PHYS 1405 – Conceptual Physics I
Laboratory # 11
Sound

Investigation #1: How can we find the speed of sound in air?

What to measure: Time for sound to travel, distance traveled.

Measuring devices: Resonating tube, microphone and computer

Calculations: Speed of Sound

Investigation #2: What are the frequencies of various pitched sounds?

What to measure: Frequency of sound.

Measuring devices: Tuning Forks, microphone with computer

Calculations: None

INTRODUCTION

In this experiment we shall investigate various properties of sound. First, we shall use an echoing resonance tube to measure the speed of sound. Then, we shall use a computer and microphone to determine the frequencies of various sounds.

Part 1: The Speed of Sound

We can calculate the speed of sound if we know how far a sound travels, and how long it takes to travel. We use this basic equation:

$$\text{Speed} = \text{Distance} / \text{Time}$$

The long tube on the lab table is a resonant tube. Sound has a hard time escaping from the tube because the sound wave has a wavelength longer than the width of the opening. Therefore, some of the sound will “bounce” back and forth, echoing inside the tube. We place a microphone at one end of the tube, to catch the initial sound we make, and any echoes that come back. First, measure the length of the tube.

Question 1: What is the total distance traveled by the sound as it bounces back and forth in the tube?

Hit the “collect” button, and have someone clap their hands loudly at the end of the tube that has the microphone. The graph on the screen will show the sound picked up by the microphone. The “peaks” that you see on the graph are the times when the microphone picks up an echo. Place the cursor over the first peak you see, and record the time that echo arrived. Determine the time for the next echo in the same way. Subtract these two values to get the time between echoes. Use distance and time values to calculate the speed of sound.

Repeat your observations for three trials total, and average the speed values you get. Present your values of distance, time, and speed in a data table.

Question 2: What is the percentage difference between the average speed value you found and the accepted value for the speed of sound at room temperature? Is this a good way to determine the speed of sound?

Part 2: Sound Frequency and Pitch

We can also use the computer and microphone to tell us the frequency of a sound, which is the technical term for its pitch. Take one of the tuning forks and strike it with the rubber clapper. *Do Not* strike it against a hard surface! Hold the fork up to your ear and listen to the pitch of the sound it makes. Note that the musical note should be inscribed on the fork, along with the supposed frequency – the number of vibrations per second for the sound.

If you hold the ringing tuning fork up to the microphone, and hit “collect,” the computer will determine the frequency of the sound. It will show up in red on the lower graph as a narrow peak. Use the cursor to determine what the frequency of that peak is. Calculate the percentage difference between the frequency inscribed on the fork and the readout on the screen.

Determine the frequency of each fork using the computer. Create a data table with the following columns: Note, Inscribed Frequency, Measured Frequency, Percentage Difference.

Question 3: Based on the percentage differences you found, how well does the computer measure frequency?

Question 4: How does frequency change with the pitch of the sound?

Note that two of the forks are marked with the "C" note. These two tones are separated by an octave.

Question 5: What is the relationship between the frequencies of sounds separated by an octave?

Use your voice or a musical instrument (both, if possible) to make a musical note or a chord into the microphone. Determine the frequency (or frequencies) of that tone. Repeat this two or three times, with different voices or instruments.

Question 6: Do human voices or musical instruments produce "pure tones" like tuning forks? Use your data to defend your answer.