Physics Lab 10: Sound Science and Musical Mathematics

NOTE: It is inevitable that we will make some noise in this lab. Let's do our best to be respectful to the class on the other side of the CAL. Let's do our best not to be obnoxious.

Getting Started:

a) Hook up your LabQuest. Launch LoggerPro. Under Experiment: Set up Sensors, choose your interface, and then find and turn on the Internal Microphone. Note the graphs and displays which come up. Under Insert: Additional Graphs, insert an FFT Graph. FFT stands for Fast Fourier Transform. The LabQuest internal microphone is located at the top right corner of the unit face.
b) Under Experiment: Data Collection, note and record the defaults Duration and Sampling Rate. The default settings will allow you to measure acceptable Sound Pressure vs. Time data, though you may need to increase the sampling rate to get cleaner results. To get a good FFT graph, you will need to increase the data collection time and decrease the sampling rate; however you will want a minimum sampling rate that is at least 5 times the primary frequency. For example, a 256 Hz tuning fork should have a sampling rate of at least 5000 samples/second and a data collection time around 0.05 – 0.1 seconds. This means you will likely need to measure each sound twice, with different settings. This is related to hardware/software limits in this investigation: you will only be able to get reasonable data for consistent sounds which last a reasonable length of time. For each sound, make sure to record your Data Collection settings.
c) You will be recording a great deal of data in this investigation. Make sure you have a good naming scheme and save all your files to an appropriately named folder in your cubbie.

Part I: Pure Tone, whole class

a) Once everyone has their LabQuest hooked up with the Internal Microphone started, we'll begin an orientation to the procedures in today's lab together. Details of the procedure are in Part II, so you can refer to your notes from this part and to Part II as needed.

Part II: Tuning Forks

a) Read through the procedure below since you will follow it in other parts.
b) If there aren't enough tuning forks, move on to another part and then come back to this part later.
c) Obtain a tuning fork. Recall that the proper way to sound a tuning fork is to strike it with a rubber mallet or to slide it along a surface. Don't strike the tuning fork on a hard surface.
d) Return to the default Data Collection settings. Zero the sensor. Sound the tuning fork, hold it near the microphone, and obtain good Sound Pressure vs. Time data. If necessary, increase the Sampling Rate.
e) Change the horizontal scaling so that you display about 5 full periods. Highlight at least 3 periods, and then fit the data with a Sine function using Curve Fit. Record A, B, C, and D.
f) Calculate the frequency f using $f = B/2\pi$.
g) Find the frequency of the tuning fork (it is usually stamped or engraved on the handle of the fork). How does your measured frequency match the labeled value?
h) Adjust your Data Collection Settings so that your Sampling Rate is at least 5 times the frequency and so that the Duration is at least 0.05 seconds (there may be a trade-off here so see what works best). Sound the tuning fork and obtain a good FFT graph. How does the primary frequency from the FFT Graph match your previous result?
i) (This part might be hard to get good data for. Do your best but don't spend more than a few minutes on it). Strike the tuning fork with your knuckle. Repeat the measurements to get a good FFT Graph. Do you notice any differences between this FFT Graph and your previous one?

Part III: Voice and Vowels.

a) Following the procedure above, obtain good Sound Pressure vs. Time and FFT Graphs for your voice saying the vowels "E" and "O". Note that you will have to say and hold the vowel sound while collecting data. As before, start and hold the sound, then hit collect, holding the sound constant while the data is collected.
b) Collect data for the other vowel sounds.

Part IV: Musical Instruments

a) If you brought a musical instrument (or bottle), obtain Sound Pressure vs. Time and FFT Graphs for different notes on your instrument. It might be hard to make a note on certain instruments and collect data at the same time; work with an instructor classmate as needed. If you are using a bottle, you might be able to make different notes by changing how hard you blow across the bottle top. Alternatively, you might be able to make different notes by filling the bottle with water to different heights (say a quarter full, a half full, three quarters full, etc.)

Part V: Musical Notes, whole class

b) At some point, the whole class will hear and obtain data for notes played on a standard musical scale.