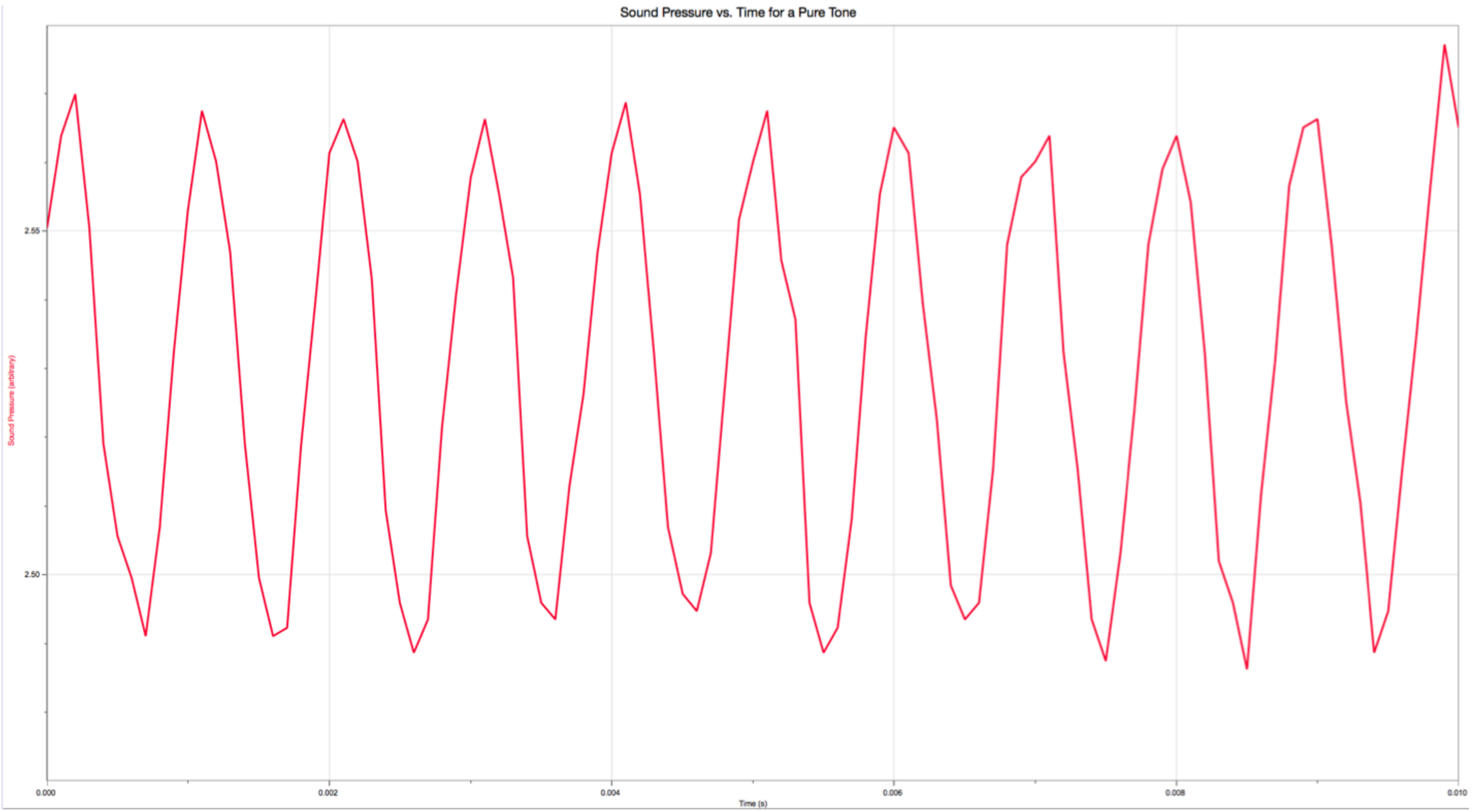
Prelab for L151

You'll practice collecting and analyzing sound data in this prelab. Read through the PowerPoint and carry out the instructions.

Enter your responses in the WebAssign form L151PL.

Part A. Frequency of a Tuning Fork

This part is problem 1 of L151PL.



