound of train?

Ans: Intensity of sound of train is 10^{-2} Wm^{-2} and sound level of faintest sound is 10^{-12} Wm^{-2} then

$$\begin{aligned} \text{Sound level of sound of train (in bel)} &= \log \frac{10^{-2}}{10^{-12}} \text{ (Bel)} \\ &= \log 10^{10} = 10 \text{ Bel} \end{aligned}$$

$$\begin{aligned} \text{Sound level of sound of train in decibel} &= 10 \log \frac{10^{-2}}{10^{-12}} \text{ (dB)} \\ &= 10 \log 10^{10} = 100 \text{ dB} \end{aligned}$$

11.4 Reflection (Echo) Of Sound:

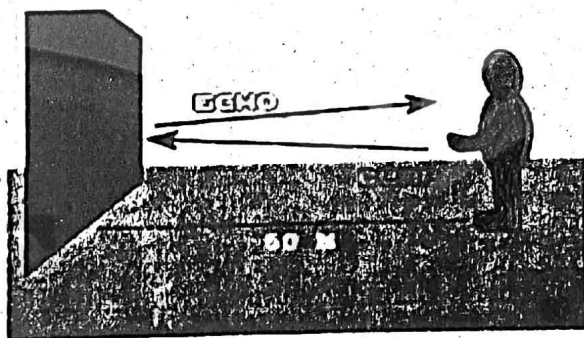
Q.12. How reflection (Echo) of sound can be defined ?

Echo:

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

Q.13. Calculate minimum distance to hear Echo.

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



Q.14. Calculate the frequency of a sound wave of speed 340 ms^{-1} and wavelength 0.5m.

Ans.

Solution:

Given that:

$$\begin{aligned} \text{Speed of waves} &v = 340 \text{ ms}^{-1} \\ \text{Wave length} &\lambda = 0.5 \text{ m} \end{aligned}$$

Required

$$\text{Frequency} = f = ?$$

Using the formula $v = f\lambda$

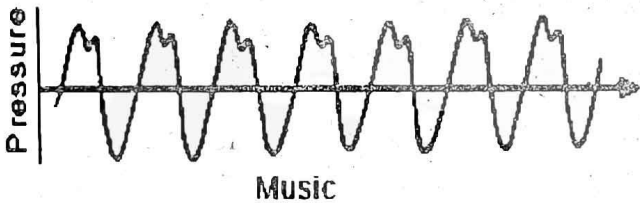
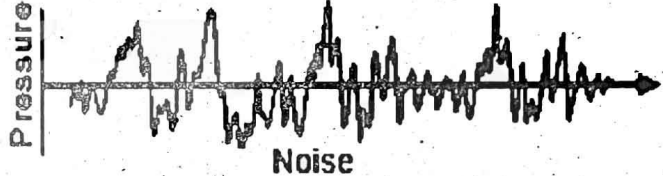
$$f = \frac{v}{\lambda} = \frac{340}{0.5}$$

$$f = 680 \text{ Hz}$$

11.5 Noise Pollution:

Q.15. What is noise pollution? Explain its sources and effects. How it is reduced? OR
Differentiate between music and noise. Explain effects of noise and safe level of noise.

Ans:

Music	Noise
• The sounds that have pleasant effect on our ears are called musical sounds. • The frequency and amplitude of musical sounds change in a regular manner. • Sounds produced by the musical instruments like flute, violin, harmonium are musical sounds.	• The sounds that have jarring or unpleasant effect on our ears are called noise. • The frequency and amplitude of the noise change in irregular manner. • Sounds of traffic or sound produced by hammering in factories are noise.
<u>Examples</u> • We enjoy the programmes of radio or television by hearing sounds of different qualities. • In musical programmes, we hear sound produced by musical instruments such as flute, harmonium, violin, drum etc.	<u>Examples</u> • Sound of machinery • The slamming of a door, • Sounds of traffic in big cities.
<u>Waveform:</u> 	<u>Waveform:</u> 

Q.16. What is meant by Noise Pollution and describe its Sources

Ans. Noise Pollution

Noise pollution has become a major issue of concern in big cities. Noise is a undesirable sound that is harmful for health of human and other species.

Sources:

The sources of noise pollution are given below

- Transportation equipment
- Heavy machinery

These are the main sources of noise pollution. For example, noise of machinery in industrial areas, loud vehicle horns, hooters and alarms.



Q.17. What are effects of Noise?

Ans. Effects of Noise:

Noise has negative effects on human health as it can cause conditions such as

- Hearing loss
- Sleep disturbances,
- Aggression,
- Hypertension,
- High stress levels.

Noise can also cause accidents by interfering with communication and warning signals.



Q.18. Enlist any five sound of Music and noise.

Ans. Musical sounds

- (i) Sound of harmonium
- (ii) Sound of flute
- (iii) Sound of tabla
- (iv) Sound of songs
- (v) Sound of violin

Noises

- (i) Sound of traffic
- (ii) Sound of moving train
- (iii) Sound of aeroplanes
- (iv) Sound of crying
- (v) Sound of horns

Q.19. What are the major sources of noise in our society?

Ans: Automobiles, aeroplanes, helicopters, trains, heavy machinery, heavy traffic, loud speakers are the major sources of noise pollution in our society.

Q.20. How noise can be reduced?

Ans: Trees and different appliances are used to reduce the noise

Q.21. What do you know by Safe Level of Noise:

Ans. Safe Level of Noise:

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

Q.22. Define acoustics protection. Explain importance of acoustic protection.

Ans. Acoustic Protection.

