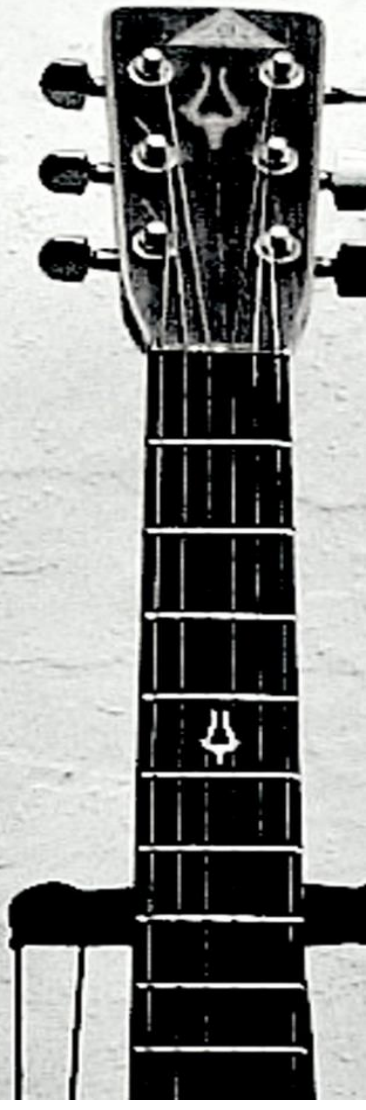
MBC

SOUND

CLASS 9

A MEMOIR



MRIDUL YADU

MBC – Mridul Bhaiya Classes

CLASS IX

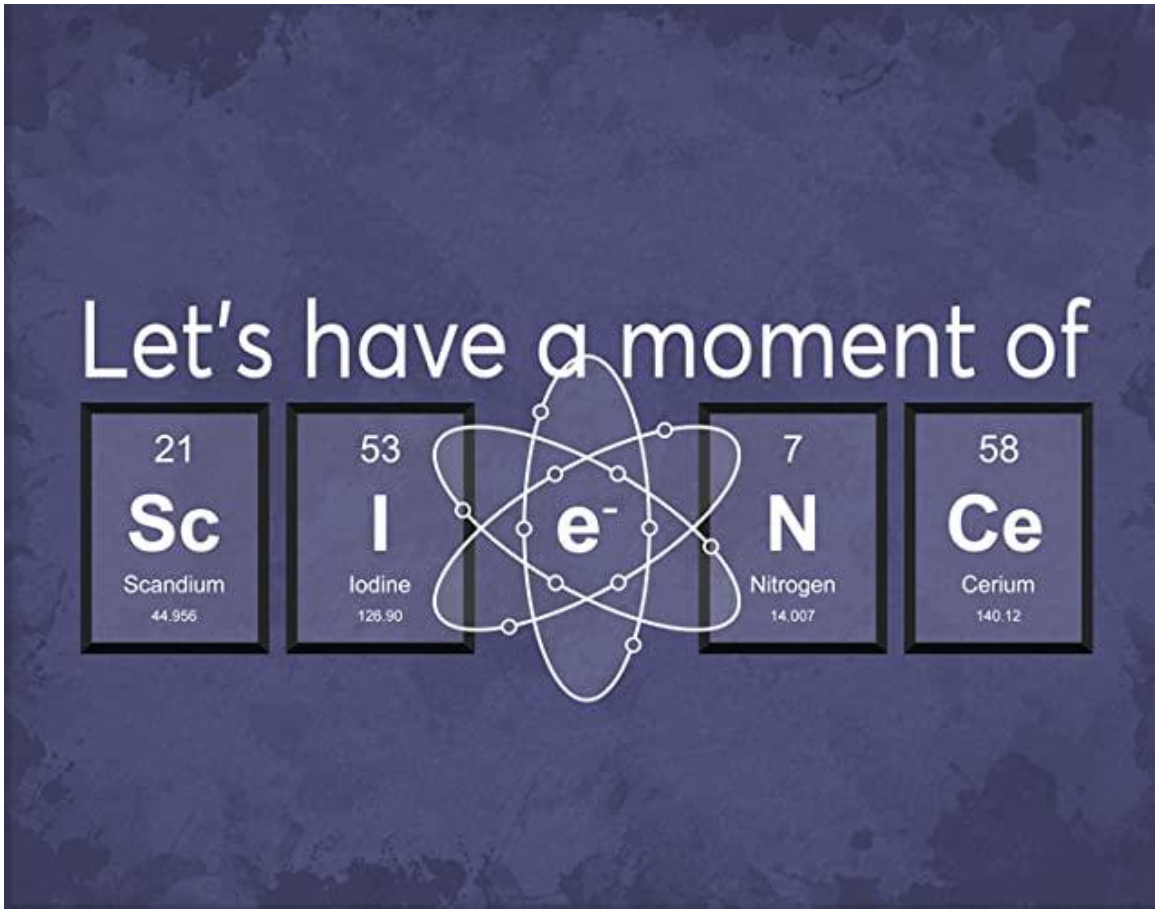
SCIENCE NOTES

SOUND

✓ Detailed notes

✓ PYQs with answers

✓ Graphics included



SOUND

Definition : *Sound is a form of energy which produces the sensation of hearing in our ear.*

PRODUCTION OF SOUND

The sound is produced by the vibrating objects or bodies.

VIBRATION :

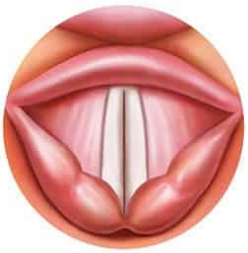
A rapid to and fro motion of an object about a fixed point is called vibration.

The energy required to make an object vibrate and produce sound is provided by some outside source (like our hand, wind etc.).

