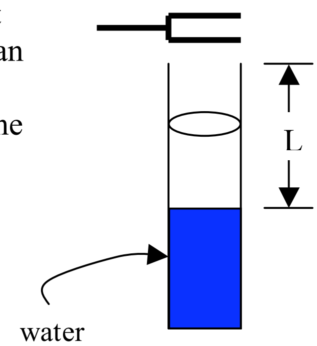
Name ________________
Physics Period ___
Date _________________

SOUND LAB



Standing waves can be produced by vibrating a medium at the resonant frequency. When this is done, an increase in amplitude occurs. This can be seen in musical instruments, buildings and bridges. In this lab the speed of sound can be determined if we know the frequency at which the air column is vibrating and the air column's length. The relationship between frequency and tube length for a tube with one open end is:

$$f_n = n\,(v/4L)$$

Purpose

Determine the speed of sound by measuring the length of an air column vibrating at its fundamental frequency (1^{st} harmonic).

Procedure

Place a plastic tube into a graduated cylinder and fill to the 70 ml mark.

Select a tuning fork and record its frequency. (Higher frequencies work the best)

Frequency (f) = _______ Hz

Strike the tuning fork (on a NON-METAL object) and hold it ~1 cm above the open end of the tube. Move both the fork and the tube up and down to find the air column length that gives the loudest sound.

Measure the length of the air column in meters. (Do not include the water).

Length (L) = _______ m

From the equation, $f_n = n\,(v/4L)$, we can state that the *wavelength* of the sound wave is four times the length of the air column.

Wavelength (λ) = ______ m

Using the frequency and wavelength of the sound, compute the speed of sound in air.
$v = \lambda * f$ SHOW ALL WORK.

Speed of sound in air = _________ m/s

Repeat the steps above for two other tuning forks. SHOW ALL WORK,

Tuning Fork #2

Frequency (f) = __________

Length (L) = __________

Wavelength (λ) = __________

Speed of sound in air = __________

Tuning Fork #3

Frequency (f) = __________

Length (L) = __________

Wavelength (λ) = __________

Speed of sound in air = __________

Results/Conclusions

Use the theoretical speed of sound in air to determine the percent error for the results from each tuning fork. SHOW ALL WORK. Theoretical speed of sound in air = _____ m/s

$$\% \text{ error} = \frac{\text{experimental value} - \text{theoretical value}}{\text{theoretical value}} \times 100$$

tuning fork # 1 = _________

tuning fork # 2 = _________

tuning fork # 3 = _________

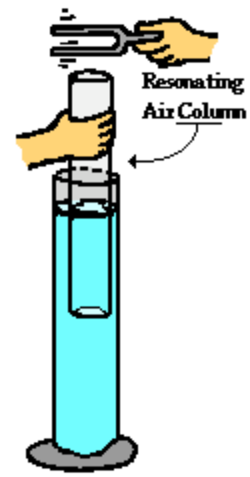
What are two sources of error in this experiment? (Do not include human error. It is already understood to exist)

1.

2.

Clearly argue why one or more of your tuning forks gave a more accurate reading of the speed of sound.

The word resonance comes from Latin and means to "resound" - to sound out together with a loud sound. Resonance is a common cause of sound production in musical instruments. In class, one of our models of resonance in a musical instrument included the resonance tube (a hollow cylindrical tube) immersed in a cylinder of water and forced into vibration by a tuning fork. The tuning fork was the object which forced the air inside of the resonance tube into resonance. As the tines of the tuning fork vibrated at their own natural frequency, they created sound waves which impinged upon the opening of the resonance tube. These impinging sound waves produced by the tuning fork forced air inside of the resonance tube to vibrate at the same frequency. Yet, in the absence of resonance, the sound of these vibrations is not loud enough to discern. Resonance only occurs when the first object is vibrating at the natural frequency of the second object. So if the frequency at which the tuning fork vibrates is not identical to one of the natural frequencies of the air column inside the resonance tube, resonance will not occur and the two objects will not sound out together with a loud sound. But the resonance tube can be moved up and down within the water, thus decreasing or increasing the length of the air column. As we have learned earlier, an increase in the length of a vibrational system (here, the air in the tube) increases the wavelength and decreases the natural frequency of that system. Conversely, a decrease in the length decreases the wavelength and increases the natural frequency. So by moving the resonance tube up and down within the water, the natural frequency of the air in the tube could be matched to the frequency at which the tuning fork vibrates. When the match is achieved, the tuning fork forces the air column inside of the resonance tube to vibrate at its own natural frequency and resonance is achieved. And always, the result of resonance is a big vibration - that is, a loud sound.



Tuning fork forcing
air coumn into
resonance