Revision Notes for Class 9 Science

Chapter 11 – Sound

Introduction

- You've discovered that sound is a type of energy. Vibrations cause it to happen. Longitudinal waves are sound waves. Because they are elastic waves, they must be transmitted through a material medium. They are not capable of being communicated in a vacuum. They can move through solids, liquids, and gases. In solids, their velocity is greatest, whereas in gases, it is lowest.

- In our daily lives, we hear a variety of sounds: pleasant sounds termed musical sounds, unpleasant noises called noise, loud sounds, high pitched sounds, and so on.

- In this chapter, we'll look at the differences between pleasant and unpleasant sound, as well as the elements that influence loudness, pitch, and other aspects of sound.

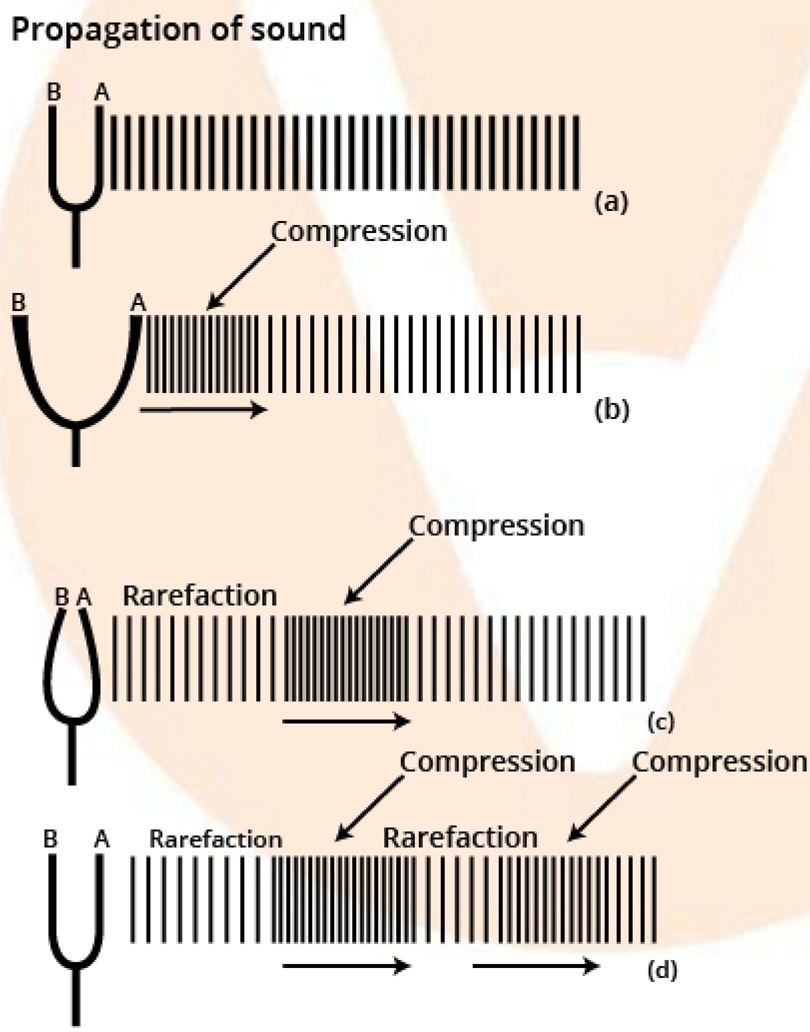
Sound as a Wave

- To us, a ringing bell, a thunderclap, laughter, and rock music are all very different noises. However, because all sounds are waves, they are all the same. Let's look at how wave qualities can be used to apply to sound.

- Sound is a kind of energy that is sent as waves and received by our ears. Our vocal cords vibrate as we talk. When we play a guitar, the spring moves back and forth, producing sound. The vibrations of a tuning fork also make sound. As a result of its vibrations, a body makes sound. Sound waves can't travel in vacuum, hence they need to travel through a material medium.

- You can hear because sound waves cause your eardrums to vibrate when they reach your ears. The vibrations are then relayed to your brain by nerves. The messages are translated into sound by the brain.

Propagation of Sound



Propagation of sound waves in air from a tuning fork:

- A longitudinal wave is a wave motion in which the particles of the medium oscillate about their mean positions in the wave's propagation direction.

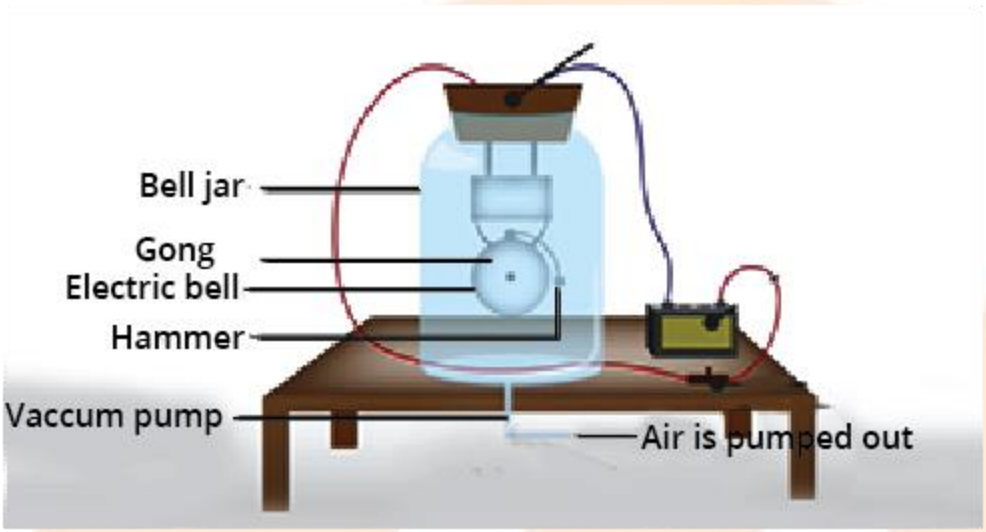
- Longitudinal waves are the most common type of sound wave. Let's look at how sound waves travel. Take a tuning fork and shake it while focusing on one of the prongs, say prong A. The tuning fork's typical position and the initial state of air particles are depicted in the diagram (a). As prong A advances to the right, air particles near it are compressed, generating a compression as depicted in fig (b). This compression proceeds forward as a disturbance due to vibrating air layers.

- The pressure on prong A's right lessens as it returns to its previous position, generating a rarefaction. As a disturbance, this rarefaction travels forward like compression. As the tuning fork continues to vibrate, waves of alternated compressions and rarefactions propagate through the air, as shown in fig (d). Because sound waves travel in the same direction as air particles, they are classed as longitudinal waves. Longitudinal waves take the shape of compressions and rarefactions as they travel.

Sound Needs a Medium to Travel

Some vibrating body is always the source of sound. The vibrations of the source may be so small or so enormous that they are impossible to detect in some situations. Tuning forks, drums, bells, guitar strings, and other instruments produce this type of vibration. The vibrations of the vocal cords give rise to the human voice, and the vibrations of the air columns give rise to musical instrument sound. Sound travels in the form of a longitudinal wave that needs to be propagated through a material medium.

Experiment to show that sound waves (mechanical waves) require a material medium for its propagation:



Electric bell suspended inside an airtight glass bell jar

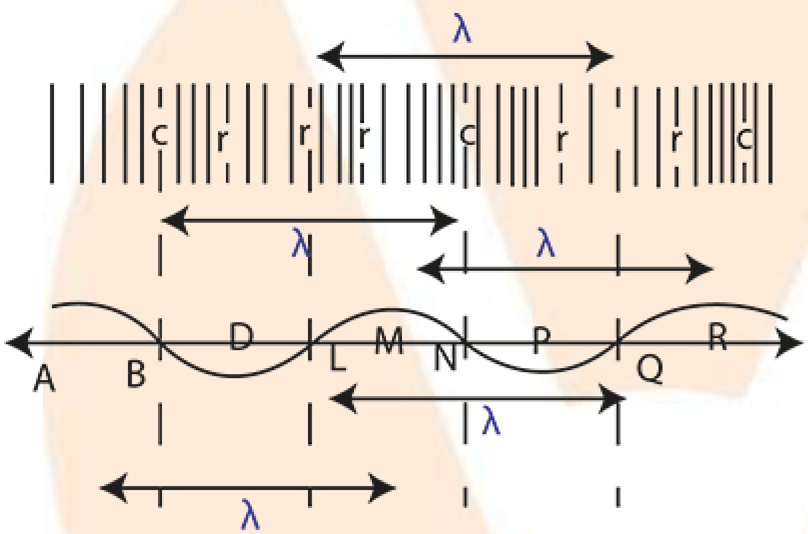
A vacuum pump is attached to an electric bell hung inside an airtight glass bell jar. The sound is heard as the electric bell circuit is finished. After the air in the bell jar is gently withdrawn with a vacuum pump, the strength of the sound gradually decreases until no sound is heard when all of the air is removed. We would observe the hammer continually striking the gong. This clearly demonstrates that sound propagation requires the presence of a substance. Not only can sound travel through gases, but it can also travel through solids and liquids. Some materials, such as air, water, and iron, are good at transmitting sound energy from one location to another. Materials like blankets and thick curtains, on the other hand, absorb the majority of sound energy.

- **Basic Terms Connected to Waves:**

Wavelength, Amplitude, Frequency, and Wave Velocity are the four key terms in the study of waves.

The distance between two consecutive spots on a wave that are in the same phase is known as the wavelength. (The same phase denotes the same vibrational state.)

The largest displacement of a particle from its mean position is called amplitude. The number of periodic oscillations completed in one second is known as frequency. The frequency f = 1/T, where 'T' is the time it takes for one oscillation to complete. The hertz Hz is the unit of measurement. The wave velocity 'v' is the rate at which energy propagates through a medium.



Sound wave

The product of the wavelength and frequency gives us the wave velocity because wavelength is the distance travelled during one oscillation and frequency is the number of oscillations per second.

Distance travelled in 1 s = number of waves in one-second x wavelength

Wave velocity = Frequency × Wavelength

or,

v = f (x)

Speed of Sound:

Although both occur at the same time, the flash of lightning caused by cloud interaction is noticed considerably before the thunder. This occurs because the speed of light is faster than the speed of sound. The qualities of the medium through which sound travels determine its speed. The medium's elasticity, density, pressure, and temperature can all change. As sound goes from a solid to a gaseous state, its speed reduces. However, in any medium, the speed of sound increases as the temperature rises. The table shows the sound speed in various mediums at different temperatures.

Speed of sound in different media at 25°		
State	**Substance**	**Speed in m/s**
Solids	Aluminium	6420
	Nickel	6040
	Steel	5960
	Iron	5950
	Brass	4700
	Glass(Flint)	3980
Liquid	Water (Sea)	1531

	Water(distilled)	1498
	Ethanol	1207
	Methanol	1103
Gases	Hydrogen	1284
	Helium	965
	Air	346
	Oxygen	316
	Sulphur dioxide	213

Reflection of Sound:

- When sound collides with a solid or liquid surface, it bounces back like light rays. The rules of reflection and refraction apply to sound waves as well. In order for sound waves to reflect, we need a huge surface or obstruction. The rolling of thunder, for example, is caused by consecutive reflections from clouds and terrain surfaces.
- The directions in which sound is incident and reflected make equal angles with the normal to the reflecting surface, and the three lie in the same plane, according to the rule of sound reflection.

Echoes:

Sound waves, like all waves, can be reflected. The enormous obstructions cause sound waves to be reflected. An echo is a sound that is heard as a result of a sound wave being reflected by a huge obstruction. Echo is normally undetectable because the reflected sound is integrated with the original sound. To hear an echo clearly, certain requirements must be met (as a separate sound). The experience of any sound lasts roughly 0.1 seconds in our ear. This is referred to as hearing persistence. The original sound and its echo cannot be separated if the echo is heard within this time span. The most critical criterion for hearing an echo is that the reflected sound should reach the ear only after the original sound has died off for at least 0.1 second. Because sound travels at 340 metres per second, the distance travelled by sound in 0.1 The second is 34 metres. This distance is twice the minimum distance between a sound source and a reflector. If the obstruction is at least 17 metres away, the reflected sound or echo can be clearly heard after 0.1Second.

