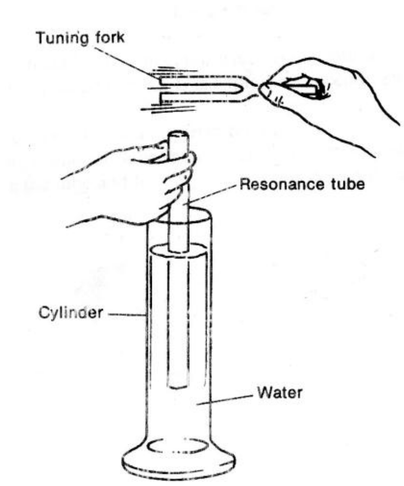
Resonance Lab

Resonance describes a dramatic increase in amplitude of a wave due to forced vibration of a medium at its natural frequency. With sound waves resonance causes an increase in loudness, or volume. In this lab you will use a tuning fork to cause a column of air in a tube to vibrate. When you adjust the air column to match the frequency of the tuning fork, the air column will resonate and sound louder. You will adjust the air column by raising or lowering the PVC tube in water. This will be what is known as a closed pipe, with the water sealing off the bottom of the tube. For a closed pipe, resonance occurs when the length of the tube is about one-fourth of the wavelength of the sound waves.

Purpose: Determine the wavelength of sound waves of known resonance frequency
Calculate the speed of sound waves in the classroom
Predict the length of resonance tube for a given frequency

Materials: PVC tube, 26+ cm tall graduated cylinder, water,
two tuning forks, rubber stopper or anvil, ruler

What to do



1. Record the frequency of all three tuning forks you will be using. (your teacher will provide these)
2. Place the resonance tube in the cylinder. Add water to your cylinder so the top of the water is at the assigned height.
3. Tap the high frequency tuning fork on a rubber object. Hold the vibrating tuning fork about 0.5 cm above the opening of the tube. You should hear the air in the tube resonate…sound gets louder. Measure the distance from the surface of the water to the top of the resonance tube. Record this as the resonance length.
4. You may recall from the introduction that the resonance length is one-fourth the wavelength of the sound wave with the same frequency of the tuning fork. In order to find the wavelength simply multiply the resonance length times four. Record the wavelength of the sound wave.
5. Use the fork frequency and the wavelength, calculate the speed of sound in the room.
   Show K-U-E-S. **Have your work approved up to this point**
6. Tap the high frequency tuning fork on a rubber object. Hold the vibrating tuning fork about 0.5 cm above the opening of the tube. Now move the tube and fork upward until you hear the resonance. Hold the tube in this position while your partner measures the distance from the surface of the water to the top of the resonance tube. Record this as the resonance length.

Data Table 1

Fork	Frequency (Hz)	Resonance length (cm)	Wavelength (cm)
#1			
#2			
#3			

K-U-E-S for speed of sound

But wait...there's more!

1. Use the actual speed of sound in the room (provided by your teacher) to determine your percent error for each tuning fork.
   Show K-U-E-S. **Have your work approved up to this point**

$$\% \text{ error} = \frac{|\text{actual speed - calculated speed}|}{\text{actual speed}} \cdot 100$$

2. Construct a wavelength v. frequency graph from your data. Use a 100 Hz range that includes the two frequencies and a 20 cm range that includes the two wavelengths. *This is one of the few times you do not need to start at zero.* **Have your graph approved at this point**
3. **Use the graph to predict the approximate tube length that would resonate with the third tuning fork in your assigned set.
4. Ask to test your prediction. If your predicted length does not result in resonance, adjust the tube's position until it resonates and measure that length. *Determine the percent error. **Show K-U-E-S*** **Have your work approved.**

$$\% \text{ error} = \frac{|\text{actual length - predicted length}|}{\text{actual length}} \cdot 100$$