1. Sound is a mechanical energy which produces sensation of hearing.
2. For hearing sound there must be (i) a vibrating body, (ii) a material medium for its propagation and (iii) a receiver, such as human ear.
3. Sound energy does not propagate through vacuum.
4. When the particles of a medium oscillate in the same direction, in which wave is being propagated, such a wave is called longitudinal wave.
5. When the particles of a medium oscillate at right angles to the direction of wave propagation, a transverse wave is produced.
6. Transverse waves can be produced in solids and liquids, but not in gases.
7. The highest point on the elevation or hump of a transverse wave is called crest.
8. The lowest point on the depression or hollow of a transverse wave is called trough.
9. Compression is a region in a longitudinal wave, where the particles of medium are crowded together. It is a region of high pressure and high density.
10. Rarefaction is a region in a longitudinal wave, where the particles of medium are spread wide apart. It is a region of low pressure and low density.
11. The change in density of a medium from maximum value to minimum value and again to maximum value in case of longitudinal wave is called one oscillation.
12. The number of compressions and rarefactions (taken together) passing through a point in one second is called frequency. Its unit is hertz.
13. The time taken by two consecutive compressions or rarefactions to cross a point is called time period.
14. The magnitude of maximum displacement of a vibrating particle about its mean position is called amplitude.
15. The pitch of sound is determined by its frequency, i.e., higher the frequency, more is the pitch, and hence, shriller is the sound.
16. The loudness of sound is determined by the amplitude, i.e., more the amplitude, louder is the sound.
17. The property by virtue of which the note of same pitch and same frequency can be distinguished is called timbre or quality of sound.
19. A conical tube commonly used for addressing a small group of people is called megaphone.
20. The phenomenon due to which repetition of sound is heard after reflection from a distant object, after the original sound from a given source dies is called an echo.
21. For hearing an echo, the minimum distance between the source of sound and reflecting body should be 17 m.
22. Vibrations within the frequency range of 0 Hz to 20 Hz are called infrasonic vibrations. Humans cannot hear them.
23. Vibrations within the frequency range of 20 Hz to 20000 Hz are called sonic vibrations. They can be heard by humans.
24. Vibrations above the frequency range of 20,000 Hz known as ultrasonic vibrations. Humans cannot hear them.
25. A device used to locate depth of sea or submarines, etc, is called sonar.

I. SUMMATIVE ASSESSMENT

NCERT QUESTIONS WITH THEIR ANSWERS

SECTION A : IN-TEXT QUESTIONS

Page 162
Q.1. How does the sound produced by a vibrating object in a medium reach your ear? [2010]
Ans. Air is the commonest material through which sound propagates. When a vibrating object, such as the prongs of tuning fork moves forward, it pushes the molecules of the air in front of it. This in turn compresses the air, creating a region of high pressure and high density and is commonly called compression. The compression so produced in the air travels forward.
As the compression produced in the air travels forward, the prongs of the tuning fork moves backward. They create a region of low pressure in the air and is commonly called rarefaction. This region has low pressure, low density and more volume.
As the tuning fork or another vibrating object continues vibrating the regions of compression in the air alternate with the regions of rarefaction. These regions of compression and rarefaction alternate at the same place, but the energy of the vibrating object travels outward. It is this energy which reaches the ears, makes the ear drums to vibrate and hence we hear sound.

Page 163
Q.1. Explain how sound is produced by your school bell.
Ans. Refer to question 1 above.
Q.2. Why are sound waves called mechanical waves?
Ans. Sound energy cannot be produced on its own. Some mechanical energy is required to make an object vibrate. It is the mechanical energy of the vibrating object which travels through a medium and ultimately reaches the ear. Thus, the sound waves are called mechanical waves.
Q.3. Suppose you and your friend are on the Moon. Will you be able to hear any sound produced by your friend?
Ans. No, you will not be able to hear any sound. It is because Moon has no atmosphere. Thus, no sound waves can travel to your ears, and hence, no sound is heard.

Page 166(I)
Q.1. Which wave property determines (a) loudness (b) pitch?
Ans. The amplitude of the wave determines the loudness, i.e., more the amplitude of a wave, more is the loudness produced.
   The frequency of the wave determines the pitch, i.e., higher the frequency of a wave, more is its pitch and shrill is the sound.
Q.2. Guess which sound has a higher pitch: guitar or a car horn?
Ans. Car horn has a higher pitch than guitar, because sound produced by former is more shrill than the later.

Page 166(II)
Q.1. What are wavelength, frequency, time period and amplitude of a sound wave?
Ans. Wavelength: The linear distance between two consecutive compressions or two consecutive rarefactions is known as wavelength.
   Frequency: The number of compressions and rarefactions (taken together) passing through a point in unit time is known as frequency.
   Time period: The time taken by two consecutive compressions or rarefactions to pass through a point is known as time period.
   Amplitude: The extent to which a medium is compressed, when a sound wave passes through it is called amplitude.
Q.2. How are the wavelength and frequency of a sound wave related to its speed?
Ans. Speed of sound = Frequency × Wavelength.
Q.3. Calculate the wavelength of a sound wave whose frequency is 220 Hz and speed is 440 m s⁻¹ in a given medium.
Ans. Frequency = 220 Hz; speed of sound = 440 m s⁻¹
   Now, Speed of sound = Frequency × Wavelength = 220 × Wavelength
   \[ \therefore \text{Wavelength} = \frac{440}{220} \text{ m} = 2 \text{ m} \]
Q.4. A person is listening to a tone of 500 Hz, sitting at a distance of 450 m from the source of sound. What is the time interval between successive compressions from the source?
Ans. Time interval = \[ \frac{1}{\text{Frequency}} \] = \[ \frac{1}{500} \] = 0.002 s.

Page 166(III)
Q.1. Distinguish between loudness and intensity of sound.
Ans. Intensity depends on the energy per unit area of the wave and it is independent of the response of the ear, but the loudness depends on energy as well as on the response of the ear.
Q.1. In which of the three media, air, water and iron, does sound travel the fastest at a particular temperature?

Ans. Sound travels fastest in iron as compared to water and air.

Q.1. An echo returned in 3 s. What is the distance of the reflecting surface from the source, given that the speed of sound is 342 ms\(^{-1}\)?

Ans. Distance of reflecting body from the source of sound = \(\frac{\text{Speed of sound} \times \text{time}}{2}\)

\[= \frac{342 \text{ ms}^{-1} \times 3 \text{ s}}{2} = 513 \text{ m}\]

Q.1. Why are ceilings of concert halls curved?

Ans. The ceilings of concert hall are curved, so that sound after reflection from it reaches all the corners of the hall, and hence, is audible to everyone in the hall.

Q.1. What is the audible range of average human ear?

Ans. An average human ear can hear sound waves between frequencies 20 Hz to 20,000 Hz.

Q.2. What is the range of frequencies associated with (a) infrasound (b) ultrasound?

Ans. (a) Sound waves between the frequencies 1 to 20 Hz are known as infrasound.
(b) Sound waves of the frequencies 20,000 Hz and above are known as ultrasound.

Q.1. A submarine emits a sonar pulse, which returns from an under water cliff in 1.02 s. If the speed of sound in salt water is 1531 ms\(^{-1}\), how far away is the cliff?

