

1. NCERT INTEXT QUESTIONS

1. How does the sound produced by a vibrating object in a medium reach your ear?

Ans :

An object sets the particles of the medium around it vibrating during vibration. The particles in the medium in contact with the vibrating object displace from its equilibrium position. It then exerts force on the adjacent particles. After displacing the adjacent particle, the first particle of medium comes back in its original position. This process continues in the medium till the sound reaches your ear.

2. Explain how sound is produced by your school bell.

Ans :

It creates a series of compressions and rarefactions making production of sound, when the bell continues to move forward and backward.

3. Why are sound waves called mechanical waves?

Ans :

Sound waves need material medium to propagate. Sound waves propagate through a medium because of the interaction of the particles present in that medium.

4. Suppose you and your friend are on the Moon. Will you be able to hear any sound produced by your friend?

Ans :

No, I will not be able to hear any sound produced by my friend because sound waves need a medium through which they can propagate. Since there is no material medium on the Moon due to absence of atmosphere, therefore, I cannot hear any sound on the Moon.

5. Which wave property determines (a) loudness, (b) pitch?

Ans :

(a) Amplitude (b) Frequency

6. Guess which sound has a higher pitch : guitar or car horn?

Ans :

High the frequency higher is the pitch. So, guitar has a higher pitch than car horn, because sound produced by the strings of guitar has high frequency than that of car horn.

7. What is wavelength, frequency, time period and amplitude of a sound wave?

Ans :

Wavelength : The distance between two consecutive compressions or two consecutive rarefactions is known as the wavelength. Its SI unit is metre (m).

Frequency : The number of complete oscillations per unit time is known as the frequency of a sound wave. It is measured in hertz (Hz).

Amplitude : The maximum height reached by the crest or trough of a sound wave is called its amplitude.

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8. How are the wavelength and frequency of a sound wave related to its speed?

Ans :

Speed, wavelength and frequency of a sound wave are related by the following equation

$$\text{Speed } (v) = \text{Wavelength } (\lambda) \times \text{Frequency } (\nu)$$

$$v = \lambda \times \nu$$

9. Calculate the wavelength of a sound wave whose frequency is 220 Hz and speed is 440 m/s in a given medium.

Ans :

Frequency of the sound wave, $\nu = 220 \text{ Hz}$

Speed of the sound wave, $v = 440 \text{ ms}^{-1}$

For a sound wave,

Speed = Wavelength \times Frequency;

$$v = \lambda \times \nu$$

$$\lambda = \frac{v}{\nu} = \frac{440}{220} = 2 \text{ m}$$

Hence, the wavelength of the sound wave is 2 m.

10. A person is listening to a tone of 500 Hz sitting at a distance of 450 m from the source of the sound. What is the time interval between successive compressions from the source?

Ans :

The time interval between two successive compressions is equal to the time period of the wave. This time period is reciprocal of the frequency of the wave and is given by the relation :

$$T = \frac{1}{\text{Frequency}} = \frac{1}{500} = 0.002 \text{ s}$$

11. Distinguish between loudness and intensity of sound.

Ans :

Intensity of a sound wave is defined as the amount of sound energy passing through a unit area per second. Loudness is a measure of the response of the ear to the sound. The loudness of a sound is defined by its amplitude. The amplitude of a sound decides its intensity, which in turn is perceived by the ear as loudness.

12. In which of the three media; air, water or iron, does sound travel the fastest at a particular temperature?

Ans :

The speed of sound depends on the nature of the medium. Sound travels fastest in solids. Its speed decreases in liquids and it is the slowest in gases. Therefore, for a given temperature, sound travels fastest in iron.

13. 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 m s⁻¹?

Ans :

Speed of sound, $v = 342 \text{ m s}^{-1}$

Echo returns in time, $t = 3 \text{ s}$

$$\begin{aligned} \text{Distance travelled by sound} &= v \times t = 342 \times 3 \\ &= 1026 \text{ m} \end{aligned}$$

In the given time interval, sound has to travel a distance that is twice the distance of the reflecting surface and the source.

Hence, the distance of the reflecting surface from the source = $\frac{1026}{2} \text{ m} = 513 \text{ m}$.

