Name: ______________________________ Date: ____________

Experiment 18: Speed of Sound in Air

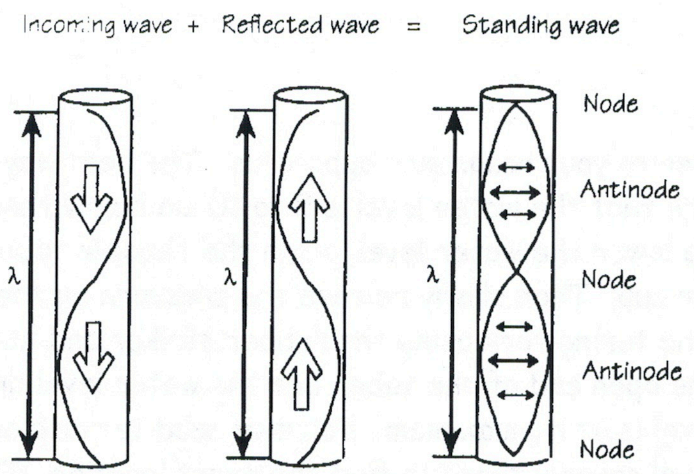
Objective: To use wave harmonics to determine the speed of sound in air and the unknown vibrational frequency of a mystery tuning fork.

Apparatus:

- Resonance tube apparatus
- Thermometer
- Three different tuning forks (1 unknown)
- Tuning fork striker
- Plastic measuring cup
- Water
- Meter stick

Theory:

A vibrating tuning fork sends a series of compressions and rarefactions through the air. When the tuning fork is held over a tube that is closed at the other end, these compressions and rarefactions will reflect back towards the source. At certain lengths of the tube constructive interference between the reflected wave and the one just produced by the tuning fork will occur. This process will create a **standing wave** pattern in the tube.



Name: ______________________________ Date: ____________

Resonance can occur when the length of the tube is such that an antinode occurs at the open end. An equation relating the length of the tube and the wavelength for this situation is:

$$L = \frac{n\lambda}{4} \qquad n = 1, 3, 5, \ldots$$

In this experiment, a vibrating tuning fork is held above a cylinder that is open at one end. The length to the closed end is adjusted by adding or removing water from the tube.

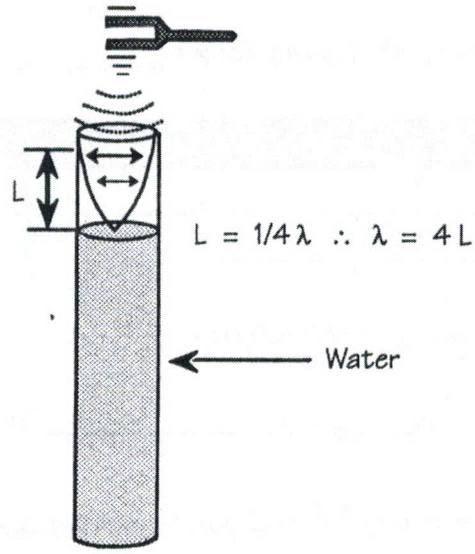
Procedures:

1. Measure room temperature using your thermometer:

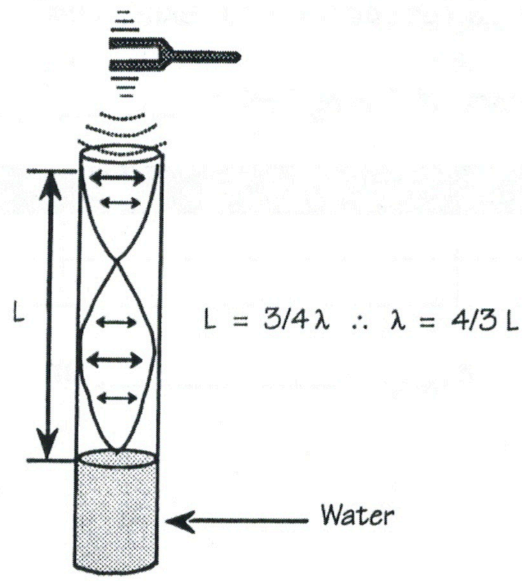
$$T_{room} = \_\_\_\_\_\_\_\_\_\_\_\_ \ ^{\circ}C$$

2. Substitute the temperature above into $v_{sound} = (331.4 + 0.6T_{room})\frac{m}{s}$ and compute the **theoretical** value of the speed of sound in air.

3. Add water to your resonance apparatus. The best way to start is to make sure that the water level is 5 to 10 cm below the top of the tube. To lower the water level, pinch the flexible tubing and lower the reservoir cup. Then slowly release the pressure on the tubing.
4. Strike the tuning fork using the rubber striker and hold it about 2 cm above the open end of the tube. Let the water level drop and until the sound level is at its maximum. You may need to raise and lower the water level several times to find the exact location. The harmonic wave produced looks like this:



5. Lower the water level until the second position at which resonance occurs. You probably want to use a similar procedure as in step 4 where you find an approximate location for the resonance point and then adjust the water level slightly to obtain its exact location. This resonance point may be more difficult to find because it will not be as loud as the one produced in step 4. The patter produced in the tube looks like:



6. Record your data in the table below:

Name: ______________________________ Date: ____________

Frequency of Tuning fork : ______________ Hz

Resonance Point	Length of Tube (cm)	Wavelength (cm)
1^{st}		
2^{nd}		

7. Compute your average wavelength:

$\lambda_{average} =$ _______________ m

8. Using the equation $v = \lambda f$ and your average wavelength, compute your **experimental** value for the speed of sound in air. Compute the percent error between this value and your theoretical value.

9. Repeat steps 4 - 8 for your second tuning fork.

Frequency of Tuning fork : ______________ Hz

Resonance Point	Length of Tube (cm)	Wavelength (cm)
1^{st}		
2^{nd}		

$\lambda_{average} =$ _______________ m

Name: ______________________________ Date: ____________

10. You will now repeat steps 4 - 7 for your unknown tuning fork:

Letter on Tuning Fork : ________________

Resonance Point	Length of Tube (cm)	Wavelength (cm)
1^{st}		
2^{nd}		

$\lambda_{average} =$ _______________ m

11. Using your theoretical value for the speed of sound in air and , $v = \lambda f$ compute the frequency of the tuning fork.

f = _______________________ Hz

Name: ______________________________ Date: ____________

Additional Questions:

1. Suppose that in this experiment the temperature of the room had been lower. What effect would this have on the length of the resonating air column for each reading? Explain.

2. At what temperature would the wavelength of a 440 Hz sound wave be 0.82 m?

3. An observer measured an interval of 10 s between seeing a lightning flash and hearing the thunder. If the temperature of air was 20^0 C, how far away was the source of sound?