PHY1002 Physics Laboratory
Short Report

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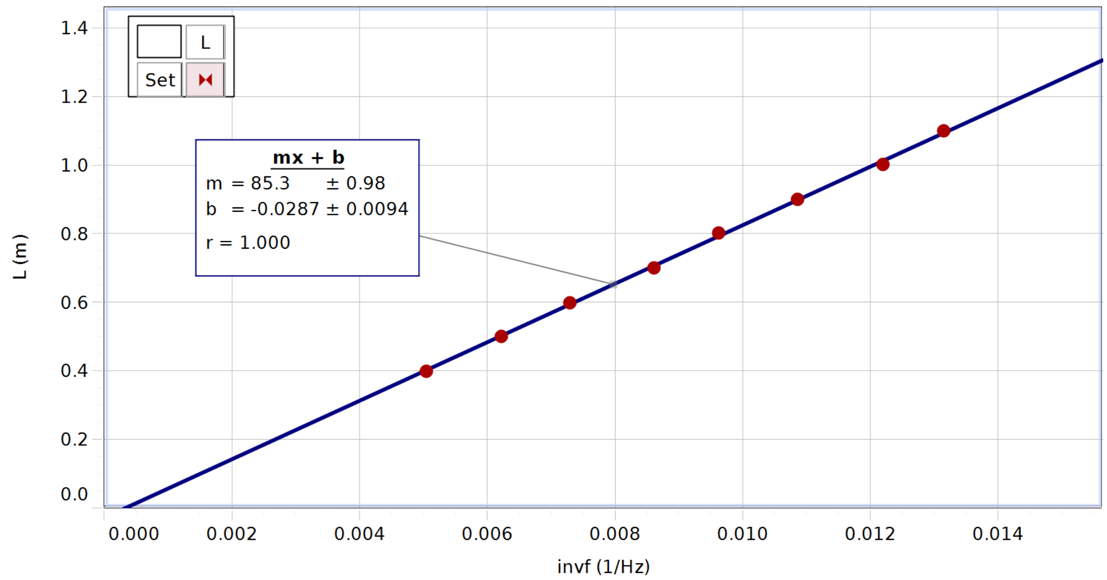
Group:	8	Date of Experiment:	Dec. 7th, 2021

Experiment 4. Resonance Air Column

1. Make a graph of Air Column Length versus Inverse Frequency (L vs.1/f) in experiment 1. Note that the horizontal axis (x-axis) is the inverse of frequency. Analyze why the y-intercept isn't zero.



According to End Effect Theory, which manifests that the actual effective length of the tube would be a little longer than the actual length. For a closed pipe, we have

$$L + 0.3d = \frac{n\lambda}{2}, n = 2k + 1, k \in N$$

where d is the diameter of the pipe. Then, we tug this equation into $v = \lambda f$, and rearrange it. We will have the following

$$L = \frac{nv}{2} \times \frac{1}{f} - 0.3d$$

where v is the speed of sound. And this equation points out the y-intercept comes from -0.3d.

2. In experiment 1, calculate the wavelength from the distance between the nodes. From this wavelength and the frequency of the Signal Generator, calculate the speed of sound.

In case 1, the distance between nodes is

$$D_1 = 2(L_1 + 0.3d) = 2.2226 \pm 0.0010 \text{ m}$$

Thus, the speed of sound is

$$v_1 = 2D_1 f_1 = 2 \times 2.2226 \text{ m} \times 76 \text{ Hz} = 337.8352 \pm 2.21 \text{ m/s}$$