14. Why are the ceilings of concert halls curved?

Ans :

Ceilings of concert halls are curved so that sound after reflection (from the walls) spreads uniformly in all directions.

15. What is the audible range of the average human ear?

Ans :

The audible range of an average human ear lies between 20 Hz to 20,000 Hz.

16. What is the range of frequencies associated with :

- (a) Infrasound
- (b) Ultrasound

Ans :

- (a) Infrasound has frequencies less than 20 Hz.
- (b) Ultrasound has frequencies more than 20,000 Hz.

17. A submarine emits a sonar pulse, which returns from an underwater cliff in 1.02 s. If the speed of sound in salt water is 1531 m/s, how far away is the cliff from the submarine?

Ans :

Time taken by the sonar pulse to return, $t = 1.02 \text{ s}$

Speed of sound in salt water, $v = 1531 \text{ ms}^{-1}$

Distance of the cliff from the submarine

$$= \text{Speed of sound} \times \text{Time taken}$$

Distance of the cliff from the submarine

$$= 1.02 \times 1531 = 1561.62 \text{ m}$$

Distance travelled by the sonar pulse during its transmission and reception in water = $2 \times \text{Actual distance} = 2d$

Actual Distance,

$$\begin{aligned} d &= \frac{\text{Distance of the cliff from the submarine}}{2} \\ &= \frac{1561.62}{2} = 780.81 \text{ m} \end{aligned}$$

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2. NCERT EXERCISE QUESTIONS

1. What is sound and how is it produced?

Ans :

Sound is a form of energy which gives the sensation of hearing. It is produced by the vibrations caused in air by vibrating objects.

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

Ans :

When a vibrating body moves forward, it creates a region of high pressure in its vicinity. This region of high pressure is known as compressions. It creates a region of low pressure in its vicinity when it moves backward. This region is known as a rarefaction. As the body continues to move forward and backwards, it produces a series of compressions and rarefactions, as shown in below figure.

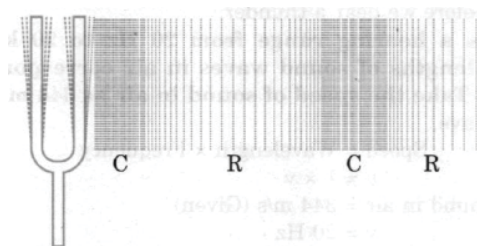


Figure: A vibrating object creating a series of compressions (C) and rarefactions (R) in the medium

3. Give an experiment to show that sound needs a material medium for its propagation.

Ans :

Take an electronic bell and an air tight glass bell jar connected to a vacuum pump. Suspend the bell inside the jar and press the switch of the bell. You will be able to hear the bell ring. Now, pump out the air from the glass jar. The sound of the bell will become fainter and after some time, the sound will not be heard. This is so because almost all air has been pumped out. This shows that sound needs a material medium to travel.

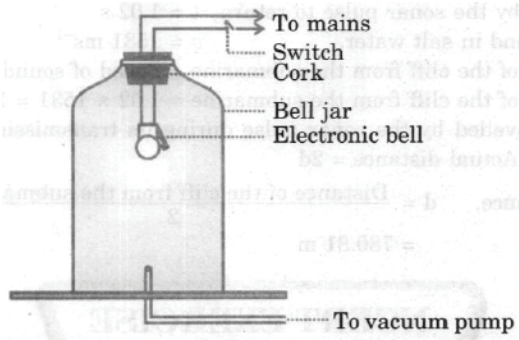


Figure: Bell jar experiment showing sound cannot travel in vacuum

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

Ans :

The air particle vibrates parallel to the direction of propagation as sound wave is produced by compressions and rarefactions in the air that is why it is called longitudinal wave.

5. Which characteristics of the sound help you to identify your friend by his voice while sitting with others in a dark room?

Ans :

The quality or timber of sound enables us to identify our friend by his voice.

6. Flash and thunder are produced simultaneously. But thunder is heard a few seconds after the flash is seen, why?

Ans :

The speed of sound (344 m/s) is less than the speed of light (3×10^8 m/s). Sound of thunder takes more time to reach the Earth as compared to light. Hence, a flash is seen before we hear a thunder.

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 two frequencies? Take the speed of sound in air as 344 m s^{-1} .

Ans :

For a sound wave,

$$\text{Speed} = \text{Wavelength} \times \text{Frequency}$$

$$v = \lambda \times \nu$$

Speed of sound in air = 344 m/s (Given)

(i) For, $\nu = 20 \text{ Hz}$, $\lambda_1 = \frac{v}{\nu} = \frac{344}{20} = 17.2 \text{ m}$

(ii) For $\nu = 20000 \text{ Hz}$, $\lambda_2 = \frac{v}{\nu} = \frac{344}{20000} = 0.0172 \text{ m}$

Hence, for humans, the wavelength range for hearing is 0.0172 m to 17.2 m .

8. Two children are at 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.

Ans :

Velocity of sound in air = 346 m/s

Velocity of sound wave in aluminium = 6420 m/s

Let length of rode be 1 m . Time taken for sound wave in air,

$$t_1 = \frac{1}{\text{Velocity in air}}$$

Time taken for sound wave in aluminium,

$$t_2 = \frac{1}{\text{Velocity in aluminium}}$$

Therefore, $\frac{t_1}{t_2} = \frac{\text{Velocity in aluminium}}{\text{Velocity in air}}$

$$= \frac{6420}{346} = 18.55$$

9. The frequency of a source of sound is 100 Hz . How many times does it vibrate in a minute?

Ans :

Frequency = 100 Hz (given)

This means the source of sound vibrates 100 times in one second. Therefore, number of vibrations in 1 minute, i.e., in 60 seconds

$$= 100 \times 60 = 6000 \text{ times}$$

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

Ans :

Sound follows the same laws of reflection as light does. The incident sound wave and the reflected sound wave make the same angle with the normal to the surface at the point of incidence. Also, the incident sound wave, the reflected sound wave and the normal to the point of incidence all lie in the same plane.

11. When a sound is reflected from a distant object, an echo is produced. Let 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 :

An echo is heard when the time for the reflected sound is heard after 0.1 s

$$\text{Time taken} = \frac{\text{Total Distance}}{\text{Velocity}}$$

On a hotter day, the velocity of sound is more. If the time taken by echo is less than 0.1 sec it will not be heard.

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

Ans :

Two practical applications of reflection of sound waves are :

1. Reflection of sound is used to measure the distance and speed of underwater objects. This method is known as SONAR.
2. Working of a stethoscope is also based on reflection of sound. In a stethoscope, the sound of the patient's heartbeat reaches the doctor's ear by multiple reflection of sound.

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 the splash heard at the top? Given, $g = 10 \text{ m s}^{-2}$ and speed of sound = 340 m s^{-1} .

Ans :

Height of the tower, $s = 500 \text{ m}$
 Velocity of sound, $v = 340 \text{ m s}^{-1}$
 Acceleration due to gravity, $g = 10 \text{ m s}^{-2}$
 Initial velocity of the stone, $u = 0$ (since the stone is initially at rest)
 Time taken by the stone to fall to the base of the tower, t_1
 According to the second equation of motion :

$$S = ut_1 + \frac{1}{2}gt_1^2$$

$$500 = 0 \times t_1 + \frac{1}{2} \times 10 \times t_1^2$$

$$t_1^2 = 100$$

$$t_1 = 10 \text{ S}$$

Now, time taken by the sound to reach the top from the base of the tower,

$$t_2 = \frac{500}{340} = 1.47 \text{ s}$$

Therefore, the splash is heard at the top after time, t where, $t = t_1 + t_2 = 10 + 1.47 = 11.47 \text{ s}$

14. A sound wave travels at a speed of 339 m s^{-1} . If its wavelength is 1.5 cm , what is the frequency of the wave? Will it be audible?

Ans :

Speed of sound, $v = 339 \text{ m s}^{-1}$

Wavelength of sound, $\lambda = 1.5 \text{ cm} = 0.015 \text{ m}$

Speed of sound = Wavelength \times Frequency

$$v = \lambda \times \nu$$

$$\nu = \frac{v}{\lambda} = \frac{339}{0.015} = 22600 \text{ Hz}$$

The frequency range of audible sound for humans lies between 20 Hz to $20,000 \text{ Hz}$. Since, the frequency of the given sound is more than $20,000 \text{ Hz}$, it is not audible.

