Sound

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. Vibration is a kind of rapid to and fro motion of an object. By striking the tuning fork, by plucking, scretching, rubbing, blowing or shaking different objects all produce sound due to vibrations.

Production of Sound by Human Beings

- The sound of human voice is produced due to vibration in the vocal cords.
- The moment, the lungs release the air through the slit, the vocal cords start vibrating and produce sound.
- Muscles attached to the vocal cords can make them tight or loose.
- When the vocal cords are tight and thin, then the type or quality of voice is different from that when they are loose and thick.
- The vocal cords in men are about 20 mm long. In women, these are about 5 mm shorter.
- Children have very short vocal cords. This is the reason why the voices of men, women and children are different.

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.

Range of Hearing

1. **Audible or Sound Waves** The waves which lie in the frequency range 20 Hz to 20000 Hz are called audible or sound waves. These waves are sensitive to human ears.
2. **Infrasonic Waves** The waves having frequencies 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 waves having frequencies greater than 20000 Hz are called ultrasonic waves.

   Human ear cannot detect these waves. Certain creatures like dog cat, bat, mosquito can detect these waves.
   Bat not only detect but also produce ultrasonic waves.

Applications of Ultrasonic Waves

- *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.*

Terms Related to Sound

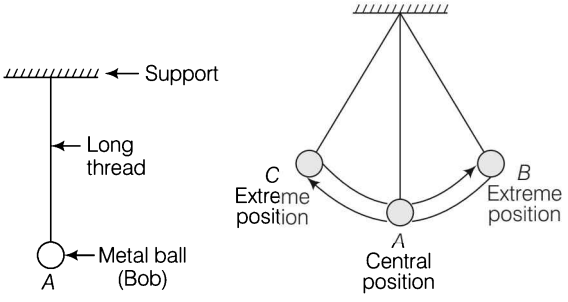
Amplitude (*a*)

- 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
e.g. the time taken by pendulum bob to travel from *A* to *B*, then *B* to *C* and then back to *A* is the time period of pendulum.

The SI unit of measuring time period is second.



(a) A simple pendulum (at rest)

(b) A vibrating (or oscillating) simple pendulum

Frequency (*f*)

- The frequency (*f*) is defined as the number of oscillations per second.
- Frequency is measured in hertz (Hz). So, when an object makes one vibration in one second, then its frequency is 1Hz.
- 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. $f = \frac{1}{T}$

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.
- 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

2. Pitch

- The characteristics 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 we can say that the sound has a lower pitch, e.g. a drum vibrates with a low frequency.
- Most of the times, the voice of woman has a higher frequency and is shriller than that of a man.

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.

Noise and Music

- The unpleasant sounds are called noise.
- Due to irregular vibrations of sound producing source, the noise is created, e.g. running of mixture and grinder in the kitchen produce noise.
- The horns of buses and trucks produce noise, even from the various of noise construction sites large amount of production of nose can be experienced.
- The sounds which are pleasant to hear are called musical sounds. It is produced by regular vibrations producing source.
  e.g. the sound produced by harmonium is musical sound, the string of sitar produces a musical sound, even when a person sings a melodious song, he also produces musical sound.
- If a musical sound becomes too loud, then it would not remain melodious and hence, become noise. This usually happens when very loud music is played at a disco and when a band plays loudly in a party.

Noise Pollution

- The presence of excessive or unwanted sounds in the environment is called noise pollution.
- The sounds of vehicles explosions including bursting of crackers, machines, loudspeakers, etc., are the major causes of noise pollution.
- The major sources of noise pollution in our homes are television and transistor radio at high volumes, some kitchen appliances, use of desert coolers and air conditioners.

Practice Exercise

1. Sound can be travel in which of the following medium?

I. Wood II. Air
III. Vacuum
(a) Only I
(b) Only II
(c) Both I and II
(d) I, II and III

2. Sound is slowest in
(a) air
(b) water
(c) solid
(d) vacuum

3. Which of the following statements are correct?

I. Sound is produced by vibrations.
II. Sound requires a medium for propagation.
III. Light and sound both require a medium for propagation.
IV. Sound travels slower than light.
(a) I and II (b) I, II and III
(c) II, III and IV (d) I, II and IV

4. What is the name of the strings which vibrate in our voice box when we talk?
(a) Ciliary muscle (b) Vocal cord
(c) Cochlea (d) Auditory canal.