Ans. Distance of cliff = \(\frac{\text{Speed of sound} \times \text{time}}{2}\)

\[= \frac{1531 \text{ ms}^{-1} \times 1.02 \text{ s}}{2} = 780.81 \text{ m}\]

Q.1. What is sound and how is it produced?

Ans. Sound is a mechanical energy which produces sensation of hearing. Sound is produced when an object is set into vibrations.

Q.2. Describe with the help of a diagram, how compressions and rarefactions are produced in air near a source of sound.

Ans. Refer to Question 1 (Textbook page 162) in text-questions.

Q.3. Cite an experiment to show that sound needs a material medium for its propagation? \[2010\]

Ans. Take an electric circuit consisting, of a cell, a switch and an electric bell is arranged inside a bell jar, which stands on the platform of an evacuating pump.
The switch of the bell is pressed to close the electric circuit. Sound is heard, when there is air within the bell jar. Air is now gradually pumped out of the bell jar. The intensity of sound goes on decreasing, and no sound is heard when the air is completely removed from the bell jar as shown in figure.

It is because, the medium of air, which has to carry energy from the bell to the bell jar, is removed.

This clearly shows that sound needs material medium for its propagation.

Q.4. Why is sound wave called a longitudinal wave?

Ans. It is called longitudinal wave because the particles of the medium vibrate in the direction of the propagation of wave.

Q.5. Which characteristic of sound helps you to identify your friend by his voice, while sitting with others in a dark room?

Ans. The characteristic of sound is quality or timbre.

Q.6. Flash and thunder are produced simultaneously, but thunder is heard a few seconds after the flash is seen. Why?

Ans. The speed of light is $3 \times 10^8$ ms$^{-1}$, whereas that of sound is 344 ms$^{-1}$ in air. Thus, flash of lightning is seen at once, but sound takes few seconds to reach the ears.

Q.7. A person has a hearing range from 20 Hz to 20 kHz. What are the typical wavelengths of sound waves in air corresponding to these frequencies? Take the speed of sound in air as 344 ms$^{-1}$.

Ans. Wavelength of sound of frequency 20 Hz = \[ \frac{\text{Speed of sound}}{\text{Frequency}} = \frac{344 \text{ ms}^{-1}}{20 \text{ s}^{-1}} = 17.2 \text{ m} \]

Wavelength of sound of frequency 20,000 Hz = \[ \frac{\text{Speed of sound}}{\text{Frequency}} = \frac{344 \text{ ms}^{-1}}{20,000 \text{ s}^{-1}} = 0.0172 \text{ m} \]

Q.8. Two children are at the opposite ends of an aluminium rod. One strikes the end of the rod with a stone. Find the ratio of times taken by the sound wave in air and in aluminium to reach the second child. (Speed of sound in aluminium and in air are 6420 ms$^{-1}$ and 346 ms$^{-1}$ respectively).

Ans. \[ \frac{\text{Time taken by sound to travel in aluminium}}{\text{Time taken by sound in air}} = \frac{\text{Speed of sound in air}}{\text{Speed of sound in aluminium}} \]

\[ \Rightarrow \frac{T_{\text{Al}}}{T_{\text{Air}}} = \frac{346 \text{ ms}^{-1}}{6420 \text{ ms}^{-1}} \Rightarrow T_{\text{Al}} : T_{\text{Air}} = 346 : 6420 = 1 : 18.55 \]
Q.9. The frequency of a source of sound is 100 Hz. How many times does it vibrate in a minute?

Ans. Number of vibrations produced in 1 second = 100

∴ Number of vibrations produced in 1 minute (60 s) = 100 × 60 = 6000.

Q.10. Does sound follow the same laws of reflection as light does? Explain.

Ans. Yes, sound and light follow the same laws of reflection as stated below:

(a) Angle of incidence at the point of incidence is equal to angle of reflection.
(b) The incident sound wave, the normal and the reflected sound wave lie in the same plane at the point of incidence.

Q.11. When a sound is reflected from a distant object, an echo is produced. If the distance between the reflecting surface and the source of sound production remains the same. Do you hear echo sound on a hotter day?

Ans. Assuming the distance between the source of sound and reflecting body is the minimum distance, if the temperature rises the speed of sound will increase. This in turn will increase the minimum distance required for hearing an echo. As the distance does not increase between the source of sound and reflecting body, therefore, no echo is heard.

Q.12. Give two practical applications of the reflection of sound waves.

Ans. (i) In stethoscope the sound of patient’s heartbeat reaches the doctor’s ears by multiple reflections in the tubes.

(ii) Megaphones are designed to send sound waves in particular direction are based on the reflection of sound.

Q.13. A stone is dropped from the top of a tower 500 m high into a pond of water at the base of the tower. When is splash heard at the top? Given g = 10 ms−2 and speed of sound is 340 ms−1.

Ans. For the downward journey of stone

Initial velocity (u) = 0; Distance (height) of tower (s) = 500 m.

Time of fall (t₁) = ? (To be calculated); Acceleration due to gravity (g) = 10 ms−2

Applying, \( s = ut + \frac{1}{2} gt^2 \); \( 500 \text{ m} = 0 \times t_1 + \frac{1}{2} \times 10 \text{ ms}^{-2} \times t_1^2 \) \( \Rightarrow 500 \text{ m} = 5 \ t_1^2 \text{ ms}^{-2} \)

\( \Rightarrow t_1^2 = 100 \text{ s}^2 \)

\( \Rightarrow t_1 = \sqrt{100 \text{ s}^2} = 10 \text{ s} \)

For the sound travelling upward

Time taken (t₂) = \( \frac{\text{Total distance (height)}}{\text{Speed of sound}} \) = \( \frac{500 \text{ m}}{340 \text{ ms}^{-1}} \) = 1.47s

∴ Time required to hear splash = \( t_1 + t_2 = 10 \text{ s} + 1.47 \text{ s} = 11.47 \text{ s} \)

Q.14. A sound wave travels at a speed of 339 ms−1. If its wavelength is 1.5 cm, what is the frequency of the wave? Will it be audible?

Ans. Wavelength of sound wave = 1.5 cm = 0.015 m

Speed of sound wave = 339 ms−1

∴ Frequency of sound wave = \( \frac{\text{Speed of sound}}{\text{Wavelength}} \) = \( \frac{339 \text{ ms}^{-1}}{0.015 \text{ m}} \) = 22600 Hz

The sound will not be audible, because humans can hear only upto 20,000 Hz.
Q.15. What is reverberation? How can it be reduced?

Ans. The repeated multiple reflections of sound in any big enclosed space is known as reverberation.

The reverberation can be reduced by covering the ceiling and walls of the enclosed space with sound absorbing materials, such as fibre board, loose woollens, etc.

Q.16. What is loudness of sound? What factors does it depend upon?

Ans. The effect produced in the brain by the sound of different frequencies is called loudness of sound.

The loudness of sound increases with the increase in amplitude and the area of the vibrating body. It also depends on the distance of the observer from the source of sound, i.e., less the distance loud is the sound.

Q.17. Explain how bats use ultrasound to catch prey.

Ans. The bats produce high pitched ultrasonic waves which are not heard by humans. The ultrasonic waves on striking the insect send back an echo, which is heard by the bat. On hearing the echo the bat homes on the insect and catches it.

Q.18. How is ultrasound used for cleaning?