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.

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

Ans :

The effect produced in the brain by the sound of different frequencies is called loudness of sound. Loudness depends on the amplitude of vibrations. In fact, loudness is proportional to the square of the

amplitude of vibrations.

17. Explain, how bats use ultrasound to catch a prey?

Ans :

Bats produce high-pitched ultrasonic squeaks. These high-pitched squeaks are reflected by objects such as preys and returned to the bat's ear. This allows a bat to know the distance of his prey.

18. How is ultrasound used for cleaning?

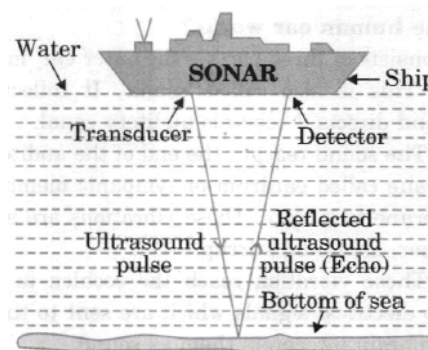
Ans :

Objects to be cleaned are put in a cleaning solution and ultrasonic sound waves are passed through that solution. The high frequency of these ultrasound waves detaches the dirt from the objects.

19. Explain the working and application of a sonar.

Ans :

SONAR is an acronym for Sound Navigation And Ranging. It is an acoustic device used to measure the depth, direction, and speed of underwater objects such as submarines and ship wrecks with the help of ultrasounds. It is also used to measure the depth of seas and oceans.



A beam of ultrasonic sound is produced and transmitted by the transducer (it is a device that produces ultrasonic sound) of the SONAR, which travels through sea water. The echo produced by the reflection of this ultrasonic sound is detected and recorded by the detector, which is converted into electrical signals. The distance (d) of the underwater object is calculated from the time (t) taken by the echo to return with speed (v) is given by $2d = v \times t$. This method of measuring distance is also known as 'echo-ranging'.

20. 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 is 3625 m .

Ans :

Time taken to hear the echo, $t = 5 \text{ s}$

Distance of the object from the submarine,

$$d = 3625 \text{ m}$$

Total distance travelled by the sonar waves during the transmission and reception in water = $2d$

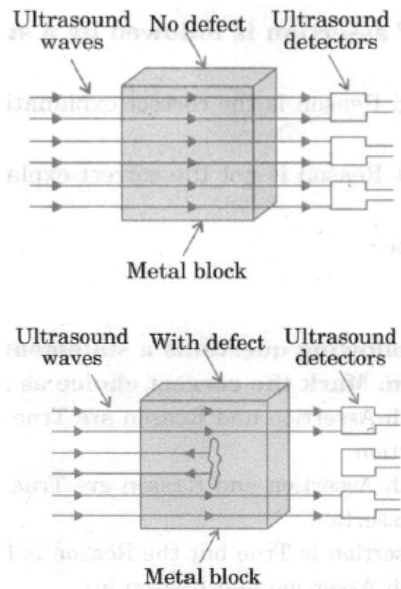
Velocity of sound in water,

$$v = \frac{2d}{t} = \frac{2 \times 3625}{5} = 1450 \text{ ms}^{-1}$$

21. Explain, how defects in a metal block can be detected using ultrasound?

Ans :

Defects in metal blocks do not allow ultrasound to pass through them and they are reflected back. This fact is used to detect defects in metal blocks. Ultrasound is passed through one end of a metal block and detectors are placed on the other end. The defective part of the metal block does not allow ultrasound to pass through it. As a result, it will not be detected by the detector. Hence, defects in metal blocks can be detected using ultrasound.



22. Explain, how the human ear works?

Ans :

The human ear consists of three parts - the outer ear, middle ear and inner ear.

- Outer ear :** This is also called 'pinna'. It collects the sound from the surrounding and directs it towards auditory canal.
- Middle ear :** The sound reaches the end of the auditory canal where there is a thin membrane called eardrum or tympanic membrane. The sound waves set this membrane to vibrate. These vibrations are amplified by three small bones - hammer, anvil and stirrup.
- Inner ear :** These vibration reach the cochlea in the inner ear and are converted into electrical signals which are sent to the brain by the auditory nerve, and the brain interprets them as sound.