When using a microphone as a probe to record sound waveforms, LP records Sound Pressure as a function of Time. Ideally, the waveform for a pure (single frequency) tone would be a smooth sine curve. In practice, the waveform will have some sharp corners due to the way the software samples the sound.

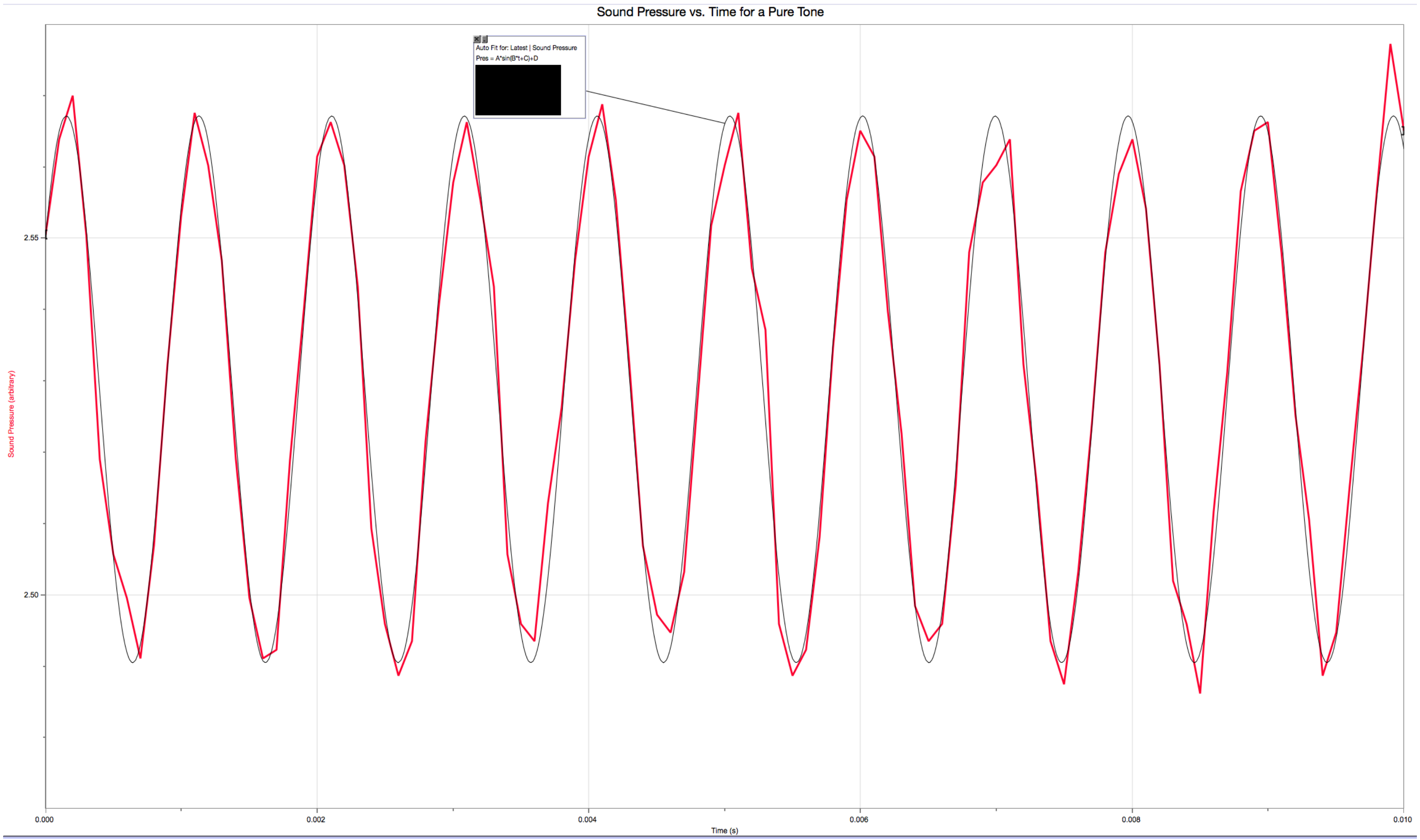
Acquiring a sound waveform

1. Connect the LabQuest Mini to your computer. Connect the microphone to CH1.
2. Open Logger Pro. The microphone should be detected automatically.
3. Go to Experiment, Data Collection. Set the Duration to 0.01 s and the Sampling Rate to 10000 samples/second.
4. Go to this link: http://onlinetonegenerator.com.

Acquiring a sound waveform, con't.

5. Enter 1024 for the frequency in the online tone generator. Click Play to produce the 1024 Hz tone. Turn up the volume. The sound is annoying, but this won't last long.
6. Hold the microphone to your computer speaker. Click the Go button in LP. A waveform should be recorded.
7. Stop the tone. If your graph didn't autoscale vertically, click the A icon at the top.
8. If your waveform differs significantly from that shown previously, try again. Try holding the microphone at different distances from the speaker. If the sound is too loud or too soft, you may get poor results.
9. When you have a good waveform, save your file with the name 1024-lastnamefirstinitial.cmbl.

Determining the frequency, Method 1



Do a curve fit to the function: Pres = Asin(Bt + C) + D. Then use the appropriate coefficient to determine the frequency. (The coefficients are intentionally masked above.)

Determining the frequency, Method 2

1. Read the times of the two furthest-separated peaks. In order to read the times, place the cursor at a peak in LP. Read the coordinates in the lower left-hand corner below the origin.
2. Find the difference of the times.
3. Divide by the number of cycles. This gives the period.
4. Invert to get the frequency.

Comparison of the methods

Find the experimental error in frequency using the Method 1 value as the accepted value.

File upload

Title your graph Sound Pressure vs. Time for a 1024 Hz Pure Tone. Save your file and upload it.

Part B. Fundamental Frequency of an Open Pipe

This part is problem 2 of L151PL.

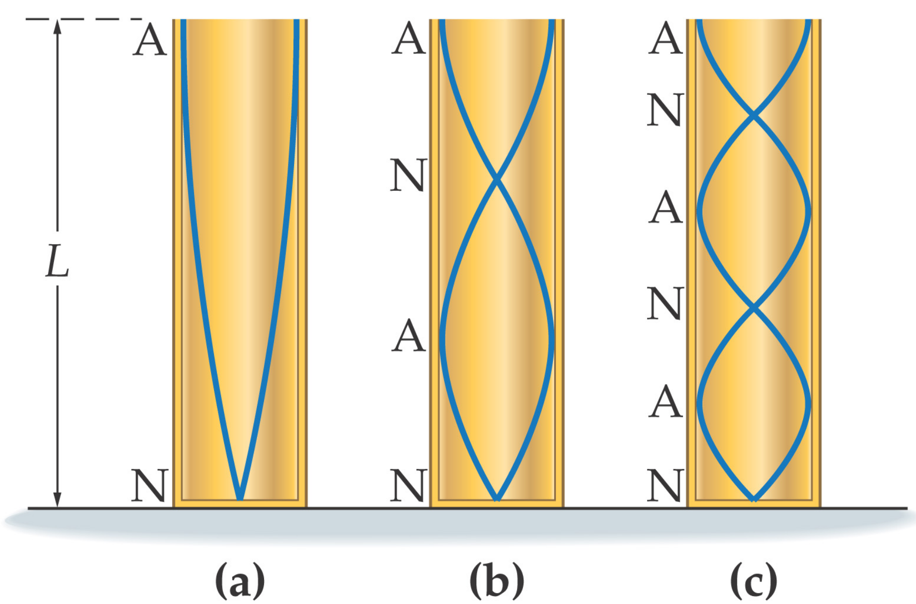
A Note about Terminology

When we say that a pipe is an *open* pipe, we mean that the pipe is open at both ends.

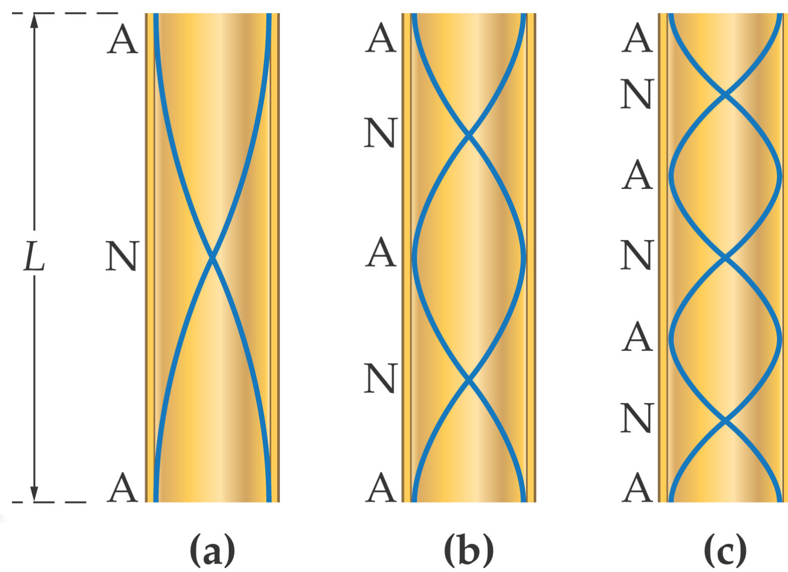
When we say that a pipe is a *closed* pipe, we mean that the pipe is closed at one end and open at the other.

Representing standing waveforms in pipes

There are two different ways to represent a standing waveform in a pipe. One of these is the method used in the text. The following are graphics (Figs. 14-27 and 14-29) from the text showing the *displacement* waveforms for standing waves in open and closed pipes.



Closed at one end



Open at both ends

Representing standing waveforms in pipes, p.2

The diagrams on the previous page are called *displacement* waveforms, because they represent the displacement of molecules in the air. We know, of course, that the actual waves are longitudinal and that the molecules are displaced longitudinally from their equilibrium positions. When we draw a displacement waveform, we're drawing an abstract representation of the displacement from equilibrium on one axis and distance along the medium on the other axis. With this representation, the antinodes are the places where the displacements are maximum, and the nodes are the places where the displacements are 0.

Representing standing waveforms in pipes, p.3

The use of displacement waveforms to represent standing waves in air is the most common method and the one that we will use in this course. This is also consistent with the textbook practice.

You may run across another method of displaying the waveforms. In this second method, *pressure waveforms* are drawn. These represent the pressure of the air as a function of position along the medium. At the open end of a pipe, the pressure must equal the normal atmospheric pressure surrounding the pipe. Thus, open ends of pipes are *pressure nodes*. Closed ends are *pressure antinodes*. Thus, you can see that a pressure node is a displacement antinode, and a pressure antinode is a displacement node.

Measuring the fundamental of a toy flute

1. You have two plastic flutes wrapped in padding in your your equipment box. Select the flute like the one below. Yours may be a different color. What's important is that, other than the holes at the ends, the flute has only one hole on the side near the blow hole.

2. Open a new Logger Pro experiment file. Go to Experiment, Data Collection, to change the Duration to 0.01 s and Sampling Rate to 10000.

Measuring the fundamental of a toy flute, con't.

3. Hold the flute near the microphone and blow to produce a steady tone. It's important not to blow too hard. If you do, you may produce harmonics higher than the fundamental. What you're trying to do is produce the lowest tone. In order to hear the tone that you're trying to produce, go to the Sound Library here:

   http://courses.ncssm.edu/apb11o/labs/L151/sound_library.html

4. When you're confident that you have the lowest, steady tone, click Go on LP to record a waveform.
5. Measure the frequency using Method 1.

Calculating the fundamental of the toy flute

1. Read the room temperature to the nearest degree on the thermostat in your house. (Or use a thermometer if you have one.) Convert the temperature to ^oC using the formula, $^oC = (5/9)(^oF - 32)$.
2. Using the fact that the speed of sound increases by 0.60 m/s for each degree Celsius of temperature rise above 0 ^oC, calculate the speed of sound in the room. Here's an example.

   If the room temperature is 68 ^oF, that converts to 20. ^oC. The speed of sound is then v_{sound} = [331 + (0.60)(20.)] m/s = 343 m/s.

3. Measure the length of the toy flute from end-to-end to the nearest 0.001 m.

Calculating the fundamental of the toy flute, con't.

4. Taking the flute to be a pipe open at both ends, determine the wavelength of the fundamental.
5. Using the wavelength of the fundamental and the speed of sound, calculate the frequency of the fundamental.
6. Using the value of frequency measured with the microphone as the accepted value, calculate the experimental error.
7. Title your graph, Sound Pressure vs. Time for the Fundamental of Toy Flute 1. Save your file with the name flute1-lastnamefirstinitial.cmbl and upload to WA.