Ans. The object to be cleaned is placed in a tank fitted with ultrasonic vibrator. The tank is filled with water containing detergent. When the ultrasonic vibrator is switched on the detergent particles rub against the object at a very high speed and hence clean it.

Q.19. Explain the working and application of sonar.

Ans. Sonar is a device fitted in sailing ships, trawlers, war ships, etc., to locate submarines or shoals of fish or depth of ocean bed.

To find the depth of an ocean, a strong ultrasonic wave from the ship is sent towards the bottom of ocean. On striking the bottom of ocean, the ultrasonic wave is reflected upward towards the ship. The reflected wave is received by a suitable receiver. The time taken by the wave to travel from the source of sound to the receiver is recorded. Knowing the velocity of sound in water, the depth of ocean floor is calculated by the following formula:

\[
\text{Depth of ocean floor} = \frac{\text{Velocity of sound in sea water} \times \text{Time}}{2}
\]

For example, if it takes 2.4 seconds to record echo by the sonar and velocity of sound in sea water is 1450 ms\(^{-1}\) then:

\[
\text{Depth of ocean floor} = \frac{1450 \text{ ms}^{-1} \times 2.4 \text{s}}{2} = 1740 \text{ m}.
\]

Q.20. A sonar device on a submarine sends out a signal and receives an echo 5 seconds later. Calculate the speed of sound in water, if the distance of object from the submarine is 3625 m.

\[
\text{Speed of sound} = \frac{1450 \text{ ms}^{-1} \times 2.4 \text{s}}{2} = 1740 \text{ m}.
\]
Ans. Speed of sound = \( \frac{2 \times \text{Distance}}{\text{Time}} = \frac{2 \times 3625 \text{ m}}{5 \text{ s}} = 1450 \text{ ms}^{-1} \)

Q.21. Explain how defects in a metal block can be detected by using ultrasound.

Ans. The ultrasound waves are allowed to pass through metal block to which are fitted detectors to detect the waves. If the metal block has a very small defect, such as an air bubble or a crack, then the ultrasound waves are reflected from such spots. The reflected ultrasonic waves indicate that metal block is defective.

Q.22. Explain how the human ear works. [2010]

Ans. The pinna collects the sound waves and then directs them through ear canal. The sound waves on striking the ear drum, make it vibrate exactly the same way as the given sound emitting object.

When the ear drum vibrates, the bones in the middle ear starts vibrating and help in magnifying the vibrations. When the magnified vibrations reach the cochlea in the inner ear, the fluid in it starts vibrating. These vibrations are picked by sensory receptors and then converted into electrical signals. The electrical signals then travel to the brain, which ultimately, interprets sound.

A. Very Short Answer Questions (1 Mark)

Previous Years' Questions

Q.1. What is reverberation? [2011 (T-II)]
Ans. The repeated multiple reflections of sound in any big enclosed space, is called reverberation.

Q.2. Name the disease that can be caused by UV rays. [2011 (T-II)]
Ans. Skin Cancer.

Q.3. If 20 waves are produced per second, what is the frequency in hertz? [2011 (T-II)]
Ans. Number of waves produced per second is called frequency.

Thus, frequency = 20 hertz.

Other Important Questions

Q.1. What do you understand by the term wave motion?
Ans. The transfer of energy by the vibratory motion of the molecules of a medium from one part to another part is called a wave motion.

Q.2. What do you understand by the term sound energy?
Ans. Sound is a form of energy which makes us hear. It is produced by any vibrating material body which produces the sensation of hearing.

Q.3. What kind of elastic wave is produced when the particles of a medium vibrate at right angles to the direction of sound propagation?
Ans. When the particles of a medium vibrate at right angles to the direction of sound propagation, transverse wave is produced.
Q.4. What kind of wave is produced when the particles of a medium vibrate in the direction of propagation of sound?

Ans. When the particles of a medium vibrate in the direction of propagation of sound, then longitudinal wave is produced.

Q.5. The frequency of a sound wave is 32 Hz. What is the time period?

Ans. \( f = 32 \text{ Hz} \).

Time period, \( T = \frac{1}{f} = \frac{1}{32} = 0.03125 \text{ s} \)

Q.6. A vibrating wire has a time period 0.025 s, calculate the frequency.

Ans. \( T = 0.025 \text{ s}; \ f = \frac{1}{T} = \frac{1}{0.025} = \frac{1000}{25} = 40 \text{ Hz} \).

Q.7. What is the linear distance between a crest and a nearest trough?

Ans. The linear distance between a crest and a nearest trough is equal to half of the wavelength.

Q.8. What is the amount of sound energy passing per second through unit area known as?

Ans. The amount of sound energy passing per second through unit area is called intensity of sound.

Q.9. If a sound wave travels in air and steel with a speed \( X \text{ m/s} \) and \( Y \text{ m/s} \) respectively, find the ratio of the time taken by the sound waves in air and steel to reach a certain point?

Ans. For air, \( T_1 = \frac{\lambda}{v_1} = \frac{\lambda}{X} \)  
For steel, \( T_2 = \frac{\lambda}{v_2} = \frac{\lambda}{Y} \)  
\[ \Rightarrow T_1 : T_2 = \frac{\lambda}{X} : \frac{\lambda}{Y} = \frac{1}{X} : \frac{1}{Y} \]

\[ \Rightarrow \frac{T_1}{T_2} = \frac{X}{Y} \]  
or  
\[ T_1 : T_2 = Y : X \]

Q.10. Give the relation between wavelength (\( \lambda \)), velocity (\( v \)) and frequency (\( f \)).

Ans. Relation between wavelength (\( \lambda \)), velocity (\( v \)) and frequency (\( f \)) is \( v = f \lambda \).

Q.11. What is the speed of sound in air at 0 °C?

Ans. Speed of sound in air at 0°C is 332 m/s.

Q.12. How are echoes produced?

Ans. Echo is produced by repetition of sound due to reflection of original sound by a broad and hard obstacle.

Q.13. The frequency of a sound wave in air is 128 Hz. What will be its frequency in water?

Ans. The frequency of a sound wave in air is 128 Hz, then its frequency in water will be also 128 Hz.

Q.14. A girl hears an echo of her own voice from a distant tall building after 2 s. What is the distance of the girl from the building? (Given speed of sound in air = 332 m/s)

Ans. \( t = 2 \text{ s}, \ v = 332 \text{ m/s}, \ s = ? \)

Required distance \( s = \frac{vt}{2} = \frac{332 \times 2}{2} = 332 \text{ m} \).
Q.15. A sound wave produces 20 compressions and 20 rarefactions in 0.045 seconds. What will be the frequency of the wave?

Ans. Here, in 0.045 s, number of vibrations produced is 20

⇒ In 1 s the number of vibrations produced will be \( \frac{20}{0.045} = \frac{20000}{45} = \frac{4000}{9} \approx 444 \) Hz.

Q.16. An elephant can hear a sound of frequency 16 Hz. What is the wavelength of sound in air at this frequency? [Given, speed of sound in air = 320 m/s]

Ans. \( f = 16 \) Hz, \( v = 320 \) m/s

Wavelength, \( \lambda = \frac{v}{f} = \frac{320}{16} = 20 \) m

Q.17. A tuning fork produces 1024 oscillations in 4 s. What is the frequency of the tuning fork?

Ans. \( f = \frac{1024}{4} = 256 \) Hz.

