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CHAPTER NOTES

Sound Waves: Characteristics and Applications Class 9 Notes | CBSE Science Chapter 12

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Your teacher for Sound Waves: Char...



Hi, I am **Ira**. I teach this syllabus all day, so **Sound Waves: Characteristics and Applications** is very much my home ground.

Ask me anything from this chapter. A concept, a numerical, or that one doubt you did not want to raise in class. Pick one to start:

Explain Sound Waves: Characteristics and Applications simply

What can the board exam ask?

Most important formulas

Quiz me on this chapter

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Sound Waves: Characteristics and Applications Class 9 Notes | CBSE Science Chapter 10

Sound Waves: Characteristics and Applications is Chapter 10 of CBSE Class 9 Science (Exploration, 2026-27). It explains how vibrating objects produce sound, why sound needs a medium, and how it travels as a longitudinal wave made of compressions and rarefactions. You then learn the quantities that describe a sound wave (wavelength, frequency, time period, amplitude, intensity and speed), how our ears perceive pitch and loudness, and how the reflection of sound gives echoes, reverberation, echolocation and sonar.

School exams test this chapter through definitions, graph reading and short numericals. Almost every numerical in the chapter uses one of four tools: $v = 1/T$, $v = \lambda \times \nu$, the echo distance $d = (v \times t)/2$, or the 0.1 s rule for hearing an echo. It also explains why sound cannot travel in vacuum and why we hear sound from behind a wall. These ideas are the foundation for Class 11 and 12.

Quick Answer - Sound Waves: Characteristics and Applications

Sound is produced by vibrating objects and cannot travel through vacuum. It moves as a **longitudinal wave** made of compressions and rarefactions, while the particles oscillate **perpendicular** to the direction of wave propagation. Frequency $\nu = 1/T$ and $v = \lambda \times \nu$ for all media. Humans hear 20 Hz to 20 kHz; pitch depends on frequency and loudness on amplitude. For echoes, the reflecting surface must be at least 17 m away.



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All Key Formulas at a Glance

Quantity	Formula	SI Unit
Frequency	$\nu = \text{number of oscillations} / \text{time taken}$	hertz (Hz) = s^{-1}
Frequency and time period	$\nu = 1 / T$ (so $T = 1 / \nu$)	Hz; second (s)
Wavelength	$\lambda = \text{distance between two consecutive crests (or troughs)}$	metre (m)
Speed of sound	$v = \lambda / T$	m s^{-1}
Wave equation	$v = \lambda \times \nu$	m s^{-1}
Distance travelled by sound	$d = v \times t$	
Echo or sonar distance	$d = (v \times t) / 2$	
Minimum echo distance (air, 340 m s^{-1})	$d = (340 \times 0.1) / 2 = 17 \text{ m}$	
Audible range (humans)	20 Hz to 20,000 Hz	
Speed in air (dry)	about 332 m/s at 0°C and 343 m/s at 22°C	



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Key Concepts

1. Production of Sound: Vibrations

You learnt in Chapter 7 that sound is a form of energy that travels from one form to another. So every sound starts with a vibration that carries energy.

Activity 10.1 (rubber band on a box): stretch a rubber band over a box and pluck it. You hear a sound and see the box vibrating.

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the sound stops. Change the tension and the sound changes. Stretch the band between two fingers without the box and the sound is softer.

Conclusion: **sound is produced by vibrations**. A **vibration** is the periodic to and fro motion (oscillation) of an object. The object that produces the sound is the **source** of the sound.

What vibrates	Example
Stretched string	Rubber band, sitar, veena, tanpura
Stretched membrane	Tabla, mridangam
Air column	Bansuri (flute): the air inside the hollow pipe vibrates
Metal object	A struck plate, a bell, a tuning fork

In most musical instruments more than one

Humans and animals. In humans, sound is produced by stretched muscular flaps inside the voice box and the shape of the oral and nasal cavity shape that sound into speech. In insects, sound is produced by rubbing their wings or legs.

The tuning fork. A tuning fork is a U-shaped piece of metal, usually aluminium. The two sides of the U are the prongs. If you hold the base and strike one prong gently on a soft rubber surface, it produces a sound. Touch a vibrating prong to water in a glass, and you will see it vibrating. A tuning fork gives a sound of nearly constant frequency.