5. The hearing range of human ear is
(a) 20 Hz to 20 kHz (b) less than 20 Hz
(c) more than 20 kHz (d) 20 Hz to 25,000 Hz

6. The normal range of vocal cords in women is
(a) 20 mm (b) 10 mm (c) 15 mm (d) 40 mm

7. Bat can known about their prey at a distance even in the right by emitting:
(a) infrasonic sound
(b) ultraviolet lights
(c) chemical release by their body
(d) ultrasonic sound

8. The standard audible capacity of a healthy human being as per WHO is in the range of :
(a) 45-50 decibels (b) 200-250 decibels
(c) 5-10 decibels (d) 2000-2500 decibels

9. Infrasonic wave has its frequency?
(a) less then 20Hz
(b) more then 20Hz
(c) more then 20,000 Hz
(d) Less then 20,000 Hz

10. The speed of sound in the air (vacuum) is :
(a) 330 m/sec (b) 220 m/sec
(c) 110 m/sec (d) 232 m/sec

11. Ultrasound has frequency of vibration
(a) between 20 and 20, 000 Hz
(b) below 20 Hz
(c) above 20, 000 Hz
(d) between 500 and 10, 000 Hz

12. The ultrasound waves can penetrate into matter to a large extent because they have
(a) very high frequency
(b) very high speed
(c) very high quality
(d) very high amplitude

13. . .....emits high frequency or high pitched ..... squeaks during flying and listen to ..... produced by reflection of their squeaks from the obstacles or prey in their.....
(a) Bats, infrasonic, sound, path
(b) Bats, ultrasonic, sound, path
(c) Pigeon, ultrasonic, light, path
(d) Bats, supersonic, sound, path

14. The maximum displacement of a vibrating body from its mean position is called
(a) frequency
(b) time period
(c) amplitude
(d) None of the above

15. Frequency is expressed in
(a) hertz (b) metre
(c) newton (d) joule

16. 1 Hz is equal to
(a) 1 vibration per second
(b) 10 vibrations per minute
(c) 60 vibrations per minute
(d) 600 vibrations per minute

17. A human heart beats 72 times in a minute. Its frequency will be
(a) 2.2 Hz (b) 3.2 Hz (c) 12 Hz (d) 1.2 Hz

18. In order to reduce the loudness of a sound we have to
(a) decrease its frequency of vibration of the sound
(b) increase its frequency of vibration of the sound
(c) decrease its amplitude of vibration of the sound
(d) increase its amplitude of vibration of the sound

19. Loudness of sound is measured in units of
(a) decibel (dB)
(b) hertz (Hz)
(c) metre (m)
(d) metre/second (m/s)

20. Pitch of sound is determined by its
(a) frequency (b) speed
(c) amplitude (d) loudness

21. The pitch of a musical sound depends on the sound waves
(a) wavelength (b) frequency
(c) speed (d) amplitude

22. The characteristics of sound that differentiates between two sound of same intensity and same frequency is called
(a) quality (b) intensity
(c) pitch (d) loudness

23. When we increase the loudness of sound produced by a radio, the property of the sound wave that changes is its
(a) amplitude (b) frequency
(c) speed (d) wavelength

24. On the surface of the moon two persons cannot listen the conversation of each other because
(a) on the moon human ears do not function
(b) as there is no atmosphere on the moon
(c) as astronaut bears a special type of garment which is not appreciable to the human ears
(d) on the moon sound waves travels very slowly

25. The loudness of sound is determined by its
(a) amplitude of vibration
(b) ratio of amplitude and frequency of vibration
(c) frequency of vibration
(d) product of amplitude and frequency of vibration

26. Beyond which range sound became panic for human ear?
(a) 80 dB (b) 40 dB
(c) 30 dB (d) 50 dB

27. Which among the following has the highest pitch?
(a) Lion (b) Mosquito
(c) Human being (d) Elephant

28. Instrument used to study the behaviour of a vibrating string is
(a) hygrometer
(b) sonometer
(c) barometer
(d) hydrometer

29. SONAR is mostly used by
(a) doctors
(b) engineers
(c) astronauts
(d) navigators

30. Unwanted sounds are called
(a) noise
(b) music
(c) Both (a) and (b)
(d) None of the above

Answers

1	(c)	2	(a)	3	(d)	4	(b)	5	(a)	6	(c)	7	(d)	8	(a)	9	(a)	10	(a)
11	(a)	12	(a)	13	(b)	14	(c)	15	(a)	16	(a)	17	(d)	18	(c)	19	(a)	20	(a)
21	(b)	22	(a)	23	(a)	24	(b)	25	(d)	26	(a)	27	(b)	28	(b)	29	(d)	30	(a)