

# 13

## Sound

### TOPICS COVERED

- 13.1 Sound: Production and Propagation. 13.2 Terms Related to Sound and Its Characteristics  
13.2 Reflection of Sound, Types of Sound and Noise Pollution

### IMPORTANT POINTS TO REMEMBER

- **Sound** is a kind of wave which gives us sense of hearing.
- Sound is produced by a vibrating body. When an object vibrates, it produces sound.
- The to and fro or back and forth motion of an object is called **vibration**.
- In human beings, sound is produced by voice box or larynx. Voice box is situated in the upper part of wind pipe.
- Vocal cords are about 20 mm long in men but are shorter in women and children. This explains the difference in voices of men, women and children.
- Sound can travel through solid, liquid and gas but it cannot travel in vacuum. Sound travels in all directions in a medium.
- **Human ear** is a complex structure. It can be divided into three main parts, viz. external ear, middle ear and internal ear.
- Number of oscillations per second is called **frequency of oscillation**. Frequency is expressed as **Hertz (Hz)**. A frequency of 1Hz means, the object is vibrating 1 time in a second.
- Maximum displacement of a wave from mean position is called **amplitude**.
- **Loudness** of sound depends on amplitude of vibration. Loudness of sound is proportional to square of amplitude of vibration. Loudness is expressed in terms of decibel.
- **Pitch** of sound depends on frequency of vibration. A high pitched sound has high frequency.
- Human beings can hear sounds between frequencies 20 Hz and 20,000 Hz. So sound between these frequencies are audible to human beings.
- Sound below 20 Hz frequency is called infrasound, while sound above 20,000 Hz frequency is called ultrasound.
- Presence of excess noise in environment is called noise pollution. Busy traffic, factories, loud music, construction works, firecrackers, etc. are the sources of noise pollution.
- Continuous exposure to noise pollution can result in lack of sleep, hypertension, anxiety and many other disorders. In some cases, it can also lead to partial loss of hearing.

- Total hearing impairment is rare but partial hearing impairment is quite common. Total hearing impairment is usually by birth.

## 13.1 SOUND: PRODUCTION AND PROPAGATION

**Sound:** It is a forms of energy which produces a sensation of hearing in our ears.

Sound is produced by a vibrating body.

Sound needs a medium to travel.

**Vibration:** It is the rapid to and fro or back and forth movement of a body along its mean position.

**Medium:** The substance through which sound is transmitted is called a medium. It can be solid, liquid or gas. Sound cannot travel in vacuum.

**Speed of Sound:** Sound travels with different speeds in different media. The speed with which sound waves travel depend on the nature of the medium.

Sound travels fastest in solids, and slowest in gases.

Speed of sound in air is 340 m/s.

Speed of sound in steel is 5960 m/s.

**Sound Production in Humans:** In humans, sound is produced by the voice box or the larynx. Two vocal cords are stretched across the voice box. When lungs force air through the narrow spacing between these two cords, it vibrates and produce sounds.

**Humans Hear Sound through Ears:** A membrane called *eardrum* in our ear vibrates from sound and sends vibrations to inner ear which sends signals to brain to make us hear.

### Exercise 13.1

#### I. Very Short Answer Type Questions (1 Mark)

1. Give one word for the following:

(a) To and fro motion of a vibrating body along its mean position. \_\_\_\_\_

(b) A condition in which sound cannot travel. \_\_\_\_\_

(c) Sound that we can hear through our ears. \_\_\_\_\_

2. Fill in the blanks:

(a) Only vibrating body produce \_\_\_\_\_.

(b) Sound travels faster in \_\_\_\_\_ as compared to liquids.

(c) Sounds needs a \_\_\_\_\_ to travel.

(d) The speed of sound in air is \_\_\_\_\_.

(e) The substance through which sound is transmitted is called a \_\_\_\_\_.

3. What is sound?

4. How is sound produced?

5. In which medium does sound travel the fastest?

## II. Short Answer Type Questions-1 (2 Marks)

6. In which material sound travels fastest?
7. Why is not possible to talk on the surface of the moon?

## III. Short Answer Type Questions-2 (3 Marks)

8. A ringing alarm clock is placed in vacuum? Will you be able to hear its ticking sound and Why?
9. Why is it more convenient to put the ear on the track to hear a train approaching from far away?
10. Which part of the musical instrument vibrate to produce sound?  
(a) Drum, (b) Violin, (c) Flute, (d) Tuning fork.

## IV. Long Answer Type Questions (5 Marks)

11. With the help of an activity, show that sound can travel through solids.
12. Show that sound requires a medium to travel with the help of an activity.

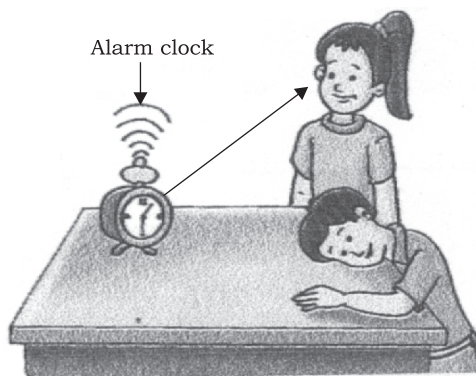
### ANSWERS

1. (a) Vibration (b) Vacuum  
(c) Audible sounds
2. (a) Sound (b) Solids  
(c) Medium (d) 340 m/s  
(e) Medium
3. It is a form of energy which produces a sensation of hearing in our ears.
4. By a vibrating body.
5. It travels fastest in solids.
6. Sound travel fastest in solids because speed with which the sound travels depends on the nature of the medium. In solids, particles are closely packed and pass on the vibrations of sound rapidly.
7. On the surface of moon, there is no atmosphere, hence no medium. We know that sound cannot travel in vacuum.
8. In vacuum, there is no air and hence no medium. So, we will not be able to hear the ticking sound of a clock. since sound needs a medium for propagation.
9. This is because sound travels fastest in solids. If the sound of the train is heard through the rails on the track and its loudness is increasing it means the train is approaching the station.
10. (a) Drum – Vibrating skin or membrane  
(b) Violin – String

- (c) Flute – Air inside the pipe  
(d) Tuning fork – Metal
11. **Aim:** To show that sound can travel through solids.

#### **Method:**

- (i) Close the doors and windows of your room, so as to cut outside noise. Place an alarm clock at one end of the table. Try to hear the ticking of the alarm clock.



Sound travels faster through a solid medium than a gaseous medium.

- (ii) Now, place your ear on the table and listen.

**Observation:** You observe that the ticking of the alarm clock sounds louder when heard through the wood.

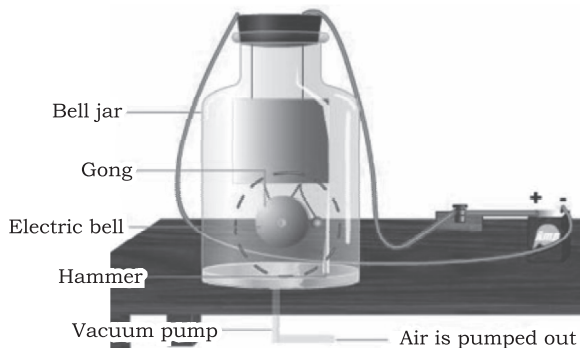
**Conclusion:** We can conclude that

- (i) Sound travels through solids.
  - (ii) Sound travels faster through a solid medium than through a gaseous medium.
12. **Aim:** To show that sound requires a medium.

**Things needed:** An electric bell, a glass bell jar, vacuum pump, a battery, a key, cork and connecting wires.

**Method:**

- (i) Place the electric bell inside the glass jar and connect it to a battery and key through connecting wires. Close the bell jar with air tight cork.
- (ii) When the switch is pressed, the hammer of the electric bell strikes the gong and sound is produced.
- (iii) Now, remove the air present inside with the help of the vacuum pump.
- (iv) Again, press the key and notice the change.



Sound requires a medium for propagation.

**Observation:** As the air is taken out of the jar loudness of the sound decreases and finally, you do not hear the sound though the hammer of the bell is seen to hit the gong as before.

**Conclusion:**

- (i) Sound cannot travel through vacuum.
- (ii) Sound requires a medium to travel.

## 13.2 TERMS RELATED TO SOUND AND ITS CHARACTERISTICS

### Terms Related to Sound

**Oscillation:** To and fro vibrational motion of an object from its one extreme position to other extreme position about its mean position is called oscillation.

**Amplitude:** The maximum displacement of an object from its mean position on either side is called its amplitude.

**Time Period:** The time taken by an object to complete one oscillation (the vibration from one extreme position to other and then back to the starting extreme position) is called its time period.

**Frequency:** The number of complete oscillations made in one second is called frequency. Its SI unit is Hertz.

One hertz is equal to total number of oscillations per second i.e.  $f = (1/T)$ .

### Characteristics of Sound

**Pitch:** It is a characteristic of sound by which you can distinguish a shrill sound from a grave sound even though the two sounds have the same loudness. The pitch of a sound depends upon the frequency of vibration.

Low frequency → Low pitch → Hoarse/flat sound

High frequency → High pitch → Shrill sound

**Example:** Voice of children and ladies is shrill as compared to the voice of men. This is because children and women have short vocal cords which therefore vibrate with a high frequency to produce high-pitched shrill voice.

*Loudness:* It is a characteristics of sound by which a loud sound can be distinguished from a faint sound even though both have the same pitch. Loudness depends upon square of the amplitude of the vibration, producing the sound.

$$\text{Loudness} \propto (\text{Amplitude})^2$$

Small amplitude  $\rightarrow$  Soft sound

Large amplitude  $\rightarrow$  Loud sound

Loudness is measured in a unit called decibel.

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## Exercise 13.2

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### I. Very Short Answer Type Questions (1 Mark)

1. Give one word for the following:

(a) Maximum displacement of a vibrating particles from its mean position. \_\_\_\_\_

(b) Time in which a vibrating particle completes one vibration. \_\_\_\_\_

(c) Numbers of vibration produced by a vibrating particle in one second. \_\_\_\_\_

(d) A property which distinguishes a loud sound from a feeble sound of the same frequency. \_\_\_\_\_

2. Fill in the blanks:

(a) \_\_\_\_\_ is the amplitude, more is the sound.

(b) The unit of frequency is \_\_\_\_\_.

(c) When frequency is low, sound is \_\_\_\_\_.

(d) When amplitude is low, sound is \_\_\_\_\_.

3. What name is given to the “to and fro” motion of a vibrating body about its mean position.

### II. Short Answer Type Questions-1 (2 Marks)

4. A body vibrates 10 times in 0.1s about its mean position. What is the frequency of the body?

5. 10 waves of water reach the shore in 5 s. What is the time period of the waves?

6. A pendulum oscillates 40 times in 4 s. Find its time period and frequency. (NCERT)

7. Give reason for the following:

(a) A bird’s voice is chirping while a lion roars.

(b) A woman’s voice is shriller from a man.

(c) The sound produced by bees is shrill and high pitched.

### III. Short Answer Type Questions-2 (3 Marks)

8. How does the pitch vary in (a) tabla (b) flute.

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9. When you listen to the sound produced by a tuning fork and the sound of the same frequency produced by a sitar, you find that tuning fork sound flat whereas the sitar sounds skill. Why?

#### IV. Long Answer Type Questions (5 Marks)

10. Define the terms: (a) Vibration, (b) Amplitude, (c) Frequency, (d) Time period. Give their units.
11. By how much will the loudness change when the amplitude is (a) doubled, (b) tripled.

#### ANSWERS

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|---|-----------------|--|
| 1. (a) Amplitude  | (b) Time period | (b) A flute has a high frequency, so the pitch is high and produces a shrill sound.  |
| (c) Frequency   | (d) Loudness    | 9. Loudness is a characteristic of sound which distinguishes a feeble sound from a loud sound of the same frequency. It depends upon the amplitude of the vibrating body. It also depends on the area of the vibrating body. |
| 2. (a) Large, loud  | (b) Hertz       | 10. (a) It is the rapid to and fro or back and forth movement of a body along its mean position.   |
| (c) flat  | (d) soft        | (b) The maximum displacement of an object from its mean position on either side is called its amplitude.   |
| 3. Oscillation  |                 | (c) The number of complete oscillations made in one second is called frequency. Its SI unit is Hertz.  |
| 4. Number of vibration = 10   |                 | (d) The time taken by the object to complete one oscillation (the vibration from one extreme position to other and then back to the starting extreme position) is called its time period.                                    |
| Time = 0.1s   |                 | 11. Loudness $\propto$ (amplitude) <sup>2</sup>  |
| $\therefore$ Frequency  |                 | If amplitude is doubled, loudness becomes four times. If amplitude is tripled, loudness becomes nine times.  |
| = (Number of oscillation/Time)  |                 |  |
| = (10/0.1) = 100 Hz   |                 |  |
| 5. Time period = (1/f)  |                 |  |
| Frequency = (10/5) = 2 Hertz  |                 |  |
| $\therefore$ Time period = (1/2) = 0.5 sec.   |                 |  |
| 6. Number of oscillations = 40  |                 |  |
| Time taken = 4s   |                 |  |
| Frequency = 40/4 = 10 Hz  |                 |  |
| Time period = 1/10 = 0.1s   |                 |  |
| 7. The frequency determines the shrillness or pitch of a sound. If the frequency is high, the sound is shrill and if frequency is low, the sound is hoarse. So as bird's voice has high frequency and small amplitude, while a lion has low frequency and large amplitude, so it has a flat yet loud sound. |                 |  |
| 8. (a) The skin of table have low frequency, hence they produce a flat sound.   |                 |  |

### 13.3 REFLECTION OF SOUND, TYPES OF SOUND AND NOISE POLLUTION

**Reflection of Sound:** When sound strikes a hard surface, it gets reflected. It does not require smooth and polished surface for its reflection. When we speak, the sound waves spread through the air in all directions. Some sound waves reach our ears directly and some waves strike the walls of the room.

Objects which are hard and have smooth surface are *good reflectors* of the sound waves. Objects which are soft and porous are *bad reflectors* of sound.

*Echo*: An echo is the repetition of the original sound heard after the sound is reflected from a distant, dense and rigid object (such as a high building). The human ear can hear two sounds separately only when they reach the ear after an interval of 1/10th of a second. This is a natural feature of the human ear. Therefore, the reflected sound which can be heard distinctly (after a lapse of atleast 0.1 sec) from the original sound is called an echo.

An echo can be heard when

- (a) the minimum distance between the source of sound and the reflecting surface is 17 m.
- (b) the sound is loud enough to be heard after reflection.
- (c) there is a high building or hill which can act as reflecting surface.

### **Types of Sound**

*Audible and Inaudible Sounds*: Our ears do not respond to sounds having frequency less than 20 Hz. Also, frequency higher than 20,000 Hz cannot be heard by human beings.

Sound whose frequency lies between 20 Hz and 20,000 Hz which we are able to hear is called **audible sound**.

*Inaudible sounds* having frequency less than 20 Hz are known as infrasonic sounds.

- (a) Rhinoceroses communicate with one another by using infrasonic sounds of frequency as low as 5 Hz.
- (b) Animals like whales and elephants also produce infrasonic sounds.

Inaudible sounds having frequency greater than 20,000 Hz are known as ultrasonic sounds.

Inaudible sounds having frequency greater than 20,000 Hz are known as ultrasonic sounds.

*Noise*: Unwanted, unpleasant and very loud sounds are called noise.

*Music*: Sounds produced by musical instruments like sitar, guitar produce pleasing effect to our ears and mind. It does not cause any health hazards.

**Noise Pollution**: Noise from any source that cause disturbance or discomfort of any kind in the environment is called noise pollution. A sound of about 90 dB and above heard for a long time causes noise pollution. Some sources of noise pollution are - moving aeroplane, use of horn, loud music system.

### **Harmful Effects of Noise Pollution**

- It causes nervous tension, irritation, earache, headache.
- It may cause lack of concentration in work or studies.
- Loud music during night disturbs our sleep.
- Prolonged exposure to high level noise effects the eardrum and may lead to deafness.

### **Measures to Reduce Noise Pollution**

- Automobiles should be fitted with silencers and soft horns.
  - Do not play radio, television and stereo system too loudly.
  - Airports and noise-making factories should be shifted away from residential areas.
  - Machines should be maintained in a good condition.
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## Exercise 13.3

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### I. Very Short Answer Type Questions (1 Mark)

1. Give one word for the following:

- (a) An example of a good reflector of sound. \_\_\_\_\_
- (b) Objects that are soft and porous are \_\_\_\_\_
- (c) Repetition of sound heard after the sound is reflected from a distant, rigid object. \_\_\_\_\_
- (d) Unwanted, unpleasant and loud sound. \_\_\_\_\_

2. Fill in the blanks:

- (a) \_\_\_\_\_ is the repetition of original sound heard after reflection from a high rise object.
- (b) For an echo to be heard, the minimum distance between the source and reflecting surface should be \_\_\_\_\_.
- (c) In a tabla, \_\_\_\_\_ produces a musical sound.
- (d) Sound produced by stringent instruments that produce a pleasant effect is called \_\_\_\_\_.
- (e) A source of noise pollution is \_\_\_\_\_.

3. What is the minimum distance required to hear an echo?

### II. Short Answer Type Questions-1 (2 Marks)

4. What is an echo? What is the minimum time required for formation of an echo?
5. What is music?
6. Name some stringent instrument which produce music.
7. What is the range of ultrasonic waves? Name two animals which can hear ultrasonic waves.

### III. Long Answer Type Questions (5 Marks)

8. Distinguish between music and noise.
9. What are infrasonic sounds? Name two animals which use infrasonic sound.
10. (a) What is noise pollution?  
(b) Name any three sources of noise pollution.  
(c) How can noise pollution be reduced?

### ANSWERS

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|---|---|
| <p>1. (a) metal, steel, bricks<br/>(b) bad reflectors of sound<br/>(c) Echo (d) Noise<br/>2. (a) Echo (b) 17 m<br/>(c) membrane (vibrating)<br/>(d) music<br/>(e) excessive use of horns<br/>3. An echo can be heard when the minimum distance between the source</p> | <p>of sound and the reflecting surface is 17 m.</p> <p>4. An echo is the repetition of the original sound heard after the sound is reflected from a distant, dense and rigid object (such as a high building). The human ear can hear two sounds separately only when they reach the ear after an interval of 1/10th of a second. This is</p> |
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a natural feature of the human ear. Therefore, the reflected sound which can be heard distinctly (after a lapse of at least 0.1 sec) from the original sound is called an echo.

5. Sounds produced by musical instruments like sitar, guitar produce pleasing effect to our ears and mind. It does not cause any health hazards.
6. Violin, Guitar, Sitar
7. Frequency more than 20,000 Hz are known as ultrasonic sounds. Dolphins, bat produce ultrasonic sound. Even dogs can hear upto 40,000 Hz.
- 8.

Music	Noise
It produces a pleasant effect.	Unpleasant effect.
Big regular and periodic vibrations.	It is produced by irregular and non-periodic vibrations.
It has a regular wave form.	Irregular wave form.
It does not cause any health hazard.	It causes serious health hazards.

9. Inaudible sounds having frequency less than 20 Hz are known as infrasonic sounds.

- (a) Rhinoceroses communicate with one another by using infrasonic sounds of frequency as low as 5 Hz.
  - (b) Animals like whales and elephants also produce infrasonic sounds.
10. (a) Noise from any source that cause disturbance or discomfort of any kind in the environment is called noise pollution. A sound of about 90 dB and above heard for a long time causes noise pollution.
- (b) Some sources of noise pollution are - moving aeroplane, use of horn, loud music system.
  - (c)
    - Automobiles should be fitted with silencers and soft horns.
    - Do not play radio, television and stereo system too loudly.
    - Airports and noise-making factories should be shifted away from residential areas.
    - Machines should be maintained in a good condition.

### Did You Know?

- There is no atmosphere on the moon. It is vacuum on the surface of the moon. So we cannot hear any sound on the moon, because sound cannot travel in vacuum. The astronauts talk with each other through radiosets, because radiowaves can travel in vacuum also.
- Thunder is heard after lightening because speed of sound in air is 340 m/s and speed of light is  $3 \times 10^8$  m/s.
- **Robotics:** Robots are designed in such a way that they can respond to simple sounds like clapping of the hands. Robots detect the sound through 'sensors' which are simply microphones.

## HOTS & VALUE BASED QUESTION

1. Name the following:
  - (a) The part of body which helps to produce sound in human.
  - (b) The medium in which sound travels the fastest.
  - (c) Audible range of human ears.
  - (d) The number of vibrations made by vibrating object in one second.
  - (e) Maximum displacement of a vibrating object from its mean position. **(HOTS)**
2. Write the part which produces sound in the following:  
Flute, Sitar, Tabla **(HOTS)**
3. Give reasons:
  - (a) Spectators watching a game of cricket hear the sound, a split of second after a batsman makes a stroke.
  - (b) A body emits frequency of 20 Hz. Will you be able to hear the sound? **(HOTS)**
4. Can we hear the sound of a bell on the surface of moon? Give reason to support your answer. **(HOTS)**
5. Calculate the frequency if the time period of oscillation is 0.05s. **(HOTS)**
6. What is the range of infrasonic waves and ultrasonic waves? **(HOTS)**
7. Atul wanted to buy a house. His friend Naman advised him to buy away from roadside and plant trees around his house. Why his friend Naman advised him so? What values are shown by Naman? **(VBQ)**

### **ANSWERS**

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|--|---|
| <ol style="list-style-type: none"><li>1. (a) Larynx <span style="margin-left: 100px;">(b) Solids</span></li><li>(c) 20 Hz to 20,000 Hz</li><li>(d) Frequency</li><li>(e) Amplitude</li><li>2. (a) Air <span style="margin-left: 100px;">(b) String</span></li><li>(c) Membrane</li><li>3. (a) Sound travels faster in solid than gas (air)</li><li>(b) Yes, a normal human ear can hear sound between range 20 Hz to 20,000 Hz</li></ol> | <ol style="list-style-type: none"><li>4. No, because there is no air on moon.</li><li>5. <math>T = (1/f)</math><br/><math>f = (1/0.05)s = 20 \text{ Hz}</math></li><li>6. Infrasonic waves = frequency below 20 Hz<br/>Ultrasonic waves = Above 2,000 Hz</li><li>7. (a) To avoid noise pollution.<br/>Trees are good absorbers of sound.</li><li>(b) Naman is intelligent, has a scientific bent of mind.</li></ol> |
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