Furthermore, for any wave to be reflected, the size of the reflector must be big in comparison to the wavelength of the sound, which is on the order of 1 metre for ordinary sound. An echo can be produced by a large building, a mountainside, or a large rock formation, among other things. In addition, the reflected sound must have sufficient strength or volume to be heard. Furthermore, the echo and the original sound should not mix or overlap if the echo is to be differentiated from the original sound. The original sound, such as a clap or a shout, should be very short in duration for this.

As a result, the following conditions could be listed for echo formation:

- The obstacle/reflector must be large in comparison to the incident sound wavelength (for reflection of sound to take place).
- There should be at least 17 metres between the sound source and the reflector (so that the echo is heard distinctly after the original sound is over).
- The sound's intensity or loudness must be adequate for the reflected sound to be audible when it reaches the ear. The original sound should only last a few seconds.

Echoes' Benefits and Drawbacks:

- Echoes can be beneficial or annoying. If the walls and roof of a music hall are not appropriately built, echoes might disrupt a performance.

- Echoes can be used to provide critical information if the walls are too hard or too flat to reflect sound waves. A ship's sonar device (Sonar stands for sound navigation ranging) emits high-frequency sound waves to determine how close the ship is to the seabed. An ultrasound scanner, which is best known for producing images of an unborn baby, works in a similar way.

- As they fly through the night, bats use echoes to navigate. It works in the same way as sonar and ultrasound scanners do. The bat emits a series of small, high-pitched squeaks that bounce off the objects along its route. The bat hears the echoes and changes its trajectory to avoid the obstacles. Many bats have big ears in order to capture as much reflected sound as possible.

- It's called echo locating when creatures like bats and dolphins use echoes. They use it to find their way about and hunt for prey. Some animals use echolocation to determine the size and location of items in their environment.

- Bats use echolocation to guide them in flying at night. They fire off a series of tiny 'clicks,' which bounce off things and return to the bat. It creates a "sound" image of its surroundings.

Reverberation:

- A sound made in a large hall will persist due to light reflection until it is lowered to a level where it is no longer audible.
- Reverberation is the persistence of audible sound caused by successive reflections from surrounding objects after the source has finished producing that sound.
- Excessive reverberation should be avoided. The auditorium's roof and walls are usually coated with sound-absorbing materials like compressed fiberboard, rough plaster, or drapes to lessen reverberation.
- Practical Applications of Reflection of Sound

Some applications of the principle of reflection of sound are:

- Megaphone
- Hearing Board
- Sound Boards
- Megaphone: A megaphone is a tube that is formed like a horn. Sound waves are limited to the air in the tube due to consecutive reflections that prevent them from spreading out.
- Hearing Board: Hearing aids are devices used by persons who have difficulty hearing. The sound waves that the hearing aid receives are reflected into a smaller region leading to the ear.

- Sound Boards: Sound waves can be reflected by curved surfaces. In an auditorium, this reflection of sound waves is employed to distribute the waves evenly around the space. Sound Boards are used to reflect sound waves back to the source. The sound board's focal point is where the speaker is positioned.

Musical Sound and Noise:

- A pleasant continuous and uniform sound created by regular and periodic vibrations is referred to as a musical sound.
- A guitar, piano, tuning fork, and other musical instruments, for example, generate a pleasing sound.
- Noise is described as an irregular series of discordant and unpleasant to the ear disruptions.
- By hearing the echo of their own sound, bats and dolphins may identify the presence of an obstruction. This is referred to as sound-ranging.

Range of Hearing:

A vibrating source emits sound waves, which are then transported via the air. Sound waves between 20 Hz and 20 KHz can be heard by the human ear. This range is referred to as the audible range. Ultrasonic waves are sound waves with frequencies above the audible range, and they are commonly referred to as ultrasound. Infrasonic waves are sound waves with frequencies lower than the hearing range.

Applications of Ultrasound:

- It's utilised for medical diagnosis and treatment, as well as surgical procedures.
- Ultrasound is used by bats and porpoises to navigate and find food in the dark.
- It's used to spot a faulty foetus.
- It's employed in the treatment of muscular pain.
- Ultrasonography (a procedure that uses ultrasonic waves to create 3-dimensional pictures) is used to pinpoint the exact location of an eye tumour.
- Ultrasound is commonly used to clean spiral tubes, electronic components, and other similar objects.
- Metal blocks are inspected with ultrasound to discover cracks and faults.