Q.18. What do you mean by bass in a musical sound?

Ans. A sound of low frequency is called bass.

Q.19. What kind of waves are used in sonography?

Ans. Ultrasonic waves are used in sonography.

Q.20. Name the factor on which loudness of sound depend.

Ans. The loudness of sound increases with the increase in amplitude and the area of the vibrating body.

Q.21. The following figures show the wave shapes of two sounds of same frequency. Which of these is likely to represent the sound produced by car-horn?

Ans. Figure (b) represents the wave shape of loud sound, so this is produced by car-horn.

Q.22. What is the nature of sound waves?

Ans. Sound waves are longitudinal waves.

Q.23. The astronauts cannot listen to each other on the surface of the moon. Why?

Ans. Sound needs a material medium for their propagation. On the surface of the moon, there is no material medium so astronauts cannot listen to each other.

Q.24. What are infrasonic and ultrasonic sounds?

Ans. A sound which has frequency less than 20 per second is called infrasonic sound.

A sound which has frequency more than 20,000 per second is called ultrasonic sound.

Q.25. On what factor does the pitch of sound depend?
Ans. Pitch depends on the frequency of sound.

Q.26. Why do we hear sound of an approaching car before the car reaches us?
Ans. Because speed of sound in air is more than the speed of the car.

Q.27. Which has higher pitch whistle or a drum?
Ans. Whistle.

B. Short Answer Questions - I (2 Marks)

Previous Years' Questions

Q.1. Three persons, A, B and C are made to hear a sound travelling through different mediums as given below:

<table>
<thead>
<tr>
<th>Person</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Iron Rod</td>
</tr>
<tr>
<td>B</td>
<td>Air</td>
</tr>
<tr>
<td>C</td>
<td>Water</td>
</tr>
</tbody>
</table>

Who will hear the sound first? Why?
Ans. Person A will hear the sound first, because velocity of sound is maximum in solid. In given medium only iron rod is solid while water is liquid and air is gas.

Q.2. (i) Define the time period of a wave.
(ii) Give the relation among speed of sound \( v \), wavelength \( \lambda \) and its frequency \( \nu \).
(iii) A sound wave travels at a speed of 339 ms\(^{-1}\). If its wavelength is 1.5 cm, what is the frequency of the wave?

Ans. (i) The time taken by one oscillation to cross a point, is called time period.
(ii) \( v = \nu \lambda \).
(iii) \( v = 339 \text{ ms}^{-1} \); \( \lambda = 1.5 \text{ cm} = 1.5 \times 10^{-2} \text{ m} \); \( \nu = ? \)
\[
\nu = \frac{v}{\lambda} = \frac{339 \text{ ms}^{-1}}{1.5 \times 10^{-2} \text{ m}} = 22600 \text{ Hz}
\]

Q.3. A hospital uses an ultrasonic scanner to locate tumours in a tissue. What is the wavelength of sound in a tissue in which the speed of sound is 1.7 km/s. The operating frequency of the scanner is 4.2 MHz. (1MHz = 10\(^6\) Hz).

Ans. \( v = 1.7 \text{ km/s} = 1700 \text{ m/s} \); \( \nu = 4.2 \text{ MHz} = 4.2 \times 10^6 \text{ Hz} \), \( \lambda = ? \)
\[
\lambda = \frac{v}{\nu} = \frac{1700 \text{ m/s}}{4.2 \times 10^6} = 4.05 \times 10^{-4} \text{ m} = 4.05 \times 10^{-2} \text{ cm}
\]

Q.4. An echo is returned in 6 seconds. What is the distance of reflecting surface from source? [given that speed of sound is 342 m/s.]

Ans. \( 2t = 6 \text{ s}, \ t = 3 \text{ s} \); \( v = 342 \text{ m/s} \)
Required distance = \( vt = 342 \text{ m/s} \times 3 \text{ s} = 1026 \text{ m} \)
Q.5. 20 waves pass through a point in 2 seconds. If the distance between one crest and adjacent trough is 1.5 m. Calculate: [2011 (T-II)]
(a) the frequency (b) the wavelength

Ans. (a) The frequency, \(\nu = \frac{20}{2} = 10\) Hz
(b) The wavelength, \(\lambda = 2 \times 1.5\) m = 3 m

\(\therefore \frac{\lambda}{2}\) = the distance between one crest and adjacent trough).

Q.6. What is meant by reverberation of sound? Does reverberation produce undesirable effects in big hall or auditorium? If yes, how are the undesirable effects avoided? [2011 (T-II)]

Ans. The repeated multiple reflections of sound in any big enclosed space, is called reverberation. Yes, reverberation produces undesirable effects in big hall or auditorium. The walls and the ceiling of the hall are covered with sound absorbing materials, such as rough plaster, fibre board or loose woolen or cotton cloth to avoid undesirable effects.

Q.7. What is echo ranging? State any one application of this technique. [2011 (T-II)]

Ans. The minimum distance between source and the reflecting body should be 17 metres for the formation of an echo, is known as echo ranging.

By applying this technique we can measure depth of sea with the help of Sonar.

Q.8. A person is listening to a tone of 500 Hz sitting at a distance of 450 m from the source of the sound. Calculate the time interval between successive compressions from the source? (Speed of sound in air = 330 m/s) [2011 (T-II)]

Ans. \(\nu = 500\) Hz, \(v = 330\) m/s; \(\lambda = ?\)

\(\lambda = \frac{v}{\nu} = \frac{330}{500}\) Hz = 0.66 m = 66 cm.

Thus, time interval between successive compressions = 66 cm.

Q.9. A body is vibrating 6000 times in one minute. If the velocity of sound in air is 360 m/s, find (a) Frequency of vibration in hertz. (b) Wavelength of the wave produced. [2011 (T-II)]

Ans. (a) Frequency, \(\nu = \frac{6000}{60}\) = 100 Hz.

(b) Wavelength, \(\lambda = \frac{v}{\nu} = \frac{360}{100}\) Hz = 3.6 m

Q.10. Waves of frequency 200 Hz are produced in a string shown in figure.
Find (a) Amplitude of the wave  
(b) Wavelength of the wave  
(c) Velocity of the wave  

Ans. (a) Amplitude of the wave = 12 cm  
(b) Wavelength of the wave = PQ = 35 cm  
(c) \( \lambda = 35 \text{ cm} = 0.35 \text{ m}, \nu = 200 \text{ Hz}, \nu = ? \)  
\[ \nu = \nu \lambda = 200 \text{ Hz} \times 0.35 \text{ m} = 70 \text{ m/s} \]  
Thus, velocity of the wave = 70 m/s.

Q.11. (i) Sound is produced when your school bell is struck with a hammer. Why?  
(ii) Which characteristic of sound helps to identify your friend by his voice while sitting with others in a dark room?  

Ans. (i) Sound is produced when a material body is made to vibrate with some mechanical energy.  
So school bell is struck with a hammer to make it vibrate and thus sound is produced.  
(ii) Timbre or quality of sound helps to identify your friend by his voice, while sitting with others in a dark room.

Other Important Questions

Q.1. What is transferred by a wave motion, matter or energy? Support your answer by an example.  

Ans. Energy is transferred by a wave motion. In case of transmission of sound through air, there is no actual movement of the air from the sound producing body to the ear. The air particles only vibrate back and forth and transfer the sound energy from one particle to another.

Q.2. Draw a diagram representing longitudinal wave.  

Ans. The diagram representing longitudinal wave is shown below:

![Diagram of Longitudinal Wave](attachment://image.png)  
C - Compression; R - Rarefaction  
Points of increased density Points of decreased density

Q.3. What kind of wave is produced when sound energy propagates through air? Give two examples of longitudinal waves?  

Ans. Longitudinal wave is produced when sound energy propagates through air. The sound waves produced in water is another example of longitudinal waves.

Q.4. Wavelength of ripples produced on the surface of water is 0.14 m. If the velocity of ripples is 42 m/s, calculate the number of ripples produced in one second.  

Ans. \( \lambda = 0.14 \text{ m}, \quad \nu = 42 \text{ m/s}, \quad f = ? \)  
Frequency, \( f = \frac{\nu}{\lambda} = \frac{42}{0.14} = \frac{42 \times 100}{14} = 300 \text{ Hz} \).
Q.5. What is meant by intensity of sound? How is it different from loudness?

Ans. The amount of sound energy passing each second through a unit area, is called intensity of sound. Intensity depends on the energy per unit area of the wave and it is independent of the response of the ear, but the loudness depends on energy as well as on the response of the ear.

Q.6. (a) What is meant by 'compression' and 'rarefaction' of longitudinal wave?
(b) Give well labelled graphical representation of a longitudinal wave.

Ans. (a) Compression: A part of wave in which particle of air are closer to one another than the normal such that there is a momentary decrease in volume and increase in pressure and density.

Rarefaction: A part of the wave, in which the particle of the air are farther away from one another than the normal, such that there is momentary increase in volume, decrease in pressure and density.

Ans. The diagram is given below:

Q.7. Flash and thunder are produced simultaneously. But thunder is heard a few seconds after flash is seen. Explain why?

Ans. The speed of light is $3 \times 10^8$ ms$^{-1}$, whereas that of sound is 344 ms$^{-1}$ in air. Thus flash of lightning is seen at once, but sound takes few seconds to reach the ears.

Q.8. For hearing distinct echoes minimum distance of the obstacle from the source of sound must be about 17.2 m. Explain why?

Ans. Let $d'$ be the minimum distance required for hearing an echo, when persistence of hearing is 1/10 second and velocity of sound is 332 ms$^{-1}$.

\[
d = \frac{v \times t}{2} = \frac{332 \times 0.1}{2} = 17 \text{ m (approx.)}.
\]

Thus, 17 m is the minimum distance required for hearing an echo.

Q.9. How does the stethoscope help the doctors in listening to the sound of the patient's heart beat?

Ans. In a stethoscope, the sound produced within the body of a patient is picked up by a sensitive diaphragm and then reaches the doctor's ear by multiple reflections.
C. Short Answer Questions - II

Previous Years’ Questions

Q.1. Ocean waves of time period 0.01 s have a speed of 15 m/s. Calculate the wavelength of these waves. Find the distance between the adjacent crest and the trough. [2011 (T-II)]

Ans. \( T = 0.01 \text{ s}; \quad v = \frac{1}{T} = \frac{1}{0.01 \text{ s}} = 100 \text{ Hz}; \quad v = 15 \text{ m/s}; \quad \lambda = ? \)

\[
\lambda = \frac{v}{T} = \frac{15 \text{ m/s}}{100 \text{ Hz}} = 0.15 \text{ m} = 15 \text{ cm}.
\]

Distance between the adjacent crest and the trough = \( \frac{\lambda}{2} = \frac{15}{2} = 7.5 \text{ cm} \)

Q.2. (i) How the bats make use of ultrasonic waves to catch their prey? Explain?
(ii) A radar signal is reflected by an aeroplane and is received 2 \( \times \) \( 10^{-5} \) s after it was sent. If the speed of these waves is \( 3 \times 10^{8} \text{ ms}^{-1} \), how far is the aeroplane? [2011 (T-II)]

Ans. (i) The bat produce high pitched ultrasonic waves. The waves on striking the insect sent back an echo, which is heard by the bat. On hearing the echo the bat homes on the insect and catches it.

(ii) Height of the aeroplane = \( \frac{\text{Speed of the waves} \times \text{Time}}{2} \)

\[
= \frac{3 \times 10^{8} \text{ m/s} \times 2 \times 10^{-5} \text{ s}}{2} = 3000 \text{ m}
\]

Q.3. State the relationship between frequency and time period of a wave. The wavelength of vibrations produced on the surface of water is 2 cm. If the wave velocity is 16 m/s find the frequency and Time period. [2011 (T-II)]

Ans. Frequency = \( \frac{1}{\text{Time period}} \) \( \Rightarrow v = \frac{1}{T} \).

\[
\lambda = 2 \text{ cm} = 0.02 \text{ m}; \quad v = 16 \text{ m/s}, \quad v = ?, \quad T = ?
\]

\[
v = \frac{v}{\lambda} = \frac{16 \text{ m/s}}{0.02 \text{ m}} = 800 \text{ Hz}
\]

\[
T = \frac{1}{v} = \frac{1}{800 \text{ Hz}} = 0.00125 \text{ s}
\]

Q.4. (a) The sound of an explosion on the surface of lake is heard by a boatman 100 m away and a driver 100 m below the point of explosion. Of the two persons mentioned (boatman or driver) who would hear the sound first? And why?
(b) Calculate the wavelength of a sound wave whose frequency is 220 Hz and speed is 440 m/s in a given medium. [2011 (T-II)]

Ans. (a) Driver would hear the sound first, because velocity of sound in water is greater than velocity of sound in air. In this case, driver is in water while boatman is in the air.
(b) \( v = 220 \text{ Hz}, \: v = 440 \text{ m/s}, \: \lambda = ? \)

\[
\lambda = \frac{v}{\nu} = \frac{440 \text{ m/s}}{220 \text{ Hz}} = 2 \text{ m.}
\]

**Q.5.** A sound wave has a frequency of 5000 Hz and wavelength of 20 cm. How long will it take to travel 1 km? **[2011 (T-II)]**

**Ans.** \( v = 5000 \text{ Hz}, \: \lambda = 20 \text{ cm} = 0.20 \text{ m}, \)

\( v = \nu \lambda = 5000 \text{ Hz} \times 0.20 \text{ m} = 1000 \text{ m/s}, \)

Now, \( v = 1000 \text{ m/s}, \: d = 1 \text{ km} = 1000 \text{ m}, \: t = ? \)

\[
t = \frac{d}{v} = \frac{1000 \text{ m}}{1000 \text{ m/s}} = 1 \text{ s}
\]

**Q.6.** Waves of frequency 100 Hz are produced in a string as shown in Fig: Give it’s:

(a) Amplitude
(b) Wavelength
(c) Velocity **[2011 (T-II)]**

![Wave diagram](image)

(a) Amplitude = **5 cm**

(b) Wavelength = **20 cm.**

(c) \( v = 100 \text{ Hz}; \: \lambda = 20 \text{ cm} = 0.20 \text{ m}, \: v = ? \)

\( v = \nu \lambda = 100 \text{ Hz} \times 0.20 \text{ m} = 20 \text{ m/s} \)

**Q.7.** (a) The frequency of a source of sound is 200 hertz. Calculate the no. of times the source of sound vibrates in 1 minute. Also calculate the time period. **[2011 (T-II)]**

(b) Which wave property determines.
   (i) Loudness
   (ii) Pitch

**Ans.** (a) In 1 s number of vibrations = 200

So in 60 s number of vibrations = 200 \times 60 = 12,000

Time period = \( T = \frac{1}{v} = \frac{1}{200 \text{ Hz}} = 0.005 \text{ s.} \)

(b) (i) Amplitude of wave determines the loudness of the sound.

   (ii) Frequency of wave determines the pitch of the sound.

**Q.8.** A boy dropped a stone in a well 45 m deep. If the speed of sound is 340 m/s, then after how much time, he will hear the splash? Take \( g = 10 \text{ m/s}^2. \) **[2011 (T-II)]**

**Ans.** Case I: When stone reaches the surface of the water.

\( u = 0, \: h = 45 \text{ m}, \: g = 10 \text{ m/s}^2, \: t_i = ? \)
Applying, \( h = ut + \frac{1}{2}gt^2 \) \( \Rightarrow 45 \text{ m} = 0 \times t_1 + \frac{1}{2} \times 10 \times t_1^2 \)

\( \Rightarrow 5t_1^2 = 45 \Rightarrow t_1^2 = 9 \Rightarrow t_1 = 3 \text{ s} \)

**Case II** : When sound of splash reaches to the boy

\[ t_2 = \frac{d}{v} = \frac{45 \text{ m}}{340 \text{ m/s}} = 0.13 \text{ s} \]

Thus, required time = \( t_1 + t_2 = 3 \text{ s} + 0.13 \text{ s} = 3.13 \text{ s} \)

Q.9. (a) Why we cannot hear an echo in a small room? [2011 (T-II)]

(b) A wave pulse on a string moves a distance of 8 m in 0.05 s.

(i) Find the velocity of the pulse.

(ii) What would be the wavelength of the wave on the string if its frequency is 200 Hz?

**Ans.** (a) The minimum distance between the source of sound and the reflecting body should be 17 metres for the formation of echo.

The small room is not capable of such distance for the formation of echo.

(b) (i) Velocity of the pulse = \( \frac{d}{t} = \frac{8 \text{ m}}{0.05 \text{ s}} = 160 \text{ m/s} \)

(ii) \( \lambda = \frac{v}{f} = \frac{160 \text{ m/s}}{200 \text{ Hz}} = 0.8 \text{ m} \)

Q.10. A sound wave has a frequency 2 kHz and wavelength 40 cm. Calculate time it take to travel 1.6 km. [2011 (T-II)]

**Ans.** \( v = 2 \text{ kHz} = 2000 \text{ Hz}, \lambda = 40 \text{ cm} = 0.40 \text{ m} \)

\( v = \nu \lambda = 2000 \text{ Hz} \times 0.40 \text{ m} = 800 \text{ m/s} \)

Now, \( v = 800 \text{ m/s}, d = 1.6 \text{ km} = 1600 \text{ m}, t = ? \)

\( t = \frac{d}{v} = \frac{1600 \text{ m}}{800 \text{ m/s}} = 2 \text{ s} \)

Q.11. In the figure given below, a displacement-distance graph for a wave is shown. The wave velocity is 320 m/s. Find [2011 (T-II)]

(a) Wavelength \hspace{1cm} (b) Frequency \hspace{1cm} (c) Amplitude

**Ans.** (a) Wavelength = 0.4 m

(b) \( v = 320 \text{ m/s}, \lambda = 0.4 \text{ m}, v = ? \)
\[ v = \frac{v}{\lambda} = \frac{320 \text{ m/s}}{0.4 \text{ m}} = 800 \text{ Hz} \]

Thus, frequency = 800 Hz.

(c) Amplitude = 2.0 cm

Q.12. A source is producing 1500 sound waves in 3 seconds. If the distance covered by a compression and an adjacent rarefaction be 68 cm, find (a) frequency (b) wavelength and (c) velocity of sound wave.

Ans. (a) Frequency \[ \frac{1500}{3 \text{ s}} = 500 \text{ Hz} \]

(b) Wavelength = \[ 2 \times 68 \text{ cm} = 136 \text{ cm} = 1.36 \text{ m} \]

(c) \[ v = v \lambda = 500 \text{ Hz} \times 1.36 \text{ m} = 680 \text{ m/s} \]

Thus velocity of sound wave = 680 m/s.

**Other Important Questions**

Q.1. 50 sound waves pass through a point in 0.1s. If the distance between one compression and the subsequent rarefaction is 0.34 m, calculate (a) frequency (b) wavelength (c) wave velocity of the longitudinal wave in air.

Ans. (a) Frequency \[ f = \frac{50}{0.1} = 500 \text{ Hz} \]

(b) \[ \lambda/2 = 0.34 \text{ m} \Rightarrow \text{wavelength, } \lambda = 2 \times 0.34 \text{ m} = 0.68 \text{ m} \]

(c) Wave velocity, \[ v = f \lambda = 500 \times 0.68 = 340 \text{ m/s} \]

Q.2. (i) An object is vibrating 61440 times in a minute. If the velocity of sound in air is 330 m/s, calculate (a) the frequency of sound in hertz (b) the wavelength.

(ii) Define amplitude of sound wave.

Ans. (i) (a) Frequency \[ f = \frac{61440}{60} = 1024 \text{ Hz} \]

(b) Wavelength, \[ \lambda = \frac{v}{f} = \frac{330}{1024} = 0.322 \text{ m} \]

(ii) The magnitude of maximum displacement of the vibrating particles of the medium on either side of their mean position is called amplitude.

Q.3. (i) A radio station is broadcasting at 200 MHz. If the velocity of radio waves is \[ 3 \times 10^8 \text{ ms}^{-1} \]. Calculate the wavelength of radio waves. [1 MHz = 10^6 Hz]

(ii) Derive a mathematical relationship between time period and frequency.

(iii) What do you mean by timbre with respect to a sound wave?

Ans. (i) \[ f = 200 \text{ MHz} = 200 \times 10^6 \text{ Hz; } v = 3 \times 10^8 \text{ m/s, } \lambda = ? \]

\[ \lambda = \frac{v}{f} = \frac{3 \times 10^8}{200 \times 10^6} = \frac{3}{2} = 1.5 \text{ m} \]

(ii) Let \( T \) seconds be the time to complete one vibration.
In \(T\) seconds number of vibrations = 1
So, in 1 second number of vibrations = \(\frac{1}{T}\)
But number of complete vibrations in 1 second is frequency,
Thus, \(f = \frac{1}{T}\)

(iii) Timbre is term used to describe the sound of high frequency, \(i.e.,\) if sound is of higher pitch, it is said to be a timbre.

Q.4. A girl is sitting in the middle of a park of dimension 12 m \(\times\) 12 m. On the left side of it, there is a building adjoining the park and on right side of the park, there is a road adjoining the park. A sound is produced on the road by a cracker. Is it possible for the girl to hear the echo of this sound? Explain your answer.

Ans. No, it is not possible for the girl to hear the echo of this sound because the distance between source and obstacle (building) is only 12 m, but echo is heard only if the minimum distance between the source of sound and the obstacle is 17.2 m.