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

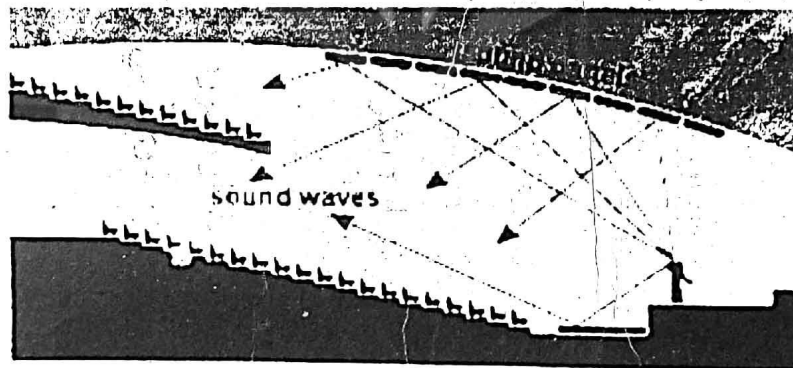
Importance of Acoustic:

Reflection of sound is more prominent if the surface is rigid and smooth and less if the surface is soft and irregular. Soft, porous materials, such as draperies and rugs absorb large amount of sound energy and thus quiet echoes and softening noises. Thus by using such materials in noisy places, we can reduce the level of noise pollution.

Q.23. What is meant by Reverberation:

Ans. When sound reflects from the wall, ceiling and floor of a room, the reflecting surfaces are too reflective and the sound becomes garbled. This is due to multiple reflections called reverberations.

In the design of lecture halls, auditorium or theatre halls, a balance must be achieved between reverberation and absorption. It is often advantageous to place reflective surfaces behind the stage to direct sound to the audience.



11.6 Audible Frequency Range:

Q.24. What is audible frequency range for human and why we cannot hear if sound ranges more than this range.

Ans: A human ear can hear sound only if its frequency lies between 20 to 20000 Hz. A human ear can neither hear a sound of frequency less than 20 Hz nor a sound of frequency more than 20000 Hz. Sounds of frequency beyond the 20000 Hz are inaudible because the eardrum of human ear cannot vibrate so rapidly. The audible range is different for different persons and it also varies with the age.

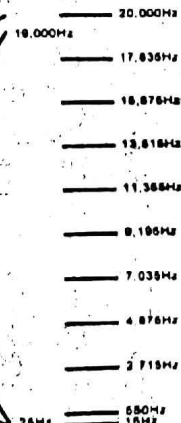
Q.25. What is silent whistle and why it is called so?

Ans: Some people use silent whistle to call dogs whose frequency lies between 20,000 Hz to 25,000 Hz and human ear cannot detect it. So, it is silent for human that is why it is called silent but it is not silent for the dogs because their audible range is much more than human.

Modern Stereo Cassette Deck
Frequency Range: 25Hz - 19,000Hz



Harman Kardon DC520



11.7 Ultrasound:

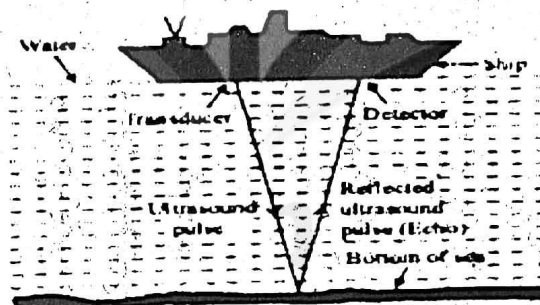
Q.26. What are ultrasonic and why they are used in our life?

Ans: "Sound waves of frequency higher than 20000 Hz are ultrasonics"

It has been seen that ultrasonic waves carry more energy than audible sound waves. Moreover, according to the relation $v = f\lambda$, the wavelength of ultrasonic waves is very small. Due to these characteristics they are usefully utilized in medical and technical fields.

Q.27. How we can find the depth of ocean?

Ans: Ultrasound is used to locate underwater depths or is used for locating objects lying deep on the ocean floor, etc. The technique is called SONAR, (sound navigation and ranging). The sound waves are sent from a transmitter, and a receiver collects the reflected sound. The time lapse is calculated, knowing the speed of sound in water, the distance of the object from the ocean surface can be estimated.



Ultrasonic are used to measure depth of water by echo method (fig 1.a)

LONG QUESTIONS

11.1 Sound Waves:

Q.1 What is sound wave? How sound is produced? Give examples.

Sound Wave

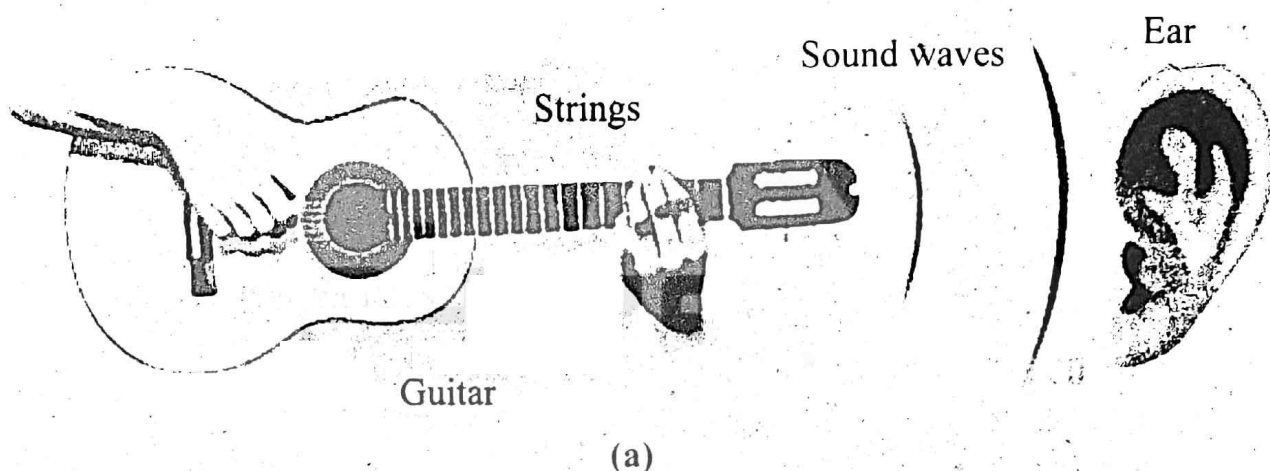
A sound wave is a pattern of disturbance caused by the movement of energy traveling through medium as it propagate away from source of sound.

