

Purpose:

The purpose of this lab is to determine the speed of sound using the principle of resonance.

Materials:

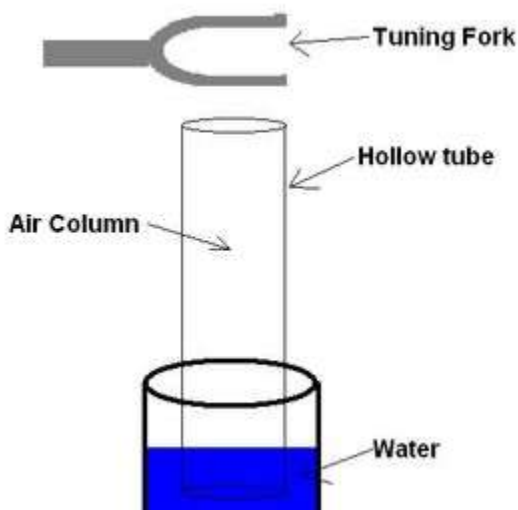
Resonance tube, large graduated cylinder, meter stick or ruler, and tuning forks

Background Research:

In this experiment you will use the principle of resonance to determine the wavelength of a sound wave. If you know the frequency of a sound source you can then calculate the speed of sound using the equation below.

$$\text{Speed of Sound} = \text{frequency} \times \text{wavelength}$$

You are familiar with the concept of resonance, but perhaps never knew what it was called. For example, you may have heard a vase across the room rattle when just one note on a piano was played. The frequency of that note just happens to be the natural frequency of the vase. By holding a vibrating tuning fork over an open tube of water and adjusting the length of the tube, it is possible to get the air column to vibrate at its resonant frequency. This will be noticed because the volume becomes louder at the proper length. For a tube open at one end, resonance occurs when the air column is about $1/4^{\text{th}}$ of the wavelength of the sound.

Experimental Setup and Pre-Lab**Procedure:**

1. Fill the graduated cylinder with water to about $2/3$ of its capacity and place the resonance tube in the water. You can vary the length of the air column by moving the tube up and down in the water.
2. Strike the tuning fork and hold it in a horizontal position, near the open tube. **ONLY use the rubber mallet or the heel of your shoe to hit the tuning fork! Tuning forks are fragile!**
3. Move both the tube and tuning fork up and down together until the sound resonates (gets louder).
Hint: There are several "louder" spots, but you want to locate the very loudest.

4. Once you find the spot of resonance, hold the position of the tube and measure the distance from the water line to the top of the tube. **Record this value in the data section of your lab write-up.**
5. To find a more accurate wavelength value, you must now correct for the small amount of air just above the tube that also vibrates. To do this, measure the diameter of the tube. **Record this value in the data section of your lab write-up.**
6. Next multiply the diameter of the tube by **0.4**. This will give you the correct distance for the small amount of air above the tube that vibrates. **Record this value in the data section of your lab write-up.**
7. Now add the extra length of the air above the tube to the length of the tube when resonance occurred. This number represents $\frac{1}{4}$ wavelength in centimeters. **Record this value in the data section of your lab write-up.**
8. Now calculate one full wavelength for the sound of the tuning fork and *convert your final answer from centimeters to meters*. **Record this value in the data section of your lab write-up.**
9. Using the frequency given on the tuning fork, and the calculated wavelength, calculate the speed of sound. **Record this value in the data section of your lab write-up.**
10. Repeat the above steps again using a second frequency.

Data Collection:

**Each test should be with a different tuning fork!!	Test # 1	Test # 2
Diameter of tube (cm)		
Length of tube when resonance occurred (cm)		
Diameter of tube x .4 (cm)		
$\frac{1}{4}$ Wavelength (cm)		
Wavelength (m)		
Frequency (read off the tuning fork)		
Speed of Sound (m/s)		

Show one set of sample calculations below:

Speed of Sound in Air

Post-Lab Questions:

1. What two variables are needed to calculate the speed of sound?
2. When the sound started to resonate from the tube at a certain spot, how much of a full wavelength did that distance represent? Draw a diagram to support your answer.
3. How did the values for the speed of sound compare with the two different frequencies that you tested? (Calculate the percent difference)
4. The accepted speed of sound is 332 m/s at 0° C, and increases 0.6 m/s for each Celsius degree above zero. Use a thermometer to find the temperature of the room in ° C. What is the accepted value for the speed of sound in your classroom? (Show your calculation)
5. How does your calculation for the speed of sound compare with the accepted value from the last problem? (Calculate the percent error)