(S1-2) Speed of Sound Using Open Columns

Aim of experiment

Determination of the speed of sound in air by using tube opened at both ends.

Apparatus

Resonance Tube Apparatus, Speaker and Wave Generator.

Theory of experiment

If a vibrating sound source like a speaker connected to a function generator, is held over one of the open end of a tube, air waves will be sent down the column of air in the tube. Resonance will occur when the standing wave pattern in the vibrating air column has an anti node (maximum amplitude) at both open ends of the tube (*see figure 1*). The length of the vibrating air column is the length between the top end of the resonance tube and its lower end.

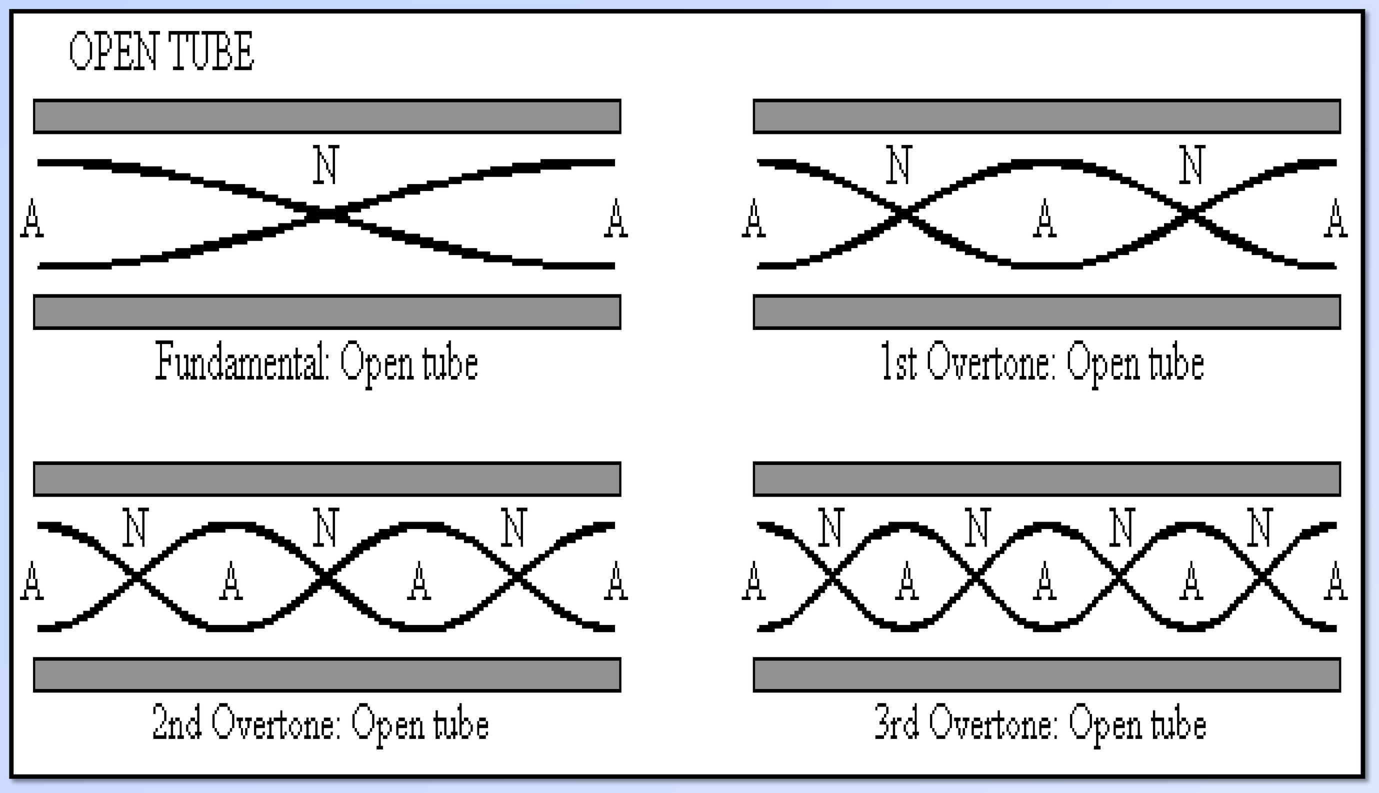

Figure 1.Different modes of Resonances in open ends tubes

As can be seen in *figure 1*, the first resonance position has the smallest air column length *L* and corresponds to a standing wave pattern of one half of a wavelength. Then, for fundamental node

$$L_o = \lambda_o / 2$$
$$\lambda_o = 2\,L_o$$

And *for* first overtone

$$L_o = \lambda_1$$

Since $v = \lambda\, f$, the general formula for the n^th^ overtone is given by the following equation

$$L_o = (n+ ½)\, \lambda_n = (n+ ½)\, v / f_n\,, \quad n=0,\ 1/2,\ 1,\ 3/2,\ 2,\ 5/2,\ \ldots$$

For the n^th^ overtone

$$\lambda_n = L_o/(n+½) = v / f_n$$

So, if the relation between λ_n and $1/f_n$ one obtains the slope equals the sound velocity.

Procedure

1. Connect the speaker to the frequency generator marked above the top end of the resonance tube.
2. Gently increase the frequency of the generation until the tone is heard, at this point, the sound will be quite loud, fundamental tone, *n=0.*
3. Record that frequency, f_o cycles/s.
4. Calculate the corresponding wavelength, λ_o in meters and record on your data sheet.
5. Perform two additional trials to determine this position. Record these two additional readings in meters and find the average of all three readings.
6. Increase gently the frequency until first, second, third and forth overtones can be heard.
7. Repeat steps *3 to 5* for each resonance tone.
8. Plot a graph between *1/f* on x-axis and λ on y-axis.
9. Calculate the slope.
10. Determine the speed of sound in air.

Results

tone	*f* (Hz)	*1/f* (s)	λ_1 (m)	λ_2 (m)	λ_3 (m)	λ_{av} (m)
0						
1/2						
1						
3/2						

$L_o=$

v=slope= *m/s*

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