Production of Sound

Like other waves sound is also produced by vibrating bodies. Due to vibration of bodies the air around them also vibrates. And the air vibration produces sensation of sound in our ear.

Examples:

- In a guitar, sound is produced due to the vibrations of its strings as shown fig (a).

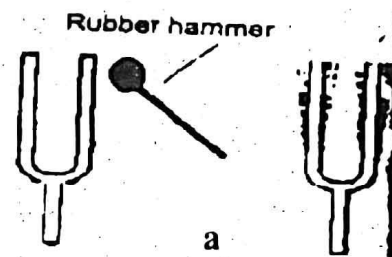


- Our voice results from the vibrations of our vocal chords.
- Human heart beats and vibrations of other organs like lungs also produce sound waves. Doctors use stethoscope to hear this sound.

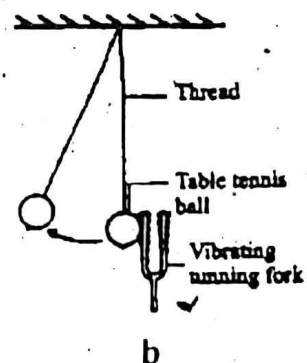
Q.2 With the help of an activity make it clear that sound is produced by vibrating body.

Activity:

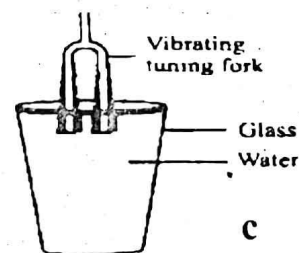
In school laboratories, we use a device called tuning fork which produces a particular sound. If we strike the tuning fork against rubber hammer, the tuning fork will begin to vibrate as shown in fig (a).



We can hear the sound produced by tuning fork by bringing it near our ear. We can also feel the vibration by slightly touching one of the prongs of the vibrating tuning fork with a plastic ball suspended from a thread as shown in fig (b).



Touch the ball gently with the prong of a vibrating tuning fork. The tuning fork will push the ball because of its vibration. Now if we dip the vibrating tuning fork into a glass of water, we will see a splash (fig c) vibrations make the water splash?



Conclusion:

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

Q.3 With the help of an experiment, show that a material medium is required for propagation of sound.

Sound requires material medium for its propagation (Activity:)

Sound waves require some material medium for their propagation, this can be proved by bell jar apparatus (as shown in fig. a). The bell jar is placed on the platform of a vacuum pump.

An electric bell is suspended in the bell jar with the help of two wires connected to a power supply. By setting on the power supply, electric bell will begin to ring. We can hear the sound of the bell. Now start pumping out air from the jar by means of a vacuum pump. The sound of the bell starts becoming more and more feeble and eventually dies out, although bell is still ringing. When we put the air back into the jar we can hear the sound of the bell again.

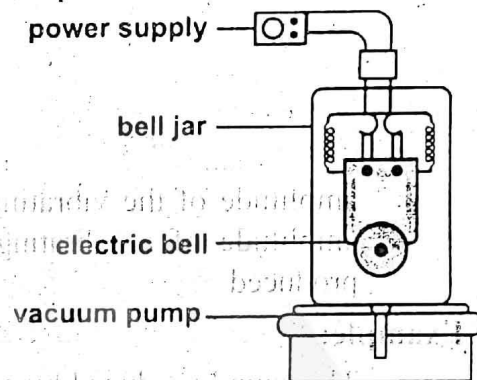


Fig. 11.5: Bell jar apparatus

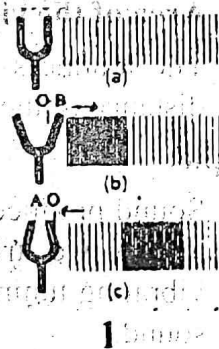
Conclusion:

From this activity we conclude that sound waves can only travel/ propagate in the presence of air (medium).

Q.4 Explain longitudinal nature of sound waves.

Propagation of sound waves produced by vibrating tuning fork can be understood by a vibrating tuning fork (as shown in fig.1).

Before the vibration of tuning fork, density of air molecules on the right side is uniform as shown in fig 1(a).



1

Vibrations of tuning fork after striking with a rubber hammer

When the right prong of tuning fork moves from mean position O to B, it exerts some pressure on the adjacent layer of air molecules and produces a compression. This compressed air layer in turn compresses the layer next to it and so on as shown fig.1(b).

A moment later, the prong begins to move from B towards A (fig.1(c)). Now the pressure in the adjacent layer decreases and a rarefaction is produced. This rarefaction is transferred to the air layer next to it and so on. As the tuning fork moves back and forth rapidly, a series of compressions and rarefactions are created in the air. In this way, sound wave propagates through the air.