Similarly, we have

$$D_2 = 2.0226 \pm 0.0010 \text{ m}, v_2 = 331.7064 \pm 2.01 \text{ m/s}$$
$$D_3 = 1.8226 \pm 0.0010 \text{ m}, v_3 = 335.3584 \pm 1.82 \text{ m/s}$$
$$D_4 = 1.6226 \pm 0.0010 \text{ m}, v_4 = 337.5008 \pm 1.65 \text{ m/s}$$
$$D_5 = 1.4226 \pm 0.0010 \text{ m}, v_5 = 330.0432 \pm 1.47 \text{ m/s}$$
$$D_6 = 1.2226 \pm 0.0010 \text{ m}, v_6 = 334.9924 \pm 1.22 \text{ m/s}$$
$$D_7 = 1.0226 \pm 0.0010 \text{ m}, v_7 = 329.2772 \pm 1.01 \text{ m/s}$$
$$D_8 = 0.8226 \pm 0.0010 \text{ m}, v_8 = 325.7496 \pm 0.83 \text{ m/s}$$

Hence, we have $\overline{v} = 332.81 \pm 1.52 \text{ m/s}$.

3. In experiment 2, What should the ratio of the open-tube frequency to the closed-tube frequency be? Why? Calculate this ratio from your experimental data and figure the cause of difference (or state that there's no difference).?

For open tube, we have $L = \frac{n\lambda}{2} + 0.6d = 1.3224 \pm 0.0002 \text{ m}$,

and for closed tube, it is $L = \frac{n\lambda}{4} + 0.3d = 1.3117 \pm 0.0001\ m$.

Its ratio is 1.98. For open tube, λ is measured as $136 \pm 1 \text{ Hz}$, while it is $70 \pm 1 \text{ Hz}$ for closed tube. Its experimental ratio is 1.94. There is still a little difference between experimental data and calculated data. During the measurement of closed tube frequency, the actual length is shorter than expected, which is the main reason of the difference. Also, random estimated error should also take place.

Appendix:
Attach the figure in tab Chart 2 in Capstone (you should write a clear and detailed caption for the figure), explain the relationship between the time in x-axis and frequency.

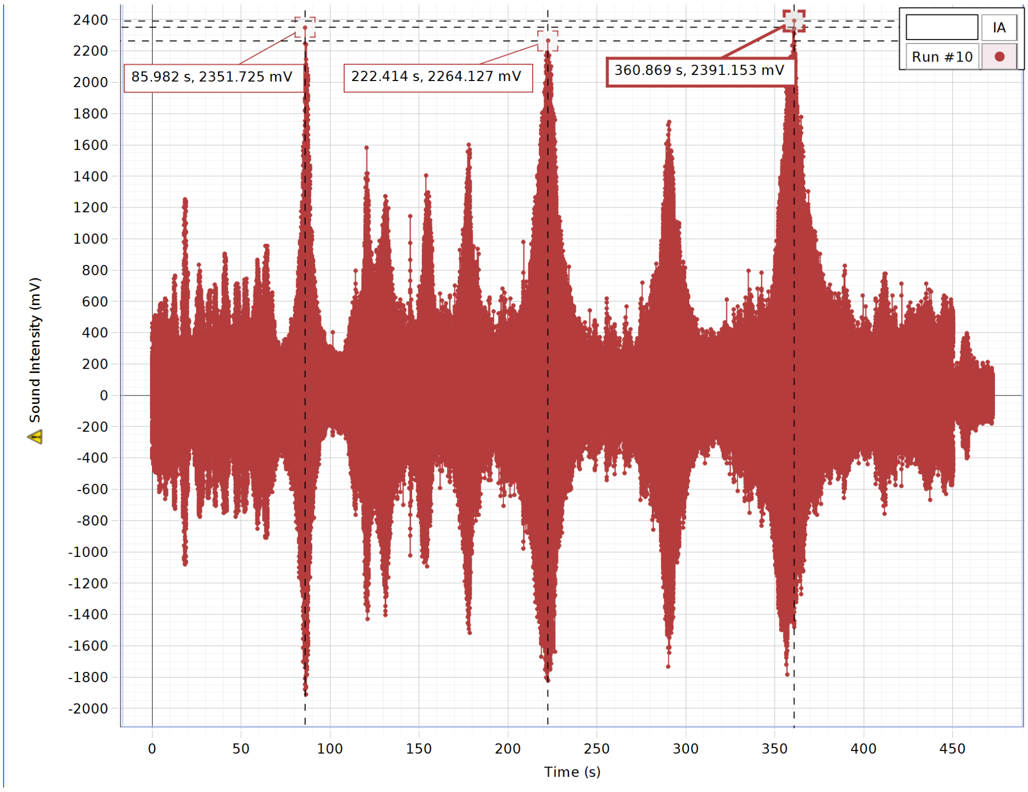


Figure 1: The Amplitude of the Open Tube from 50 Hz to 500 Hz in 450 seconds

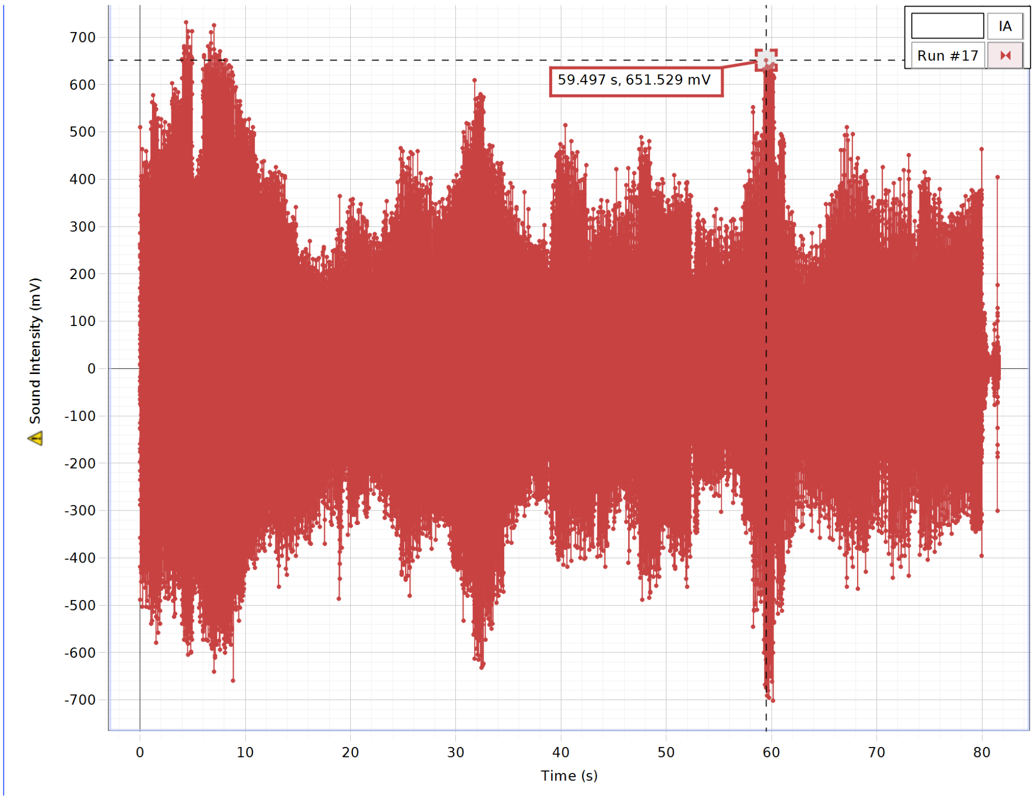


Figure 2: The Amplitude of the Closed Tube from 130 Hz to 50 Hz in 80 seconds

In Figure 2, the frequency increment is 1 Hz per second. It ranges from 50 Hz to 500 Hz. In Figure 3, it ranges from 130 Hz to 50 Hz with decrement 1 Hz per second.

--- End of Laboratory Report ---

Notes:

- **Submit soft copies online.**
- **No further modification allowed after deadline.**
- **Please don't exceed 2 pages (exclude appendix), with normal margin and 1.0 line space.**
- **No figure is required if not specified.**