Measurement of velocity of sound in free air

Theory: Sound is a vibration that travels through an elastic medium as a wave. In contrast to a transverse wave, a longitudinal wave is one in which vibrations occur in the same direction as the direction of travel of the wave. The most common example of longitudinal wave is the sound wave. This is propagated by alternate compressions and rarefactions of air. Both the transverse and longitudinal waves are progressive meaning that the wave profile moves along with the speed of the wave. If a snapshot is taken of a progressive wave, it repeats at equal distances. The repeat distance is known as wavelength (λ). If one point is taken, and profile is observed as it passes at this point, the profile is seen to repeat at equal interval of time. The repeat time is the period T. The speed of sound describes how much distance such a wave travels in unit time. It is dependent on the properties of the medium (e.g. air), and not on the frequency (f) or amplitude of the sound.

The vibrations of the particles in progressive wave are of same amplitude and frequency. But the phase of vibrations changes for different points along the wave. This phase difference can be observed by displaying both transmitted and received waves on CRO. In this way wavelength could be determined by measuring the distance when the two waves are in phase again. Like any wave, a sound wave has a speed which is mathematically related to the frequency and the wavelength.

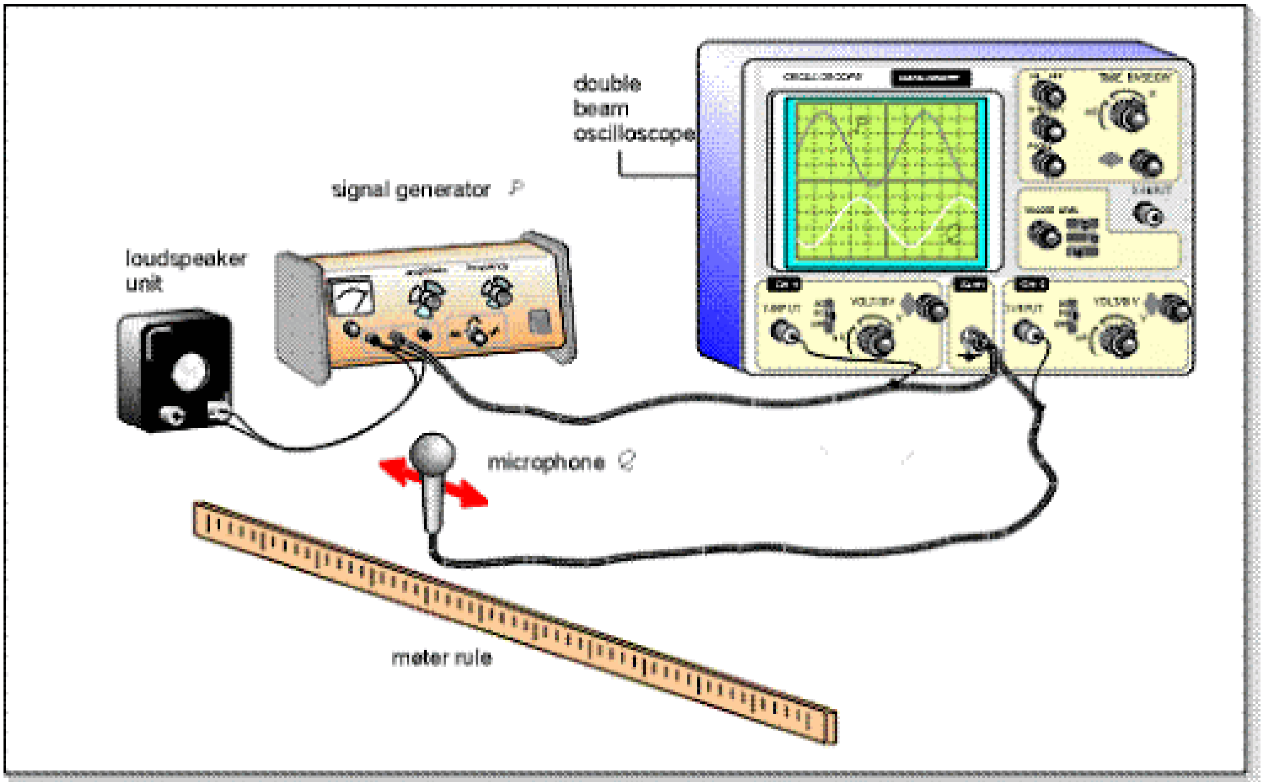
$$\textbf{Speed = wavelength . frequency} \qquad \textbf{or} \;\; \nu = f.\lambda$$

The speed of the sound is variable and depends mainly on the temperature and the properties of the substance through of which the wave is travelling. The speed of sound in dry ir is given approximately

$$\nu \text{ (sound in air)} \approx (331.4 + 0.6\, T_c) \text{ m/s}, \qquad \text{where } T_c \text{ is the Celsius temperature of air.}$$

Apparatus: signal generator, optical bench fitted with loudspeaker and microphone, thermometer, meter ruler, C.R.O.

Procedure: Signal generator is connected to the loudspeaker and to the CH2 (Y2 plates) of the double beam oscilloscope. A microphone mounted on optical bench is connected toCH1 (Y1 plates). Microphone is moves towards or away from the loudspeaker so that the wave signal is in phase with the signal generated by signal generator. The distance between microphone and loudspeaker is equal to the value of wavelength for phase difference equal to 0. Record the observation for phase change of 2π and 0.



S. no.	Frequency f (Hz)	Position of microphone when phase difference φ		Calculate λ=(X2-X1) (cm)	Average λ (m)	ν= fλ (m/s)
		φ=0 ; X1 (cm)	φ= 2π;X2(cm)			
1	3000					
2						
3						
4	4000					
5						
6						
7	5000					
8						
9						

Room temperature $T_c = 34^\circ C$

Average value of ν=

Actual value of ν= 331.4 + 0.6 T_c m/s =

Percentage error=