Conclusion:

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

11.2 Characteristics Of Sound:

Q.5 Define loudness of sound and what are the factors affecting it?

Ans: Definition

"The characteristic of sound by which a loud and faint sound can be distinguished is called loudness of sound".

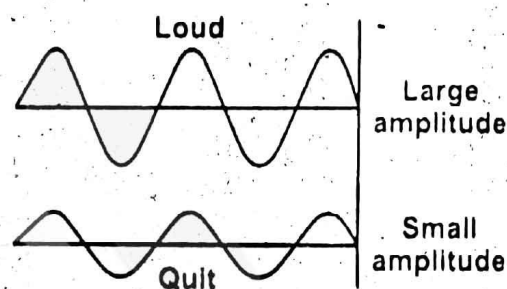
Factors affecting loudness of Sound

Following are the factors that affect the loudness of sound.

- (i) Amplitude of vibrating body
- (ii) Area of vibrating body
- (iii) Distance from vibrating body
- (iv) Physical condition of ear

(a) Amplitude of the vibrating body:

The loudness of the sound varies directly with the amplitude of the vibrating body (fig.1). The greater the amplitude of a vibrating object the louder the sound produced



Example:

The sound produced by a sitar will be loud if we pluck its wires more violently. Similarly, when we beat a drum forcefully, the amplitude of its membrane increases and we hear a loud sound.

(b) Area of the vibrating body:

The loudness of sound also depends upon the area of the vibrating body. "Lesser the distance of the listener from the vibrating body louder is the sound produced?"

Example:

Sound produced by a large drum is louder than that by small one because of its vibrating area. If we strike a tuning fork on a rubber pad, a feeble sound will be heard. But if the vibrating tuning fork is placed vertically on the surface of a bench, we will hear a louder sound.

From this we can conclude that the loudness increases with the area of the vibrating body and vice versa.

(c) Distance from the vibrating body:

Loudness of sound also depends upon the distance of the vibrating body from the listener.

Example

We move away from a drum being beaten violently to avoid uncomfortably loud sound. We also experience that sound is heard to be louder if it travels in the same direction in which the wind blows. It seems to be faint if it travels in the opposite direction. It is caused by the decrease in amplitude due to increase in distance.

Physical condition of ear

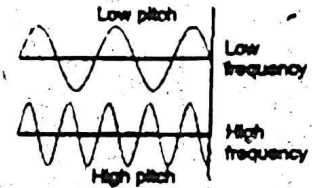
Loudness of sound also depends on the physical condition of ear. A sound appears louder to a person with sensitive ears than to a man with defective ears

Q.6 Pitch: Define pitch of the sound and explain the relation between pitch and frequency with an example?

Ans: The characteristic of sound by which a shrill sound can be distinguished from a grave one is called the pitch of the sound.

Dependence on Frequency

It depends upon the frequency, the greater the frequency, the higher the pitch and lower the frequency, the lower the pitch.



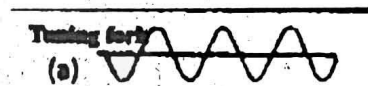
Example:

The frequency of the voice of ladies and children is greater than that of men. Therefore, the voice of ladies and children is shrill and is of high pitch as compared to men.

Q.7 What is meant by quality of sound?

Quality:

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



Sound wave form produce by tuning fork

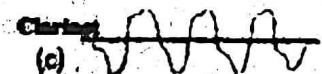
Examples:

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



Sound wave form produce by flute

Fig.1(a),(b),(c) shows the waveform of the sound produced by a tuning fork, flute and clarinet. The loudness the pitch of these three sounds are the same but their waveforms are different. So their quality is different and they can be distinguished from each other.



Sound wave form produce by clarinet

Q.8 What is intensity of sound and how you will relate intensity of sound with loudness of sound?

Ans: Intensity of sound

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

Unit

The unit of intensity of sound is watt per square meter (Wm^{-2}). Intensity is a physical quantity and can be measured accurately.

Intensities of Faintest and Loudest sound

The intensity of faintest sound is 10^{-12} Wm^{-2} and the intensity of the loudest sound, which can be heard without pain, is 1 Wm^{-2} .

Comparison of intensity with the loudness of sound

It may be remembered that intensity of sound is a physical quantity and it does not depend on condition or sensitiveness of the ear whereas the magnitude of the sensation produced on the ear by a sound is called loudness. The loudness of a sound depends not only on the intensity of sound but also on the physical condition of the ear.

Weber Fechner Law

It has been proved experimentally loudness (L) of a sound is directly proportional to the logarithm of intensity that is given as under:

$$L \propto \log I$$

$$L = K \log I \quad \dots\dots\dots (1)$$

Above equation (1) is the mathematical representation of the Weber Fechner law and K is the constant of proportionality.

If L_0 represents the loudness of the faintest audible sound of intensity I_0 and L is the loudness of an unknown sound of intensity I then equation (1) can be written as:

$$L_0 = K \log I_0 \quad \dots\dots\dots (2)$$

Intensity Level or Sound Level

The difference between the loudness of any unknown sound and faintest sound ($L - L_0$) is called the intensity level or sound level.

By subtracting equation (2) from equation (1), we have

$$\text{Sound level} = L - L_0 = K \log I - K \log I_0$$

$$\text{Sound level} = L - L_0 = K (\log I - \log I_0)$$

$$\text{Sound level} = K \log \frac{I}{I_0} \quad \dots\dots\dots (3)$$

The value of K depends not only on the unit of I and I_0 but also on the unit of intensity level.

Unit of Intensity Level or Sound Level

The unit of intensity level or sound level is Bel.

Bel

If the intensity of any unknown sound is 10 times greater than the intensity I_0 of the faintest audible sound i.e. $I = 10I_0$ then the intensity level of such sound is taken as unit, called Bel.

- It is SI unit of sound level.
- Bel is very large unit of sound level.

The value of K becomes 1 in Weber Fechner law equation. By substituting $K = 1$, equation (3) becomes:

$$\text{Sound Level} = \log \frac{I}{I_0} \text{ (Bel)} \quad \dots\dots\dots (4)$$

Decibel

- Generally a smaller unit called decibel is used.
- Decibel is abbreviated as (dB).
- 1 Bel is equal to 10 dB.

If sound level is to measured in decibels then equation (4) can be written as:

$$\text{Sound Level} = 10 \log \frac{I}{I_0} \text{ (dB)} \quad \dots\dots\dots (5)$$

Calculation of Sound Level of different sounds

Example 1 (Sound level of faintest audible sound)

Intensity or sound level of faintest audible sound can be calculated by substituting $I = I_0 = 10^{-12} \text{ Wm}^{-2}$ in equation (5), we have

$$\text{Sound level of faintest audible sound is} = 10 \log \frac{I}{I_0} = 10 \log \frac{I_0}{I_0} = 0 \text{ (dB)}$$

Example 2 (Sound level of rustle of leaves)

By substituting $I = 10^{-11}$ in equation (5), we have

$$\text{Sound level of rustle of leaves} = 10 \log \frac{I}{I_0} = 10 \log \frac{10^{-11}}{10^{-12}} = 10 \log 10 = 10 \text{ dB}$$

Example 3 (Sound level of whispering)

By substituting $I = 10^{-10}$ in equation (5), we have

$$\text{Sound level of whispering} = 10 \log \frac{I}{I_0} = 10 \log \frac{10^{-10}}{10^{-12}} = 10 \log 100 = 20 \text{ dB}$$

$$\text{Intensity level of faintest audible sound} = 10 \log \frac{I}{I_0}$$

$$= 10 \log \frac{I}{I_0}$$

$$= 0 \text{ dB}$$

((b) As the intensity of the rustle of leaves is $I = 10^{-11} \text{ Wm}^{-2}$

Therefore,

$$\begin{aligned} \text{Intensity level due to rustling of leaf} &= 10 \log 10^{-11}/10^{-12} \\ &= 10 \log 10 = 10 \text{ dB} \end{aligned}$$

11.3 Reflection (Echo) Of Sound:

Q.9 How reflection (Echo) of sound can be defined and explained.

OR

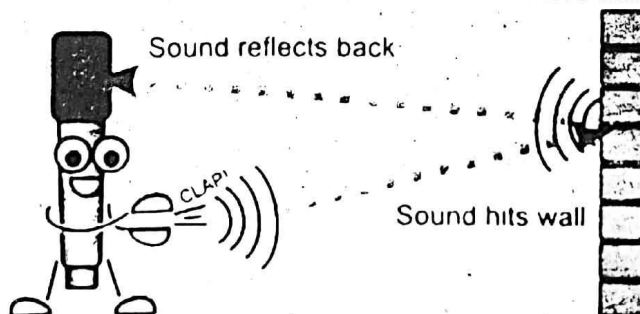
Define Echo and explain it. Also calculate minimum distance to hear Echo.

Echo:

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

Explanation:

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



Minimum Distance to hear Echo:

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

11.4 Speed Of Sound:

Q.10 How can calculate speed of sound?

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

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

$$V = f\lambda \dots\dots\dots (11.6)$$

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

Measuring speed of sound by Echo Method

Q.11 How can we measure speed of sound by Echo method?

Apparatus:

measuring tape. Stopwatch, flat wall that can produce a good echo.

Procedure:

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

11.5 Noise Pollution:

Q.12 What is noise pollution? Explain its sources and effects. How it is reduced?

OR

Differentiate between music and noise. Explain effects of noise and safe level of noise.

Music:

"Such sounds which are pleasant to our ears are called musical sounds."

Examples:

- We enjoy the programmes of radio or television by hearing sounds of different qualities.
 - In musical programmes, we hear sound produced by musical instruments such as flute, harmonium, violin, drum etc.
- Sound of these instruments cast pleasant effect on our ears.

Noise:

"Sound which has jarring and unpleasant effect on our ears is called noise. Noise corresponds to irregular and sudden vibrations produced by some sounds."

Examples:

- Sound of machinery
- The slamming of a door,
- Sounds of traffic in big cities.

Sound of above mentioned examples cast unpleasant effect on our ears

Noise Pollution and its Sources:

Noise pollution has become a major issue of concern in big cities. Noise is a undesirable sound that is harmful for health of human and other species. The sources of noise pollution are given below.

- Transportation equipment
- Heavy machinery

These are the main sources of noise pollution. For example, noise of machinery in industrial areas, loud vehicle horns, hooters and alarms.

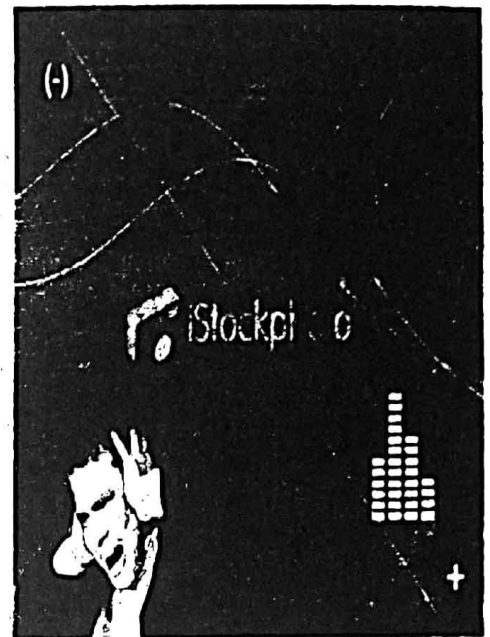
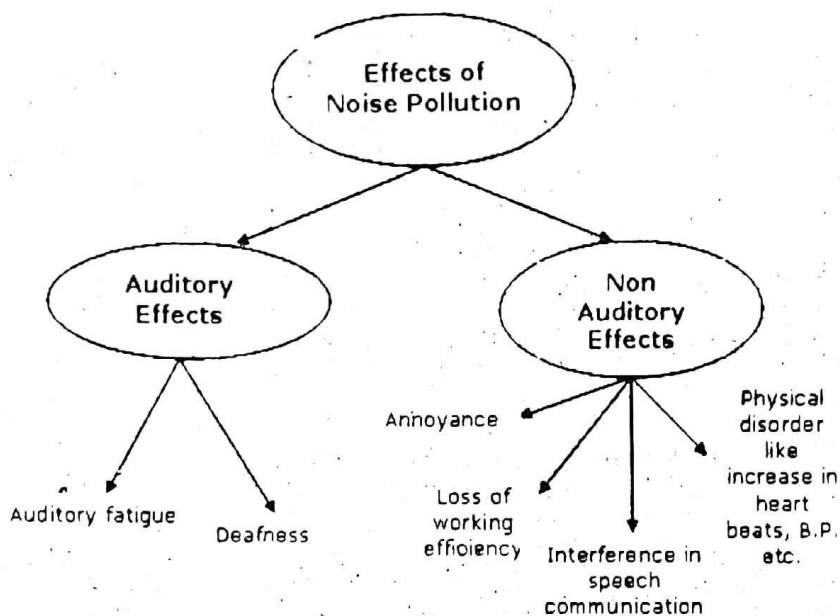
Effects of Noise:

Noise has negative effects on human health as it can cause conditions such as

- Hearing loss
- Sleep disturbances
- Aggression,
- Hypertension
- High stress levels.
- Noise can also cause accidents by interfering with communication and warning signals.

Safe Level of Noise:

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



Q.13 Define acoustics protection. Explain importance of acoustic protection.

Acoustics Protection.

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

Importance of Acoustic:

Reflection of sound is more prominent if the surface is rigid and smooth,, and less if the surface is soft and irregular. Soft porous materials, such as draperies and rugs absorb large amount of sound energy and thus quiet echoes and softening noises. Thus by using such materials in noisy places. We can reduce the level of noise pollution. However, if the surface of classrooms to public halls are too absorbent, the sound level may be low for the audience.

Reverberation:

When sound reflects from the wall, ceiling and floor of a room, the reflecting surfaces are too reflective and the sound becomes garbled. This is due to multiple reflections called reverberations.

In the design of lecture halls, auditorium or theatre halls, a balance must be achieved between reverberation and absorption. It is often advantageous to place reflective surfaces behind the stage to direct sound to the audience.

Curved ceiling of lecture halls:

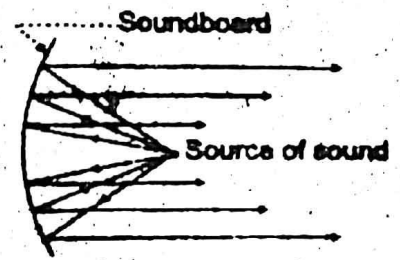
Generally the ceilings of lecture halls, conference halls and theatre halls are curved so that sound after reflection may reach all the corners of the hall (Fig a) .



Curved ceiling of conference halls

Curved Sound Board:

Sometimes curved sound boards are placed behind the stage so that sound after reflection is distributed every across the hall (Fig. b)



Sound board used in big hall

11.6 Audible Frequency Range:

Q.14 What do you know about audible frequency range?

Audible Frequency Range:

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

Explanation:

We know that sound is produced by a vibrating body. A normal human ear can hear a sound only if its frequency lies between 20Hz and 20,000 Hz, in other words, a human ear neither hears a sound of frequency less than 20Hz nor a sound of frequency more than 20,000 Hz. Different people have different range of audibility. It also decreases with age. Young children can hear sound of 20,000 Hz but old people

Cannot hear sounds even above 15,000Hz.

11.7 Ultrasound:

Q.15 What are ultrasonic? And write some of the uses of ultrasonic?

Ans: Ultrasound:

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

Why do we use ultrasonic in medical and technical field?

It has been seen that ultrasonic waves carry more energy than audible sound waves. Moreover, according to the relation $v = f\lambda$, the wavelength of ultrasonic waves is very small. Due to these characteristics they are usefully utilized in medical and technical fields. Some of the uses of ultrasonic are given as under:

A. Uses In Medical Field

For treatment of different diseases

Ultrasonic waves are being used to diagnose and treat different ailments. For diagnosis of different diseases ultrasonic waves are made to enter the human body. These waves are reflected differently by different organs, tissues, benign or malignant tumors. The reflected ultrasonic waves are then amplified and fed to a monitor which form an image of internal organs of the body which helps to detect the defects of these organs.

For diagnose purposes

Ultrasound can also be used to get the pictures of thyroid gland for diagnosis purposes.

Removal of Blood clots

Powerful ultrasonic are now being used to remove blood clots formed in the arteries.

