Experiment No. 6

KUNDT'S TUBE EXPERIMENT

I. OBJECTIVE

Determine the speed of sound in air using the Kundt's tube apparatus.

II. APPARATUS

- Transparent tube with 59 mm diameter and 1000 mm length with reading scale.
- At one end of the tube, a loudspeaker is attached and at the other end, a movable piston with reflector and a microphone is connected.
- Piston on a long rod to create various length long tubes.
- Kundt's tube amplifier with oscillator unit for interfacing the microphone, speaker, headphone and DSO.
- Support blocks to hold the tube horizontally up from the workbench.

III. THEORY

This experiment deals with the sound wave which is a longitudinal wave. It is also a

compression wave since the longitudinal displacement of the gas molecules is caused by the changing pressure. A transverse wave would not be possible in gaseous and fluidic substances as the interlinking perpendicular to the propagation direction is missing. The propagation speed of the wave depends on the elasticity of the medium. In turn, the elasticity depends more or less on the temperature. Thus the sound velocity is a function of the temperature. The velocity v of any wave is given by

$$V = v\lambda$$

where ν is the frequency and λ the wavelength of the wave. In the case of the longitudinal waves, the wave length is the distance between two consecutive compressions or rarefactions while the frequency is the number of compressions or rarefactions that pass any point in the medium per second.

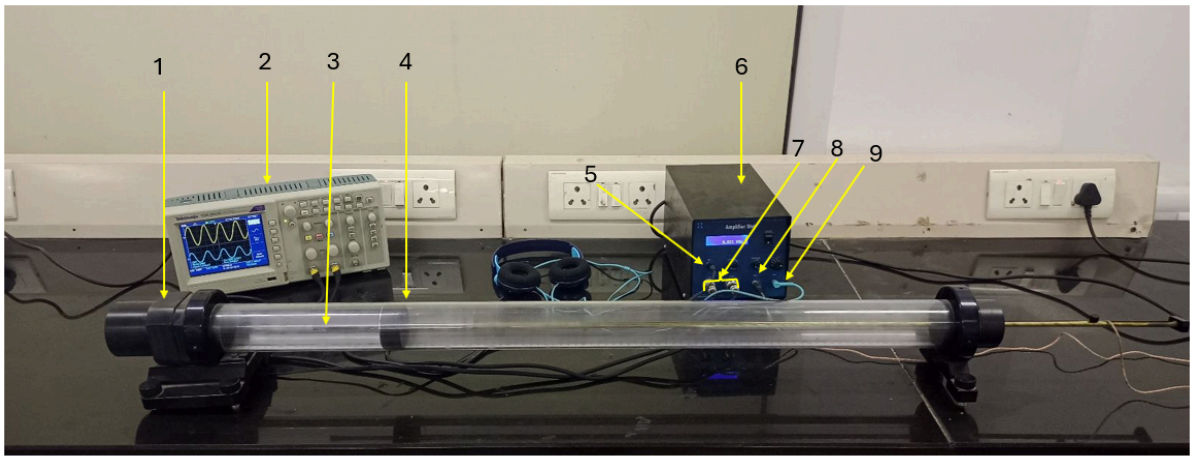
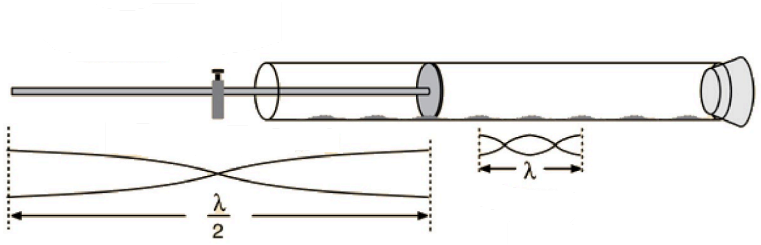


Figure 1: Apparatus for Kundt's Tube experiment

1.	Loud Speaker	6.	Audio Amplifier Unit
2.	Digital Storage Oscilloscope	7.	DSO Inputs
3.	Microphone inside the tube	8.	Microphone Input
4.	Reflector	9.	Speaker out (Headphones)
5.	Loud Speaker input		



In the Kundt's tube the sound wave from the speaker and the reflected wave from the other end of the tube results in the formation of the standing waves. Standing waves are produced when two waves of nearly equal wavelength and amplitude propagate in opposite directions in the same medium. A pattern of loops, or antinodes, is produced,

each of which spans one-half wavelength. By measuring the distance between the quiet points, or nodes, in the pattern, you can determine the wavelength (λ) of the sound. If the frequency (ν) of the sound is then the velocity (*V*) of the sound waves can be found from the basic wave relation.

IV. EXPERIMENTAL SETUP AND PROCEDURE

a. Speed of sound with head phone

- Place the Kundt's tube apparatus on a flat vibration free surface.
- Connect the speaker, headphone and microphone to the Amplifier-Oscillator Unit.
- Set the oscillator at some specific frequency (any value between 0.200 kHz to 5 kHz) Record the value as ν.
- Adjust the volume of the headphone and speaker.
- Starting with the piston close to the speaker, gradually pull it out, while listening carefully to headphone.
- Find a position of the piston where you hear maximum loudness in the tube to get the resonance condition.
- Note the length from the speaker to the reflector and this is the tube length "L". Move back the microphone to bring it close to the speaker.
- Starting with the microphone close to the speaker, gradually pull it back slowly.
- Note down the position of the point where the maximum/minimum (antinodes/nodes) sound is heard in the headphone and this is "X_1".
- Pull back the microphone slowly and count the number of points with maximum/minimum (antinodes/nodes) sound being heard. Note this as "*n*".
- Also note down the position of the nth point where maximum/minimum (antinodes/nodes) sound is heard and this is "X_2".
- Then ($X_2 - X_1/n$) gives half the wavelength in millimetre i.e. $\lambda/2$.
- With the data find the velocity of sound by using the relation $V = \nu\lambda$.
- Repeat the experiment for different frequencies and different tube lengths.

V. RESULTS AND CALCULATIONS

Frequency (ν) (Hertz)	**Tube Length (L) (m)**	**Initial Position Of The Microphone For Node/Antinode X_1 (m)**	**Final Position Of The Microphone For Node/Antinode X_2 (m)**	**Number of Nodes /Antinodes (*n*)**	$\lambda = 2 * \frac{X_2 - X_1}{n}$ **(m)**	$V = \nu\lambda$ **(m)**

VI. <u>PRECAUTIONS</u>

- Store the tube in a safe place where it can't be exposed to danger of humidity and dust.
- Do not expose the Kundt's tube to any mechanical stress or strain.
- Do not bend the movable piston while pushing it in or pulling it out.