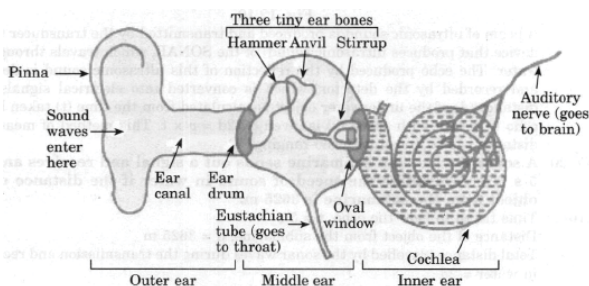


Figure: Auditory parts of human ear

3. NCERT EXEMPLAR

Objective Type Questions

- Note is a sound :
 - of mixture of several frequencies.
 - of mixture of two frequencies only.
 - of a single frequency.
 - always unpleasant to listen.

Ans : (c) of a single frequency.
- A key of a mechanical piano struck gently and then struck again but much harder this time. In the second case :
 - sound will be louder but pitch will not be different.
 - sound will be louder and pitch will also be higher.
 - sound will be louder but pitch will be lower.
 - both loudness and pitch will remain unaffected.

Ans : (a) sound will be louder but pitch will not be different.

- In SONAR, we use :
 - ultrasound waves
 - infrasonic waves
 - radio waves
 - audible sound waves

Ans : (a) ultrasound waves
- Sound travels in air if :
 - particles of medium travel from one place to another.
 - there is no moisture in the atmosphere.
 - disturbance moves.
 - both particles as well as disturbance travel from one place to another.

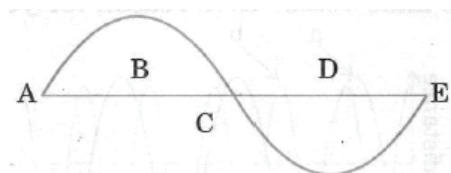
Ans : (c) disturbance moves.

- When we change feeble sound to loud sound we increase its :

(a) frequency	(b) amplitude
(c) velocity	(d) wavelength

Ans : (b) amplitude

6. In the half curve the wavelength is :



- | | |
|--------|--------|
| (a) AB | (b) BD |
| (c) DE | (d) AE |
- Ans : (b) BD

- Earthquake produces which kind of sound before the main shock wave begins?

(a) Ultrasound	(b) Infrasonic
(c) Audible	(d) Inaudible

Ans : (b) Infrasonic

8. Infrasound can be heard by :
 (a) Dog (b) Bat
 (c) Rhinoceros (d) Human being

Ans : (c) Rhinoceros

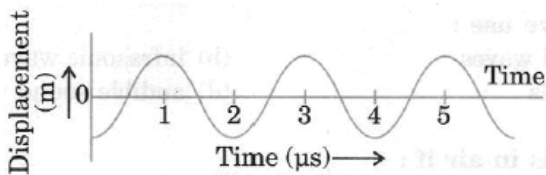
9. Before playing the orchestra in a musical concert, a sitarist tries to adjust the tension and pluck the string suitably. By doing so, he is adjusting :
 (a) intensity of sound only.
 (b) amplitude of sound only.
 (c) frequency of the sitar string with the frequency of other musical instruments.
 (d) loudness of sound.

Ans : (c) frequency of the sitar string with the frequency of other musical instruments.

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Short Answer Questions

10. The given graph (fig.) shows the displacement versus time relation for a disturbance travelling with velocity of 1500 m s^{-1} . Calculate the wavelength of the disturbance.



Ans :

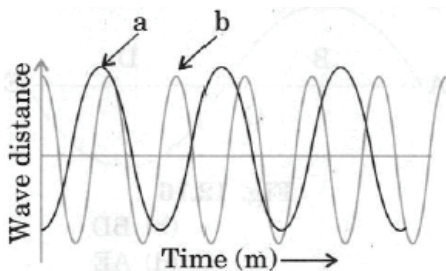
From the graph

Time period, $T = 2 \times 10^{-6} \text{ s}$

Frequency, $\nu = \frac{1}{T} = 5 \times 10^5 \text{ Hz}$

Wavelength, $\lambda = \frac{\text{Velocity } (v)}{\text{Frequency } (\nu)}$
 $= \frac{1500}{5 \times 10^5} = 3 \times 10^{-3} \text{ m}$

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



Ans :

Usually the male voice has less pitch (or frequency) as compared to female. Thus, graph (a) represents the male voice.

12. A girl is sitting in the middle of a park of dimension $12 \text{ m} \times 12 \text{ m}$. 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 :

If the time gap between the reflected sound and original sound received by the listener is around 0.1 s , only then the echo can be heard. The minimum distance travelled by the reflected sound wave for distinctly listening the echo

$$= \text{velocity of sound} \times \text{time interval}$$

Then, $344 \times 0.1 = 34.4 \text{ m}$

In this case, the distance travelled by the sound reflected from the building and then reaching to the girl will be $(6 + 6) = 12 \text{ m}$, which is much smaller than the required distance. Therefore, no echo can be heard.

13. Why do we hear the sound produced by the humming bees while the sound of vibrations of pendulum is not heard?

Ans :

Humming bees produce sound by vibrating their wings which is in the audible range. In case of pendulum the frequency is below 20 Hz which does not come in the audible range.

14. If any explosion takes place at the bottom of a lake, what type of shock waves in water will take place?

Ans :

Longitudinal waves will take place.

15. 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 $= 340 \text{ m s}^{-1}$)

Ans :

Speed of sound $= 340 \text{ ms}^{-1}$

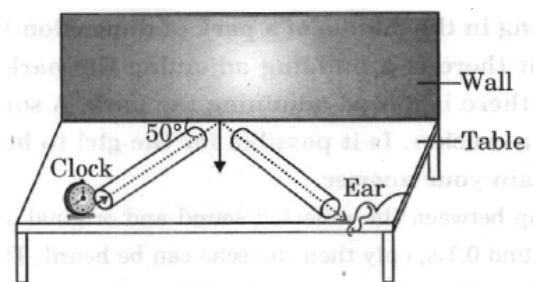
time $= 10 \text{ s}$

We know, $\text{speed} = \frac{\text{Distance}}{\text{Time}}$

Therefore, Distance $= \text{speed} \times \text{time}$

Distance $= 340 \times 10 = 3400 \text{ m}$

16. For hearing the loudest ticking sound heard by the ear, find the angle x in the figure given below.



Ans :

From the diagram, $\angle i = \angle r$

So, $x = 90^\circ - \angle r = 90^\circ - 50^\circ = 40^\circ$

For hearing the loudest ticking sound heard by the ear the angle is 40° .

17. Why is the ceiling and wall behind the stage of good conference halls or concert halls made curved?

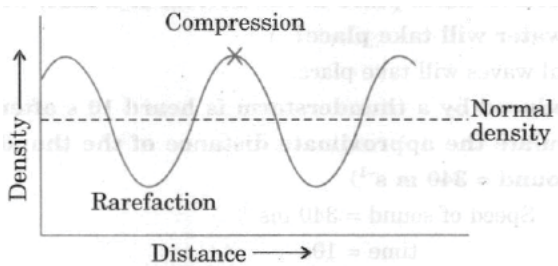
Ans :

Ceiling and walls are made curved so that sound after reflection reaches the target audience.

Long Answer Questions

18. Draw a curve showing density or pressure variations with respect to distance for a disturbance produced by sound. Mark the position of compression and rarefaction on this curve. Also define wavelengths and time period using this curve.

Ans :



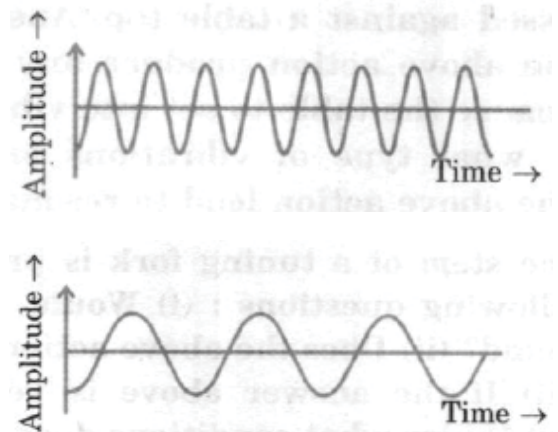
Wavelength is the distance between two consecutive compression and rarefaction. Time period taken to travel the distance between any two consecutive compression or rarefaction from a fixed point.

19. Represent graphically by two separate diagrams in each case :

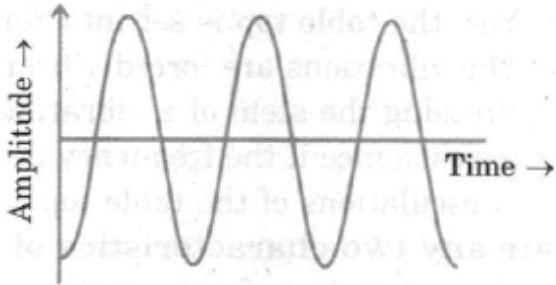
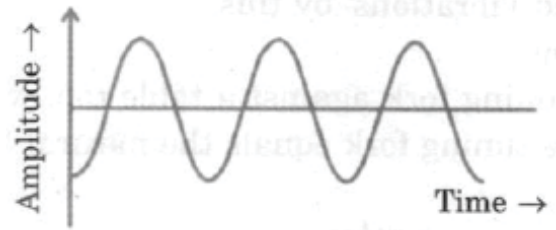
- (a) Two sound waves having the same amplitude but different frequencies.
- (b) Two sound waves having the same frequency but different amplitudes.
- (c) Two sound waves having different amplitudes and also different wavelengths.

Ans :

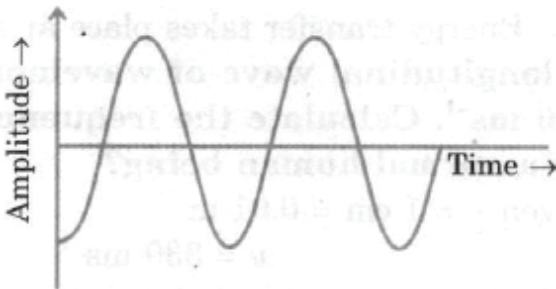
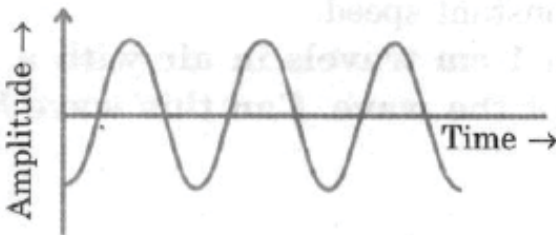
(a) Same amplitude but different frequency



(b) Same frequency but different amplitude



(c) Different amplitude and different wavelengths



20. Establish the relationship between speed of sound, its wavelength and frequency. If velocity of sound in air is 340 ms^{-1} , calculate wavelength when frequency is 256 Hz .

Ans :

Derivation of formula,

$$v = \nu\lambda$$

$$340 = 256 \lambda$$

$$\lambda = \frac{340}{256} = 1.33 \text{ m}$$

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Science IX

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NCERT_Text_7	NCERT_Sol_7	OBJECTIVE_7	QUES_BANK_7
NCERT_Text_8	NCERT_Sol_8	OBJECTIVE_8	QUES_BANK_8
NCERT_Text_9	NCERT_Sol_9	OBJECTIVE_9	QUES_BANK_9
NCERT_Text_10	NCERT_Sol_10	OBJECTIVE_10	QUES_BANK_10
NCERT_Text_11	NCERT_Sol_11	OBJECTIVE_11	QUES_BANK_11
NCERT_Text_12	NCERT_Sol_12	OBJECTIVE_12	QUES_BANK_12
NCERT_Text_13	NCERT_Sol_13	OBJECTIVE_13	QUES_BANK_13
NCERT_Text_14	NCERT_Sol_14	OBJECTIVE_14	QUES_BANK_14
NCERT_Text_15	NCERT_Sol_15	OBJECTIVE_15	QUES_BANK_15