Removal of Dirt from teeth

Ultrasonic waves are used for the scaling of teeth as their vibrations are so intense they remove easily the dirt and plaque sticking to the teeth.

Killing of Bacteria

Germ and bacteria in the liquids can be destroyed by using high intensity ultrasonics.

Removal of Kidney Stone

The kidney stones can be crushed and removed out through urine with the help of ultrasonics waves without any surgery

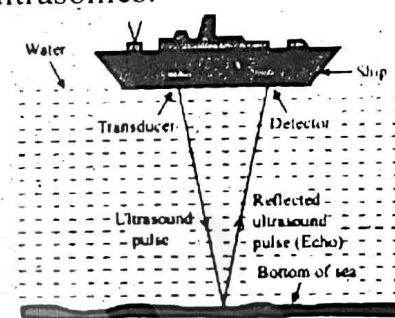
B. Use in Technical Fields

Searching of Oil and Gas

The source of oil and gas inside earth are searched by using ultrasonics.

Finding the Depth of water

Ultrasound is used to locate underwater depths or is used for locating objects lying deep on the ocean floor, etc. The technique is called SONAR; (sound navigation and ranging). The sound waves are sent from a transmitter, and a receiver collects the reflected sound (Fig. 1 a). The time lapse is calculated, knowing the speed of sound in water, the distance of the object from the ocean surface can be estimated



Ultrasonic are used to measure depth of water by echo method (fig 1.a)

SONAR (sound navigation and ranging)

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

Detection of Cracks

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

NUMERICAL PROBLEMS

11.1 A normal conversation sound intensities of about $3.0 \times 10^{-6} \text{ Wm}^{-2}$. What is the decibel level for this intensity? What is the intensity of the sound for 100 dB?

(a) **Given Data**

Intensity of sound = $I = 3.0 \times 10^{-6} \text{ Wm}^{-2}$

Intensity of faintest sound = $I_0 = 10^{-12} \text{ Wm}^{-2}$

Required

Intensity level = $L - L_0 = ?$

Solution

As we know that

$$L - L_0 = 10 \log \frac{I}{I_0} \text{ dB}$$

$$= 10 \log \frac{3 \times 10^{-6} \cancel{\text{Wm}^{-2}}}{10^{-12} \cancel{\text{Wm}^{-2}}} \text{ dB}$$

$$L - L_0 = 10 \log \left(\frac{3 \times 10^{-6}}{10^{-12}} \right)$$

$$= 10 \log (3 \times 10^{-6+12}) \text{ dB}$$

$$= 10 \log (3 \times 10^6) \text{ dB}$$

$$= 10 \times 6.47 \text{ dB}$$

$$= 64.7 \text{ dB}$$

(b) **Given Data**

Intensity level $L - L_0 = 100 \text{ dB}$

Intensity of faintest audible sound = $I_0 = 10^{-12} \text{ Wm}^{-2}$

Required

Intensity of given sound = $I = ?$

Solution

We know that

$$L - L_0 = 10 \log \frac{I}{I_0} \text{ dB}$$

$$100 \text{ dB} = 10 \log \frac{I}{10^{-12} \text{ Wm}^{-2}} \text{ dB}$$

$$\Rightarrow \frac{100}{10} = \log \frac{I}{10^{-12} \text{ Wm}^{-2}}$$

$$10 = \log \frac{I}{10^{-12}}$$

$$10 = \log 10^{12} \times I$$

Taking antilog on both sides

$$\text{Antilog } 10 = \text{Antilog} [\log (10^{12} \times I)]$$

$$1 \times 10^{10} = 10^{12} I$$

$$\frac{1 \times 10^{10}}{10^{12}} = I$$

$$I = 1 \times 10^{-2}$$

$$I = 0.01 \text{ Wm}^{-2}$$

11.2 If at Anarkali bazaar Lahore, the sound level is 80 dB, what will be the intensity level of sound there?

Given Data

$$\text{Sound level} = L - L_0 = 80 \text{ dB}$$

$$\text{Intensity of faintest audible sound} = I_0 = 10^{-12} \text{ Wm}^{-2}$$

Required Intensity of sound = $I = ?$

Solution We know that

$$L - L_0 = 10 \log \frac{I}{I_0} \text{ dB}$$

$$80 \text{ dB} = 10 \log \frac{I}{10^{-12} \text{ Wm}^{-2}} \text{ dB}$$

$$\frac{80}{10} = \log \frac{I}{10^{-12} \text{ Wm}^{-2}}$$

$$8 = \log (10^{12} \times I)$$

Taking antilog on both sides

$$\text{Antilog } 8 = \text{Antilog} [\log (10^{12} \times I)]$$

$$10^8 = 10^{12} \times I$$

$$\frac{10^8}{10^{12}} = I$$

$$I = 10^{8-12}$$

$$I = 10^{-4} \text{ Wm}^{-2}$$

- 11.3** At a particular temperature, the speed of sound in air is 330ms^{-1} . If the wavelength of a note is 5cm , calculate the frequency of the sound wave. Is this frequency lies in the audible range of the human ear?

Given Data

$$\text{Speed of sound} = v = 330 \text{ ms}^{-1}$$

$$\text{Wavelength} = \lambda = 5\text{cm}$$

$$= \frac{5}{100} \text{ m} = 0.05\text{m}$$

Required

$$\text{Frequency} = f = ?$$

Solution

We know that

$$v = f\lambda$$

$$\Rightarrow f = \frac{v}{\lambda}$$

$$= \frac{330\text{ms}^{-1}}{0.05\text{m}}$$

$$= 6600\text{s}^{-1} \quad \text{s}^{-1} = \text{Hz}$$

$$f = 6.6 \times 10^3 \text{ Hz}$$

$\therefore$ yes this frequency lies in the range of human ear.

