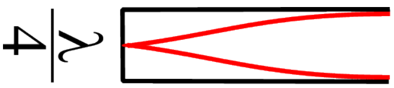
Speed of Sound in Air

Purpose: to measure the speed of sound in air using a closed water pipe and tuning fork.

Materials:

1000 mL graduated cylinder
Resonance tube
Turning fork of known frequency
Meter stick
Thermometer

Understanding:



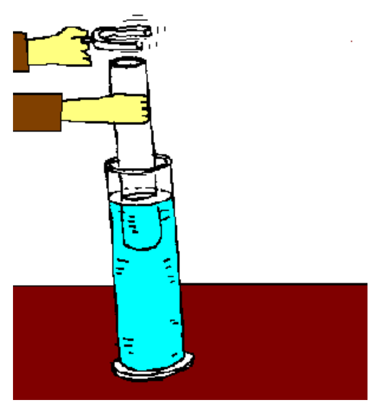
Sound can reflect off a surface like that of water. The glass tube is called a resonance tube. When the length of the air column is equal to one quarter the wavelength of a given sound, it will resonate or amplify the tone so that you can hear it clearly. Look at the image to the left. Since tuning forks are printed with their frequency, if you measure the wavelength of the sound with a resonance tube, you can calculate the speed of sound in air using v = fλ. When you are done, you'll use the room temperature to calculate the speed of sound using this formula and compare the two values:

$$v_{air} = 331.3\ m/s + (.6m/s/deg\ C)(T)$$

The temperature must be in degrees celcius.

It is important to note that it is very easy to break a resonance tube by touching it with a vibrating tuning fork. Pay attention to what you are doing.

Procedure



1. Fill the graduated cylinder with water to about 5 cm from the top. Use tap water, not water from the fountain.
2. Use a meter stick to measure the inside diameter of the resonance tube and record it here in METERS: ____________
3. Have a partner hold the resonance tube partially suspended in the graduated cylinder full of water.
4. Strike the tuning fork against the heel of your shoe. Quickly place the fork just over the top of the hollow tube, as shown.
5. Move the resonance tube up and down until the *loudest* sound is heard. If there is more than one position in which the sound appears the loudest, choose the position in which the length of the tube above the water's surface is the shortest.
6. Record the length, L, of the air column to the nearest 0.1 cm _________
7. Record the frequency of the tuning fork. It is printed on the fork. ______________
8. Use the thermometer to measure the room temperature in degrees celcius and record it here: ________

Observations

1. The diameter of the tube impacts the resonance point and so you have to take it into account. Calculate the wavelength of the turning fork using the following formula. Be certain your measurements are in **meters**.
   Wavelength = (4 x Length) + (4 x Diameter) Show your work below:

2. Calculate the speed of sound in air using the following formula: **$v = f\lambda$.** Show your work below:

3. Calculate the expected velocity of sound in air using the formula for temperature: v_{air} = 331.3 m/s + (.6m/s/degC)(T). Show your work below:

4. The speed of sound determined from the temperature is more accurate than that done with the tube because there are fewer places to make a measuring error. Calculate your percent error using ((O-A)/A) * 100 = error. Show your work below:

Conclusions

1. If a tuning fork with a different frequency were used, would you expect a different value for the speed of sound? Explain your answer.

2. If this investigation were performed at a temperature of 5˚C above or below the actual temperature, would the speed of sound be different? Explain your answer.