



CLASS 9 SCIENCE — CHAPTER 10

SOUND WAVES: CHARACTERISTICS AND APPLICATIONS



New NCERT *Exploration* Science Textbook | 2026–27

This chapter explains how sound is produced, how it travels, how sound waves are described and measured, how humans perceive sound, reflection of sound, echoes, reverberation, ultrasound, infrasound, echolocation and SONAR. ([Tiwari Academy](#))



1. WHAT IS SOUND?

Sound is a form of **energy** that produces the sensation of hearing.

We experience sound everywhere:



Music



Human speech



Birds singing



Mobile phones



Thunder



Vehicle horns



Musical instruments

But how is sound produced?



Sound is produced by vibrating objects.

For example:



A vibrating guitar string produces sound.



A vibrating drum membrane produces sound.



Vibrating vocal cords produce our voice.

 A vibrating loudspeaker diaphragm produces sound.

2. VIBRATION

Definition

Vibration is the repeated to-and-fro motion of an object about its mean position.

For example, when a stretched rubber band is plucked:

← → ← →

it moves repeatedly about its original position.

This vibration produces sound.

3. PRODUCTION OF SOUND

Sound is produced when an object vibrates.

Examples:

Human voice

Vocal cords vibrate → Sound is produced.

Guitar

Strings vibrate → Sound is produced.

Drum

Membrane vibrates → Sound is produced.

Bell

Bell vibrates → Sound is produced.

Loudspeaker

Diaphragm vibrates → Sound is produced.



4. SIMPLE EXPERIMENT — RUBBER BAND

Stretch a rubber band around a box.

Pluck the rubber band.

What do you observe?

The rubber band vibrates.

You also hear a sound.

Now stop the vibration.

What happens?

The sound stops.

Conclusion:

Sound is produced by vibrations.

The new textbook uses activities involving a rubber band and tuning fork to demonstrate this idea. ([Tiwari Academy](#))



5. TUNING FORK

A tuning fork is a metal instrument with two prongs.

When struck:



Strike tuning fork



 **Prongs vibrate**



 **Sound is produced**

The tuning fork provides a clear demonstration that a vibrating object produces sound.

6. HOW DO WE PRODUCE OUR VOICE?

Our voice is produced with the help of:

Vocal cords

When air from the lungs passes through the voice box, the vocal cords vibrate.

These vibrations produce sound.

The sound can then be modified by structures in our mouth and throat to produce speech.

7. HOW DOES SOUND TRAVEL?

Producing sound is only the first step.

The sound must travel from its source to our ears.

Sound travels through a:

Material medium

A medium can be:

-  Solid
 -  Liquid
 -  Gas
-

8. SOUND CANNOT TRAVEL THROUGH VACUUM

A vacuum contains essentially no particles.

Sound needs particles to transfer the disturbance from one place to another.

Therefore:

★ **Sound cannot travel through vacuum.**

This is why sound is called a:

Mechanical wave

The bell-jar experiment is used to demonstrate that sound requires a medium. ([Collegedunia](https://collegedunia.com))

9. BELL-JAR EXPERIMENT

Imagine an electric bell placed inside a bell jar.

Initially, air is present.

 The bell can be heard.

Now air is gradually removed from the jar.

As the amount of air decreases:

 Sound becomes weaker.

When nearly all the air is removed:

✗ **Sound cannot be heard.**

However, the bell continues to vibrate.

★ **Conclusion:**

Sound needs a material medium for propagation.

10. SOUND TRAVELS THROUGH DIFFERENT MEDIA

Sound can travel through:

Solids

Example:

Sound travelling through a metal rod.

Liquids

Example:

Sound travelling through water.

Gases

Example:

Sound travelling through air.

11. WHY CAN SOUND TRAVEL THROUGH SOLIDS?

Particles in solids are closely packed.

When one particle vibrates, it can transfer the disturbance to neighbouring particles.

Therefore, sound can travel through the solid.



