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Sound is a form of energy. It is produced when something vibrates.

For example sound is produced when we pluck a guitar string or bang a drum or when we talk (the vocal cord vibrates). Mosquitoes produce sound by flapping their wings very quickly.

Vibration

Vibration means back and forth (or up and down) movement of an object. For example:

1. A guitar string moves back & forth (vibrates) when we pluck it.
2. When we 'speak' our vocal cord vibrates.

Vibrations are important because vibrations produce sound.

Methods of producing sound in the laboratory'?

1 Producing sound using tuning Fork & water.

Material needed: Tuning Fork, a bowl of water and rubber pad.

Procedure:

1. Strike the tuning fork gently on a rubber pad.
2. It will start vibrating & will produce a humming sound.
3. Touch the vibrating fork gently on the surface of water. You will observe splash or ripples on the water surface.

Summary:- We know that vibrating objects produce sound. Here the prongs (arms of tuning fork) are vibrating. When a vibrating tuning fork comes in contact with air, the air particles start vibrating. These vibrations are what we call **sound**.

Similarly when the tuning fork touches the water surface, it makes the water vibrate and we see the ripples.

2 Producing sound using a Ruler on Desk.

Material needed: A plastic or wooden ruler, a table or desk.

Procedure:

a. Place the ruler on the desk such that a part of the ruler hangs from the edge.
b. Press down and release the ruler. It will start vibrating and will produce a buzzing sound.
c. We can try changing the length of ruler hanging off the desk:-
    - More length hanging- Deeper sound (sound pitch) - slower vibrations.

- Less length hanging - sharper sound (higher pitch)- faster vibrations.

3 Producing sound using a spring.

Material needed. Spring, two students.

Procedure:

a. One student held one at the end of the spring.
b. The second student pulled the spring & let go.
c. We will observe waves forming in the spring.
d. The spring will vibrate back & forth. These vibrations will produce sound.

Sound & the Particle model of matter

The particle model of matter states that every matter is made up of particles (atoms and molecules).

In solid the particles are arranged in a fixed pattern. In liquid the particles can slide past each other. In gases the particles are moving randomly in all directions.

How does a tuning fork produce sound?

A tuning fork produces sound when its prongs are vibrating.

a. When the prongs move outward, they push the air particles together.
b. The air particles come very close to each other. This region of air where particles are very close to each other is called COMPRESSION.
c. When the prongs move inwards, the air particles get space to spread out. This region where particles are spread out is called RAREFACTION.

d. When prongs of a tuning fork vibrate, these compressions & rarefactions get created and they travel in air & reaches to our ear in the form of sound.

Remember

Compressions are regions of high pressure (more particles per volume), rarefaction are regions of low pressure (lesser particles per volume).

Very Important: In compression & rarefactions, the particles (atoms & molecules) are not compressed or stretched. The particles are just brought closer together and then allowed to spread out. ***So remember, particles are not compressed.***

Propagation of Sound in Different media

Sound moves through a medium when the particles of the medium vibrate.
Solid, Liquid and Gas are medium containing particles (atoms & molecules). Hence sound can travel through them. So basically sound need particles in a medium for its movement.

Vacuum

A vacuum is a region of space which has no particles (atoms & molecules). Since vacuum does not have any particles, hence nothing can vibrate to carry the sound. **So we can say that sound cannot travel through a vacuum.**

Speed of sound in different media

Speed of sound is maximum in Solids, intermediate in Liquids and minimum in gaseous.
So speed of sound varies as

Gases < Liquids < Solid

Reason: We know that sound travels through the vibration of particles. It means one vibrating particle will set the neighbouring particle in vibration.

a. In solids, particles (atoms/molecules) are closely packed together. So they can transfer vibration very easily. Hence sound travels fastest in solids.
b. In liquids, the particles are a little bit apart than in solid. Hence vibrations take a long time to move. So sound travels slower in liquids than in solids.
c. In gases, the particles are very far apart from each other. Any vibrating particle will pass on the vibration when it touches other particles. This slows down the speed of sound. Hence sound travels slowest in gases.

