CHAPTER

02

SOUND

In this chapter, we concentrate on the propagation and characteristics of sound and also discuss range of hearing of audible and waves, infrasonic waves and ultrasonic waves and their uses.

Sound is a form of energy which produces a sensation of hearing in our ears. A sound is produced by the vibration in an object. The sound of human voice is produced due to vibrations in the vocal cords.

Propagation of Sound

- The path through which sound travels is called **medium**, i.e. it can be solid, liquid and gas.
- Sound travels through all states of matter. The velocity of sound is maximum in solids and least in gases.

Terms Related to Sound

Amplitude (*a*)

- The amplitude *(a)* of vibration is defined as the maximum displacement of a vibrating object from its central position.
- The amplitude describes, how much far the oscillating object is displaced from its central position.

Time Period (*t*)

The time period *(t)* is the time taken by a vibrating (oscillating) object to complete one vibration.

Frequency (*f*)

- The frequency *(f)* is defined as the number of oscillations per second.
- Frequency is measured in hertz (Hz).

- When an object makes one vibration in one second, then its frequency is 1 Hz.
- If an object makes 20 oscillations in one second, then its frequency is 20 Hz.

Relation between Time Period and Frequency

Since, the frequency of vibrating body is equal to the reciprocal (or inverse) of its time period.

i.e. $$f = \frac{1}{T}$$

Velocity of sound (v) = frequency × wave length

i.e., $v = n\lambda$

Characteristics of Sound

There are three characteristics of sound by which it can be recognised. These are loudness, pitch and quality.

1. Loudness

- The loudness of sound depends on the amplitude of vibrations of vibrating body. e.g. When a sitar string is plucked lightly, then it vibrates with small amplitude and produces a faint of sound.
- On the other hand, when the sitar string is plucked hard, then it starts vibrating with a large amplitude and produces a loud sound.
- The loudness of sound depends on the amplitude of vibration of sound producing object. Loudness of sound is proportional to the square of the amplitude of the vibration producing the sound, e.g. if the amplitude becomes twice, then the loudness increases by a factor of 4.
- The loudness is expressed in a unit called decibel (dB).

Sound	Loudness
Normal breathing	10 dB
Soft whisper (at 5 m)	30 dB
Normal conversation	60 dB
Busy traffic	70 dB
Average factory	80 dB

Note Above dB, the noise becomes physically painful.

2. Pitch

- The characteristic property of sound by which differentiate between sounds of same loudness is known as pitch of sound.
- Man's voice from a woman's voice on the basis of their pitch or shrillness. The pitch of sound depends on the frequency of vibration of sound producing object.
- When the frequency of vibration is higher, then the sound has a lower pitch, e.g. a drum vibrates with a low frequency. Most of the times, the voice of a woman has a higher frequency and is shriller than that of a man.
- Humming of mosquito has a high pitch but low loudness while roar of a lion has high loudness but low pitch.

3. Quality

- The characteristics of sound which differentiate between two sounds is known as quality of sound.
- The sounds produced by different singers can be distinguished by their quality.

Range of Hearing

1. **Audible or Sound Waves** The frequency (which lies between the) range of 20 Hz to 20000 Hz are called audible or sound waves. These waves are sensitive to human ears.
2. **Inaudible or Infrasonic Waves** The waves frequencies (which is) less than 20 Hz are called infrasonic waves. These waves are produced by sources of bigger size such as earthquakes, volcanic eruptions, ocean waves and by elephants and whales.
3. **Ultrasonic Waves** The frequencies (which is) greater than 20000 Hz are called ultrasonic waves. Human ear cannot detect these waves. But certain creatures like dog, cat, bat, mosquito can detect these waves.
   Bat not only detect but also produce ultrasonic waves.

The applications of Ultrasonic waves are as follows

- For sending signals.
- For measuring the depth of sea.
- For cleaning cloths, aeroplanes and machinery parts of clocks.
- For removing lamp-shoot from the chimney of factories.
- In sterilising of a liquid.
- In ultrasonography.
- In SONAR (Sound Navigation and Ranging).
- SONAR is used for navigation.

Sonometer is a device which is used to study the behaviours of vibrating string.

Earthquake Waves

- An earthquake is a vibration of the earth surface.
- Earthquake waves are seismic waves that are created when energy build up in rocks and they fracture.
- The instrument used to record earthquake waves is called seismograph.
- The Richter scale of earthquakes to measure magnitude was devised by Charles F Richter.

Noise and Music

In our daily life, we hear different types of sounds. Some of these sounds are unpleasant to hear. The unpleasant sounds are called noise. Blowing of horns of motor vehicles, Bursting of crackers, Running of mixer and grinder are examples of Noise.

On the other hand, some sounds are pleasant. The sounds which are pleasant to hear are called musical sounds or music. The sound produced by musical instruments is also a musical sound.

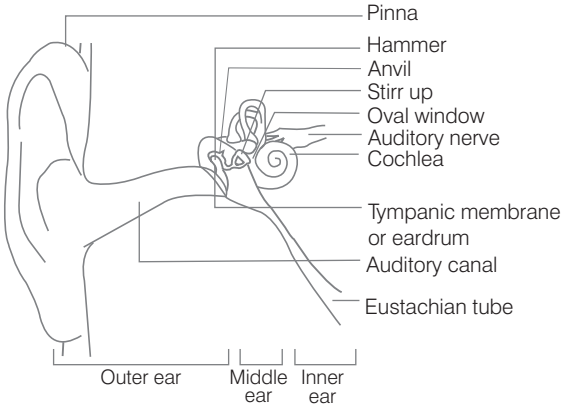
Noise Pollution

The presence of loud, unwanted, and disturbing sounds in our environment is called noise pollution.

Television and transistor radio as high volumes, some Kitchen appliances, desert coolers air conditioners contribute to noise pollution.

Human Ear

The ears are the sense organs which helps us in hearing sound. It allows us to convert pressure variations in air with audible frequencies into electric signals which travel to the brain *via* **auditory nerve**.



Internal Structure of Ear

Structure of Human Ear

The ear consists of three compartments outer ear, middle ear and inner ear

(i) **Outer Ear** It consists of a broad part pinna, ear canal, a thin elastic circular membrane, ear drum.

(ii) **Middle Ear** It consists three small bones viz hammer, anvil and stir up, which are connected with each-other.

(iii) **Inner Ear** It has a coiled tube Cochlea.

The side of cochlea is connected to auditory nerve going into the brain.

PRACTICE EXERCISE

1. Which one of the following statements is correct regarding the velocity of sound?
(a) It does not depend upon the nature of media
(b) It is maximum in gases and minimum in liquids
(c) It is maximum in solids and minimum in liquids
(d) It is maximum in solids and minimum in gases

2. The ceilings of a concert hall are generally curved because
(a) they reflect the sound to the audience.
(b) they can absorb noise.
(c) it better aeration in the hall.
(d) as any sound from outside cannot pass through a curved ceilling.

3. A human heart beats 72 times in a minute. Its frequency will be
(a) 1.9 Hz (b) 1.2 Hz
(c) 2.5 Hz (d) 8.2 Hz

4. If sound of lightening is heard after 12 seconds of lightening, then distance of observation of sound from the place where lightening occurs, is
[Given, speed is sound = 330 m/s]
(a) 1980 m
(b) 2970 m
(c) 3960 m
(d) 1485 m

5. Loudness of sound can be increased by
(a) increasing frequency.
(b) decreasing frequency.
(c) increasing amplitude.
(d) decreasing amplitude.

6. A sound wave has frequency of 2 kHz and wavelength of 35 cm. If an observer is 1.4 km away from the source. At what time interval could the observer hear the sound?
(a) 2s (b) 20s
(c) 0.5s (d) 4s

7. A person rings a metallic bell near a strong concrete wall. He hears the echo after 0.3 s. If the sound moves with a speed of 340 m/s. The wall is far from him?
(a) 102 m (b) 11 m
(c) 51 m (d) 30 m

8. A baby recognises her mother by her voice. The characteristics of sound involved is
(a) quality (b) pitch
(c) loudness (d) shrillness

9. By which property of sound the change in air temperature is affected ?
(a) Amplitude (b) Intensity
(c) Frequency (d) Wavelength

10. Sound waves are similar to the waves
(a) of laser light passing through air
(b) generated in a stretched wire by hitting or plucking the wire
(c) generated in a pipe filled with air by moving the piston attached to the pipe up and down
(d) generated by the mobile phone towers

11. The range of human audibility lies between
(a) 10 to 10,000 Hz (b) 20 to 20,000 Hz
(c) 30 to 30,000 Hz (d) 40 to 40,000 Hz

12. Bat can know about their prey at a long distance even in the night by emitting
(a) infra-red lights
(b) ultraviolet lights
(c) chemicals from their body
(d) ultrasonic sounds

13. Which one of the following statement is not correct about sound waves?
(a) Sound waves in gases are longitudinal in nature
(b) Sound waves having frequency below 20 Hz are known as ultrasonic wave
(c) Sound waves having higher amplitudes are louder
(d) Sound waves with high audible frequencies are sharp

14. Which type of sound produced by a bat?
(a) audible (b) subsonic
(c) infrasonic (d) ultrasonic

15. Ultransound cleaner use ultrasonic waves of frequency about ..... .
(a) 40 KHZ (b) 80 KHZ
(c) 5 KHZ (d) 100 KHZ

16. A person standing on railway platform listens to the whistles of arriving and departing trains. The whistle heard is
(a) the same in both cases in all respects
(b) of higher intensity when train arrives
(c) of higher pitch when train arrives
(d) of higher pitch when train departs

17. The unit of noise pollution (level) is measured in
(a) decibel
(b) decimal
(c) ppm
(d) None of these

18. SONAR is a device to measure distance, direction and speed of underwater objects. It is based on
(a) light waves (b) infrasonic waves
(c) ultrasonic waves (d) radio waves

19. The location of submerged objects can be detected by
(a) Radar (b) SONAR
(c) Quasar (d) Pulsar

20. The depth of oceans can be measured by
(a) RADAR (b) SONAR
(c) audible (d) None of these

21. The study of behaviours of vibrating string can be detected by of sound.
(a) Sonometer (b) Barometer
(c) Hydrometer (d) Hygrometer

22. What is the name of the strings which vibrate in our voice box when we talk is
(a) air column (b) pinna
(c) vocal cord (d) string

Answers

1	*(d)*	2	*(b)*	3	*(b)*	4	*(c)*	5	*(c)*	6	*(a)*	7	*(c)*	8	*(a)*	9	*(d)*	10	*(c)*
11	*(b)*	12	*(d)*	13	*(b)*	14	*(d)*	15	*(a)*	16	*(c)*	17	*(a)*	18	*(c)*	19	*(b)*	20	*(b)*
21	*(a)*	22	*(c)*																