Example :

- Sound of our voice is produced by vibration of two vocal cords in our throat.

vocal cords in open position



vocal cords in closed position

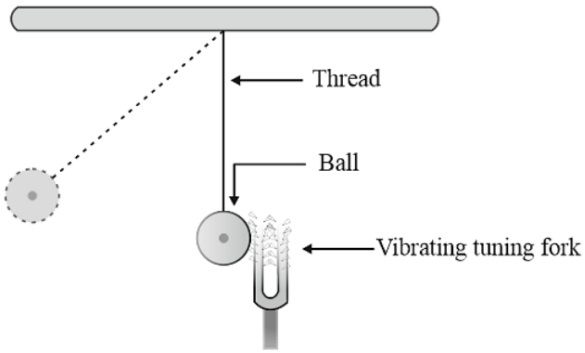
vocal cords attempting closed position (with one sided palsy)

- Sound of a drum or tabla is produced by vibration of its membrane when struck.

- In laboratory experiments, sound is produced by vibrating tuning fork. The vibrations of tuning fork can be shown by touching a small suspended pith ball (cork ball) with a prong of the sounding tuning fork. The pith ball is pushed away with a great force.

Sound can be produced by following methods :

(i) By vibrating string (sitar)
(ii) By vibrating air (flute)
(iii) By vibrating membrane (table, drum)
(iv) By vibrating plate (bicycle bell)
(v) By friction in objects
(vi) By scratching or scrubbing the objects etc.

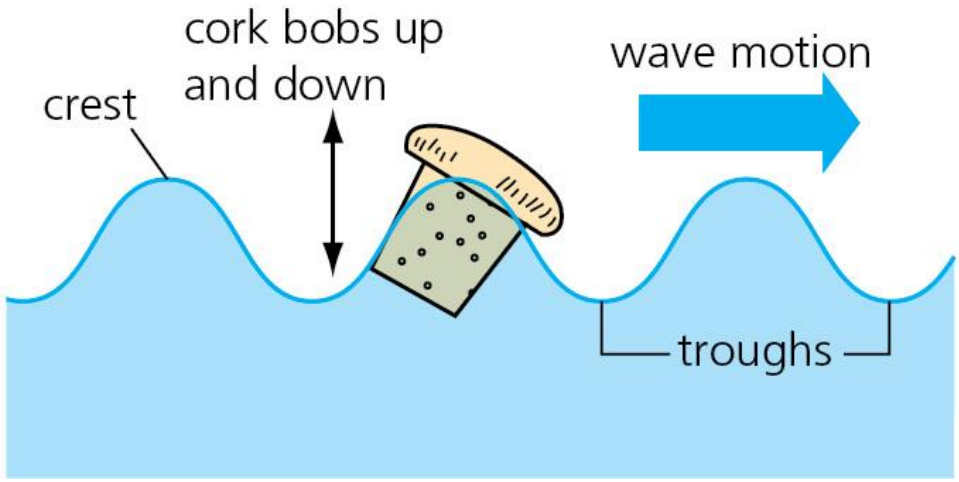


WHAT IS A WAVE ?

Definition : *The movement of the disturbance through a medium due to the repeated periodic motion of the particles of the medium about their mean position is known as wave.*

NOTE : Wave transfer energy and not the matter

To understand this put a cap of your water bottle on water and observe that ripple move the cap of the bottle up and down but the cap doesn't move from one point to another or (travel from one place to another).



Types of wave :

i. Mechanical wave
ii. Electromagnetic wave
iii. Matter Wave

In this chapter we will study about mechanical wave

Sound is a example of mechanical wave

MECHANICAL WAVE

A mechanical wave is a periodic disturbance which requires material medium (i.e. solid, liquid, gas) for its propagation.

In other words, *Waves that are characterised by the motion of particles of a medium are called mechanical waves.*

Examples of mechanical waves :

(i) Sound Waves in air.
(ii) Waves waves.
(iii) Waves produced due to the earthquake (known as seismic wave)
(iv) Waves produced to a supersonic jet planes. (known as shock wave)
(v) Waves produced in a streched string.
(vi) Waves produced in a slinky or a long spring.

Types of mechanical waves :

Mechanical Waves are of two types

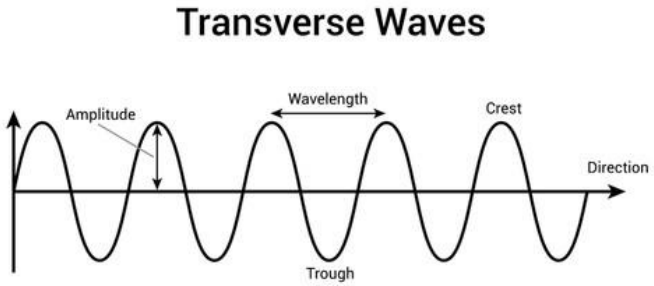
1. Transverse Wave 2. Longitudinal Wave

TRANSVERSE WAVE

If the particles of a medium vibrate or oscillate about their equilibrium positions in a direction perpendicular to the direction of propagation (i.e advancement) of the disturbance, then the wave is called transverse wave.

For Example :

(i) Wave produced in a streched string is a transverse wave.
(ii) Water wave are transverse waves.

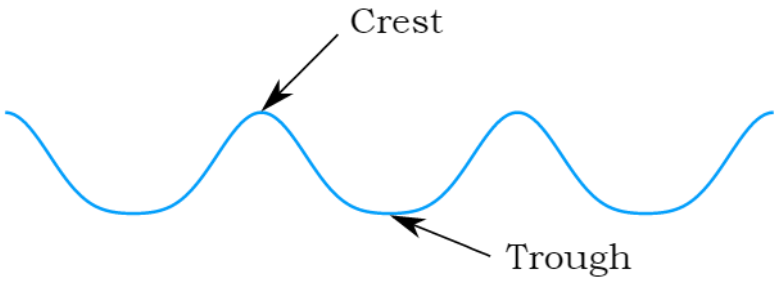


NOTE :

When transverse wave travels through the medium, the shape of the medium changes.

Crest : The highest point on the elevation of the medium whose distance from the mean position is maximum is known crest. (C)

Trough : The lowest point on the depression of the medium whose distance from the mean position is maximum is known as trough. (T)

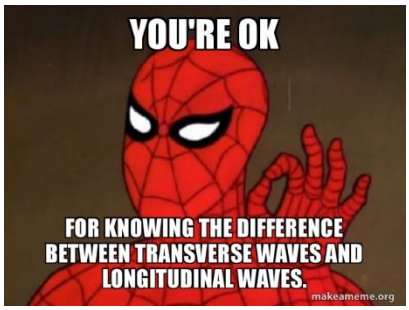


LONGITUDINAL WAVE

If the particles of a medium vibrate or osillate to and fro about their mean or equilibrium positions along the direction of propagation of the disturbance, then the wave is called longitudinal wave.