12. SOUND IN LIQUIDS

Liquid particles can also transfer vibrations from one particle to another.

Therefore:

Sound can travel through liquids.

For example, whales and dolphins communicate using sound underwater.



13. SOUND IN AIR

When a vibrating object produces sound:

The nearby air particles begin to vibrate.

They transfer the disturbance to neighbouring particles.

This continues through the air until the disturbance reaches our ears.



14. DOES THE MEDIUM MOVE FROM SOURCE TO EAR?

✗ No.

The particles of the medium mainly vibrate about their mean positions.

The disturbance and energy travel through the medium.



Sound transfers energy, not the bulk matter of the medium.



15. SOUND AS A WAVE

A wave is a disturbance that transfers energy from one place to another.

Sound is therefore a:

Mechanical wave

because it requires a material medium.

↔ 16. LONGITUDINAL WAVE

Sound travelling through air is generally a:

Longitudinal wave

In a longitudinal wave, particles of the medium vibrate:

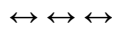
Parallel to the direction of wave propagation.

Example:

If the wave travels:



the particles vibrate:



17. COMPRESSIONS

When particles of the medium come closer together, a region of:

High pressure and high density

is produced.

This region is called:

Compression

Symbol:

C

18. RAREFACTIONS

When particles move farther apart, a region of:

Low pressure and low density

is produced.

This region is called:

Rarefaction

Symbol:

R

19. COMPRESSION AND RAREFACTION

A sound wave consists of alternating:

Compressions and rarefactions

So we can represent it as:

C → R → C → R → C → R

Where:

C = Compression

R = Rarefaction



20. COMPRESSION VS RAREFACTION

Compression

Particles close together

High pressure

High density

Region of crowding

Rarefaction

Particles farther apart

Low pressure

Low density

Region of spreading



21. WHY IS SOUND LONGITUDINAL?

In air, sound particles vibrate back and forth in the same direction in which the sound disturbance travels.

Therefore:



Sound is a longitudinal wave.



22. SOUND CARRIES ENERGY

When a sound wave travels, it transfers energy.

For example:



A loudspeaker produces sound.

The vibrating diaphragm transfers energy to the surrounding air.

The energy reaches our ears.

Therefore:

★ Sound is a form of energy transfer.



23. GRAPHICAL REPRESENTATION OF SOUND

Sound waves can be represented graphically.

A graph can show changes associated with the wave, such as:



Displacement



Pressure



Time

Important wave quantities include:

Wavelength

Frequency

Time period

Amplitude

Speed



24. WAVELENGTH

The distance between two successive compressions or two successive rarefactions is called:

Wavelength

It is represented by:

λ (lambda)

SI unit:

metre (m)

Therefore:

Wavelength = Distance between two successive compressions or rarefactions



25. FREQUENCY

Frequency tells us how many complete vibrations occur in one second.



Definition

Frequency = Number of vibrations per second

Symbol:

f or v

SI unit:

Hertz (Hz)



26. FREQUENCY FORMULA

Frequency = Number of vibrations / Time

In symbols:

$$\mathbf{f = N / t}$$

where:

f = frequency

N = number of vibrations

t = time



27. Example — Frequency

A source makes 200 vibrations in 4 seconds.

Frequency:

$$f = N / t$$

$$f = 200 / 4$$

$$f = 50 \text{ Hz}$$



28. TIME PERIOD

The time taken to complete one vibration is called:

Time period

Symbol:

T

SI unit:

second (s)



29. RELATION BETWEEN FREQUENCY AND TIME PERIOD

$$T = 1 / f$$

and:

$$f = 1 / T$$

Therefore:

Frequency and time period are inversely related.



30. Example — Time Period

A sound source has frequency:

$$f = 50 \text{ Hz}$$

Therefore:

$$T = 1 / f$$

$$T = 1 / 50$$

$$T = 0.02 \text{ s}$$



31. AMPLITUDE

Amplitude is the:

Maximum displacement of particles from their mean position.