Speed of sound (in m/s)		
Solids	Liquids	Gases
5000 – 6000	1500	340

Summary

1. In solids, particles are very close so vibrations move quickly.
2. In liquids, particles are a bit far apart so vibration slows down.
3. In gases, particles are very far apart, vibrations take a lot of time & hence speed is minimum.

Reflection of Sound

You may have observed that when we throw a ball towards a wall, the ball hits the wall and bounces right back to us. This is known as **Reflection**.

In the same way, sound is also reflected when it hits a surface.

1. Good reflectors of sounds:- Hard and smooth surfaces like walls, floors, ceiling, mountains are very good reflectors of sound.
2. Bad reflectors of sound:- Soft and spongy materials like carpets, curtains or foam absorb sound waves. They are good absorber of sound.

Echo

An echo is a reflected sound. When sound bounces back from a surface, it is called echo. You may have observed that when you shout "HELLO" near a mountain, then you hear "HELLO" again after a short time. This is known as echo.

Why does it happen? Sound waves travel through air, reach and hit the mountain surface and get reflected from it. The reflected sound is called echo.

Important fact: The human brain needs a difference of at least **0.1 seconds** between the original sound & the reflected sound to hear them as separate sounds.

It means we can hear an echo clearly only when the reflected sound (echo) comes at least 0.1 seconds later than the original sound.

It means the reflected sound must come 0.1 seconds after the original sound.

Now we know that speed of sound in air is 340 m/s

Speed = 340m/s

Time duration = 0.1 seconds

Now sound must go to wall & get reflected & come back in 0.1 second

So distance travelled by sound in 0.1 second

Distance = Speed x Time

= 340 x 0.1

= 34 meters.

So sound must travel at least 34 meters. So the wall/mountain must be at least 17 meters away from you (34 ÷ 2 = 17).

Imagine you are standing in front of a wall/mountain. You shout any word, say "HELLO". The sound goes to the wall & gets reflected back and reaches back to you.
You can hear echo clearly if the reflected sound comes after at least 0.1 second after the original sound.

Reverberation

Imagine you are standing in a hall and you shout something. Your sound goes in all directions, reaches the walls, floors and ceiling and gets reflected back. If the hall is not very large, then all the reflected sound mixes with the original sound.

Also since the hall is not very large then the sound keeps bouncing back and forth between the walls & ceiling. So you can hear a **very long sound**. This is known as **Reverberation**.

Reverberation means repeated reflection of sound from the floor, walls & ceilings of a room which make the sound appearing longer than original.

We can hear Reverberation in large halls, empty rooms or Auditoriums.

How to stop Reverberations? We can use Sound absorbing materials like Curtains, Carpets, foam & furniture in the room or auditorium. These materials absorb sound and hence do not cause reverberations.

Difference between Echo & Reverberation

Echo	Reverberation
Time gap of at least 0.1 second between original & reflected sound	Time sap of **less than** 0.1 second between original & reflected sound.
Echo happens in open space like hills & mountains.	Reverberations occur in closed space like Halls & Auditorium.
Echo is heard as a separate sound.	Reverberation is heard as a continuous, persisting sound.
Example: Saying HELLO near a mountain.	Clapping in an empty Hall

Problem: why do we cup our hands around the mouth to shout louder?

Solution: we focus the sound in a particular direction by cupping our hand. Generally sound travels in all direction and hence sound energy gets lost. To reduce the spreading & loss of energy, we cup our hands.

Problem:- Why do we cup our hands to our ears to hear a whisper?

Solution: We cup our hands to collect more sound waves. It will help to hear better.

The hands works like a funnel, collecting more sound and directing it to the ear.

Parabolic Reflector of Sound

A parabolic reflector is a curved surface like a dish used to collect sound waves and focus them at one point (called the focus).

Uses of Parabolic Reflector of Sound:

1. In labs, they are used to show how sound can be collected & focused.
2. Hearing wildlife like the sounds of birds & animals.

Diagram: