UNIQUE NOTES | PHYSICS - 10

Chapter 13

SOUND

Key concepts:

- Production and propagation of sound
- Speed of Sound
- Characteristics of sound
- Reflection (Echo) of sound
- Refraction and diffraction of sound
- Audible frequency
- Acoustics of buildings

Q.1 How is sound produced? Explain.

Key points: Production of sound, Examples

Production of Sound

Sound is produced by vibrating objects. When an object vibrates, it makes the air around it vibrate as well. These air vibrations travel to our ears and create the sensation of sound.

Examples

- For example, in a guitar, the sound is produced when its strings vibrate.
- Similarly, our voice is produced by the vibrations of our vocal cords.
- The human heart and other organs like the lungs also create sound waves when they vibrate. Doctors use a stethoscope to listen to these sounds.
- In school laboratories, a tuning fork is used to produce a specific sound. When a rubber hammer is struck with the tuning fork, it begins to vibrate. By bringing it close to our ear, we can hear the sound produced by these vibrations.

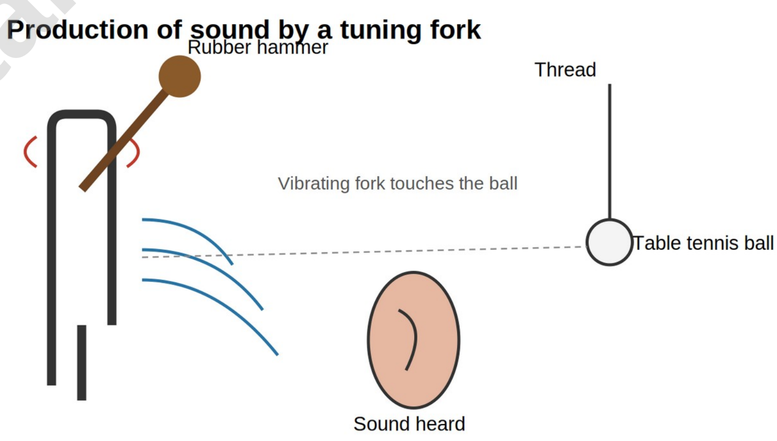


Fig. 13.1–13.3: Vibration of a guitar string and tuning fork produce sound waves

- We can also observe the vibrations of a tuning fork by bringing one of its prongs in contact with a small table tennis ball hanging from a thread. When the vibrating prong touches the ball, the ball moves, showing the presence of vibrations.

- Similarly, if we place the vibrating tuning fork into a glass of water, we will notice water splashing. The vibrating tuning fork generates sound waves, which transfer energy to water, making it splash; this simple activity demonstrates that vibrations are responsible for producing sound.

Tidbit: Sound needs a medium (like air, water, or solids) to travel through. In vacuum, there are no particles to vibrate, which is why sound cannot travel there.

Q.2 How is sound propagated? Describe an experiment to demonstrate that sound waves cannot travel in vacuum.

Key points: Propagation of sound, Experiment to show sound waves require a medium

Propagation of Sound

- Sound needs a medium, such as air, water, or a solid, to travel from one place to another.
- When a tuning fork vibrates, it creates compressions (high pressure) and rarefactions (low pressure) in the air, allowing sound to travel.
- As the prong moves forward, it pushes air molecules together, forming a compression that moves outward.
- When it moves back, it creates a rarefaction, where air molecules spread apart.
- This continuous cycle of compressions and rarefactions propagates sound as a longitudinal wave, meaning air molecules move in the same direction as the wave.

Propagation of sound as compressions and rarefactions

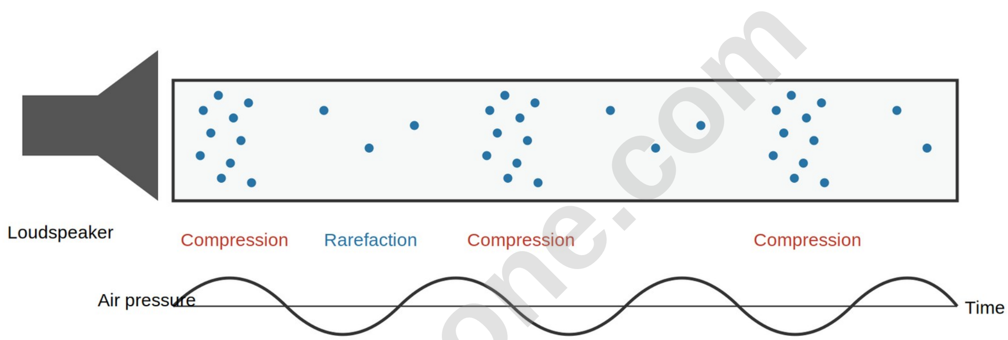


Fig. 13.4: Longitudinal waves showing compression and rarefaction in sound propagation

- The wavelength of a sound wave is the distance between two successive compressions or rarefactions.

Do You Know? Q. What are the three key properties of sound waves? Ans. Sound is a mechanical wave, meaning it requires a medium to propagate. It can travel through solids, liquids, and gases, but not through a vacuum. The particles of the medium vibrate in the same direction as the wave travels, making it a longitudinal wave.

Experiment to Show Sound Waves Require a Medium

- Sound waves need a material medium to propagate. This can be demonstrated using a bell jar setup.
- The bell jar is placed on the base of a vacuum pump, with an electric bell suspended inside using two wires connected to a power supply.
- When the power supply is turned ON, the electric bell rings, and we can hear the sound.
- Next, air is pumped out of the jar using the vacuum pump. As the air is removed, the sound of the bell becomes weaker and eventually fades, even though the bell continues ringing.
- When air is reintroduced into the jar, the sound becomes audible again. This demonstrates that sound waves require a medium, such as air, to propagate.

Bell jar apparatus

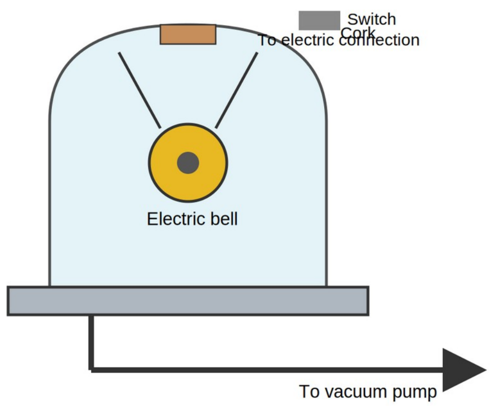


Fig. 13.5: Bell jar apparatus

Brain Teaser — Q. If sound is created by vibrations, how do particles move when sound waves pass through the air? Ans. The particles of air move back and forth in the same direction as the sound wave travels. This is because sound is a longitudinal wave. As the wave passes, it creates compressions (where particles are pushed closer together) and rarefactions (where particles are spread apart).

Q.3 Describe longitudinal nature of sound waves.

Key point: Longitudinal nature of sound waves

Longitudinal Nature of Sound Waves

- The propagation of sound waves can be understood through the example of a slinky.
- Sound travels in the form of a longitudinal wave. This means the particles of air move back and forth in the same direction as the sound wave. If we push and pull one end of the slinky, we will see some parts where the coils come close together (called compression) and some parts where they spread apart (called rarefaction).
- In the same way, when sound moves in air, it creates compressions (where air particles are closer) and rarefactions (where particles are far apart).
- The distance between two compressions or two rarefactions is called the wavelength.
- So, just like the slinky, sound moves by making compressions and rarefactions, showing that it is a longitudinal wave.

Q.4 Describe speed of sound waves in air.

Key point: Speed of sound

Speed of Sound

- Sound waves require a medium with vibrating particles to travel and cannot propagate through vacuum.
- The speed of sound varies with the type of medium. It moves 5 times faster in liquids and 15 times faster in solids than in gases.
- In air, factors like temperature and humidity affect its speed.
- At room temperature (21°C), sound travels at 343 m s^{-1} in air, increasing with higher temperature and humidity.
- Since solids and liquids transmit sound faster than gases, the material of the medium plays a key role in determining sound speed.

- The speed of sound v is calculated using a specific equation:

$v = f\lambda$ .... *(13.1)*

where v is the speed of sound, f is the frequency, and λ is the wavelength of the sound wave. The speed of sound in various media is shown in Table 13.1.

Table 13.1: Speed of sound in various media

Gases

Medium	Speed (m s^{-1})
Air (0 °C)	330
Air (25 °C)	346
Air (100 °C)	391
Hydrogen (0 °C)	1290
Oxygen (0 °C)	317
Helium (0 °C)	972

Liquids at 25 °C

Medium	Speed (m s^{-1})
Distilled water	1498
Sea water	1531

Solids at 25 °C

Medium	Speed (m s^{-1})
Wood	200
Aluminium	6420
Brass	4700
Nickel	6040
Iron	5950
Steel	5960
Flint glass	3980

Q.5 Describe characteristics of sound waves in detail.

Key points: Characteristics of sound (Loudness, Pitch and Quality)

Characteristics of Sound

Sounds from different objects can be identified based on their distinct characteristics, as explained below:

1. Loudness

Definition: *"Loudness is a property of sound that allows us to differentiate between loud and faint sound."*

a. Example

For example, when speaking with friends, our voice is soft, but while addressing a large audience, we speak louder. The loudness of a sound depends on several factors, which influence how we perceive its intensity.

b. Factors Affecting Loudness

Some of these factors are discussed below:

i. Amplitude of the vibrating body

- The loudness of sound depends on the amplitude of the vibrating object.
- If we pluck the strings of a guitar with more force, the vibrations will have greater amplitude, producing a louder sound.
- Likewise, striking a drum harder causes its membrane to vibrate more intensely, resulting in a louder noise.

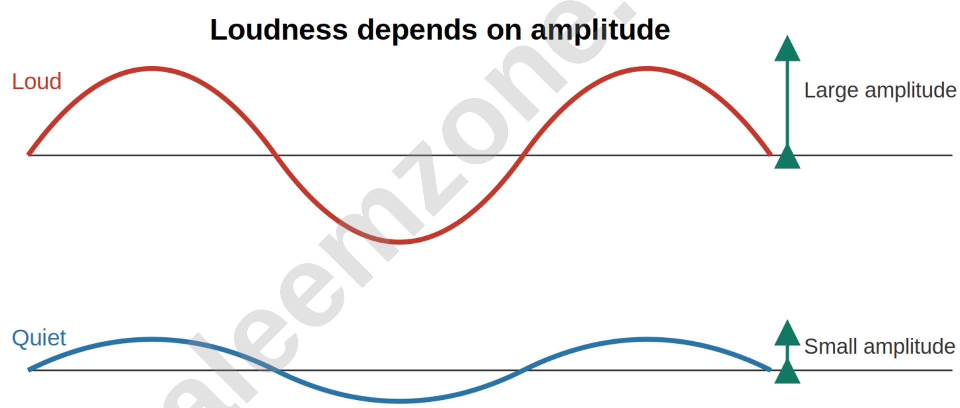


Fig. 13.7: Variation of loudness with amplitude

ii. Area of the vibrating body

- The loudness of sound is also influenced by the size of the vibrating surface.
- A large drum produces a louder sound than a smaller one because its greater surface area allows more air to vibrate.
- Similarly, striking a tuning fork alone creates a faint sound, but placing it on a solid surface, like a bench, amplifies the sound.
- This demonstrates that a larger vibrating area increases loudness, while a smaller area produces a weaker sound.

iii. Distance from the vibrating source

- The loudness of a sound decreases as the distance between the vibrating source and the listener increases. This occurs because the amplitude of the sound wave diminishes with distance.

Brain Teaser — Q. Does the loudness of a sound affect the time it takes for an echo to return? Ans. No, the loudness of a sound does not affect the time for an echo to return. The time depends only on the distance to the reflecting surface and the speed of sound in the medium. Loudness is related to the amplitude of the wave, not its speed, which remains constant under given conditions.

iv. Listener's hearing ability

A person with sensitive ears perceives sound as louder compared to someone with hearing impairment. However, there is a physical characteristic of sound that remains independent of the listener's hearing ability. This is known as the intensity of sound, which is a measurable quantity and does not rely on human perception.

2. Pitch

Definition: *"Pitch is the characteristic of sound that allows us to differentiate between a shrill and a deep (grave) sound."*

Explanation

- It is directly related to frequency; higher frequency results in higher pitch, while lower frequency produces lower pitch.
- For example, the voices of women and children have a higher frequency, making them shrill and high-pitched, whereas the voices of men have a lower frequency, giving them a deeper and lower-pitched sound.

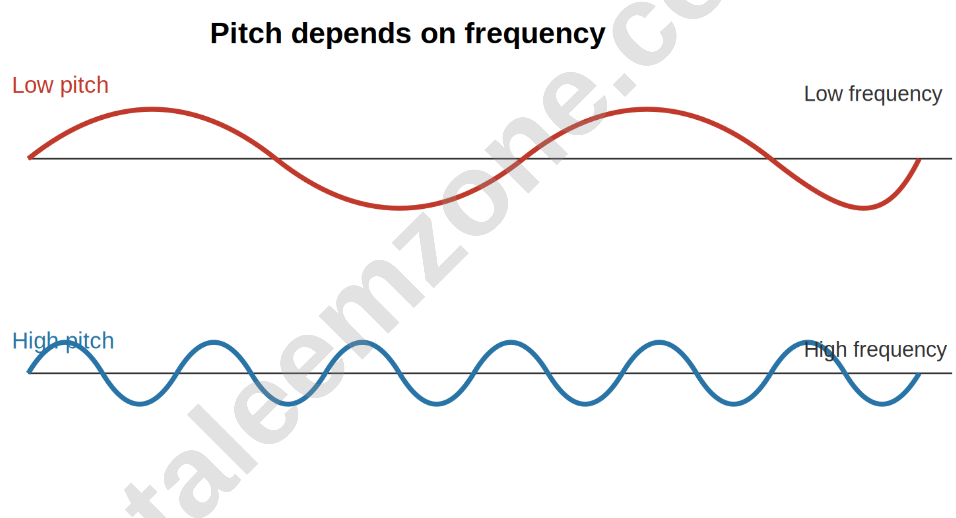


Fig. 13.8: Variation of pitch with frequency

- The relationship between pitch and frequency is represented above.

Do You Know? Sound waves that are squished together have a high frequency and high pitch. Sound waves that are stretched out have a low frequency and a low pitch.

3. Quality of Sound

Definition: *"The quality of sound is the characteristic that allows us to differentiate between two sounds having the same loudness and pitch."*

Explanation

- This distinct quality arises due to the unique waveforms produced by each sound source. For example, a violin, trumpet, flute, and oboe each generate a distinctive waveform. The oscilloscope traces of these instruments show different shapes, with varying levels of complexity and harmonic content.
- The violin has a rich, complex waveform, while the flute produces a simpler, more regular waveform.
- The trumpet and oboe each exhibit their own unique oscillation patterns, further demonstrating the diversity in sound production among instruments.

- The shape of these waveforms, when displayed on an oscilloscope, visually represents the timbre (quality) of each instrument.
- These differences in waveform structure are key to understanding how different sound sources can produce sound waves with varying qualities, despite having the same pitch and loudness.

Tidbit: The shape of a sound wave on an oscilloscope is affected by the instrument's unique construction and the way it produces vibrations.

Q.6 Differentiate between musical sound and noise. What are effect of noise pollution? How we can control noise pollution?

Key points: Musical sound and noise, Effects of noise pollution and ways to control noise pollution

Musical Sounds and Noise

In daily life, we hear sounds of different qualities. Musical instruments like the guitar, violin, recorder, and drum produce sounds with controlled pitch and quality, which are pleasant to hear. Such sounds are called musical sounds. However, some sounds, like traffic noise, door slamming, and machinery, are harsh and unpleasant. These are classified as noise. Noise results from irregular and sudden vibrations and is considered a form of pollution that affects both humans and animals.

Effects of Noise Pollution

Excessive noise from industrial machinery, vehicle horns, alarms, and construction work can lead to stress, lack of concentration, hearing loss, sleep disturbances, aggression, and hypertension.

Controlling Noise Pollution

The recommended safe noise level is 85–90 dB for a maximum of eight-hour workday. Noise pollution can be reduced by

- (i) using quieter, eco-friendly machinery.
- (ii) installing sound barriers.
- (iii) wearing hearing protection devices.

By controlling noise pollution, we can create a healthier environment.

Q.7 Describe an echo as the reflection of sound waves. Describe an experiment to study reflection of sound waves. How speed of sound is measured by an Echo method?

Key points: Reflection (Echo) of sound and speed of sound by echo method

Reflection (Echo) of Sound

Definition: *"When sound waves hit a surface and bounce back into the same medium, the phenomenon is called an echo or reflection of sound."*

Explanation

- When we clap or shout near a tall building or mountain, we hear the sound return after a brief delay. This repeated sound is called an echo, caused by the reflection of sound waves from a surface.

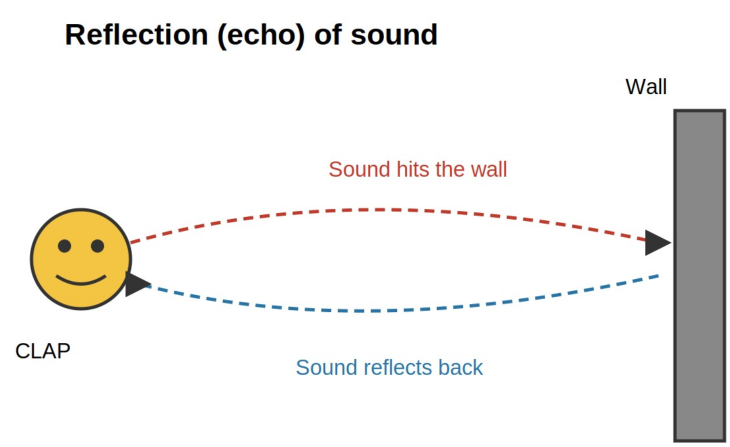


Fig. 13.10: Reflection of sound

- The human brain retains sound for about 0.1 seconds, so to hear a distinct echo, the reflected sound must reach us after at least 0.1 seconds. Given the speed of sound in air (340 m s^{-1}), the minimum distance for an echo to form is 34 metres (total distance travelled by sound), meaning the reflecting surface must be at least 17 metres away. Echoes can also repeat multiple times due to successive reflections.

Brain Teaser — Q. How do bats use echo to find food? Ans. Bats emit high-frequency sound waves from their mouth or nose. When these waves hit an object (like an insect), they reflect back as an echo. By analyzing the echo, bats can determine the object's location, size, shape, and texture, allowing them to navigate and hunt in darkness.

Activity (Reflection of Sound)

- Take two identical plastic tubes of appropriate length (or create them using chart paper).
- Position the tubes on a table, ensuring they are near a wall.
- Place a clock close to the open end of one tube and listen for its sound through the other tube.
- Adjust the alignment of the tubes until the sound of the clock is distinctly heard.
- Measure the angles of incidence and reflection, then analyze their relationship.
- Gently raise the right tube slightly upward and observe any changes that occur.

Brain Teaser — Q. Why can we hear our voice echoing back to us when we shout? How do the particles in the air play a role in this? Ans. We hear an echo because sound waves reflect from a surface and return to our ears. The particles in the air are essential for this process — they vibrate back and forth, transmitting the sound wave as compressions and rarefactions to the surface and back. Without a medium like air, sound cannot travel, so no echo would be heard.

Measuring Speed of Sound by Echo Method

1. Apparatus:

Measuring tape, stopwatch, flat wall that can produce a good echo.

2. Procedure

- a. Use a measuring tape to mark a 50 m distance from a wall.
- b. Stand at this point and clap your hands, listening carefully for the echo from the wall. Ensure the echo is not reflecting from any other nearby structures. The time interval between the clap and its echo represents the time taken for sound to travel 100 m.
- c. Begin clapping rhythmically and start a stopwatch with the first clap. Count each clap and stop both the clapping and the stopwatch upon hearing the echo of the 10th clap.
- d. Determine the average time for 10 claps. By calculating the time interval t between consecutive claps and applying the formula; S = vt, the speed of sound can be computed.

Brain Teaser — Q. Can we hear someone scream if we are in space with him? Ans. No, we cannot hear someone scream in space. Sound requires a material medium (like air, water, or solid) to travel. Since space is a vacuum with no particles to carry sound waves, the scream would not reach our ears even if we are nearby.

