Speed of Sound in Air Remote Lab      Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Purpose:** Determine the speed of sound in air using temperature and air column resonance.

[Introductory Video](https://www.youtube.com/watch?v=GkNJvZINSEY) (Post-lab quiz my include questions from this video)

**A. Temperature Method**

Theory: Speed of sound in air (in m/s) at temperature T (in Kelvin) is given by;

   
where γ = 1.40 (ratio of specific heats for air),   
m = 4.8 x 10-26 kg (average molecular mass of air), and   
k = 1.38 x 10-23 J/K (Boltzmann constant).   
  
Using the given room temperature calculate the speed of sound.  
  
DATA:

Room temperature, *t* = 22.50C = \_\_\_\_\_\_\_\_\_\_K.

Speed of sound (using temperature) = *V* = \_\_\_\_\_\_\_\_\_\_\_\_

Q. Calculate the average molecular mass of air (assume dry air, no H2O) using the three most abundant gases found in the Earth’s lower atmosphere by following these steps:

1. Write down the percentages of the three most abundant gases (avoid H2O) found in the Earth’s lower atmosphere using the website shown below: (Scroll down to get to Table 7a-1) [**http://www.physicalgeography.net/fundamentals/7a.html**](http://www.physicalgeography.net/fundamentals/7a.html)

2. Write down the atomic masses for the above three gases using this periodic table: <https://ptable.com/#Properties>

3. Calculate the average molecular mass of air using the above three abundant gases found in the Earth’s lower atmosphere. Avogadro’s number = 6.0221409 x 1023

**B. Air-Column Resonance method**

Background: Watch this video on [**Air-Column Resonance**](https://www.youtube.com/watch?v=d7W2niNqHWg)

Theory: In wind instruments the wind (air) is made to resonate. Resonance makes the sound audible. In this investigation a simulation will be used to study resonances in air columns.

Procedure:   
  
1. Open the simulation below:

<http://physics.bu.edu/~duffy/HTML5/speed_of_sound.html>

The tuning fork (possible frequencies are 440, 512, and 660 Hz) is held above the open end of the resonance tube, which has water. The water level can be changed by sliding the blue circle.

2. Click the frequency 440 Hz and set the water level to zero, which represents an air column of length zero.

3. Slide the blue circle to right and increase the length of air column and obtain the first resonance as shown below. Record the first resonance point in the data table.

4. Increase the length of air column further and obtain the second resonance as shown below. Record the second resonance point and complete the row for 440 Hz in the data table.

5. Repeat the measurements for other frequencies and complete the data table.

|  |  |
| --- | --- |
| First Resonance at *L1* | Second Resonance at *L2* |
|  |  |

DATA

The wavelength, λ is given by: λ = 2 (*L2 - L1*).   
The speed of sound in air, V is given by: V = λ∙f, f = frequency.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Frequency (Hz) | First Resonance Point, *L1* (cm) | Second Resonance Point, *L2* (cm) | Change in Resonance Points,  *L2-L1* (cm) | Wavelength, λ (cm) | Speed of sound, V (cm/s) | Speed of sound, V (m/s) |
| 440 |  |  |  |  |  |  |
| 512 |  |  |  |  |  |  |
| 660 |  |  |  |  |  |  |
| Average Speed of Sound from Resonance | | | | | |  |
| Speed of sound (using temperature) | | | | | |  |
| Percent Difference | | | | | |  |

Write a conclusion: