• **Project #1**: What lengths of a column of air will resonate with a known frequency?

1. Record the temperature in the room:  \( T = \) _____________ °C

2. Calculate the speed of sound in air. The equation for the speed of sound as a function of temperature is:  \( v \approx (331 + 0.60T) \) m/s where \( T \) is in °C.

The column of air is a closed (at one end) tube resonator. By changing the height of the water, you change the length of this tube resonator. For a fixed wavelength of sound, the shortest tube length which will give resonance is given approximately by \( \lambda = 4L \). By increasing \( L \), you can fit more wavelengths in the tube. (NOTE: the tuning fork does not change, so the frequency and wavelength are constant.) However, only certain lengths will result in a resonating standing wave in the tube and hence a louder tone.

3. Record the length of the air tube for the first 3 resonances.

   - first resonance:  \( L_1 = \) ________________ m
   - second resonance:  \( L_2 = \) ________________ m
   - third resonance:  \( L_3 = \) ________________ m

   (Make sure your \( L_1 \) is the smallest possible length which gives resonance.)
4. Calculate the *wavelength* of the sound for your tuning fork using the above information.  
   (Hint: What is the theoretical prediction for $L_2 - L_1$ and $L_3 - L_2$? Do *not* use $\lambda = 4L_1$ since this is only approximate.)

5. Using the speed of sound and the wavelength, calculate the *frequency* of the tuning fork:

6. What is the percent difference between your calculated frequency and the frequency stamped on the fork? Do they agree? (Is the difference within the expected difference due to experimental uncertainty?)

**Homework:**

H1. For the first resonance length ($L_1$), qualitatively sketch the vibrational motion of the air molecules inside the tube.
Standing Sound Waves in an Air Column

H2. Assume the tube is set at length $L_1$. If the tuning fork you used had a frequency $f_0$, would a tuning fork of frequency $2f_0$ give a standing wave? How about $3f_0$? Please explain your answer. (Hint: which harmonics resonate in a closed tube resonator?)

H3. If you used the same tuning fork, but did the entire experiment in Helium gas, how would the first resonance length ($L_1$) change? Why? (Show your calculation. You will need to look up the speed of sound in Helium.)

H4. Would the tuning fork sound different, if you and the fork were in the Helium? Explain your answer. (Assume you are still alive in the Helium.)