Q.8 Define and explain refraction and diffraction of sound waves.

Key points: Refraction and diffraction of sound

1. Refraction of Sound

Definition: *"Refraction occurs when sound waves change direction due to a variation in the medium's properties, such as density or temperature. This change occurs because the speed of sound differs in various materials."*

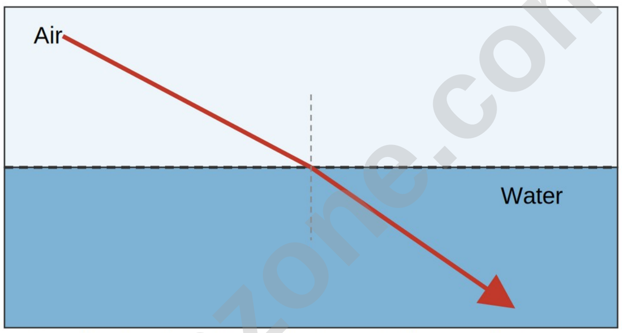
a. Explanation

Sound waves, like other waves, exhibit various behaviours, including refraction and diffraction, in addition to reflection.

b. Example

When sound waves travel from air into water, they bend due to the difference in density, causing sound to move faster in water than in air. This is why a submerged person can clearly hear underwater sounds, while someone above the surface may struggle to hear them.

Refraction of sound



Sound bends and speeds up as it enters water (denser medium)

Fig. 13.12: Refraction of sound

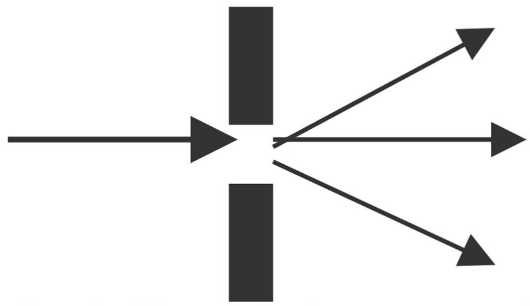
2. Diffraction of Sound

Definition: *"Diffraction is the bending of sound waves around obstacles or through openings. It allows sound to spread out and be heard even when the source is not directly visible."*

a. Explanation

Diffraction occurs when sound waves bend around obstacles or spread out after passing through narrow openings. This property allows sound to be heard even when the source is not in direct view.

Diffraction of sound waves



Sound spreads out after passing through a narrow gap or around an obstacle

Fig. 13.13: Diffraction of sound waves

b. Examples

- If someone is speaking from behind a wall, his voice can still be heard because the sound waves bend around the barrier.
- Similarly, sound can travel through an open doorway and spread into a room, allowing people inside to hear noises from the outside even if they cannot see the source.
- We can hear someone speaking even if he is around a corner or behind a wall. This is because sound waves diffract around the obstacle and reach our ears.

Tidbit: Refraction of sound occurs when it travels through layers of air at different temperatures. That is why on a cool morning, sound may travel farther — it bends back toward the ground due to slower speed in colder air. This is why distant train horns or bird calls sound clearer at dawn.

Q.9 Define audible frequency range. What are infrasound? Give their uses.

Key points: Audible frequency, Infrasound, Uses of infrasound

Audible Frequency

Definition: *"The human ear can detect sounds within the 20 Hz to 20,000 Hz range, known as the audible frequency range."*

Explanation

- Sounds below 20 Hz or above 20,000 Hz are inaudible to humans.
- Hearing ability declines with age.
- Young children can hear up to 20,000 Hz, while older individuals may struggle with sounds above 15,000 Hz.

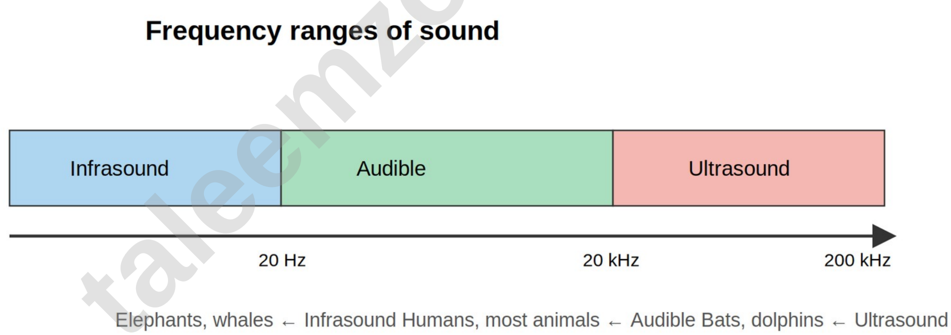


Fig. 13.14: Frequency of sound — infrasound, audible frequencies, and ultrasound

Infrasound

Definition: *"Infrasound refers to sound waves below 20 Hz, which humans cannot hear but may feel as vibrations."*

1. Explanation

- Many animals, like elephants and whales, use infrasound for communication.
- It is produced by natural events (earthquakes, volcanoes), industrial processes, and human activities (machinery, explosions).
- Due to its ability to travel long distances, infrasound is used for monitoring natural disasters.

Tidbit: Infrasound sensors are used to monitor volcanic eruptions, earthquakes, and even tsunamis before they strike. The low frequency waves from these natural events travel great distances and help scientists issue early warnings!

2. Uses of Infrasound

a. Elephant Communication

- Elephants use infrasound to communicate over long distances.
- Their deep rumbles travel far through air and ground, helping them stay connected.
- They can sense these vibrations not just with their ears but also through their feet and trunks.

b. Earthquake Detection

- Scientists use infrasound to detect earthquakes before the strong shaking starts.
- These low frequency waves act as an early warning system.

c. Volcano Monitoring

- When a volcano erupts, it creates unique infrasound waves.
- Scientists study these waves to predict eruptions and assess risks.

d. Nuclear Explosion Detection

Special sensors track infrasound waves from nuclear explosions.

Do You Know? Q. How do blue whales use infrasound for communication? Ans. Blue whales produce infrasound (sound waves below 20 Hz) that can travel extremely long distances through water. These deep calls allow them to communicate with other whales hundreds of kilometers apart, helping them stay connected across vast oceans.

Q.10 What are ultra sound? Illustrate applications of ultrasound in different fields of life.

Key points: Ultrasound and its uses

Ultrasound

Sounds with frequencies above 20,000 Hz, which are inaudible to humans, are called ultrasound or ultrasonics.

Uses of Ultrasound

a. Medical Applications

- Ultrasound is widely used in medical. When ultrasonic waves pass through the body, they reflect differently from various tissues and organs.
- These reflected waves are then captured and converted into images on a screen, a process known as ultrasonography.
- This helps in visualizing organs such as the heart, liver, and kidneys, as well as in monitoring pregnancies. For example, parental scanning uses ultrasound to observe the fetus inside the womb, assess its development, and detect any potential issues. Additionally, ultrasound aids in thyroid gland imaging for diagnosis, providing clear visual representations that help doctors evaluate thyroid health.

Do You Know? Q. How do doctors use ultrasound waves to see inside the body? Ans. Doctors use ultrasound waves (frequencies above 20,000 Hz) to create images of internal organs. The waves pass through the body and reflect differently from various tissues. These reflections are captured and converted into images on a screen (ultrasonography). This safe, non-invasive method is used to monitor pregnancies, examine organs, and diagnose medical conditions.

b. Underwater Exploration (SONAR)

Ultrasound is used to measure ocean depth and locate objects on the seabed. SONAR (Sound Navigation and Ranging) works by sending ultrasonic waves into water; the reflected waves help to determine the distance and shape of an object.

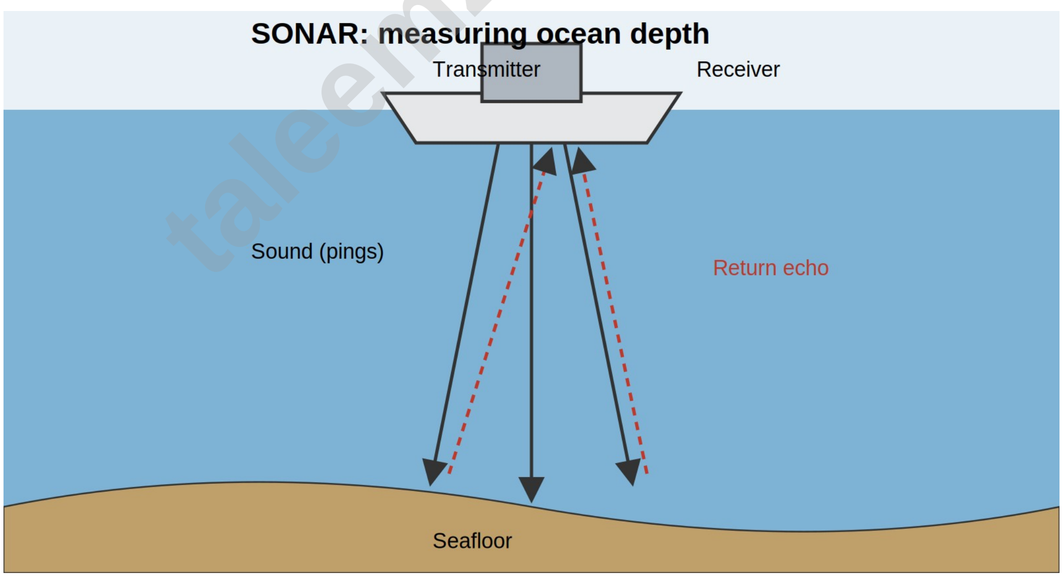


Fig. 13.15: Illustration of sonar used by a ship

c. Calculating Distance in Sonar

The formula used to calculate distance (or depth) in sonar systems is:

Distance = (Speed of Sound in Water × Time) / 2 ……… (13.2)

- Where speed of sound in water is approximately 1500 m s^{-1} at room temperature.
- Time is the duration it takes for the ultrasound pulse to travel to the object and return to the source.

- The distance is divided by 2 because the pulse travels to the object and then returns to the source.

d. Industrial Applications

- Ultrasound helps to detect cracks in machines like turbines, ship engines, and airplane parts. Ultrasound waves reflect from damaged areas, revealing hidden defects.
- It is also used to destroy bacteria in liquids through high-intensity waves.

Q.11 How does acoustic protection contribute to building design? (OR) What strategies are used to manage sound in public spaces like auditoriums and lecture halls?

Key point: Acoustics of buildings

Acoustics of Buildings

- Acoustic protection reduces unwanted sound using soft, porous materials like carpets and curtains, which absorb sound and minimize echoes.
- Hard, smooth surfaces reflect more sound, while excessive absorption can weaken audibility in classrooms and halls.
- Multiple reflections, known as reverberation, can distort sound, so a balance between reflection and absorption is essential in auditoriums, lecture halls, and theaters.
- Reflective surfaces behind the stage help direct sound to the audience.
- Additionally, curved ceilings and sound boards are often used to ensure even sound distribution throughout the hall.

Tidbit: In concert halls and theaters, curved ceilings and soft walls do not just look stylish. They are engineered to shape sound! While carpets and curtains absorb echoes, curved panels and reflectors bounce the music toward the audience so that even the person in the last row hears every note clearly. That is the science of acoustics in action — a perfect harmony of silence and sound!

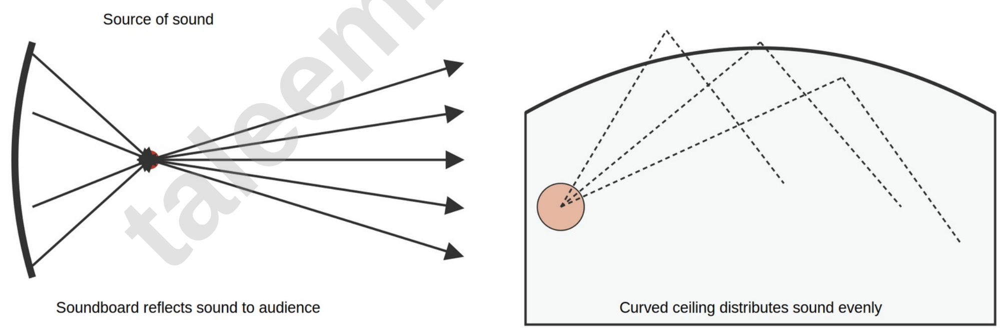


Fig. 13.16(a) & (b): Soundboard used in a big hall; curved ceiling of a conference hall

Formula Sheet

Sr. #	Formula	Description
1	$v = f\lambda$	Wave equation / Wave speed
2	$s = vt$	Distance travelled
3	s = (speed of sound × time) / 2	Distance travelled (echo/sonar)

Solved Examples

Example 13.1: Calculate the frequency of a sound wave of speed 340 m s^{-1} and wavelength 2.0 m.

Solution:

Given that:

Speed of wave v = 340 m s^{-1}

Wavelength λ = 2.0 m

To find: f = ?

Using formula; $v = f\lambda$ or $f = v/\lambda$

Substituting the values: f = 340 m s^{-1} / 2 m = 170 Hz

Result: The frequency of sound waves is 170 Hz.

Example 13.2: Flash of lightning is seen 2 seconds earlier than the thunder. How far away is the cloud in which the flash has occurred? (Speed of sound = 332 m s^{-1}).

Solution

Given that:

Time t = 2 s

Speed of sound v = 332 m s^{-1}

To find: Distance S = ?

As distance of the cloud; S = vt = 332 m s^{-1} × 2 s; S = 664 m

Result: The cloud is 664 m away.

Example 13.3: A sonar device on a ship sends out a sound pulse that returns after 3.2 seconds. If the speed of sound in water is 1600 m s^{-1}, what is the distance from the ship to the seafloor?

Solution

Given that:

Time for the sound pulse to return t = 3.2 seconds

Speed of sound in water v = 1600 m s^{-1}

The sound pulse travels to the seafloor and back, so the total distance covered is twice the distance from the ship to the seafloor.

Using the formula; d = v × t

Substituting the values: d = 1600 m s^{-1} × 3.2 s = 5120 m

Since the distance covered is twice the actual distance to the seafloor, we divide by 2 to find the distance.

d = 5120 m / 2 = 2560 m

Result: The distance from the ship to the seafloor is 2560 metres.

Multiple Choice Questions Exercise

#	Question	Option A	Option B	Option C	Option D
1	What is required for the production of sound?	(a) A vacuum	(b) Vibrations of a medium	(c) Only air	(d) Light waves
2	An echo is produced due to:	(a) refraction of sound waves	(b) reflection of sound waves	(c) diffraction of sound waves	(d) absorption of sound waves
3	An example of a longitudinal wave is:	(a) light wave	(b) water wave	(c) sound wave	(d) radio wave
4	In which medium does sound travel the fastest?	(a) Gases	(b) Liquids	(c) Solids	(d) Vacuum
5	What is the approximate speed of sound in air?	(a) 150 m s^{-1}	(b) 330-350 m s^{-1}	(c) 500 m s^{-1}	(d) 1,000 m s^{-1}
6	Why is acoustic protection important in building design?	(a) To increase noise pollution	(b) To reduce echo and improve sound quality	(c) To amplify sound	(d) To increase the speed of sound
7	For a normal person, the audible frequency range for sound waves lies 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

Answer Key

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

SLO Based Additional MCQs + Past Papers MCQs of Punjab Boards

Sound Production and Propagation

#	Question	Option A	Option B	Option C	Option D
1	Sound is produced by:	(a) stationary objects	(b) vibrating objects	(c) objects in a vacuum	(d) objects in water
2	Sound waves are classified as:	(a) transverse waves	(b) electromagnetic waves	(c) longitudinal waves	(d) surface waves
3	To travel from one place to another, sound requires:	(a) a vacuum	(b) a medium	(c) light	(d) heat
4	The experiment that demonstrates sound cannot travel in a vacuum uses a:	(a) tuning fork and water	(b) slinky	(c) bell jar and electric bell	(d) guitar and oscilloscope

Speed of Sound

#	Question	Option A	Option B	Option C	Option D
5	In which medium does sound travel the fastest?	(a) Gases	(b) Liquids	(c) Solids	(d) Vacuum
6	The approximate speed of sound in air at room temperature is:	(a) 150 m s^{-1}	(b) 250 m s^{-1}	(c) 330-350 m s^{-1}	(d) 500 m s^{-1}
7	The formula relating speed (v), frequency (f), and wavelength (λ) of a sound wave is:	(a) $v = f + \lambda$	(b) $v = f / \lambda$	(c) $v = f\lambda$	(d) $v = \lambda / f$
8	Which factor does NOT affect the speed of sound in air?	(a) Temperature	(b) Humidity	(c) Amplitude	(d) Density of air

Characteristics of Sound: Loudness, Pitch, and Timbre

#	Question	Option A	Option B	Option C	Option D
9	The characteristic of sound that distinguishes a loud sound from a faint one is:	(a) Pitch	(b) Timbre	(c) Loudness	(d) Frequency
10	The loudness of sound depends on the:	(a) frequency of vibration	(b) amplitude of vibration	(c) speed of sound	(d) medium
11	A sound with a high frequency is perceived as having a:	(a) low pitch	(b) high pitch	(c) constant pitch	(d) no pitch

12	The unique quality of sound that allows us to distinguish between a violin and a flute playing the same note is called:	(a) Loudness	(b) Pitch	(c) Timbre	(d) Amplitude

Reflection of Sound (Echo)

#	Question	Option A	Option B	Option C	Option D
13	An echo is caused by the ______ of sound waves.	(a) refraction	(b) diffraction	(c) reflection	(d) absorption
14	For a distinct echo to be heard, the reflecting surface must be at least ______ away from the source.	(a) 17 m	(b) 34 m	(c) 50 m	(d) 100 m
15	Bats use echoes to navigate and hunt. This process is known as:	(a) Sonar	(b) Echolocation	(c) Ultrasonography	(d) Refraction

Audible Frequency, Infrasound, and Ultrasound

#	Question	Option A	Option B	Option C	Option D
16	The range of frequencies audible to a normal human ear is:	(a) 2 Hz to 200 Hz	(b) 20 Hz to 20,000 Hz	(c) 200 Hz to 2,000 Hz	(d) 20,000 Hz to 200,000 Hz
17	Sound waves with a frequency above 20,000 Hz are called:	(a) Infrasound	(b) Audible sound	(c) Ultrasound	(d) Sonic waves
18	Which animal is known to use infrasound for long-distance communication?	(a) Bat	(b) Dog	(c) Elephant	(d) Dolphin
19	In medical imaging, ultrasound is used for:	(a) parental scanning	(b) treating fractures	(c) amplifying sound	(d) creating music

Refraction and Diffraction of Sound

#	Question	Option A	Option B	Option C	Option D
20	The bending of sound waves when they pass from one medium to another is called:	(a) Reflection	(b) Diffraction	(c) Refraction	(d) Reverberation
21	Sound waves can bend around obstacles. This phenomenon is known as:	(a) Reflection	(b) Refraction	(c) Diffraction	(d) Echo
22	On a cool morning, sound seems to travel farther because of:	(a) increased wind	(b) refraction due to temperat	(c) decreased humidity	(d) diffraction around buildings

			ure layers		

Acoustics of Buildings

#	Question	Option A	Option B	Option C	Option D
23	In auditorium design, soft and porous materials are used to:	(a) reflect sound	(b) absorb sound and reduce echo	(c) increase reverberation	(d) speed up sound
24	The repeated reflection of sound that persists in a hall is called:	(a) Echo	(b) Refraction	(c) Reverberation	(d) Diffraction
25	Curved ceilings in concert halls are often used to:	(a) look stylish	(b) evenly distribute sound to the audience	(c) increase echo	(d) absorb low-frequency sounds

Answer Key

1	2	3	4	5	6	7	8
b	c	b	c	c	c	c	c
9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
c	b	b	c	c	a	b	b
17	**18**	**19**	**20**	**21**	**22**	**23**	**24**
c	c	a	c	c	b	b	c
25							
b							

Exercise Short Questions

13.1 How does the medium affect the speed of sound?

The speed of sound depends on the medium through which it travels. Sound travels fastest in solids, slower in liquids, and slowest in gases. This is because particles are closer together in solids, allowing vibrations to transfer more quickly. For example, sound travels about 15 times faster in solids than in air. In air, factors like temperature and humidity also affect its speed.

13.2 Does sound wave show reflection?

Yes, sound shows reflection. When sound waves hit a surface and bounce back into the same medium, it is called reflection of sound or echo. For example, when we shout near a tall building or a mountain, we hear the reflected sound after a short time.

13.3 What factors influence the loudness of sound?

The loudness of sound is influenced by three main factors:

(i) Amplitude: Greater amplitude of vibration produces a louder sound.

(ii) Area of the vibrating body: A larger vibrating surface area produces a louder sound.

(iii) Distance from the source: Loudness decreases as the distance from the vibrating source increases.

13.4 Why do we hear an echo when we clap near a building?

We hear an echo because the sound waves from the clap travel to the building, reflect off its hard surface, and travel back to our ears. For a distinct echo to be heard, the reflecting surface must be at least 17 metres away, so that the reflected sound reaches our ears more than 0.1 seconds after the original sound.

13.5 What is ultrasound, how is it used in medicine?

Sound waves with frequencies higher than 20,000 Hz, which are inaudible to humans, are called ultrasound. Use in Medicine: In medicine, ultrasound is used for diagnosis and imaging. Ultrasonic waves are sent into the body, and their reflections from different tissues and organs are captured to create an image on a screen. This process, called ultrasonography, is used to observe a fetus during pregnancy and to examine organs like the heart, liver, and kidneys.

SLO Based Additional Short Questions + Past Papers Short Questions of Punjab Boards

Production and Propagation of Sound

Q.1 What role do vibrations play in the production of sound?

Sound is produced when an object vibrates. These vibrations cause the surrounding air particles to vibrate as well. The vibrating air particles transfer energy from one layer to another in the form of compressions and rarefactions. When these vibrations reach our ears, we hear sound.

Q.2 What are compressions and rarefactions in sound propagation?

Compressions are high-pressure regions where air molecules are pushed together by the vibrating source. Rarefactions are low-pressure regions where molecules spread apart. These alternate to form longitudinal sound waves that travel through the medium.

Q.3 Why is sound considered a mechanical wave? Explain briefly.

Sound is called a mechanical wave because it requires a material medium for its propagation. It travels through the vibration of particles of the medium. Without particles, such as in vacuum, sound cannot propagate. Hence, sound depends on mechanical vibrations.

Q.4 How does a tuning fork demonstrate that sound is produced by vibrations?

When a tuning fork is struck, it begins to vibrate and produces sound. If its vibrating prong touches a table tennis ball, the ball moves, showing vibrations. Similarly, placing the vibrating fork in water causes splashing. These observations prove that sound is produced due to vibrations.

Speed of Sound

Q.5 What factors affect the speed of sound in air?

The speed of sound in air is affected by temperature and humidity. It increases with higher temperature and higher humidity. For example, at 0°C, sound travels at 330 ms^{-1}, while at 25°C, it travels at about 346 ms^{-1}.

Q.6 Why does sound travel faster in solids than in gases? Explain.

In solids, particles are closely packed and strongly bonded, which allows vibrations to pass quickly from one particle to another. In gases, particles are far apart, so vibrations take more time to transfer. Therefore, sound travels faster in solids than in gases.

Characteristics of Sound

Q.7 How does amplitude affect the loudness of sound?

Loudness of sound depends on the amplitude of vibration. A larger amplitude means the particles vibrate more strongly, producing a louder sound. A smaller amplitude results in weaker vibrations and a softer sound. Thus, loudness increases with amplitude.

Q.8 Why does loudness decrease with distance from the sound source?

As sound travels away from its source, its energy spreads over a larger area. This causes the amplitude of sound waves to decrease. As a result, the sound becomes fainter with increasing distance from the source.

Q.9 How is pitch related to frequency?

Pitch is the characteristic of sound that tells how high or low a sound is. It depends directly on the frequency of sound waves. Higher frequency produces a higher pitch, while lower frequency produces a lower pitch. For example, children's voices have higher pitch due to higher frequency.

Musical Sound, Noise, and Pollution

Q.10 Why is noise considered a form of pollution?

Noise is produced by irregular and unpleasant vibrations. Continuous exposure to noise causes stress, lack of concentration, hearing problems, and sleep disturbance. Because it harms human health and the environment, noise is considered a form of pollution.

Q.11 How can noise pollution be controlled?

Noise pollution can be controlled by using quieter machines and installing sound barriers. Wearing hearing protection devices also helps reduce harmful effects. Limiting exposure time to high noise levels creates a healthier environment.

Reflection and Echo of Sound

Q.12 Why is a minimum distance required to hear an echo clearly?

The human brain retains sound for about 0.1 seconds. For a distinct echo, the reflected sound must return after this time. At the speed of sound, this requires the reflecting surface to be at least 17 metres away, so that the sound travels a sufficient distance.

Q.13 How is the speed of sound measured using the echo method?

In the echo method, a person stands at a known distance from a wall and produces a sound. The time between the sound and its echo is measured using a stopwatch. Since sound travels to the wall and back, the speed is calculated using distance and time.

Frequency Ranges

Q.14 Define infrasound and give one use.

Infrasound is sound below 20 Hz, felt as vibrations. Elephants use infrasound for long-distance communication. Scientists detect earthquakes using infrasound sensors.

Q.15 How is ultrasound used in SONAR?

SONAR (Sound Navigation and Ranging) uses ultrasound to measure underwater depth and locate objects. A ship sends ultrasonic pulses into the water; the time taken for the echo to return is measured. Using the formula Distance = (Speed of sound in water × Time) / 2, the depth or distance to an object is calculated.

Constructed Response Questions

13.1 Why does a tuning fork placed on a wooden table produce a louder sound than when held in the air? What does this tell us about the role of surface area in sound propagation?

Ans. A tuning fork on a wooden table produces louder sound due to larger vibrating surface area.

Reason: When the vibrating tuning fork is held in air, only its prongs vibrate the air, which is a small surface area. When placed on a table, the vibrations are transferred to the large surface area of the table. The table then vibrates and forces a much larger volume of air to vibrate, resulting in a louder sound. This demonstrates that a larger vibrating surface area increases the loudness of sound.

13.2 If sound needs a medium to travel, how does the bell jar experiment prove this requirement? What happens when air is removed, and why?

Ans. The bell jar experiment proves that sound requires a medium (like air) to travel.

Reason: In the experiment, an electric bell rings inside a sealed bell jar. When the jar is full of air, the sound is heard clearly. As the air is pumped out using a vacuum pump, the sound becomes fainter and eventually inaudible, even though the bell is still seen vibrating. This happens because sound waves cannot travel through a vacuum. When air is reintroduced, the sound becomes audible again, confirming that air (a medium) is necessary for sound propagation.

13.3 A person hears his echo when shouting near a tall building. Why must the building be at least 17 metres away for the echo to be heard clearly?

Ans. To hear a distinct echo, the reflecting surface (building) must be at least 17 metres away from the source.