Q.5. (i) If any explosion takes place at the bottom of a lake, what type of shock waves will take place in water?
(ii) Sound produced by a thunderstorm is heard 10 s after the lightning is seen. Calculate the approximate distance of the thunder cloud. (Given speed of sound = 340 ms\(^{-1}\).)
(iii) For hearing the loudest ticking sound heard by the ear, find the angle \(x\) in the figure.

Ans. (i) Longitudinal waves are produced in water.
(ii) \(t = 10\text{ s},\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ v = 340\text{ m/s}\)

Thus, required distance, \(d = v \times t = 340 \times 10 = 3400\text{ m} = \frac{3400}{1000}\text{ km} = 3.4\text{ km}.

(iii) From the figure, angle of incidence = angle of reflection.
 Thus, \(50^\circ + x + x + 50^\circ = 180^\circ\)
\[\Rightarrow 2x = 180^\circ - 100^\circ \Rightarrow x = \frac{80^\circ}{2} = 40^\circ\]

Q.6. Represent graphically by two separate diagrams in each case.
(i) Two sound waves having the same amplitude but different frequencies.
(ii) Two sound waves having the same frequency but different amplitude.
(iii) Two sound waves having different amplitudes and also different wavelengths.
Ans. (i) Two sound waves having the same amplitude but different frequencies:

(ii) Two sound waves having the same frequency but different amplitude.

(iii) Two sound waves having different amplitudes and also different wavelengths.

Q.7. (i) Why is the ceiling made dome shaped and the wall behind the stage of good conference halls or concert halls made curved?

(ii) The graph given below shows the displacement versus time relation for a disturbance travelling with velocity of 1500 ms⁻¹. Calculate the wavelength of the disturbance.

(iii) Which of the above two graphs (a) and (b) representing the human voice is likely to be a male voice? Give reason for your answer.

Ans. (i) The ceiling is made dome shaped and the wall behind the stage of good conference hall or concert halls made curved so that sound after reflection reaches all corners of the hall.

(ii) \( v = 1500 \text{ m/s} \) From the graph, Time period, \( T = 2 \text{ s} \)
\( \lambda = vT = 1500 \times 2 = 3000 \text{ m} = 3 \times 10^3 \text{ m} \)
(iii) Graph (a) representing the human voice is likely to be a male voice because male
voice has low frequency in comparison to a female voice having the same amplitude.

Q.8. Mention three characteristics of sound waves. State the factors on which they depend.

Ans. The pitch, the loudness and timbre are characteristics of sound wave.

Q.9. A ship sends out ultrasound that return from the sea bed and it detected after 3.42 s. If the
speed of ultrasound through sea water is 1531 ms\(^{-1}\). What is the distance of sea bed from the
ship?

Ans. Distance of the sea bed = \(\frac{\text{Velocity of the sound in sea } \times \text{Time}}{2}\)

\[= \frac{1531 \times 3.42}{2} m = 2618.0 m\]

D. Long Answer Questions (5 Marks)

Previous Years' Questions

Q.1. (a) Write the full name of SONAR. How will you determine the depth of a sea using echo
ranging?

(b) A SONAR device on a submarine sends out a signal and receives an echo 5 s later.
Calculate the speed of sound in water if the distance of the object from the submarine in
3625 m.

[2011 (T-II)]

Ans. (a) The full name of SONAR is Sound Navigation and Ranging. Sonar is based on the
principle of reflection of sound wave. Powerful pulses of ultrasound are sent out at regular
intervals from a transmitter mounted on a ship. When these pulses are intercepted by
submerged objects, they get reflected. The reflected sound or echo is detected by an
underwater receiver, which is also mounted on the ship.

If speed of ultrasound be \(v\) and \(t\) is the elapsed time between the transmission and the
reception of the ultrasound signal, the depth of the submerged object underwater is

\[h = \frac{v \times t}{2}\]

(b) \(t = 5\ s, h = 3625\ m, v = ?\)

\[v = \frac{2 \times h}{t} = \frac{2 \times 3625\ m}{5\ s} = 1450\ m/s\]

The, speed of sound in water = 1450 m/s.

Q.2. (a) If velocity of sound in air is 340 m/s. Calculate

(i) wavelength when frequency is 256 Hz.

(ii) frequency when wavelength is 0.85 m.

(b) What is meant by reflection of sound? State the laws of reflection of sound.

[2011 (T-II)]
Ans. (a) \( v = 340 \text{ m/s} \)

(i) \( v = 256 \text{ Hz} \)

\[
\lambda = \frac{v}{\nu} = \frac{340 \text{ m/s}}{256 \text{ Hz}} = 1.33 \text{ m}
\]

(ii) \( \lambda = 0.85 \text{ m} \)

\[
v = \frac{v}{\lambda} = \frac{340 \text{ m/s}}{0.85 \text{ m}} = 400 \text{ Hz}
\]

(b) When sound wave falls on smooth surface it returns back in the same medium, this event is called reflection of sound.

Laws of reflection of sound.

(i) Angle of incidence is equal to angle of reflection.

(ii) Incident wave, reflected wave and the normal lie in the same plane.

Q.3. (a) What is meant by echo?

(b) State two conditions for hearing a distinct echo.

(c) A ship sends out ultrasound that returns from the sea bed and is detected after 3.4 s. If the speed of sound in sea water is 1500 m/s, calculate the distance of sea bed from the ship.

Ans. (a) The phenomenon due to which repetition of sound is heard after reflection from a distant object (such as a high building or a hillock), after the original sound from a given source dies off, is called an echo.

(b) Two conditions for hearing a distinct echo:

(i) The minimum distance between the source of sound and the reflecting body should be 17 meters.

(ii) The wavelength of sound should be less than height of the reflecting body.

(c) \( t = 3.4 \text{ s}, \ v = 1500 \text{ m/s}, \ d = ? \)

\[
d = \frac{v \times t}{2} = \frac{1500 \text{ m/s} \times 3.4 \text{ s}}{2} = 2550 \text{ m}
\]

Q.4. (a) Mention two practical applications of reflection of sound waves.

(b) How is the pressure variation in a sound wave amplified in human ear?

(c) In a ripple tank, ten ripples are produced per second. If the distance between a trough and a neighbouring crest is 12 cm, calculate the frequency, wavelength and velocity of the wave.

Ans. (a) Two practical applications of reflection of sound waves:

(i) Megaphone or speaking tube: A horn shaped metal tubes, commonly called megaphone. In this device, the sound energy is prevented from spreading out by successive reflection from the horn-shaped tubes.

(ii) Ear trumpet or hearing aid: It is a device which is used by the persons who are hard of hearing. Its shape like a trumpet. The narrow end of it is kept in the ear hole of the person, whereas the wider end faces the speaker. The waves received by the wider end are reflected into the narrow end, which increases the sound energy and thus person can hear clearly.
(b) The middle ear consists of a chain of three bones, which on one side are connected to ear drum and on the other side to the inner ear. When the ear drums vibrate, the bones in the middle ear start vibrating due to pressure variation in sound. In this way, the bones help in magnifying the vibrations of the ear drum.

(c) Frequency = Number of ripples produced per second = 10 Hz

Wavelength = 2 × 12 cm = 24 cm = 0.24 m

Velocity of the wave = Frequency × wavelength = 10 Hz × 0.24 m = 2.4 m/s.

