Government of Tamilnadu

Department of Employment and Training

Course : TNPSC Group II Exam

Subject : Physics

Topic : **Sound**

Commissioner,
Department of Employment and Training.

SOUND

SOUND

- Sound waves can travel through liquids, solids as well as gasses. The substance (solid, liquid or gas) through which sound waves travel is called a medium. Sound waves need a material medium to propagate, they cannot travel through vacuum.
- Robert Boyle, the scientist, proved that sound waves cannot pass through vacuum or empty space.

Wave

- "If the particles of a medium vibrate in a direction, parallel to or along the direction of propagation of wave, it is called a longitudinal wave"
- Sound waves travel in the form of longitudinal waves through gases.
- "If the particles of the medium vibrate in a direction, perpendicular to the direction of propagation, the wave is called a transverse wave."

Definitions of some terms used in relation to waves:

Amplitude (a)

- The maximum displacement of a particle from the mean position is called amplitude. Its unit is metre.

Time period (T)

- Time taken by a particle of the medium to complete one vibration is called Time period. Its unit is second.

Frequency (n)

- The number of vibrations completed by a particle in one second is called frequency. Its unit is hertz. $n = \frac{1}{T}$

Wave Length (λ)

- Distance moved by a wave during the time a particle completes one vibration. Its unit is metre.

Reflection of Sound WAVES

- Echo reflected sound waves reach the ear it can be heard distinctly after the original sound has stopped. This is called an Echo. The sensation of sound persists in our brain for about 1/10th of a second. If the reflected sound wave reaches the ear in less than 1/10th of a second the brain cannot make out the difference between the original sound and the echo. If the reflected sound wave reaches the ear after 1/10th of a second then a distinct echo can be heard. 340 m/s at a temperature of 15°C, sound waves must travel about 34m if it is to be heard as an echo. Therefore, to hear a distinct echo, the surface reflecting the sound should be at least 17 meters away.

Distance = velocity x time

= 340 x $\frac{1}{10}$

= 34 m. (17 m going and 17 m return)

- Dry air at 0^{0}C the speed of sound is 331m/s or 750m/h.
- The speed of sound in air, water and steel at 0^{0}C are
- Air - 331 m/s, water - 1450 m/s, steel - 5000 m/s

The speed of sound

- The Pitch and loudness of sound have no effect on their speed. The speed of sound increases with humidity. Sound travels moist air than in through day air. The speed of sound in air increases by 0.61 metre per second for each degree rise in temperature above 0^{o}C. The speed of sound depends on the medium. It is more in solids, less in liquids, and the least in gases.

Range of hearing

- Human – 20 to 20000 hertz
- Above 20000hz ultrasonic sound, below 20hz infrasonic sound

Applications of Ultrasound

1. SONAR (Sound Navigation And Ranging)
2. Ultra Sonography 'Ultra sonic waves' can be used to visualize inner organs of the human body.

Reverberation

- The repeated reflection that results in the persistence of sound, often referred to as 'rolling sound' is called reverberation.

Intensity of sound

❖ The intensity is defined as the amount of energy crossing per unit area per unit time perpendicular to the direction of propagation of the wave. Intensity is measured in Wm^{-2}.

Loudness : The loudness of a sound is related to the energy of the waves and depends on amplitude. The relative loudness of a sound is measured in decibels.

Noise level of 85db or above can impair (or) damage hearing.

Refraction of sound : Sound travels from one medium to another, it undergoes refraction.

Applications of refraction of sound

❖ It is easier to hear the sound during night than during day-time. During day time, the upper layers of air are cooler than the layers of air near the surface of the Earth. During night, the layers of air near the Earth are cooler than the upper layers of air. As sound travels faster in hot air, during day-time, the sound waves will be refracted upwards and travel a short distance on the surface of the Earth. On the other hand, during night the sound waves are refracted downwards to the Earth and will travel a long distance.

Doppler Effect

❖ The phenomenon of the apparent change in the frequency of sound due to the relative motion between the source of sound and the observer is called Doppler effect.

- When the source moves towards the stationary observer the pitch sound to increase.
- When the source moves away from the stationary observer the pitch sound appears to decrease.
- When the observer moves towards the stationary source the pitch the sound appears to increase.
- When the observer moves away from the stationary source the pitch of the sound appears to decrease.

Applications of Doppler Effect

1. To measure the speed of an automobile
2. Tracking a satellite
3. Radar (Radio Detection And Ranging)
4. Sonar (Sound Navigation And Ranging)

Amplitude of second wave determines its frequency