It represents how large the vibration is.

Greater amplitude generally means greater sound energy and a louder sound.



32. LOUDNESS

Loudness is related to how strong a sound appears to our ears.

A sound with greater amplitude generally sounds:



Louder

A sound with smaller amplitude generally sounds:

 **Softer**

★ **Remember:**

Amplitude → Loudness

33. PITCH

Pitch tells us whether a sound is:

 High/shrill

or

 Low/deep

Pitch depends mainly on:

Frequency

Higher frequency:

 **Higher pitch**

Lower frequency:

 **Lower pitch**

34. PITCH VS LOUDNESS

Pitch	Loudness
Depends mainly on frequency	Related to amplitude
High frequency → high pitch	Greater amplitude → louder sound
Low frequency → low pitch	Smaller amplitude → softer sound

★ **Memory Trick:**

Frequency → **Pitch**

Amplitude → **Loudness**

35. SPEED OF SOUND

The speed of a sound wave depends on:

 **Temperature**

 **Nature of medium**

and other conditions.

In general, sound travels:

Fastest in solids

then

Liquids

and generally slowest in

Gases

36. WAVE SPEED FORMULA

The most important formula of this chapter is:

$$v = f \times \lambda$$

where:

v = speed of wave

f = frequency

λ = wavelength



37. Other Forms of the Wave Formula

From:

$$v = f \times \lambda$$

we can obtain:

$$f = v / \lambda$$

and:

$$\lambda = v / f$$

These are important for numerical questions.



38. Example — Wave Speed

A sound wave has:

Frequency = 500 Hz

Wavelength = 0.68 m

Find speed.

Formula:

$$v = f \times \lambda$$

Substitution:

$$v = 500 \times 0.68$$

Answer:

$$v = 340 \text{ m/s}$$



39. Example — Wavelength

Speed of sound:

$$v = 340 \text{ m/s}$$

Frequency:

$$f = 170 \text{ Hz}$$

Find wavelength.

Formula:

$$\lambda = v / f$$

Substitution:

$$\lambda = 340 / 170$$

Answer:

$$\lambda = 2 \text{ m}$$



40. HUMAN HEARING

Humans cannot hear every sound frequency.

The commonly stated audible range for a healthy human ear is approximately:

20 Hz to 20,000 Hz

or:

20 Hz to 20 kHz



41. INFRASOUND

Sound with frequency:

Below 20 Hz

is called:

Infrasound

Humans generally cannot hear infrasound.

Some animals can detect very low-frequency sounds.



42. ULTRASOUND

Sound with frequency:

Above 20,000 Hz

or:

Above 20 kHz

is called:

Ultrasound

Humans generally cannot hear ultrasound. ([Learn Insta](#))



43. SOUND FREQUENCY RANGES

Type	Frequency
Infrasound	Below 20 Hz

Human audible range About 20 Hz – 20 kHz

Ultrasound Above 20 kHz



44. ANIMALS AND SOUND

Different animals have different hearing abilities.

Some animals can hear frequencies outside the normal human range.

Examples:



Bats → use ultrasound



Dolphins → use high-frequency sound



Elephants → can communicate using very low-frequency sounds



45. ECHOLOCATION

Some animals use reflected sound to locate objects.

This is called:

Echolocation

Bats produce high-frequency sounds.

The sound waves strike objects.

They are reflected back.

The bat detects the returning sound.

Thus, it can estimate:



Location



Distance

and sometimes:

🎯 Shape or movement of objects.

46. REFLECTION OF SOUND

When sound strikes a suitable surface and returns into the same medium, the phenomenon is called:

Reflection of sound

Examples:

🗣️ Voice in a large empty hall

🏔️ Sound near mountains

🔊 Sound reflected from a wall

47. ECHO

An **echo** is a reflected sound heard separately from the original sound after a sufficient time delay.

For a distinct echo, the reflected sound must reach the listener after enough time for the ear to distinguish it from the original sound.

The commonly used minimum time gap is about:

0.1 second

48. ECHO FORMULA

For an echo:

$$\text{Distance} = \text{Speed} \times \text{Time} / 2$$

Why divide by 2?

Because sound travels:

Object → **Reflecting surface**

and then:

Reflecting surface → **Listener**

So the measured time represents the **round-trip distance**.



49. Minimum Distance for an Echo

Take speed of sound as:

340 m/s

Minimum time gap:

0.1 s

Distance travelled by sound:

$$\text{Distance} = \text{Speed} \times \text{Time}$$

$$= 340 \times 0.1$$

$$= 34 \text{ m}$$

This is the total round-trip distance.

Therefore, distance to the reflecting surface:

$$34 / 2$$

$$= 17 \text{ m}$$

So a reflecting surface generally needs to be about:

17 m or more away

for a distinct echo under these assumptions. ([Collegedunia](#))



50. REVERBERATION

Sometimes reflected sound reaches us repeatedly and overlaps with the original sound.

This persistence of sound due to repeated reflections is called:

Reverberation

It can occur in:



Large halls



Auditoriums



Buildings



51. ECHO VS REVERBERATION

Echo	Reverberation
Reflected sound heard separately	Reflections overlap with the original sound
Distinct repetition may be heard	Sound persists
Requires sufficient time gap	Many reflections arrive close together



52. CONTROL OF REVERBERATION

Excessive reverberation can make speech difficult to understand.

Auditoriums may use:



Cushioned seats

 Curtains

 Sound-absorbing materials

 Special wall and ceiling designs

These reduce unwanted reflections.

53. INTENSITY OF SOUND

Intensity is related to the amount of sound energy passing through a unit area per unit time.

It helps describe the strength of a sound wave.

★ **Important distinction:**

Intensity is a physical quantity.

Loudness is the sensation perceived by the ear.

54. QUALITY / TIMBRE OF SOUND

Different instruments can produce sounds with the same pitch and similar loudness but still sound different.

For example:

 Piano

 Guitar

 Violin

may play the same note.

Yet we can distinguish them.

This property is associated with:

Quality or timbre of sound

It depends on the waveform and harmonic content of the sound.

55. SONIC BOOM

When an object moves through a medium faster than the speed of sound in that medium, it can produce a strong shock-wave effect.

This is associated with:

Sonic boom

Fast-moving aircraft can produce sonic booms.

56. APPLICATIONS OF ULTRASOUND

Ultrasound has many applications.

Medical imaging

Ultrasound is used to produce images of structures inside the body.

Diagnosis

Doctors can use ultrasound to examine internal organs and tissues.

Breaking kidney stones

Certain medical procedures use focused ultrasound energy to help break kidney stones.

57. SONAR

SONAR stands for:

Sound Navigation and Ranging

It uses sound waves to detect objects and determine distances, especially underwater.

58. How SONAR Works

Step 1

A sound pulse is sent into water.



Step 2

The sound reaches an underwater object.



Step 3

The sound is reflected back.



Step 4

The returning signal is detected.



Step 5

The time taken is measured.

Using the speed of sound in water, the distance can be calculated.

59. SONAR DISTANCE FORMULA

$$\text{Distance} = \text{Speed} \times \text{Time} / 2$$

where:

Speed = speed of sound in water

Time = total time for the sound pulse to travel to the object and return.



60. Uses of SONAR

SONAR can be used to:



Detect underwater objects



Measure water depth



Locate submarines



Study underwater structures and objects



Map the seabed



61. ULTRASOUND VS SONAR

Ultrasound	SONAR
Uses high-frequency sound	Uses sound pulses, often ultrasonic
Commonly used in medicine	Mainly used for underwater detection/ranging
Imaging internal body structures	Detecting underwater objects/depth
Medical diagnosis	Navigation and ranging



62. SOUND AND SOCIETY

Sound has many useful applications:

 Communication

 Entertainment

 Medical diagnosis

 Navigation

 Animal echolocation

 Warning systems

 Public speaking



63. NOISE AND UNWANTED SOUND

Not every sound is pleasant or useful.