Q.5. (a) What is meant by intensity of sound?
(b) Mention the conditions for an echo to be heard clearly.
(c) A ball is dropped into a pond from a height of 44.1 m. The splash of sound is heard 3.13 second after the ball is dropped. Determine the velocity of sound in air.

Ans. (a) The amount of sound energy passing each second through a unit area, is called intensity of sound.
(b) Two conditions for an echo to be heard clearly
   (i) The minimum distance between the source of sound and the reflecting body should be 17 metres.
   (ii) The wavelength of sound should be less than the height of the reflecting body.
(c) In case of downward motion of the ball,

\[ u = 0, \quad g = 9.8 \text{ m/s}^2, \quad h = 44.1 \text{ m}, \quad t_1 = ? \]

Applying,

\[ h = ut + \frac{1}{2}gt^2 \Rightarrow 44.1 = 0 \times t_1 + \frac{1}{2} \times 9.8 \times t_1^2 \]

\[ \Rightarrow 4.9t_1^2 = 44.1 \Rightarrow t_1^2 = 9 \Rightarrow t_1 = 3 \text{ s}. \]

Thus, time taken to splash of sound is heard,

\[ t = 3.13 \text{ s} - 3 \text{ s} = 0.13 \text{ s} \]

Velocity of sound in air = \[ \frac{d}{t} = \frac{44.1 \text{ m}}{0.13 \text{ s}} = 339.23 \text{ m/s} \]

Other Important Questions

Q.1. (i) How does a sonar detect the depth of submerged objects?
   (ii) State two differences between infrasound waves and ultrasound waves.
   (iii) Which property determines pitch of sound?

Ans. (i) Sonar is based on the principle of reflection of sound wave. Powerful pulses of ultrasound are sent out at regular intervals from a transmitter mounted on a ship. When these pulses are intercepted by submerged objects, they get reflected. The reflected sound or echo is detected by an underwater receiver which is also mounted on the ship.

If speed of ultrasound be \( v \) and \( t \) is the elapsed time between the transmission and the reception of the ultrasound signal, the depth of the submerged object underwater is

\[ h = \frac{v \times t}{2} \]

(ii) Difference between infrasound waves and ultrasound waves:

**Infrasound waves**

1. A sound wave whose frequency is less than 20 Hz is known infrasound wave.
2. Due to low frequency, it can not propagate freely in solids and liquids.
Ultrasound waves

1. A sound wave whose frequency is higher than 20,000 Hz is known as ultrasound wave.
2. Due to high frequency, it can propagate freely in solids and liquids.

(iii) By measuring frequency of sound, we can determine the pitch of the sound. A sound wave of higher pitch means more number of compressions and rarefactions pass through a point in one second.

Q.2. (i) Define reverberation.
(ii) How can reverberation produced in an enclosed space be reduced.
(iii) State the laws of reflection of sound waves.

Ans. (i) Reverberation: The overlapping of sound due to repeated reflections is called reverberation. A sound made in big hall gets reflected repeatedly from the walls. The reflected sound waves superimpose with one another, so the sound appears to last for a longer time.
(ii) Reverberation produced in an enclosed space can be reduced by covering the walls and the roofs with sound absorbent material.
(iii) Laws of reflection of sound waves:
   (a) The angle of incidence is equal to the angle of reflection.
   (b) The incident ray, the normal to the reflecting surface at the point of incidence lie in the same plane.

Q.3. (a) Give two differences between transverse and longitudinal waves.
(b) Write two uses of ultrasound
(c) What is audible range of human ear?
(d) What is SONAR? Write its one use.

Ans. (a) | Longitudinal waves | Transverse waves |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1. The particle of the medium oscillate in the same plane in which the wave propagates.</td>
<td>1. The particles of the medium oscillate at right angles to the direction of the wave propagation.</td>
</tr>
<tr>
<td>2. Longitudinal waves can be produced in gases.</td>
<td>2. Transverse waves cannot be produced in gases.</td>
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(b) (i) The ultrasonic vibrations are used for homogenising milk. Milk is agitated with ultrasonic vibrators, so that the larger fat particles break to form smaller particles. On the same principle, ultrasonic vibrations are used for homogenising cosmetics.
(ii) They are used for welding metals like tungsten, which cannot be welded by conventional methods. One of the two pieces of the tungsten is held firmly against the other piece and then vibrated with an ultrasonic vibrator. The heat produced due to friction, at the point of contact, melts the metal. On stopping the vibrator, the melted ends of metal fuse to form a tight weld.
(c) An audible range of human ear is 20 Hz to 20,000 Hz.
(d) Sonar is a device fitted in sailing ships, trawlers, warships, etc. It is used to locate submarines or shoals of fish or depth of ocean bed.

Q.4. (a) Draw a diagram depicting soft sound and a louder sound. What is the main difference between the two.
(b) Why are ceiling of concert halls and conference halls made curved? Explain by giving a diagram.
(c) Can two astronauts talk on the surface of the moon as they do on the surface of the earth? Why?

Ans. (a) The loudness is responsible for soft sound and loud sound.

(b) The sound obey the laws of reflection on the plane as well as curved reflecting surfaces. In order to spread sound evenly in halls, the ceiling is made curved.

(c) No. Because sound needs a material medium for their propagation. But on the surface of the moon there is no material medium for their propagation.

Q.5. (a) How does the temperature affect the speed of sound?
(b) What determines the pitch of a sound?
(c) Give a graphical representation of low pitched and high pitched sound.
(d) What is an echo?
(e) What is the range of frequency associated with:
   (i) Infrasonic sound   (ii) Ultrasonic sound

Ans. (a) As temperature increases speed of sound increases.
(b) Frequency determines pitch of sound.

The range of frequency associated with:
(i) Infrasonic sound - Frequency is below 20 Hz
(ii) Ultrasonic sound - Frequency is above 20,000 Hz

(c) low pitch sound
    high pitch sound
(d) The phenomenon due to which repetition of sound is heard after reflection from a distant object, after the original sound from a given source dies off is called an **echo**.

(e) (i) 0 – 20 Hz
(ii) Greater than 20,000 Hz

**II. FORMATIVE ASSESSMENT**

**A. Demonstration**

Teachers are requested to demonstrate the experiment “sound needs a material medium for propagation” provided they have the necessary equipments in their laboratory.

**B. Activity**

To find which of the following materials produce more sound than others. Take a steel spoon and strike it gently on (i) coffee table, (ii) a dining table, (iii) a plastic suitcase (iv) a pillow (v) a sofa, etc. Strike the spoon on at least 40 items around you. Make a note of the objects, which produce (a) no sound (b) feeble sound (c) loud sound (d) sharp sound.

**C. Seminar**

Request the school doctor to explain how ultrasonic waves are used in (i) detection of abnormalities in the body (ii) curing certain diseases with operation.

**D. Discussions**

(A) Discuss at least six or more situations where ultrasound waves are used by us or the animals. Make an exhaustive chart of the use of ultrasonic waves.

(B) Analyse the following and explain why the wave reacts differently on what surface it hits:

1. What happens when a sound wave hits a flat surface?
2. What happens when a sound wave hits a porous surface?
3. What happens when a sound wave hits an irregular surface?
4. What happens when a sound wave hits a concave shaped surface?
5. What will happen if the irregular surface is replaced by another parabolic surface? Justify.

**E. Charts**

Make a coloured chart of the human ear.