Sudden loud sounds. In firecrackers and thunder, there is a sudden disturbance in air density. In the case of a supersonic aircraft, flying faster than sound, the air is compressed into a shock wave.

2. Propagation of Sound: Sound Needs a Medium

The material through which sound propagates is called the medium. Sound can travel through solids, liquids, and gases.

- **Solid (Activity 10.3):** press your ear on the table and hear the knock through the wood.



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- **Liquid (Activity 10.4):** tap two metal spoons together fully under water in a bucket. You still hear the tap, so the sound travelled through water and then air.
- **Gas:** almost every sound you hear reaches you through air.

A space with no matter in it is a **vacuum**. In the **vacuum bell jar experiment**, an electric bell rings inside a glass jar connected to a vacuum pump. As air is pumped out, the sound becomes fainter. Near vacuum, almost no sound is heard even though the bell is seen ringing. When air is let back in, the sound gradually becomes as loud as before.

Conclusion: **sound cannot propagate in vacuum; it needs a material medium**. You can still see the bell because light does not need a medium.

Astronauts on a spacewalk. Outer space is a near vacuum. Astronauts cannot directly hear each other speak or hear metal parts clanking. They talk through special devices fitted in their spacesuits.

3. Sound as a Wave: Compression

The slinky analogy (Activity 10.5). Mark a friend holding the far end. Push your end where the turns are **closer together** and release the slinky. The marked turn does not travel; it stays in its position of rest, parallel to the direction of

The piston in a tube. Picture a long tube containing an oscillating piston is a simple model of a sound wave.

1. **Piston at rest:** the air has a uniform density.
2. **Piston moves forward:** it pushes nearby air particles forward, creating a region of high density above average. This region is a **compression (C)**. The particles ahead, which collide with their neighbors, also move forward. The particles themselves do not travel with the piston.
3. **Piston moves back:** the air near it becomes less dense below average is a **rarefaction (R)**. It also moves back.
4. **Piston keeps oscillating:** compressions and rarefactions move away from the source.

Definition: a **sound wave** is the disturbance consisting of compressions and rarefactions propagating through a material medium. The direction in which it travels is the direction of propagation.



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Longitudinal waves. In sound, the particles vibrate back and forth **parallel** to the direction of propagation. Such waves are **longitudinal waves**.

Mechanical waves. Waves that need a material medium to propagate are **mechanical waves**. Sound is a mechanical wave.

Feature	Longitudinal wave	Transverse wave
Particle vibration	Parallel to the direction of propagation	Perpendicular to the direction of propagation
Examples in the chapter	Sound; the longitudinal seismic waves, first to be detected by seismographs	Light, which travels even through vacuum

Not all waves are mechanical. Light can travel through vacuum, which is why sunlight reaches the Earth. In open air, a small source sends out waves that spread out in all directions as **spherical waves**.

4. Graph of a Sound Wave: Wavele

At one instant, the density of the medium is at its average value. On a graph with **distance** on the x-axis, a horizontal dashed line.

- In a **compression** the density rises above the average density).
- In a **rarefaction** it falls below average. The



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Quantity	Definition (NCERT)	Symbol	SI unit
Wavelength	The distance between two consecutive crests or two consecutive troughs	λ (lambda)	metre (m)
One complete oscillation	The change in density at a fixed point from maximum to minimum and back to maximum (or vice versa)	-	-
Frequency	The number of density oscillations at a fixed point per unit time	ν (nu)	s^{-1} , called hertz (Hz)
Time period	The time taken for one complete density oscillation at a fixed point	T	second (s)

Relation (Eq. 10.1): $\nu = 1 / T$. A shorter time period means a higher frequency. A 50 Hz wave has $T = 1/50 = 0.02$ s; a wave with $T = 0.001$ s

- Crest to next crest is one wavelength; c
- One compression plus one rarefaction r
- More crests in the same distance mean

Everyday sounds contain a mixture of many frequencies. The sound that comes from a tuning fork or oral whistling, singing Sa, Re, Ga, Ma, Pa, Dha, Ni, Sa, the first note. Each note has its own distinct frequency.

5. Energy of Sound, Amplitude and

Activity 10.6 (dancing grains). Stretch a rubber sheet over a shallow tray and sprinkle rice or salt on it. Make a loud sound by clapping your hands. The sound wave that travelled through air, made the sheet vibrate.

So **sound is a form of energy**. The vibrating particles pass it on by vibrating and colliding with neighbouring particles. Particles stay near their mean positions. Particles do not transfer thermal energy; a passing wave only increases the energy of the particles.

- A **microphone** converts sound energy into electrical energy. The diaphragm vibrates, and the vibrations become an electrical signal.



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- A **speaker** does the opposite: an electrical signal vibrates a cone or diaphragm, which produces sound.

Amplitude is the maximum change in the density of air in a compression (or a rarefaction) compared to the average density. On the graph it is the height of a crest above the average line. A wave with a larger amplitude carries more energy: strike the plate harder in Activity 10.6 and the grains jump higher.

Intensity of sound is the amount of sound energy passing through a unit area perpendicular to the direction of propagation in a unit time. As sound spreads out, the same energy covers a larger area, so intensity decreases with distance. Sounds with a larger initial amplitude travel further before fading away.

6. Speed of Sound

The **speed of sound** is the distance which a point on the wave, such as a crest (or a trough), travels in unit time.

Deriving $v = \lambda \times v$: a crest moves one wavelength in one period, so $v = \lambda / T$. Since $v = 1/T$, $v = \lambda \times v$

Speed depends on the medium: fastest in solids, about 4 to 5 times faster in water and

State	Medium	Speed of sound
Solid	Steel	5000 m s ⁻¹
Liquid	Water	1500 m s ⁻¹
Gas	Air	340 m s ⁻¹

Temperature and humidity. In air, the speed of sound is about 331 m s⁻¹ in dry air at 0 °C and near 345 m s⁻¹ for air; use the value given.

Frequency does not change the speed. In a given medium, and neither on the source nor on the observer, the **wavelength** changes instead: $\lambda = v/v$, so $\lambda \propto 1/v$



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Lightning and thunder. Both happen together, but light (about $300,000\text{ km s}^{-1}$) reaches you almost instantly while sound is far slower. The delay $\times$ speed of sound gives the distance to the strike.

7. Human Perception of Sound: Pitch, Loudness and the Audible Range

Frequency, amplitude and speed are measurable physical properties. How we experience sound is subjective and is described by **pitch** and **loudness**, which have no simple relation with the physical properties.

Pitch is how frequency is perceived by humans. A whistle or siren is shrill (high pitch); thunder or an aircraft rumble is deep (low pitch). In general, higher frequency means higher pitch, although the exact relation is complicated. During adolescence, boys' vocal cords lengthen and thicken and vibrate less frequently, deepening their voice. Similarly, a thin rubber band vibrates faster than a thick one, giving a higher frequency and a shorter time period.

Loudness is how humans perceive the amplitude of sound. Loudness decreases as you move away from the source and also depends on the listener's hearing ability.

Physical property	Perceived property
Frequency	Pitch
Amplitude	Loudness
Pattern and intensity of overtones	Timbre

Audible range: humans hear **20 Hz to 20,000 Hz**, which decreases with age.

- **Infrasonic waves:** below 20 Hz. Elephants can hear these.
- **Ultrasonic waves:** above 20 kHz. Dogs can hear these.

Decibels and noise. Loudness is commonly measured in decibels (dB), normal conversation about 60 dB, and a 10 dB increase means a large rise in intensity. Unwanted sound is called noise.



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sound can affect health and sleep and cause hearing loss. Hearing aids contain a microphone, an amplifier and a speaker.

Tone, note, timbre, octave. A **tone** has a single frequency (tuning fork, whistling). A **musical note** combines a lowest frequency, the **fundamental**, with higher frequencies called **overtones**. **Timbre** is why a flute, ektara and tabla sound different on the same note at the same loudness; it depends on the shape, material and construction of the instrument. An **octave** is the interval between two notes where one has double the frequency of the other, such as 200 Hz and 400 Hz.

8. Reflection of Sound: Echo, Reverberation, Ultrasound and Sonar

Sound waves bounce off obstacles such as solids or liquids: this is **reflection of sound**. It follows the same laws as light. The incident and reflected directions make equal angles with the normal at the point of incidence, and all three lie in the same plane.

Echo. Shout near a cliff or down a long corridor. This reflected sound is an **echo**.

The 0.1 s rule. Two sounds are heard separately in a small room, reflections arrive too quickly, so they are not heard as echoes.

Minimum echo distance (340 m s^{-1}): in 0.1 s, sound travels 34 m **and back**, so the surface must be at least 17 m away.

Echoes are strongest from hard, smooth surfaces that reflect sound. Soft surfaces absorb sound and scatter it, so echoes from them are unclear.

Echo formula: the sound covers $2d$ in time t .

Reverberation. In a large hall, multiple reflections occur before the sound from the source stops. This occurs when reflection is strong. Auditoriums are designed to have desirable reverberation. Soft surfaces, absorbing panels, upholstered chairs, curtains reduce reverberation, which would otherwise make speech unclear.



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Point	Echo	Reverberation
Reflections	A distinct reflection heard as a repeat	Multiple reflections in a large hall
Time gap	At least 0.1 s after the original	Less than 0.05 s apart
What you hear	The sound again, separately	The sound lingering after the source stops

Uses of infrasonic and ultrasonic waves.

Wave	Applications given in the chapter
Infrasonic (below 20 Hz)	Detecting earthquakes, volcanic eruptions and severe storms, since these waves travel lo
Ultrasonic (above 20 kHz)	Imaging internal orga kidney stones; ultras detecting defects ins waves

Echolocation. Most bats send out short bursts of sound waves towards objects. By sensing the echoes, the bat finds the location of objects using reflected sound waves is echolocation.

Sonar (sound navigation and ranging). Ships use reflected waves to find the distance, direction and depth of submarines or shipwrecks. Depth = (speed of sound in water × time taken for the wave to return) / 2. It works the same way in air, using ultrasound.

Formula and Reaction Sheet

This is a physics chapter, so the sheet lists formulas and reactions.



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Quantity or rule	Formula or value	Notes
Frequency from a count	$v = \text{number of oscillations} / \text{time taken}$	Hz (s^{-1})
Frequency and time period	$v = 1/T, T = 1/v$	Inversely related
Wave equation	$v = \lambda/T = \lambda \times v$	$\lambda = v/v, v = v/\lambda$
One-way travel	$d = v \times t$	Thunder, a knock on a fence
Echo, sonar, echolocation	$d = (v \times t)/2$	t = time to go and come back
Hearing two sounds separately	Gap of at least 0.1 s	Minimum echo distance 17 m
Reverberation	Reflections 1 apart	
Audible range	20 Hz to 20	
Speeds at 15 °C	Steel 5000, v 340	
Speed in dry air	About 331 at v at 22 °C	
Wavelength from a graph	Crest to next v to next trough	



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Important Definitions

- **Vibration:** the periodic to and fro motion
- **Medium:** the material through which sound travels
- **Vacuum:** a space where there is no medium
- **Compression (C):** a region of the medium with a higher density than the average density.

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- **Rarefaction (R):** a region of the medium with a lower density than the average density.
- **Sound wave:** the disturbance consisting of a series of alternating compressions and rarefactions propagating through a medium, without the actual flow of the particles of the medium.
- **Longitudinal wave:** a wave in which the particles vibrate in a direction parallel to the direction of wave propagation.
- **Transverse wave:** a wave in which the particles vibrate perpendicular to the direction of wave propagation.
- **Mechanical wave:** a wave that requires a material medium for propagation.
- **Wavelength (λ):** the distance between two consecutive crests or two consecutive troughs.
- **Frequency (ν):** the number of density oscillations at a fixed point per unit time.
- **Time period (T):** the time taken for one complete density oscillation at a fixed point.
- **Amplitude:** the maximum change in air density in a compression (or a rarefaction) compared to the average density.
- **Intensity of sound:** the amount of sound energy passing through a unit area in the direction of propagation of the sound wave per unit time.
- **Speed of sound:** the distance which a sound wave travels in a unit time.
- **Pitch:** how frequency is perceived by human ear.
- **Infrasonic and ultrasonic waves:** sound waves with frequency less than 20 kHz and more than 20 kHz respectively.
- **Echo:** sound heard again after reflecting from a hard surface.
- **Reverberation:** the persistence of sound due to multiple reflections.
- **Echolocation:** the ability to locate objects by emitting sound waves and listening to the echoes.



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Solved Examples (NCERT)

Example 1: Frequency and time period

Question: If there are 10 density oscillations in 2 seconds, calculate (i) frequency of sound wave, and (ii) its time period.

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Solution: (i) Frequency = $10 / 2 \text{ s} = 5 \text{ Hz}$. (ii) Time for one oscillation = $2 \text{ s} / 10 = 0.2 \text{ s}$. Check: $1/0.2 = 5 \text{ Hz}$.

Example 2: Wavelengths at the edges of human hearing (NCERT Example 10.2)

Question: Human hearing roughly spans 20 Hz to 20 kHz. What are the corresponding wavelengths in air for these two frequencies? Use the speed of sound in air as 344 m s^{-1} .

Solution: $\lambda = v / \nu$.

- (i) $\nu = 20 \text{ Hz}$: $\lambda = 344 / 20 = 17.2 \text{ m}$.
- (ii) $\nu = 20000 \text{ Hz}$: $\lambda = 344 / 20000 = 0.0172 \text{ m} = 1.72 \text{ cm}$.

Example 3: Distance of a lightning strike (NCERT Example 10.3)

Question: During a thunderstorm, lightning travels much slower than light. If the time between the flash and the sound of the thunder is measured to be 5 s, estimate the distance of the lightning strike. Use the speed of sound in air as 340 m s^{-1} . Assume that light travels instantaneously.

Solution: One-way travel, so $d = v \times t = 340 \times 5 = 1700 \text{ m}$.

Example 4: Frequency and time period (NCERT Example 10.4)

Question: A sound wave in steel has a wavelength of 10 m. Calculate its frequency and time period if the speed of sound in steel is 5000 m s^{-1} .

Solution: $\nu = v / \lambda = 5000 / 10 = 500 \text{ Hz}$.
 $T = 1 / \nu = 1 / 500 = 0.002 \text{ s}$.

Example 5: Distance from a wall by echo (NCERT Example 10.5)

Question: You clap in an empty corridor and hear the echo after 1 s. Calculate the distance from you to the wall. Use the speed of sound in air as 340 m s^{-1} .

Solution: Sound travels to the wall and back, so the distance is $d = v \times t / 2 = 340 \times 1 / 2 = 170 \text{ m}$.



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Example 6: Naval sonar (NCERT Example 10.6)

Question: A naval sonar signal sent into seawater returns after 0.90 s. The speed of sound in seawater is 1530 m s^{-1} . How far is the object?

Solution: Time to reach the object = $0.90/2 = 0.45 \text{ s}$. Distance = $1530 \times 0.45 = 688.5 \text{ m}$.

Example 7: Two sounds along a steel fence (NCERT Pause and Ponder 11)

Question: Two friends are standing along a steel fence at a distance of 340 m from each other. Gunjan places her ear over the fence and her friend knocks the fence with a metal object. Using the values of the speed of sound in steel and air given in Table 10.1, calculate the time difference between the sound that reached Gunjan through the air and the steel. Would it have been possible for her to distinguish between the two sounds? (The time interval between two sounds must be at least 0.1 s to be heard separately.)

Solution:

- Through air: $340 / 340 = 1 \text{ s}$.
- Through steel: $340 / 5000 = 0.068 \text{ s}$.
- Difference = $1 - 0.068 = 0.932 \text{ s}$.

0.932 s is more than 0.1 s, so **yes**, she heard through the air.

Example 8: Minimum distance for

Question: An experiment is being set up to study the emission of sound. What minimum distance should be maintained between the source and the observer if the speed of sound is to be 343 m s^{-1} .

Solution: Path in 0.2 s = $343 \times 0.2 = 68.6 \text{ m}$.

Example 9: Parking sensor (NCERT Example 10.7)

Question: A vehicle is fitted with an ultrasonic system which provides echolocation, while emitting a wave (about 40 kHz) which is reflected by an obstacle at a distance of 1.2 m from the obstacle, how long does it take for the wave to come back? Assume the speed of sound in air is 343 m s^{-1} .



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Solution: Total path = $2 \times 1.2 = 2.4$ m. $t = 2.4 / 345 \approx 0.00696$ s $\approx$ **0.007 s** (about 7 milliseconds). The 40 kHz value only tells you the wave is ultrasonic; it is not needed.

Example 10: Thunder on a cold day (NCERT Exercise 12)

Question: The speed of sound in air is about 331 m s^{-1} at 0°C and nearly 344 m s^{-1} at 22°C . Roughly how much extra time will the sound of thunder take to travel a distance of 1720 m, if the air temperature changes from 22°C to 0°C ? Assume that all other conditions remain unchanged.

Solution: At 22°C : $1720 / 344 = 5.00$ s. At 0°C : $1720 / 331 \approx 5.20$ s. Extra time $\approx$ **0.2 s**, because sound is slower in colder air.

Competency-Based Questions (with answers)

1. Case-based: Repairs on a space

Two astronauts are repairing the arm of a spanner, which clangs against the frame in

(a) Do they hear the clang directly? No. Sound travels through the metal medium.

(b) Can they see the spanner hit the frame?

(c) How do they talk to each other? Through radio.

(d) Which experiment shows the same idea? The experiment where a bell is rung inside a glass jar being pumped out while the bell is still seen ringing.

2. Assertion-Reason (NCERT Pause)

Assertion (A): We cannot hear the sound of a bell inside a glass jar being pumped out.

Reason (R): Sound requires a medium to travel.

(i) Both A and R are true, but R is not the correct explanation of A. (ii) A is true and R is the correct explanation of A. (iii) A is false and R is true.



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Answer: (ii). With most of the air removed there is almost no medium to carry the sound, so R explains A.

3. Assertion-Reason (NCERT Pause and Ponder 4)

Assertion (A): Compressions and rarefactions move through the medium.

Reason (R): Individual particles of the medium continuously move forward with the wave.

Answer: (iii) A is true, but R is false. The compressions and rarefactions travel; the particles only oscillate about their mean positions, like the marked turn of the slinky.

4. Assertion-Reason

Assertion (A): An echo is not heard when you clap in a small room.

Reason (R): The reflected sound from the walls reaches you less than 0.1 s after the original sound.

Answer: Both A and R are true, and R is the correct explanation of A. The distance is less than 17 m, so the reflection arrives too quickly to be heard as an echo.

5. Competency MCQs (NCERT Exercise 12.2)

(a) Which observation best supports the fact that sound is a longitudinal wave?
(i) Sound travels in a straight line (ii) Sound needs a medium to travel (iii) Sound carries energy (iv) Sound travels faster in solids than in liquids

Answer: (ii). A mechanical wave is one that needs a medium to travel, and sound is a mechanical wave. It carries energy, and light travels faster in solids than in liquids.

(b) For a sound wave propagating in a medium, which of the following does not change with frequency?
(i) wavelength (ii) speed (iii) number of compressions per second (iv) amplitude

Answer: (iii). Speed stays the same; wavelength and amplitude change with frequency.

(c) If 20 compressions pass a point in 4 s, what is the frequency of the wave?
(i) 5 Hz (ii) 0.2 Hz (iii) 20 Hz (iv) 0.05 Hz

Answer: (ii). $v = 20/4 = 5 \text{ Hz}$.

6. Source-based: Speed of sound

Approximate speed of sound at 15 °C: steel 5000 m/s, water 1500 m/s, air 340 m/s

(a) Speed in water relative to air? $1500/340 \approx 4.4$, which fits "about 4 to 5 times faster".



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(b) Speed in steel relative to water? $5000/1500 \approx 3.3$.

(c) A 500 Hz sound passes from air into water. What happens to its wavelength? In air $\lambda = 340/500 = 0.68$ m; in water $\lambda = 1500/500 = 3$ m. The wavelength increases because the speed increases while the frequency stays that of the source.

7. Case-based: Designing a school auditorium

A new school hall has bare concrete walls, a high hard ceiling and hard chairs. Students at the back say the principal's voice sounds garbled and seems to linger after each sentence.

(a) Name the effect. Reverberation: multiple reflections make the sound persist after the speaker stops.

(b) Suggest three changes. Sound-absorbing wall panels, upholstered chairs, and curtains or other soft, porous materials.

(c) Should all reflections be removed? No. Some reverberation so that the whole audience can hear.

8. Data-based: Same cliff, air and water

Two identical sources, A in air and B under water, send a sound to a vertical face of a cliff. Both send a sound to A after 4.5 times the time it takes to return to A.

(a) Ratio of the speed of sound in air to that in water is proportional to time: $v_{\text{air}}/v_{\text{water}} = 1/4.5 = 2/9$

(b) If B's echo takes 0.2 s and sound in water travels at 1500 m/s, the distance to the cliff is $(1500 \times 0.2)/2 = 150$ m.

Important Questions for Chapter 15

1-Mark Questions

1. Name the part of the human body that produces sound in the larynx.

2. What is the SI unit of frequency? Hertz (Hz), the same as s⁻¹.



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3. **What is a compression?** A region of the medium with a higher density than the average density.
4. **State the audible range for humans.** 20 Hz to 20,000 Hz (20 kHz).

2-Mark Questions

5. **If the frequency of a sound wave produced by an oscillating piston of a long tube filled with air is 20 Hz, then how many oscillations does the piston complete per minute? (NCERT Pause and Ponder 8)**
20 oscillations per second $\times$ 60 s = **1200 oscillations.**
6. **A source produces a sound wave of wavelength 3.44 m. If the wave travels with a speed of 344 m s^{-1} find its time period. (NCERT Exercise 9)**
 $v = 344/3.44 = 100 \text{ Hz}$, so $T = 1/100 = \textbf{0.01 s}.$
7. **Distinguish between infrasonic and ultrasonic waves, naming an animal that detects each.**
Infrasonic: below 20 Hz, detected by elephants. Ultrasonic: above 20 kHz, detected by bats (also dogs, cats, dolphins).
8. **Why are echoes unclear from curtains reflected; rough surfaces scatter it in many directions.**



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3-Mark Questions

9. **In a movie, while showing the explosion along with sound at the same time. Why is the flash seen before the sound is heard? (NCERT Pause and Ponder 8)**
(1) Space is a near vacuum and sound requires a medium. Light travels through vacuum, so showing the flash is faster than sound, so the flash would be seen first.
10. **A sonar signal sent to find the depth of the ocean at that location if the speed of sound is 1500 m s⁻¹. (NCERT Pause and Ponder 13)**
One-way time = 2 s. Depth = $1500 \times 2 = 3000 \text{ m}.$
11. **A ship searching for a sunken ship sends an ultrasonic wave travels at 1525 m s^{-1} in 5 s. How deep is the wreckage of the sunken ship located? (NCERT Exercise 10)**
One-way time = 2.5 s. Depth = $1525 \times 2.5 = 3812.5 \text{ m}.$

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2. **Show that the minimum distance of a reflecting surface for an echo in air is 17 m (speed 340 m s^{-1}).**

Two sounds must be at least 0.1 s apart. In 0.1 s sound travels 34 m, which covers the trip there and back, so the surface must be at least **17 m** away.

5-Mark Questions

3. **Using a piston in a tube of air, explain how sound travels through a medium. Define compression, rarefaction and sound wave, and explain why sound is a longitudinal mechanical wave.**

At rest, the air in the tube has a uniform average density. When the piston moves forward it squeezes the nearby air, making a region of higher than average density, a **compression**. These particles collide with those ahead, so the compression moves forward while each particle stays near its own place. When the piston moves back, the nearby air thins out into a **rarefaction**, a region of lower than average density, which also moves forward. A continuously oscillating piston sends out alternate compressions and rarefactions. A **sound wave** is this disturbance propagating through a medium. Particles of the medium vibrate parallel to the direction of propagation. Sound can travel through a vacuum without particles, as the bell jar shows,

4. **(a) Define wavelength, frequency and speed of sound. Find its wavelength in air at 340 m s^{-1} . Find its frequency if the wavelength is 0.68 m.**

(a) Wavelength: distance between two consecutive regions of maximum density oscillations at a fixed point per second. Frequency: number of oscillation at a fixed point.

(b) A crest moves one wavelength λ in one second.

(c) $\lambda = 340/500 = \mathbf{0.68 \text{ m}}$. $T = 1/500 = \mathbf{0.002 \text{ s}}$

5. **(a) What is echolocation and how do bats use it? (b) A ship sends ultrasonic waves into the sea. The reflected wave returns after 1.2 s. Find the distance of the submarine.**

(a) Echolocation is the ability to locate objects by emitting bursts of ultrasonic waves and sense the reflected waves. Bats use echolocation to find their prey in the dark.

(b) A ship sends ultrasonic waves into the sea. The reflected wave returns after 1.2 s. Find the distance of the submarine.

(c) $d = (1500 \times 1.2)/2 = \mathbf{900 \text{ m}}$.



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Common Mistakes and Examiner Tips

1. **Mistake:** writing that air particles travel from the source to the ear. **Fix:** particles only vibrate about their mean positions; the disturbance and the energy travel.
2. **Mistake:** forgetting to halve in echo and sonar numericals. **Fix:** use $d = (v \times t)/2$ for reflected sound. For thunder or a direct knock, use $d = v \times t$.
3. **Mistake:** calling sound a transverse wave. **Fix:** particles vibrate parallel to propagation, so sound is longitudinal.
4. **Mistake:** saying a higher frequency makes sound travel faster. **Fix:** in air the speed depends on the medium; a higher frequency gives a shorter wavelength.
5. **Mistake:** measuring wavelength from a crest to the next trough. **Fix:** that is half a wavelength; use crest to crest or trough to trough.
6. **Mistake:** mixing up kHz and Hz. **Fix:** convert first: 20 kHz = 20,000 Hz.
7. **Mistake:** linking pitch to amplitude or loudness to frequency. **Fix:** pitch goes with frequency; loudness goes with amplitude.
8. **Mistake:** writing that sound is fastest in air (340 m s⁻¹). **Fix:** sound is fastest in solids (e.g., 5000 m s⁻¹).
9. **Mistake:** saying sound slows down in high humidity. **Fix:** sound speed is slightly higher in humid air.
10. **Mistake:** confusing echo and reverberation. **Fix:** echo is a distinct reflection; reverberation is lingering sound from multiple reflections.
11. **Tip:** different questions use 340, 343, or 330 m s⁻¹. Always use the value given in the question.



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Quick Revision Points

- Sound is produced by vibrating objects.
- Human voice: vibrating vocal cords in the larynx.
- Sound travels through solids, liquids and gases.
- The bell jar experiment shows sound needs a medium.
- Compression: density above average. Rarefaction: density below average.
- A sound wave is a series of alternating compressions and rarefactions.

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- Sound is longitudinal and mechanical. Light is transverse and travels through vacuum.
- Sound carries energy; microphones turn sound into electrical energy, speakers do the reverse.
- On a density-distance graph: compression = crest, rarefaction = trough.
- $v = 1/T$ and $v = \lambda \times \nu$.
- Larger amplitude: more energy, louder sound. Intensity falls with distance.
- Speed: solids > liquids > gases; rises with temperature and humidity in air.
- Pitch depends on frequency, loudness on amplitude, timbre on overtones.
- Audible range 20 Hz to 20 kHz; below is infrasonic, above is ultrasonic.
- Conversation is about 60 dB; noise is unwanted or harmful sound.
- An octave doubles the frequency (200 Hz to 400 Hz).
- Sound obeys the laws of reflection of light.
- Echo needs a gap of at least 0.1 s; minimum distance is 17 m.
- Echo or sonar distance: $d = (v \times t)/2$.
- Reverberation: multiple reflections less than 0.1 s apart.
- Bats use echolocation; ships use sonar.

Weightage and Exam Pattern

Class 9 has no board exam. This chapter is important for internal assessment (term and annual papers), and the NCERT textbook has some questions with short numericals.



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Question type	What this chapter typically supplies
MCQ and one-word	SI units, audible range, pitch and loudness, frequency from a count
Assertion-Reason	Sound in vacuum, particles versus disturbance, echo in a small room
Short answer	Wave definitions, $v = 1/T$ and $v = \lambda v$ numericals, echo distance, uses of ultrasound
Long answer	Piston model, derivation of $v = \lambda v$, echolocation and sonar with a numerical
Graph and case-based	Labelling C and R, reading wavelength and amplitude, thunder, sonar, auditorium design

The chapter is the foundation for Class 10 wavelength, frequency and $v = \lambda v$ are use



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