

Lab 13: Speed of Sound

Name:

PES 115 Report

Lab Section: PES 115-002

Objective

The purpose of this lab was to measure how long it takes sound to travel down and back in a long tube. By doing this, we were able to calculate the speed of sound in air and compare that value to the accepted value.

This day has been a long time coming, but it is finally time for you to leave the nest and try writing the reports on you own!

Data and Calculations



Figure 1: Experimental Setup for measuring the Speed of Sound

For this experiment, we used a microphone connected to a computer to determine the speed of sound at room temperature. The microphone recorded a snap and then the echo after the sound had traveled up to the closed end of the tube and then back down to the microphone.

First, we measured the length of the tube, since the sound wave will have to traverse two times the length during its travels.

Length of Tube [m]

1.575

Next, since the speed of sound is a function of both altitude (which we are ignoring) and Temperature, we recorded the room temperature during the experiment.

Temperature of Room [°C]

20.5

Formatted: Font: Not Bold

Formatted: Centered

Formatted: Font: Not Bold

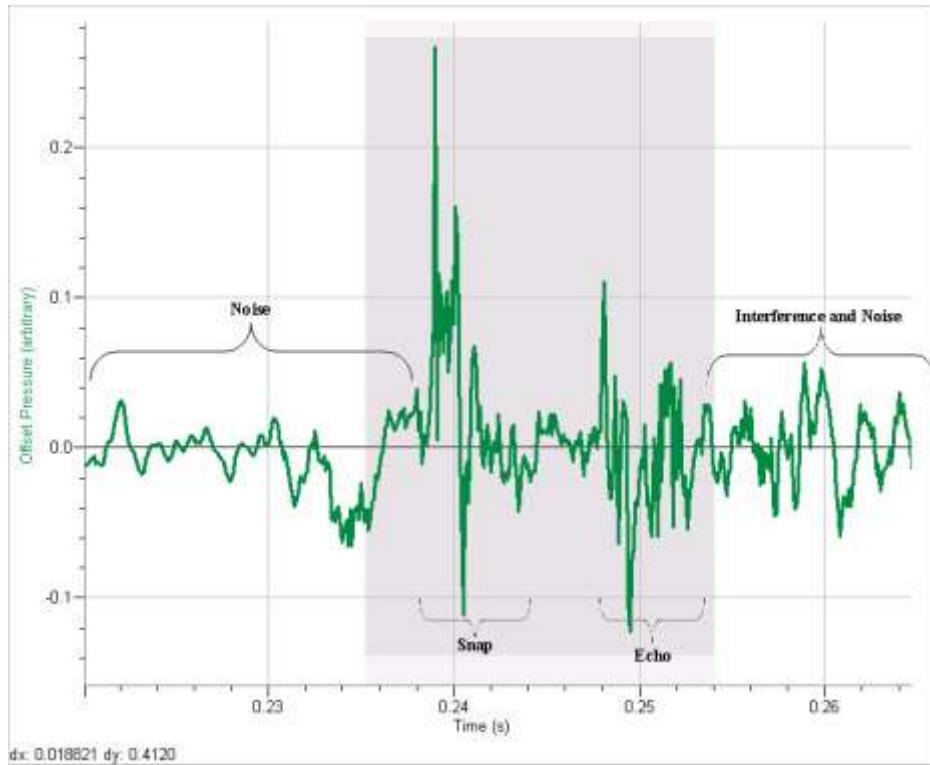


Figure 2: Experimentally Collected Data from Logger Pro

<u>Trial</u>	<u>Start of First Vibration [s]</u>	<u>Start of Echo Vibration [s]</u>
<u>1</u>	<u>0.23898</u>	<u>0.2481</u>
<u>2</u>	<u>0.094196</u>	<u>0.10268</u>
<u>3</u>	<u>0.019202</u>	<u>0.028198</u>
<u>4</u>	<u>0.17943</u>	<u>0.18793</u>
<u>5</u>	<u>0.011236</u>	<u>0.020285</u>
<u>6</u>	<u>0.06339</u>	<u>0.072455</u>
<u>7</u>	<u>0.11498</u>	<u>0.124</u>
<u>8</u>	<u>0.4406</u>	<u>0.44971</u>
<u>9</u>	<u>0.048313</u>	<u>0.057302</u>
<u>10</u>	<u>0.2048</u>	<u>0.21392</u>

'Total Travel Time' = Δt = 'Start of Echo' - 'Start of Snap'

'Speed' = $\frac{2 * \text{'Length of Tube'}}{\text{'Total Travel Time'}}$

Trial	Total Travel Time [s]	Speed [m/s]
<u>1</u>	<u>0.00912</u>	<u>345.3947</u>
<u>2</u>	<u>0.008484</u>	<u>371.2871</u>
<u>3</u>	<u>0.008996</u>	<u>350.1556</u>
<u>4</u>	<u>0.0085</u>	<u>370.5882</u>
<u>5</u>	<u>0.009049</u>	<u>348.1048</u>
<u>6</u>	<u>0.009065</u>	<u>347.4903</u>
<u>7</u>	<u>0.00902</u>	<u>349.2239</u>
<u>8</u>	<u>0.00911</u>	<u>345.7739</u>
<u>9</u>	<u>0.008989</u>	<u>350.4283</u>
<u>10</u>	<u>0.00912</u>	<u>345.3947</u>
Average		352.3842

$$v_{\text{Sound}} = 331.4 \frac{\text{m}}{\text{s}} + 0.6 \frac{\text{m}}{\text{s}^{\circ}\text{C}} (\text{Temp})$$

$$v_{\text{SoundTheory}} = 331.4 \frac{\text{m}}{\text{s}} + 0.6 \frac{\text{m}}{\text{s}^{\circ}\text{C}} (20.5^{\circ}\text{C}) = 344.3 \frac{\text{m}}{\text{s}}$$

$$v_{\text{SoundTheory}} = 344.3 \frac{\text{m}}{\text{s}}$$

We can now compare this with the theoretical speed of sound at sea level:

$$\% \text{ difference} = \frac{|v_{\text{Sound,Theory}}| - |v_{\text{Sound,Measured}}|}{|v_{\text{Sound,Theory}}|} \times 100\% = \frac{\left(344.3 \frac{\text{m}}{\text{s}}\right) - \left(352.3842 \frac{\text{m}}{\text{s}}\right)}{\left(344.3 \frac{\text{m}}{\text{s}}\right)} \times 100\%$$

$$\% \text{ difference} = -2.348\%$$

Part A:

Additional Questions

•question 1

Formatted: Indent: Left: 0", First line: 0"

Formatted: Bullets and Numbering

Formatted: Indent: First line: 0"

Conclusion

You are intelligent scientists. Follow the guidelines provided and write an appropriate conclusion section based on your results and deductive reasoning. See if you can think of any possible causes of error.

** NOTE: There are several components of error which could significantly modify the results of this experiment. Some of these are listed below:

- Background noise (Computer, Talking, Breathing, Other groups, etc...)
- Length of Snap
- Superposition of Waves (Constructive/Destructive interference)
- Tube Internal Interference
- Human judgment of start and stop points
- Changing temperature (temperature gradient) of the room
- Number of samples captured per second
- Parallax from meter stick (also tube was longer than 1 meter, so had to move stick – does this increase error?)
- Altitude of Colorado Springs (Note that the calculation of the “accepted” value was for sea level – and we’re nearly 6200 feet above sea level)
- Weather (Note that depending upon the weather outside there can be a drop or increase in ambient barometric pressure)
- Degradation of waves over distance in a medium (lost energy)
- Others (You’re intelligent scientists – come up with other possible reasons)

Formatted: Bullets and Numbering

A few of the potential errors listed above may be applicable to YOUR experiment.