Reason: The human brain retains sound for about 0.1 seconds, so the reflected sound must reach us after this duration. Given the speed of sound in air is approximately 340 m s^{-1}, sound travels 34 metres in 0.1 seconds. Since an echo involves sound traveling to the wall and back, the minimum one-way distance required is half of 34 metres, which is 17 metres.

13.4 Why do voices of men sound deeper than those of women or children, even when they are speaking at the same volume? Explain using the relationship between frequency and pitch.

Ans. Men's voices sound deeper than women's or children's because they have a lower pitch.

Reason: Pitch is the characteristic of sound that depends on frequency. A higher frequency results in a higher pitch (shrill sound), and a lower frequency results in a lower pitch (deep sound). Men's vocal cords vibrate at a lower frequency, producing a lower-pitched, deeper sound. Women and children have vocal cords that vibrate at a higher frequency, producing a higher-pitched, shriller sound.

13.5 In what ways do soft materials like carpets or curtains improve the acoustics of a room? How do they affect echoes and sound quality?

Ans. Soft materials like carpets and curtains improve room acoustics by absorbing sound waves.

Reason: Hard, smooth surfaces (like bare walls and floors) reflect sound waves strongly, causing multiple reflections (reverberation) and echoes that distort sound and make it unclear. Soft, porous materials absorb these sound waves instead of reflecting them. This reduces unwanted echoes and reverberations, resulting in clearer and better-quality sound within the room.

13.6 When a person claps near a canyon and hears the echo after a few seconds, how can they calculate the distance to the canyon? What principle is used in this method?

Ans. The distance to the canyon can be calculated using the speed of sound and the time taken for the echo to return: $d = (v \times t) / 2$

Principle: Echo method uses reflection principle; measure time t for sound to travel to canyon and back at speed v, divide by 2 for one-way distance.

Comprehensive Questions

13.1 What is the approximate speed of sound in air, and what factors affect it?

Ans. See Q.#4 of theory.

13.2 Why does sound travel faster in solids than in liquids and gases?

Ans. In solids, particles are closely packed and strongly bonded, which allows vibrations to pass quickly from one particle to another. In gases, particles are far apart, so vibrations take more time to transfer. Therefore, sound travels faster in solids than in gases.

13.3 How do amplitude and frequency affect the quality of sound? Explain.

Ans. See Q.#5 of theory.

13.4 How does echo occur? Explain.

Ans. See Q.#7 of theory.

13.5 How do reflection, refraction, and diffraction affect the behaviour of sound waves?

Ans. See Q.#7 & 8 of theory.

13.6 What are infrasound and ultrasound, and how are they used in different applications?

Ans. See Q.#10 of theory.

Numerical Problems

13.1 At a particular temperature, the speed of sound in air is 333 m s^{-1}. If the wavelength of a sound wave is 3 cm, calculate the frequency of the sound wave. Is this frequency in the audible range of the human ear?

Solution

Given Data:

Speed of sound in air = v = 333 m/s

Wavelength of sound wave = λ = 3 cm = 0.03 m

To Find:

Frequency of the sound wave f = ?

Whether f is in the audible range (20 Hz to 20,000 Hz)

Solution:

Using the wave equation: $v = f\lambda$

$f = v / \lambda = 333 / 0.03 = 11.1$ kHz

The audible range for humans is 20 Hz to 20,000 Hz. Since 11.1 kHz (11100 Hz) lies within this range, it is audible.

Result:

f = 11 kHz (approximately), yes, it is audible.

13.2 A clock chimes 48 times in 1 minute. Calculate the frequency and period of the chimes.

Solution

Given Data:

Number of chimes = n = 48

Time taken, t = 1 minute = 60 s

To Find:

Frequency of chimes f = ?

Time period of chimes T = ?

Solution:

Frequency is the number of oscillations per second: $f = n/t = 48/60 = 0.8$ Hz

Time period is the inverse of frequency: $T = 1/f = 1/0.8 = 1.25$ s

Result:

f = 0.8 Hz, T = 1.25 s

13.3 A car horn emits a sound with a wavelength of 0.5 m. If the speed of sound in air is 340 m s^{-1}, calculate the frequency of the sound produced by the car's horn.

Solution

Given Data:

Wavelength of sound = λ = 0.5 m

Speed of sound in air = v = 340 m/s

To Find:

Frequency of the sound = f = ?

Solution:

Using the wave equation: $v = f\lambda$

$f = v/\lambda = 340/0.5 = 680$ Hz

Result:

$f = 680$ Hz

13.4 A wave travels with a speed of 500 m s^{-1} and has a wavelength of 2 metres. Calculate the time period of the wave.

Solution

Given Data:

Speed of wave, $v = 500\ ms^{-1}$

Wavelength, $\lambda = 2$ m

To Find:

Time period of the wave, T = ?

Solution:

First, find frequency using $v = f\lambda$: $f = v/\lambda = 500/2 = 250$ Hz

Then, time period: $T = 1/f = 1/250 = 0.004$ s

Result:

$T = 0.004$ s

13.5 A research boat sends a sound wave straight to the seabed and receives the echo 2 seconds later. The speed of sound in seawater is 1600 m s^{-1}. Find the depth of the sea at this position.

Solution

Given Data:

Time for echo to return = t = 2 s

Speed of sound in seawater = $v = 1600\ ms^{-1}$

To Find:

Depth of the sea = d = ?

Solution:

The sound travels to the seabed and back, so the total distance travelled is 2d.

Using distance = speed × time: $2d = v \times t = 1600 \times 2 = 3200$ m

$d = 3200 / 2 = 1600$ m

Result:

$d = 1600$ m

13.6 A person claps his hands near a mountain and hears the echo after 6 seconds. If the speed of sound is 343 m s^{-1}, what is the distance of the mountain from the person?

Solution

Given Data:

Time for echo to return = t = 6 s

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

To Find:

Distance to the mountain d = ?

Solution:

The sound travels to the mountain and back, so total distance = 2d.

$2d = v \times t = 343 \times 6 = 2058$ m

$d = 2058 / 2 = 1029$ m

Result:

$d = 1029$ m

Important Questions of Board Examination

(i) How sound is produced? Describe longitudinal nature of sound waves.

(ii) Name of the characteristics of sound. Explain them in detail.

(iii) Write a note on speed of sound.

(iv) Describe audible frequency range.

(v) Define ultrasound. Write its uses.

Important Short Questions of Board Examination

(i) What do you mean by reverberation?

(ii) Define loudness.

(iii) Define pitch and quality.

(iv) On what factors pitch of sound depend?

(v) On what factors loudness of sound depend?

(vi) What is reflection of sound?

(vii) How can depth of sea be measured by ultrasonic?

(viii) What is meant by ultrasound?

(ix) Why sound cannot travel through vacuum?

(x) Differentiate between compression and rarefaction.

(xi) Why does sound travel faster in solids than in gases?

(xii) What is an Echo? State the minimum distance required for echo.

(xiii) How do sound waves propagate in air?