- 11.4** A doctor counts 72 heartbeats in 1 min. Calculate the frequency and period of the heartbeats.

Given Data

$$\text{No of heartbeats} = n = 72$$

$$\text{Time} = t = 1 \text{ min}$$

$$= 1 \times 60\text{sec} = 60\text{sec}$$

Required

$$\text{Frequency} = f = ?$$

$$\text{Time period} = T = ?$$

Solution

We know that

$$f = \frac{n}{t}$$

$$= \frac{72}{60\text{sec}}$$

$$= 1.2 \text{ s}^{-1} \quad \text{s}^{-1} = \text{Hz}$$

$$= 1.2 \text{ Hz}$$

As

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

$$= \frac{1}{1.2\text{s}^{-1}}$$

$$T = 0.833 \text{ sec.}$$

- 11.5 A marine survey ship sends a sound wave straight to the sea bed. It receives an echo 1.5s later. The speed of sound in a sea water is 1500 ms^{-1} . Find the depth of the sea at this position.

Given Data:

$$\text{Time taken} = t = 1.5 \text{ s}$$

$$\text{Speed} = v = 1500 \text{ ms}^{-1}$$

Required:

$$\text{Depth of sea water} = h =$$

Solution:

As we know that

$$S = vt$$

$$= (1500) (1.5)$$

$$= 2250 \text{ m}$$

For hearing echo, the minimum depth from sea bed to ship must be half of this depth (2250m)

$$h = \frac{S}{2}$$

$$= \frac{2250}{2}$$

$$= h = 1125 \text{ m}$$

- 11.6 A student clapped his hands near a cliff and heard the echo after 5s. What is the distance of the cliff from the student if the speed of the sound, v is taken as 346 ms^{-1} ?

Given data:

$$\text{Time taken} = t = 5 \text{ s}$$

$$\text{Speed} = v = 346 \text{ ms}^{-1}$$

Required:

$$\text{Distance} = d = ?$$

Solution:

As we know that

$$S = vt$$

$$= 346 \times 5$$

$$S = 1730 \text{ m}$$

For hearing echo, the minimum distance from obstacle to the source of sound must be half of this distance (1730m).

$$d = \frac{S}{2}$$

$$d = \frac{1730}{2}$$

$$d = 865 \text{ m}$$

- 11.7** A ship sends out ultrasound that returns from the seabed and is detected after 3.42s. If the speed of ultrasound through seawater is 1531 ms^{-1} , what is the distance of the seabed from ship?

Given data:

Time taken = $t = 3.42 \text{ s}$

Speed = $v = 1531 \text{ ms}^{-1}$

Required:

Depth of sea water = $h = ?$

Solution:

As we know that

$$S = vt$$

$$= 1531 \times 3.42$$

$$= 5236.02 \text{ m}$$

For hearing echo, the minimum depth from sea ship must be half of this distance (5236.02m)

$$h = \frac{s}{2}$$

$$= \frac{5236.02}{2}$$

$$h = 2618 \text{ m}$$

- 11.8** The highest frequency sound humans can hear is about 20,000 Hz. What is the wavelength of sound in air at this frequency at temperature of 20°C ? What is the wavelength of the lowest sounds we can hear of about 20 Hz? Assume the speed of sound in air at 20°C is 343 ms^{-1} .

Given Data

Highest frequency = $f_1 = 20,000 \text{ Hz}$

Lowest frequency = $f_2 = 20 \text{ Hz}$

Speed of sound = $v = 343 \text{ ms}^{-1}$

Required

Wavelength of highest frequency = $\lambda_1 = ?$

Wavelength of lowest frequency = $\lambda_2 = ?$

Solution:

We know that $v_1 = f_1 \lambda_1$

$$\Rightarrow \lambda_1 = \frac{v}{f_1}$$

$$= \frac{343 \text{ ms}^{-1}}{20,000 \text{ s}^{-1}}$$

$$\lambda_1 = 0.01715 \text{ m} = 1.7 \times 10^{-2} \text{ m}$$

As

$$\begin{aligned} V &= f_2 \lambda_2 \\ \Rightarrow \lambda_2 &= \frac{v}{f_2} \\ &= \frac{343 \text{ ms}^{-1}}{20 \text{ s}^{-1}} \\ &= 17.15 \text{ m} \\ \lambda_2 &= 17.15 \text{ m} \end{aligned}$$

11.9 A sound wave has frequency of 2 kHz and wavelength 35cm. How long will it take to travel 1.5 km?

Given Data:

Frequency = $f = 2 \text{ KHz}$

$$= 2 \times 10^3 \text{ Hz}$$

$$\text{Wavelength} = \lambda = 35 \text{ cm} = \frac{35}{100} \text{ m} = 0.35 \text{ m}$$

$$\text{Distance} = s = 1.5 \text{ Km} = 1.5 \times 1000 \text{ m} = 1500 \text{ m}$$

Required:

$$\text{Time} = t = ?$$

Solution:

We know that

$$\begin{aligned} V &= f\lambda \\ &= 2 \times 10^3 \text{ Hz} \times 0.35 \text{ m} \\ &= 700 \text{ ms}^{-1} \end{aligned} \quad \text{Hz} = \text{s}^{-1}$$

As

$$S = v \times t$$

$$1500 \text{ m} = 700 \text{ ms}^{-1} \times t$$

$$t = \frac{1500 \text{ m}}{700 \text{ ms}^{-1}}$$

$$= 2.1 \text{ sec}$$