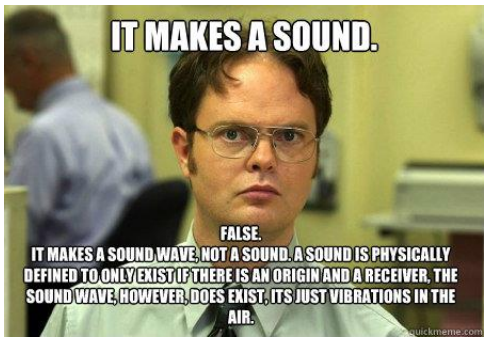
For Example :

(i) Sound waves are longitudinal waves.



PRODUCTION OF SOUND

When a body or an object vibrates, then the particles of the medium around the object are set into vibrations.



This is how, a sound wave propagates in a medium.

- Sound needs a medium to travel
- Sound waves are longitydinal waves.

Region where the number of particles strike against the neighbouring particles is large is known as **Compression (C).**

Region when the vibrating body moves backward is known as region of emptiness or **Rarefaction (R).**

ACTIVITY TO SHOW THAT SOUND NEEDS MEDIUM TO TRAVEL

Put an electric bell inside a closed glass jar connected with a vaccum pump. Initially, air from the jar is not taken out. Connect the electric bell with a battery. It rings and the sound produced is heard by us.

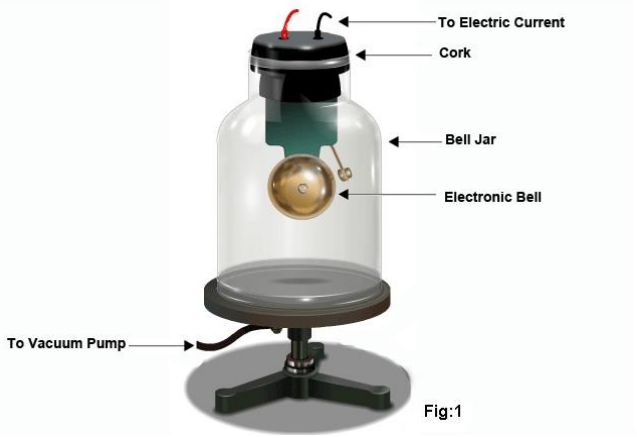


Fig:1

Now, start evacuating the air from a glass jar using a vaccum pump, we will hear less and less sound I.e the loudness of sound decreases. When there is no air in glass jar , we do not hear sound.

This activity shows that sound waves require medium for its propagation.

CHARACTERISTICS OF A SOUND WAVE

The characterstics or quantities to describe a sound wave are:

1. **Amplitude :** *The maximum displacement of a vibrating body or particle from its rest position is called amplitude.*
   S.I Unit : metre (m)

2. **Wavelength :** *The distance between two successive crest (compression) or trough (rarefractions) is known as wavelength of a sound wave.*
   S.I Unit : metre (m)
   Denoted by : λ (lambda)

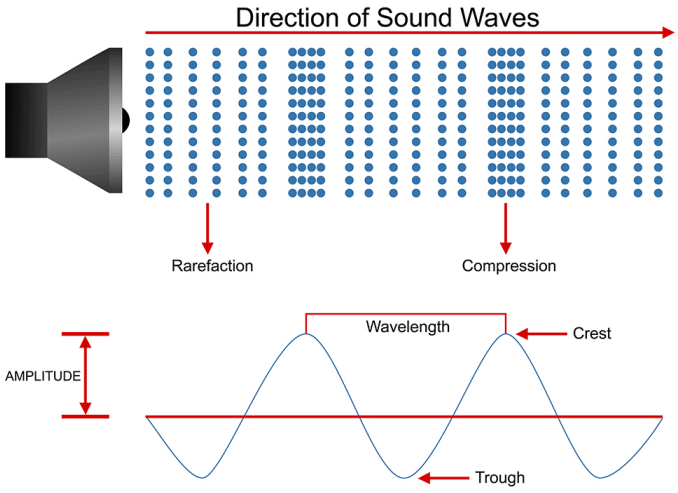
3. **Frequency :** *The number of compressions or rarefactions crossing a point per unit time is known as the frequency of sound wave.*
   Denoted by : ν (Neu)
   S.I Unit : **hertz** (Hz)

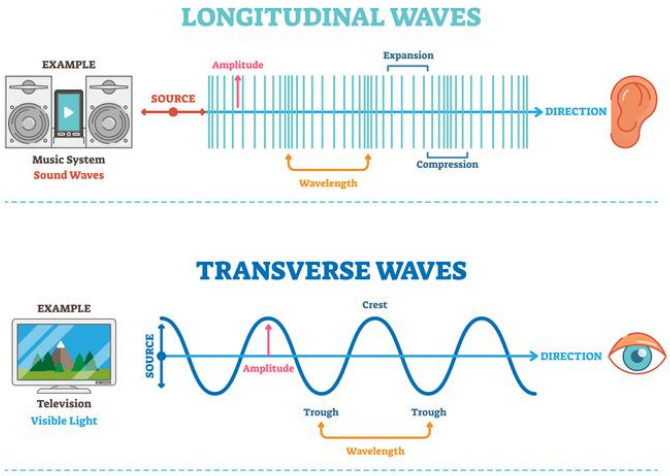
   1 hertz : *one oscillation completed by a vibrating body or a vibrating particle In one second.*

4. Time period : Time taken by two consecutive compression or rarefaction to cross a fixed point is known as time period.

It is denoted by : T

S.I Unit : second (s)





Relation between Frequency and time period

Let T = time period of a vibrating body.

Number of oscillation completed in T seconds = 1

∴ number of oscillation completed in 1 seconds = 1/T

But, Number of oscillation completed in 1 second = frequency (ν)

$$\therefore \nu = \frac{1}{T}$$

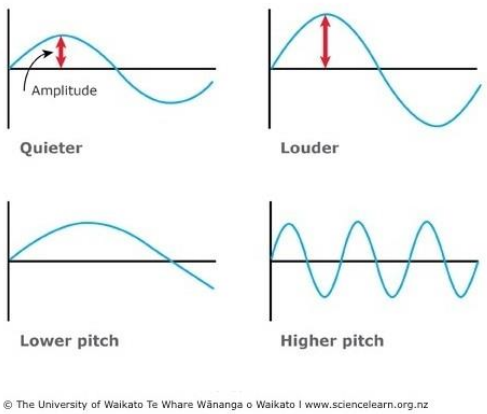
Thus, Frequency = $\frac{1}{Time\ Period}$

5. Pitch or Shrillness : Pitch Is the characteristic of a sound that depends on the frequency received by a human ear.

A sound wave of high frequency has high pitch and a sound wave of low frequency has a low pitch.

Woman has higher pitch than the voice of a man.

thus, frequency of woman's voice is higher than the frequency of man's voice.



6. Loudness : Loudness of a sound depends on the amplitude of the vibrating body producing the sound.

Loudness is a Subjective Quantity. It depends on the sensitivity or the response of our ears. A loud sound may be feeble sound for another person who is hard of hearing.

7. Timbre or Quality : Quality or timbre is a characteristic (i.e a typical feature) of a sound which enables us to distinguish between the sounds of same loudness and pitch.

Reason : The quality of two sounds of same loudness and pitch are distinguishable because of different waveforms produced by them.

8. Intensity : Intensity of a sound is defined as the sound energy transferred per unit time through a unit area placed perpendicular to the direction of the propagation of sound.

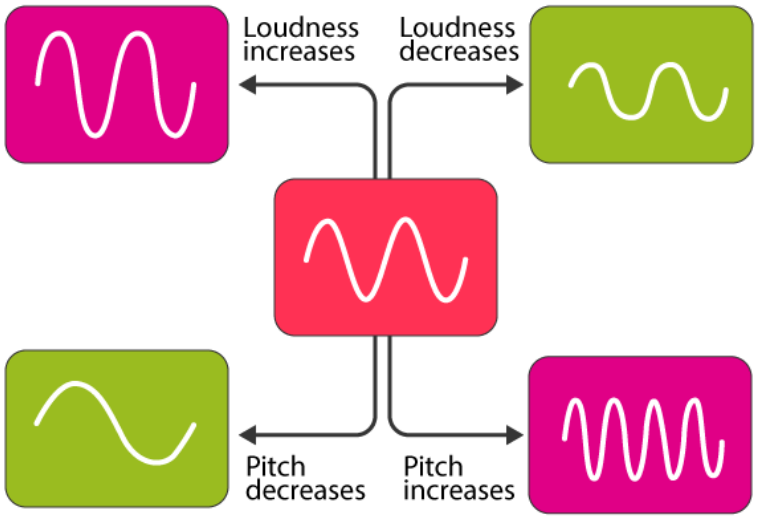
$$\text{Intensity of Sound} = \frac{Sound\ Energy}{Time \times Area}$$

Intensity of a sound is an **objective physical Quantity**. It does not depend on the response of our ears.

S.I unit : joule s^{-1} m^{-2} or watt m^{-2}

DIFFERENCE BETWEEN LOUDNESS AND INTENSITY OF SOUND

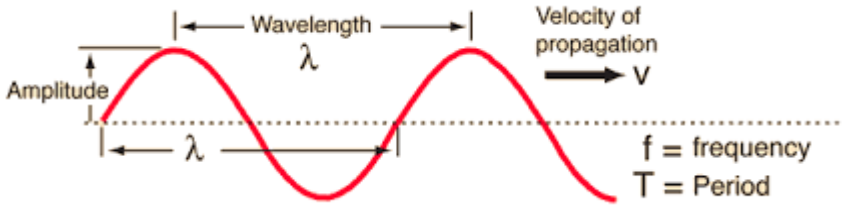
Loudness	Intensity
Loudness is the measure of response of the ear to the sound.	Intensity is the sound power per unit area.
Loudness is measured in decibels.	Intensity is measured in Watt per meter square.
Loudness is dependent on the sensitivity of the human ears.	Intensity is independent of the sensitivity of the human ears.
Loudness is a subjective quantity.	Intensity is an objective quantity.



RELATION BETWEEN WAVE SPEED, FREQUENCY AND WAVELENGTH

Let, Time period of vibrating body = T

Distance travelled by wave = λ



Now, Wave speed = $\frac{Distance\ travelled\ by\ wave}{Time\ take}$

$$\therefore wave\ speed, V = \lambda v$$

Thus, **wave speed = wavelength × frequency**

OSCILLATION :

The change in density or pressure from maximum value to minimum value and again to maximum value makes one oscillation.

NUMERICALS

Formula used : v = λv ; **Units :** v is measured in ms^{-2}, v in **Hz** and λ in **m**.

Q. A bat can hear sound of frequency 100kHz. Find the wavelength of the sound wave in air corresponding to this frequency. Given speed of sound in air = 344 ms^{-1}.

Q. Calculate the time taken by a sound wave of frequency 1000 Hz and wavelength 50 cm to travel a distance of 500 m.

Q. A sound wave has frequency 2 kHz and wavelength 40 cm. Calculate time it takes to travel 1.6 km.

Q. Audible range of frequencies is 20 Hz to 20,000 Hz. Find the range of wavelenghs corresponding to this frequency. Given, velocity of sound = 334 ms^{-1}.

Q. A source sound produces 20 compressions and 20 rarefactions in 0.2 seconds. The distance between a compression and the next rarefaction is 50 cm. Find the wavelength, frequency and time period of the wave.

Q. 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 kms^{-1}? The operating frequency of the scanner is 4.2 MHz.

Q. 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 (c) Velocity of sound wave.

Q. A wave pulse on a string moves a distance of 8 m in 0.5s, (i) Find the velocity of the pulse. (ii) what would be the wavelength of the wave on the string is its frequency is 200 Hz ?

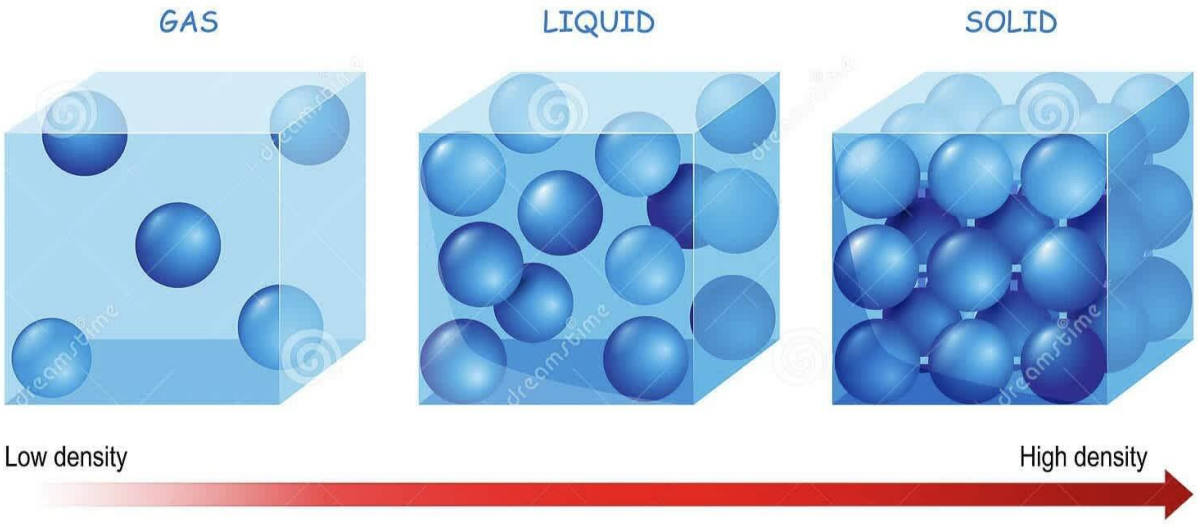
SPEED OF SOUND IN DIEFFERENT MEDIA

Sound travels with different speed in different media because, sound travels in a medium due to the transfer of energy from one particle to another particle of the medium.

Since, Particles of solid are very close to each other, the transfer of energy is very fast. Hence, **speed of sound in solids is large.**

In case of liquids, the distance between the particles are large as compared to solid, the transfer of energy is therefore slower as compared to solid. Hence **Speed of sound in liquids is less than the speed in solid.**

In case of gases, the particles are far away from each other as compared in case of solids and liquids, therefore the energy transfer is quite slow. Hence **speed of sound in gases is less than the speed of sound in liquid and solid.**



Conclusion : Speed of sound in solids is greater than the speed of sound in liquid and speed of sound in liquid is greater than speed of sound in gases.

Effects of temperature on the speed of sound.

The speed of sound in medium increases with increase in temperature, as the particles of medium collide more frequently and hence the disturbance spread faster.

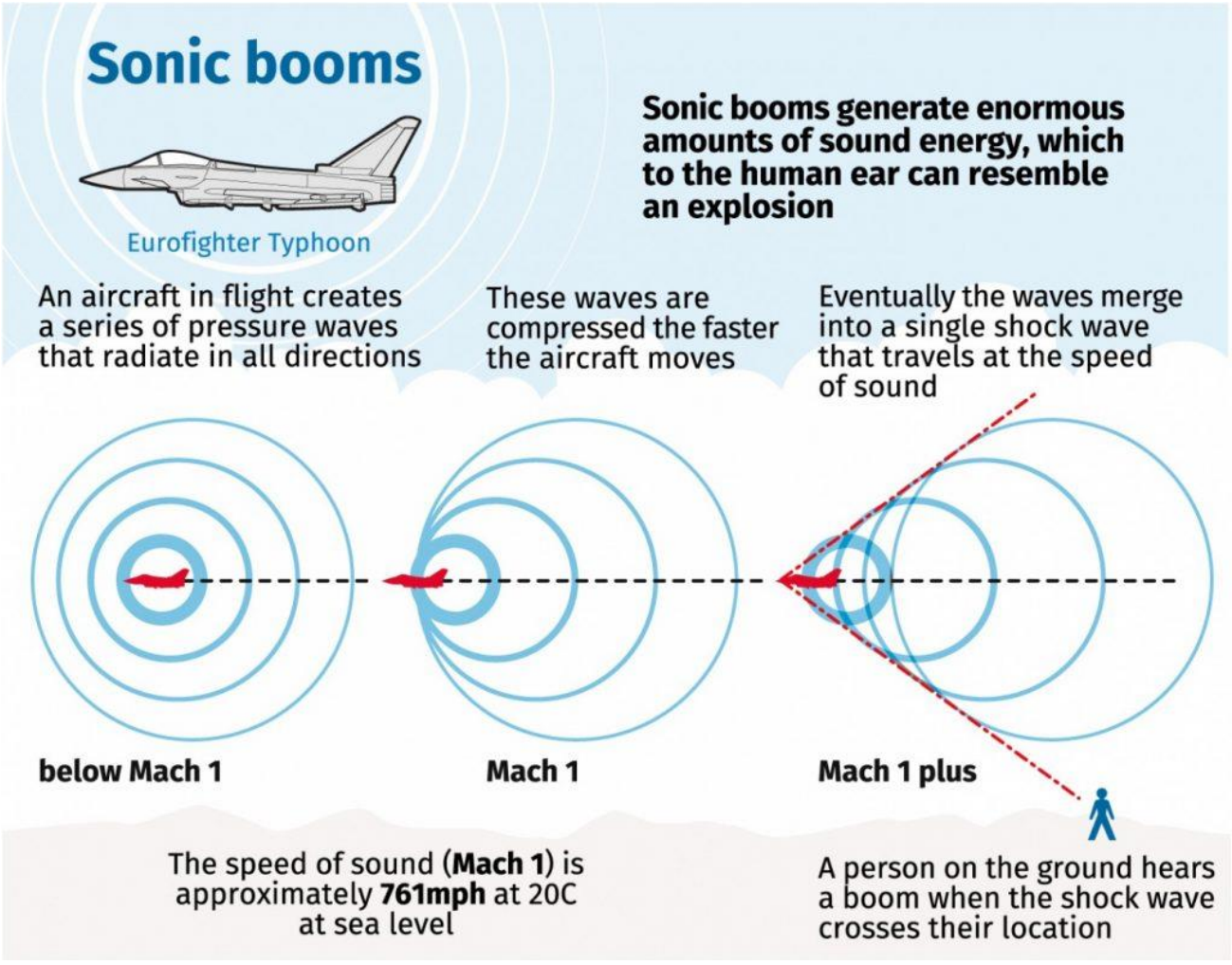
Speed of sound in medium ∝ Temperature of medium

SHOCK WAVES – SONIC BOOM

The speed of any object moving faster than the speed of sound is known as **supersonic speed.**

When an object is moving with supersonic speed, then sound waves produced by them are piled in the form of cone-shaped wave known as **shock wave.** (highly compressed air)

The shock wave produces a very loud sound called **Sonic Boom**.



When a shock wave produced by a supersonic jet aircrafts strikes a building, the glass window panes start rattling and sometimes even get break.

Reason : This is because, the large energy carried by shock wave forces the glass window panes to vibrate violently. As a result of these variations, the glass window panes may break.

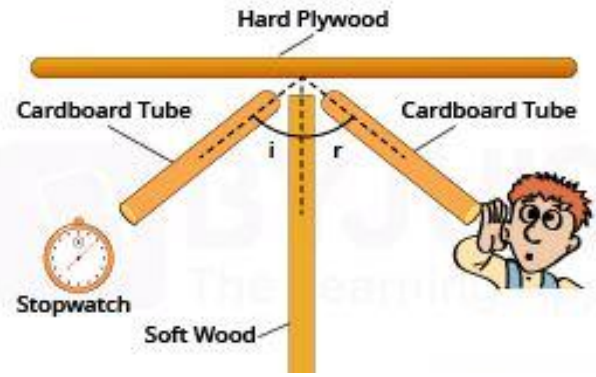
REFLECTION OF SOUND

Definition : When a sound wave travelling in a medium bounces back to same medium after stricking the second medium.

Laws of Reflection of Sound :

(i) Incident angle = Reflected angle

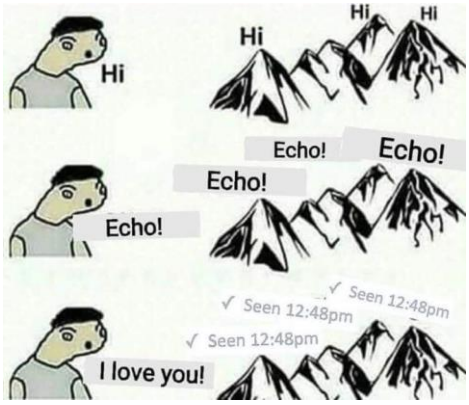
(ii) The incident direction of sound, reflected direction of sound and the normal to point of incidence all lie at the same plane.



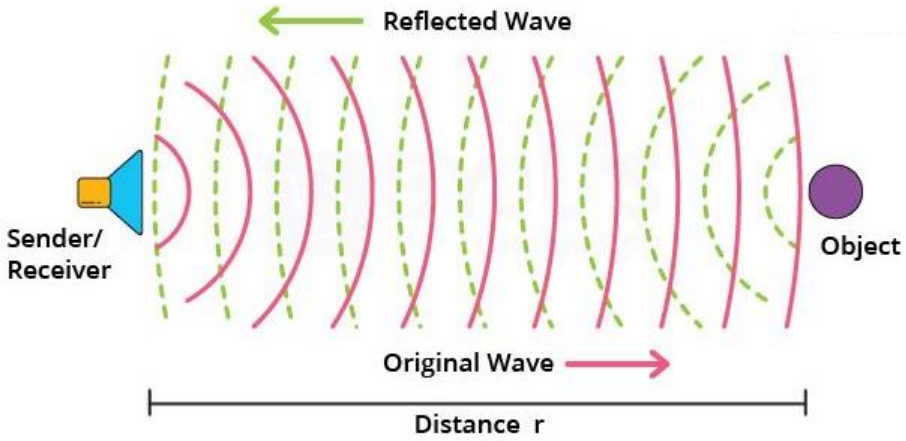
ECHO

Definition : *Echo is a repetition of sound due to the reflection of original sound by a large and hard obstacle.*

Conditions for the production of an echo



1. **Time gap between the original sound and the reflected sound.**
   → Echo will be heard if the original sound reflected by an obstacle reaches our ears after 0.1 s.
2. **Distance between the source of source and obstacle.**
   → Echo is heard only if the minimum distance between the source of sound and the obstacle is 17 m.
3. **Nature of the obstacle**
   → The reflecting surface or the obstacle must be rigid such as building, hill or cliff.
4. **Size of the obstacle**
   → The size of obstacle must be large.

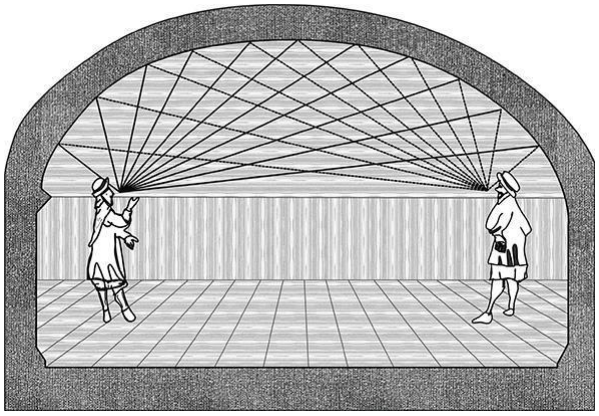


We can hear two sounds separately if the time gap between these two sound is more than 1/10th s or 0.1 s. the time interval of 0.1 s is known as **peristance of hearing.**

MULTIPLE ECHOES

When a sound wave is reflected many times by an obstacle, multiple echoes are heard.

Whispering Galleries : A whis pering gallery is a dome shaped st ructure.



Example :

i. Multiple echoes are heard when sound is produced between two distant hills or buildings or cliffs
ii. Multiple echoes are heard due to successive reflections of sound of thunder from various reflecting surface.

REVERBERATION

In big rooms and halls, echoes follow so closely behind the original sound that the original sound appears to be prolonged even when the source of sound stops producing sound. This effect of sound is known as **reverberation.**

Reverbation time : *The time interval for which the original sound appears to be prolonged.*

How to decrease the reverberation time ?

i. By using sound absorbing materials in auditorium.
ii. Windows of the auditorium are covered with heavy curtains.
iii. Special tiles known as acoustic tiles are used for flooring of auditorium.
iv. Padded seats are arranged in the hall.
v. Some plants in pot are also arranged in the hall to reduce the reverberation time.

USES OF MULTIPLE REFLECTION OF SOUND

1. **Megaphone** : Device used to address public meetings.
2. **Hearing aid** : Electronic device designed to amplify sound for person who is hard hearing.
3. **Sound boards** : Sound board are curved surface are used in big halls.
4. **Sterthoscope** : Device used by doctors to listen sound of hearts and lungs.
5. **Ceilings of concert halls are curved.**

RANGE OF HEARING (i.e AUDIBLE RANGE)

The waves having frequency between 20 Hz to 20,000 Hz are known as sound waves. Thus, the audible range of frequency is 20 Hz to 20,000 Hz.

The waves having frequency less than 20 Hz and greater than 20,000 Hz cannot be heard by human ear.

Infrasonic or Intrasound.

The waves of frequency less than 20 Hz are known as infrasonic waves.

Animals like elephants, rhinoceroses and whales etc produces infrasonic waves.

It has been observed that animals behavious becomes unusual just before the tremor is felt.

Reason : This is because the animals has the ability to detect infrasonic waves produced at the time of tremor.

Ultrasonic or Ultrasound.

The waves of frequency greater than 20,000 Hz are known as Ultrasonic waves or Ultrasound.

Bats and Dolphins catch there prey using ultrasonic waves.

APPLICATION OF ULTRASOUND (ULTRASONIC WAVES)

Ultrasonic waves have number of uses :

A. For Communication

1. Ultrasonic waves are used to establish underwater communication.
2. Ultrasonic waves are used to determine the depth of sea. It is done with the help of SONAR.

B. Industrial Uses

1. Used for cleaning hidden parts of an instrument. This is known as Ultrasonic Cleaning.
2. Used for welding plastic.
3. Used to find faults and cracks in metals.

C. Medical Uses

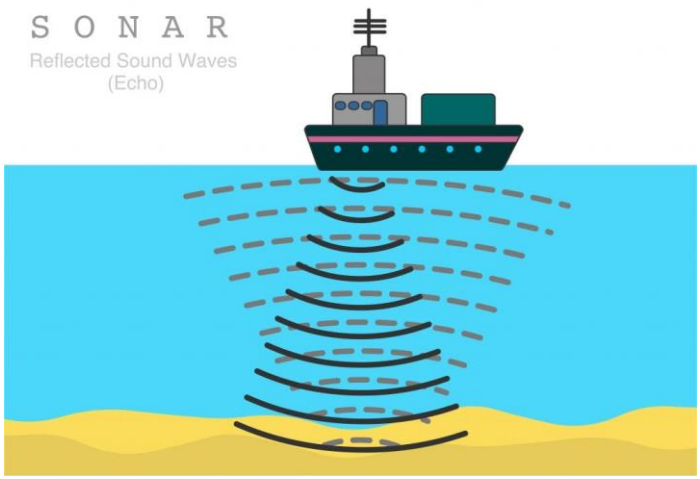
1. Used for diagnosing the diseases in human body.
2. Used to kill bacteria in liquids.
3. Used to study the development of an unborn child.
4. Echocardiography : it Is medical diagnostic technique in which ultrasonic waves are used to construct the image of heart.

SONAR

SONAR stands for **Sound Navigation and Ranging.**

It is a device which is used in the ships to locate rocks, icebergs, submarines, old ships sank in sea etc. It is also used to measure the depth of a sea.

Principle : It is based on the principle of the reflection of sound wave (i.e echo).



Determination of the depth of a sea using Sonar.

A beam of ultrasonic waves from the transmitter of a SONAR fitted on the ship is sent towards the bottom of the sea. This beam is relected back from the bottom of the sea and is received by the receiver or detector of the SONAR ship.

Let 't' time taken for ultrasonic wave to go and come back to the ship. Therefore time taken for ultrasonic wave to reach the bottom is t/2 seconds.

Using, S = v $(\frac{t}{2})$ we can find depth of sea.

Method of finding the distance of object using echo is called **echo-ranging**.

The method of finding the depth of sea using echo is called **echo-depth ranging.**

In this case, SONAR is called **fathometer.**

NUMERICALS

Formula used : S = $vt/2$; **Units :** v is measured in ms^{-2}, t in **s** and S in **m**.

Q. A boy blew a whistle while standing in front of a cliff. He heard the echo after 2s. Find the distance of the cliff from the boy if the velocity of sound in air is 332 ms^{-1}.

Q. A sonar device fitted in a submarine receives receives ab echo 4s later the signal is transmitted towards another submarine 3060 m away. Find the speed of sound in water.

Q. A boy dropped a stone in a well 45m deep. If speed of sound is 340 ms^{-1}.then after how much time, he will hear the splash ? Take g = 10 ms^{-2}.

Q. A ball is dropped into a pond from height of 44.1 m. The splash of sound is heard 3.13s after the ball is dropped. Determine the velocity of sound in air.

Q. In a submarine fitted a SONAR, the time interval between the generation of an ultrasonic wave and the receipt of its echo from an enemy submarine is 200s. What is the distance of the enemy submarine ? Speed of sound in water = 1450 ms^{-1}.

Q. A person was standing between two vertical cliffs such that he was 640m away from the nearest cliff. When he shouted, he heard the first echo after 4s and the second echo 3s later. Calculate :

(a) Velocity of sound in air

(b) distance between the cliffs.

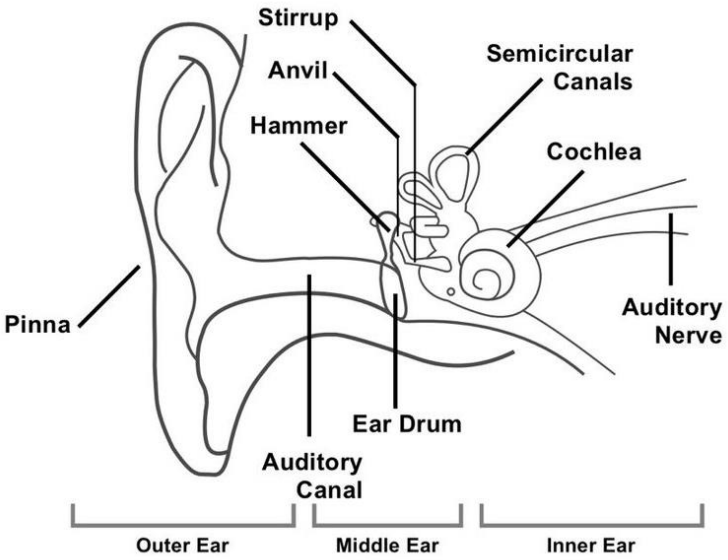
STRUCTURE OF HUMAN EAR (HEARING DEVICE)

The human ear is divided into three parts :

→ External Ear

→ Middle Ear

→ Inner Ear



- The external ear is known as **Pinna.** This collects the sound and sends it to the auditory canal.
- The sound in the form of compression or rarefaction reaches **ear drum.**
- When the compression or rarefaction strike the ear drum, the ear drum beings to vibrate.
- These vibration are transmitted across the middle ear by the **three ossicles** (the hammer, the anvil, and the stirrup).
- The vibration produced by eardrum are amplified by the three ossicles. The amplified vibrations are then transmitted to the **cochlea.**
- Cochlea is a coiled and fluid filled tube having the sense organ of hearing. The movement of the fluid in the cochlea due to vibrations stimulates the **auditory nerve**.
- The impression is carried by the auditory nerve to the brain. This impression is interpreted as sound by the brain.

Pinna → Ear drum → Three Ossicle → Cochlea → Auditory nerve → Brain

Important NCERT Questions

Q1. 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?

Sol. Speed of sound = 339 m/sec.

Wavelength $\lambda = 1.5\ m = 0.015\ m.$

$$\text{Frequency} = \frac{\text{Speed}}{\text{Wavelength}} = \frac{339}{0.015} = 22600\text{Hz}.$$

It will not be audible.

Q2. What is sound and how is it produced ?

Sol. Sound is mechanical energy which produces a sensation of hearing. When an object is set into vibrations, sound is produced.

Q3. City an experiment to show that sound needs a material medium for its propagation.

Sol. Take an electric circuit which consists of a cell, a switch and an electric bell 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. When there is air within the bell jar, sound is heard. Air is now pumped out of the bell jar. When the air is completely removed from the bell jar, no sound is heard as it is obvious from fig. because the medium of air which has to carry energy from the bell to the bell jar is removed. It shows that sound needs material medium for its propagation.

Q4. Why is sound wave called a longitudinal wave?

Sol. Sound wave is called longitudinal wave because the particles of the medium vibrate in the direction of the propagation of wave.

Q5. Flash and thunder are produced simultaneously. But thunder is heard a few second after the flash is seen, why?

Sol. Speed of sound is 330 m/sec in air medium at 0°C. Whereas speed of light is 3×10^8 m/sec.When we compare the speed of light with that of speed of sound, speed of light is greater than that of speed of sound. Therefore, thunder is heard a few seconds after the flash is seen.

KUCH QUESTIONS KHUD SE BHI KRO !!!

Q6. 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 ms^{-1}.

Sol. When $v = 20$ Hz

Speed of sound in air = 344 m/s.

Wavelength, $\lambda = ?$

Speed = wavelength × Frequency

$$\therefore \text{ Wavelength} = \frac{\text{Speed}}{\text{Frequency}} = \frac{344}{20} = 17.2\text{m}.$$

When $V = 20$ kHz

Speed of sound in air = 344 m/s.

$(\text{speed}), \upsilon = V \times \lambda$

$$\lambda = \frac{V}{v} = \frac{344}{20,000} = 0.0172\,\text{m}.$$

Thus, the wavelength of sound corresponding to 20 Hz and 20 kHz is 17.2 m and 0.0172 m respectively.

Q7. 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.

Sol. Speed of sound in air, $V_1 = 346$ m/sec

Speed of sound in aluminium, $V_2 = 6420$ m/sec.

Let the length of the aluminium rod = x m.

$$\text{We know that speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{Time} = \frac{\text{distance}}{\text{speed}}$$

$$\text{Time taken in air} = \frac{x}{346}\text{sec}. \qquad (\text{distance} = x\text{ m})$$

$$\text{Time taken in aluminium} = = \frac{x}{6420}\text{sec}.$$

$$\text{Required ratio} = \frac{\frac{x}{346}}{\frac{x}{6420}} = \frac{x}{346} \times \frac{6420}{x} = 18.55$$

Q8. The frequency of a sources / sound is 100 Hz. How many times does it vibrate in a minute?

Sol. Frequency of sound = 100 Hz.

Time taken = 1 minute = 60 sec

$$\text{We know, Frequency} = \frac{\text{No. of oscillations}}{\text{Time taken}}$$

$\therefore$ No. of oscillation = $v \times t$

$= 100 \times 60$

$= 6000$ times.

Q9. Explain how bats use ultrasound to catch a prey.

Sol. Bats search out its prey by emitting and detecting reflections of ultrasonic waves. The high-pitched ultrasonic squeaks of bat are reflected from the obstacles or prey and return to bat's ear. The nature of reflection tells the bat where the obstacle or prey is and what it is like.

Q10. How is ultrasound used for cleaning?

Sol. Ultrasound is used to clean parts located in hard-to-reach places (i.e.) spiral tube, odd shaped parts, electronic components etc. Objects to be cleaned are placed in a cleaning solution and ultrasonic waves are sent into the solution. Due to the high frequency, the dust particles, grease get detached and drop out. The objects thus get thoroughly cleaned.

AB PHOD DO !!!

This Chapter Ends here !! But not your work

Go to Practice Questions, Solve Dpps attend MCQs and revise the notes after some 2nd 4th and 7th day

To get 95+ you have to keep on revising what you studied.

[Remember Consistency and HardWork Gives Great Result]

NOTES MADE BY

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