

Standing Sound Waves

As you work through the steps in the lab procedure, record your experimental values and the results on this worksheet. Use the exact values you record for your data to make later calculations.

Standing Waves in an Air Column Lab – Simulation and Tools

Open the Virtual Sound Waves simulation to do this lab. You will need to use the VPL Grapher to complete this lab.

I. Finding the Wavelength and Wave Speed from the Spacing of Nodes

3. Using Table 1,

- record your values for lengths L_1 and L_4 .
- calculate λ_c and record it as your wavelength value, λ .
- calculate the velocity of sound in air at 0°C using equation 1 ($v = \lambda f$) with λ .
- calculate the percentage error between your experimental value for the velocity of sound in air at 0°C and the accepted value for the speed of sound at 0°C of 331.5 m/s.

Table 1: Speed of Sound in Air at 0°C

Quantity	Value
Frequency, C4	Hz
L_1	m
L_4	m
λ	m
$v = \lambda f$	m/s
% error	%

Show your calculations of λ , v , and percentage error.

II. The Effect of Air Temperature on the Speed of Sound

1. Record the value of L_4 (0°C).

2. As you increased the temperature, what happened to the loudness of the sound?

3.a. Record the value of L_4 (40°C).

3.b. Has the wavelength of the sound increased or decreased?


5. Based on equation 1 ($v = \lambda f$), has the speed of sound increased or decreased with this increase in temperature? Explain your reasoning.

6. Let's determine the relationship between the speed of sound in air and the temperature of the air. You again need to determine the wavelength experimentally and then calculate the wave speed using equation 1 ($v = \lambda f$) for each temperature setting. Just as before, you'll find λ_c from equation 4 ($\lambda = \frac{2}{3}(L_4 - L_1)$). Calculate and record this as your wavelength, λ , for each temperature in Table 2.

Use Table 2 to find the velocity at each of the five temperatures given. You're looking for very small changes, particularly in the L_1 value. Patience is a virtue.

Table 2: Variation of Speed of Sound in Air

Temperature (°C)	L_1 (m)	L_4 (m)	$\lambda = \frac{2}{3}(L_4 - L_1)$ (m)	$v = \lambda f$ (m/s)
0				
10				
20				
30				
40				

7. Take a **Screenshot**  of your graph of velocity vs. temperature and upload it as "sound-waves_vt". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

8. Write your equation in $y = mx + b$ format.

9. Using the accepted values (for this apparatus) for the slope and y -intercept gives the equation

$$v = 0.679T \text{ m/s} + 329.9 \text{ m/s.}$$

This is an empirical equation that works fairly well for a limited range of temperatures. To see how well your results compare to these accepted values, calculate the percentage error for your slope and for your y -intercept.

Show your calculations for percentage error for both your slope and your y -intercept.

III. Determining the End Correction for the Tube

1. Determine the experimental value of the end correction. (Use any necessary data from Table 2.)

Show your work clearly.

3. Determine the theoretical value of the end correction.


Show your work.

4. Calculate the percentage error between the experimental and theoretical values for the end correction.

Show your calculations for the percentage error.

IV. The Effect of Air Column Length on Resonance Frequencies; Musical Instruments

12. Record the second frequency producing resonance in an air column of length 0.66 m.

15. Take a **Screenshot**  of the upper end of the tube and upload it as “soundwaves_Figure6c”. (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

16. How many quarters of C3's wavelength fit in this 0.66-m "tube"?

17. What did you find above for C3's wavelength?

18. How many quarters of G4's wavelength fit in this 0.66-m "tube"?

19. Using equation 6 $\left(\lambda_n = \frac{4L}{n}\right)$ determine G4's wavelength.

20. Show your theoretical calculations of G4's wavelength and frequency using equation 6 $\left(\lambda_n = \frac{4L}{n}\right)$ and equation 7 $\left(f_n = \frac{nv}{4L}\right)$.

21. What do the two values for n in #16 and #18 tell you about the two frequencies? You can find out by considering the fact that for a constant velocity, $\lambda_{C3}f_{C3} = \lambda_{G4}f_{G4}$.

22. Show your calculations of the ratio of $\frac{f_{G4}}{f_{C3}}$.