Unwanted or excessively loud sound is generally called:

Noise

Examples:

 Traffic

 Loudspeakers

 Construction machinery

 Aircraft



64. IMPORTANT EFFECTS OF EXCESSIVE NOISE

Long exposure to excessive noise can:

 Affect hearing

 Disturb sleep

 Cause stress

 Affect concentration

Therefore:

★ **Noise pollution should be controlled.**

65. INDIAN CONNECTIONS IN THE CHAPTER

The new *Exploration* textbook also connects sound science with Indian contexts.

 **Sir C. V. Raman**

His scientific work is an important part of India's scientific heritage.

The chapter also connects acoustics with Indian musical instruments such as:

 Tabla

 Mridangam

The new textbook includes Indian science and cultural connections alongside the physics concepts. ([Tiwari Academy](#))

66. SOUND IN EVERYDAY LIFE

Sound helps us:

 Communicate

 Detect our surroundings

 Receive warnings

 Enjoy music

 Diagnose diseases

 Navigate underwater

 Locate objects through echolocation



67. IMPORTANT FORMULAS

★ Formula 1 — Frequency

$$f = N / t$$

where:

f = frequency

N = number of vibrations

t = time

★ Formula 2 — Time Period

$$T = 1 / f$$

★ Formula 3

$$f = 1 / T$$

★ Formula 4 — Wave Speed

$$v = f \times \lambda$$

★ Formula 5 — Wavelength

$$\lambda = v / f$$

★ Formula 6 — Frequency

$$f = v / \lambda$$

★ Formula 7 — Echo Distance

$$\text{Distance} = \text{Speed} \times \text{Time} / 2$$



68. SI UNITS

Quantity	Symbol	SI Unit
Frequency	f	Hertz (Hz)
Time period	T	second (s)
Wavelength	λ	metre (m)
Speed	v	metre per second (m/s)
Amplitude	—	metre (m), when expressed as displacement
Intensity	I	watt per square metre (W/m ²)



69. NUMERICAL EXAMPLE

A sound source produces 600 vibrations in 3 seconds.

Find frequency.

Formula:

$$f = N / t$$

Substitution:

$$f = 600 / 3$$

Answer:

$$f = 200 \text{ Hz}$$



70. NUMERICAL EXAMPLE

A sound wave has:

Frequency = 250 Hz

Wavelength = 1.36 m

Find speed.

Formula:

$$v = f \times \lambda$$

$$v = 250 \times 1.36$$

$$v = 340 \text{ m/s}$$



71. NUMERICAL EXAMPLE

A wave travels at 340 m/s and has frequency 680 Hz.

Find wavelength.

Formula:

$$\lambda = v / f$$

$$\lambda = 340 / 680$$

$$\lambda = 0.5 \text{ m}$$



72. NUMERICAL EXAMPLE — ECHO

A reflected sound returns after 2 seconds.

Speed of sound = 340 m/s.

Find distance of reflecting surface.

Formula:

$$\text{Distance} = \text{Speed} \times \text{Time} / 2$$

Substitution:

$$\text{Distance} = 340 \times 2 / 2$$

$$\text{Distance} = 340 \text{ m}$$



73. COMPETENCY-BASED QUESTION

A student strikes a tuning fork in a vacuum.

Will the tuning fork vibrate?

☒ **Yes.**

Will the sound reach another person through the vacuum?

☐ **No.**

Why?

The tuning fork can vibrate, but sound needs a material medium to propagate.



74. COMPETENCY-BASED QUESTION

Two sound waves have different frequencies.

Wave A:

100 Hz

Wave B:

500 Hz

Which has higher pitch?



Wave B

Because:

Higher frequency → Higher pitch



75. COMPETENCY-BASED QUESTION

Two sounds have the same frequency but different amplitudes.

Which characteristic is different?

Loudness

The wave with greater amplitude generally produces a louder sound.



76. COMPETENCY-BASED QUESTION

A sound wave has:

Frequency = 400 Hz

Wavelength = 0.85 m

Find its speed.

Formula:

$$v = f \times \lambda$$

Calculation:

$$v = 400 \times 0.85$$

$$v = 340 \text{ m/s}$$

77. COMPETENCY-BASED QUESTION

Why can astronauts not communicate directly by shouting to one another in outer space?

Answer:

Outer space is essentially a vacuum.

There are no particles available to transfer the sound disturbance.

Therefore:

Sound cannot travel through vacuum.

Astronauts use communication systems that convert signals into electromagnetic waves.

78. IMPORTANT DIFFERENCES

Sound vs Light

Sound	Light
Mechanical wave	Electromagnetic wave
Needs a medium	Can travel through vacuum
Cannot travel through vacuum	Travels through vacuum

Usually longitudinal in air

Electromagnetic waves are transverse

79. Mechanical Wave vs Electromagnetic Wave

Mechanical Wave

Requires a material medium.

Examples:



Sound



Water waves

Electromagnetic Wave

Does not require a material medium.

Examples:



Light



Radio waves

80. Longitudinal vs Transverse

Longitudinal Wave

Particles vibrate parallel to the direction of propagation.

Example:



Sound in air

Transverse Wave

Particles vibrate perpendicular to the direction of propagation.

Example:

 Waves on a stretched string



81. IMPORTANT DEFINITIONS

Vibration

Repeated to-and-fro motion about a mean position.

Sound

A form of energy that produces the sensation of hearing.

Mechanical wave

A wave that requires a material medium for propagation.

Longitudinal wave

A wave in which particles vibrate parallel to the direction of propagation.

Compression

Region of high pressure and density.

Rarefaction

Region of low pressure and density.

Amplitude

Maximum displacement from the mean position.

Frequency

Number of vibrations per second.

Wavelength

Distance between successive compressions or successive rarefactions.

Time period

Time required for one complete vibration.

Pitch

Characteristic mainly related to frequency.

Loudness

Perception related to the strength/amplitude of sound.

Echo

A reflected sound heard separately after a sufficient time delay.

Reverberation

Persistence of sound due to repeated reflections.

Ultrasound

Sound with frequency above 20 kHz.

Infrasound

Sound with frequency below 20 Hz.

Echolocation

Use of reflected sound to locate objects.

SONAR

A system using sound waves for underwater detection and ranging.



82. IMPORTANT EXAM QUESTIONS

Q1. How is sound produced?

Sound is produced by vibrating objects.

Q2. Why is sound called a mechanical wave?

Because sound requires a material medium for propagation.

Q3. Why can't sound travel through vacuum?

A vacuum has no particles to transfer the vibration.

Q4. What is a longitudinal wave?

A wave in which particles vibrate parallel to the direction of propagation.

Q5. What are compressions?

Regions of high pressure and density in a longitudinal sound wave.

Q6. What are rarefactions?

Regions of low pressure and density in a longitudinal sound wave.

Q7. Define frequency.

Frequency is the number of complete vibrations occurring per second.

Q8. Define wavelength.

Wavelength is the distance between two successive compressions or two successive rarefactions.

Q9. What determines pitch?

Pitch depends mainly on frequency.

Q10. What is the relation between amplitude and loudness?

Greater amplitude generally produces greater loudness.

Q11. Write the wave-speed formula.

$$v = f \times \lambda$$

Q12. What is an echo?

An echo is a reflected sound heard separately from the original sound after a sufficient time delay.

Q13. What is reverberation?

Reverberation is the persistence of sound caused by repeated reflections.

Q14. What is ultrasound?

Sound with frequency above 20 kHz.

Q15. What is infrasound?

Sound with frequency below 20 Hz.

Q16. What is SONAR?

SONAR is a system that uses sound waves to detect and locate underwater objects and determine distances.

83. COMMON MISTAKES TO AVOID

Mistake 1

Sound can travel through vacuum.

Correct:

Sound needs a material medium.

Mistake 2

Higher amplitude means higher pitch.

Correct:

Higher frequency → Higher pitch

Greater amplitude → Greater loudness

Mistake 3

Frequency is measured in metres.

Correct:

Frequency → **Hertz (Hz)**

Mistake 4

Wavelength is measured in Hertz.

Correct:

Wavelength → **metre (m)**

Mistake 5

Sound particles travel all the way from the source to the ear.

Correct:

Particles vibrate about their mean positions and transfer energy through the medium.

Mistake 6

Echo and reverberation are exactly the same.

Correct:

Echo → distinct reflected sound.

Reverberation → persistence due to multiple/reflected sounds overlapping.

84. QUICK REVISION

 Sound → Produced by vibrations.

 Vibration → To-and-fro motion.

 Sound needs → Material medium.

 Vacuum → Sound cannot travel.

 Sound → Mechanical wave.

↔ Sound in air → Longitudinal wave.

 Compression → High pressure/density.

 Rarefaction → Low pressure/density.

 Wavelength → λ .

 Frequency → f .

 Time period → T .

 Amplitude → Maximum displacement.

 Frequency → Pitch.

 Amplitude → Loudness.

 Wave speed → $v = f \times \lambda$.

 Human hearing → About 20 Hz to 20 kHz.

 Infrasound → Below 20 Hz.

 Ultrasound → Above 20 kHz.

 Reflection → Sound bounces back.

 Echo → Reflected sound heard separately.

 Reverberation → Persistence of sound.

 Echolocation → Using reflected sound to locate objects.

 SONAR → Underwater detection/ranging.

85. MEMORY TRICKS

SOUND

VIBRATION → SOUND

No vibration → No sound production.

PITCH

Frequency → Pitch

F = Frequency → F = Fine/high pitch

LOUDNESS

Amplitude → Loudness

A = Amplitude → Amount/strength of vibration

WAVE FORMULA

$$v = f \times \lambda$$

Think:

Speed = Frequency × Wavelength

TIME PERIOD

$$T = 1 / f$$

Higher frequency → Smaller time period.

Lower frequency → Larger time period.

HEARING

20 Hz → 20 kHz

Below → **Infrasound**

Above → **Ultrasound**

SONAR

Send → Reflect → Receive → Calculate

86. COMPLETE FORMULA SHEET

Frequency

$$f = N / t$$

Time period

$$T = 1 / f$$

Frequency and time period

$$f = 1 / T$$

Wave speed

$$v = f \times \lambda$$

Wavelength

$$\lambda = v / f$$

Frequency

$$f = v / \lambda$$

Echo / SONAR distance

Distance = Speed × Time / 2

🌟 87. CHAPTER 10 — FINAL TAKEAWAY

The complete journey of sound is:

🔄 **Vibration**



🔊 **Production of sound**



🗣️ **Medium**



🌊 **Longitudinal wave**



🔵 **Compressions + Rarefactions**



📏 **Wavelength + Frequency + Amplitude**



⚡ **Speed + Energy transfer**



👂 **Human perception**



Reflection



Echo + Reverberation



Ultrasound + Infrasound



SONAR + Echolocation + Medical Applications

★ The five things you absolutely must remember:

1. Sound is produced by vibrations.
2. Sound needs a material medium and cannot travel through vacuum.
3. Sound in air is a longitudinal mechanical wave made of compressions and rarefactions.
4. $v = f \times \lambda$
5. Frequency controls pitch, while amplitude is related to loudness.

These are the core concepts on which the rest of Chapter 10 builds.