

Marimba



Introduction

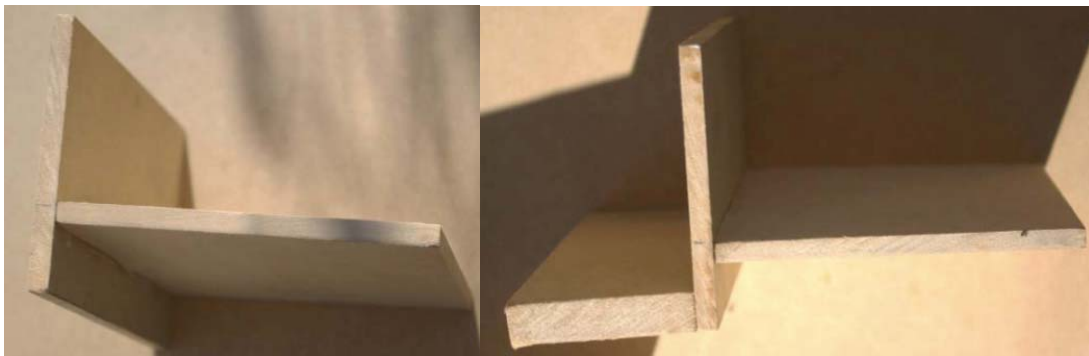
When trying to decide what to do for my project, I came across the idea of building a marimba. Since I don't play electric guitar or have any use for amps, I was trying to focus on something that no one had done before. My piano background, led me down the road of something piano based, but nothing too specific. That's when my friend suggested trying to build a small wooden marimba. I took his advice and looked online to see how complicated or difficult it was to assemble one. Besides tuning each note, the actual assembly process was not very expensive so I went with the idea. The project took me close to 30 hours of actual work to complete, and another 2 hours to properly test each note.

Materials and Tools



The total cost of the project was right around \$75. Luckily, I already possessed many of the tools required to make this project (power sander, hammers, screwdrivers, etc). In addition to the tools, the list of materials was quite long. It included three different kinds of wood ($\frac{1}{2}$ " MDF board for the outside of the base, $\frac{1}{4}$ " MDF board for the inside partitions, and $\frac{1}{2}$ " oak for the bars), rubber tubing for the bars to rest on, nails, screws, rubber feet for the bottom, and wood glue. Thankfully, all of these supplies can be found at a local hardware store, although the quantity in which they come in is way more than the necessary amount.

Assembly: The Base



The base of the marimba was actually far more complicated than I had originally estimated. In order to produce the right notes, the base consisted of 4 major parts: the outside case and three separate dividers. The idea was that depending on the frequency of the note, it would need more or less space underneath it. The space underneath was used to reverberate the noise properly. Each section contains roughly three different notes. In the end, it took me about 15 hours worth of work to make (closer to 18 if I include painting, sanding and staining it for its overall appearance).



Assembly: The Bars

The bars are what took the absolute longest during the construction process. Between the time it took to cut the bars to the right length, then sand down the bottoms to create the right pitch, and then staining them, it took close to 10 hours. The process of sanding the bars was far more complicated than I had ever imagined. The slightest bit of sanding changes the overall pitch dramatically, but the amount that needs to be sanded off is also quite a lot. It took a very steady balance of sanding and checking to make sure I did not take too much off. The overall result turned out pretty close to the notes that I expected.

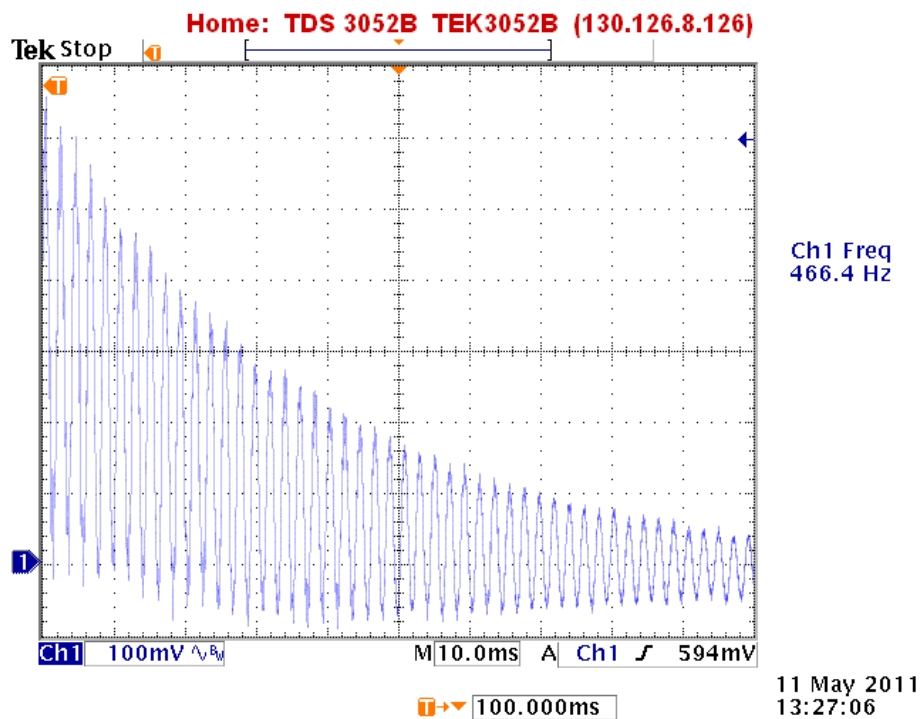


Assembly: Finishing the Project

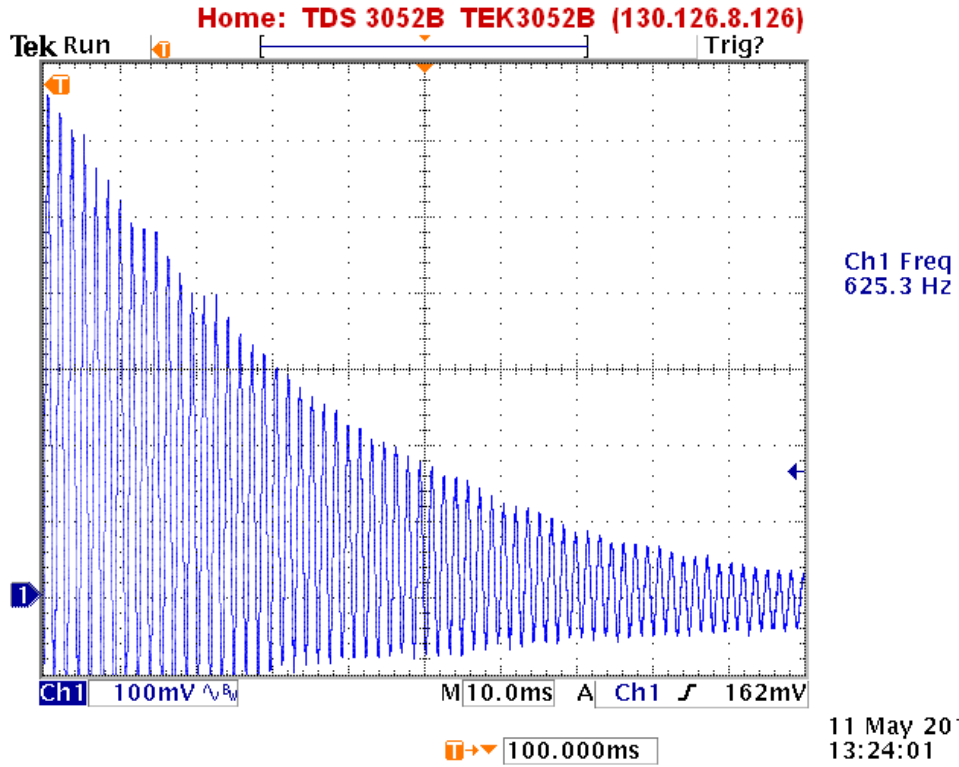
After finishing the bars and the base, the last step was to put on the rubber and screws that the marimba bars would eventually sit on. This was also a slow process since the distances between each screw had to be perfect, otherwise the bars would wiggle too much or not fit at all. Each bar was traced on to the rubber tube that had been laid down, and then holes were drilled into the tubing and the base for the screws. To finish my project it took just a couple more hours, bringing my total to the aforementioned time of roughly 30 hours. After everything was built, I took time to paint the marimba base, and finish my last coat of staining for the bars (both of these decisions were more for aesthetic appeal than anything else). After this whole assembly process was finished, the more scientific part of my project took place: the measuring of frequencies of each individual note.

Testing: Time Spectra

In order to understand exactly what kind of note the bars were going to produce, a time spectra was first taken for 3 individual notes (the lowest, middle, and highest frequency bars). The result was way more surprising than first imagined. The spectra that each bar produced showed the wide range of the bars. If more time had existed, programming could have been done to produce more accurate and exact measurements of the bars. Using this programming would have allowed easier inspection of the individual notes produced. So without further explanation necessary, here is the spectra for each of the three bars that were measured.

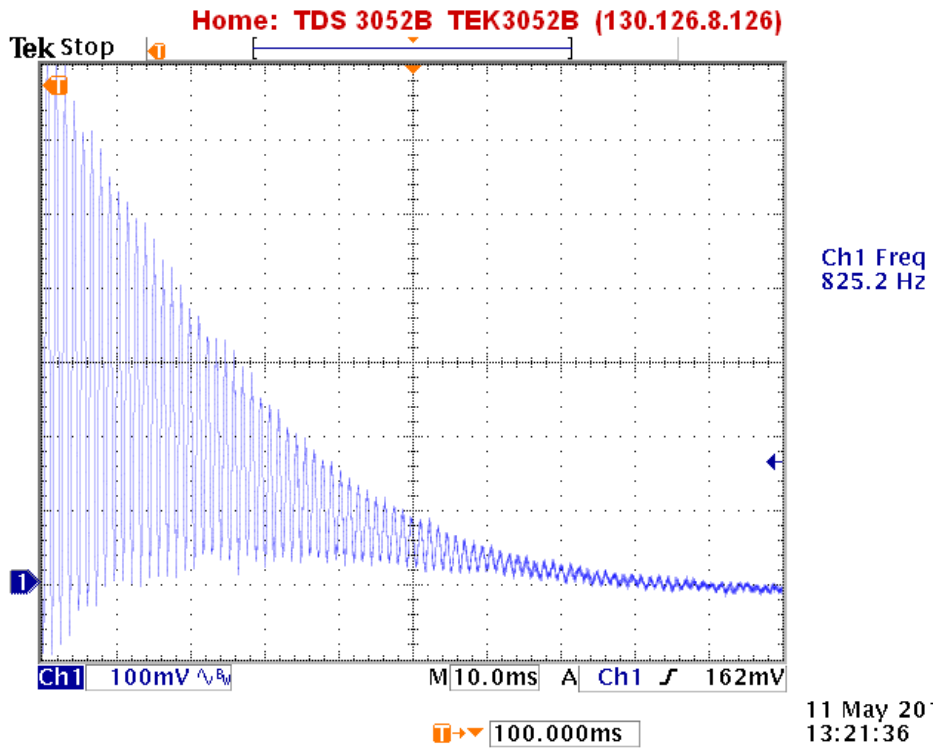


Lowest:



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13:24:01

Middle:



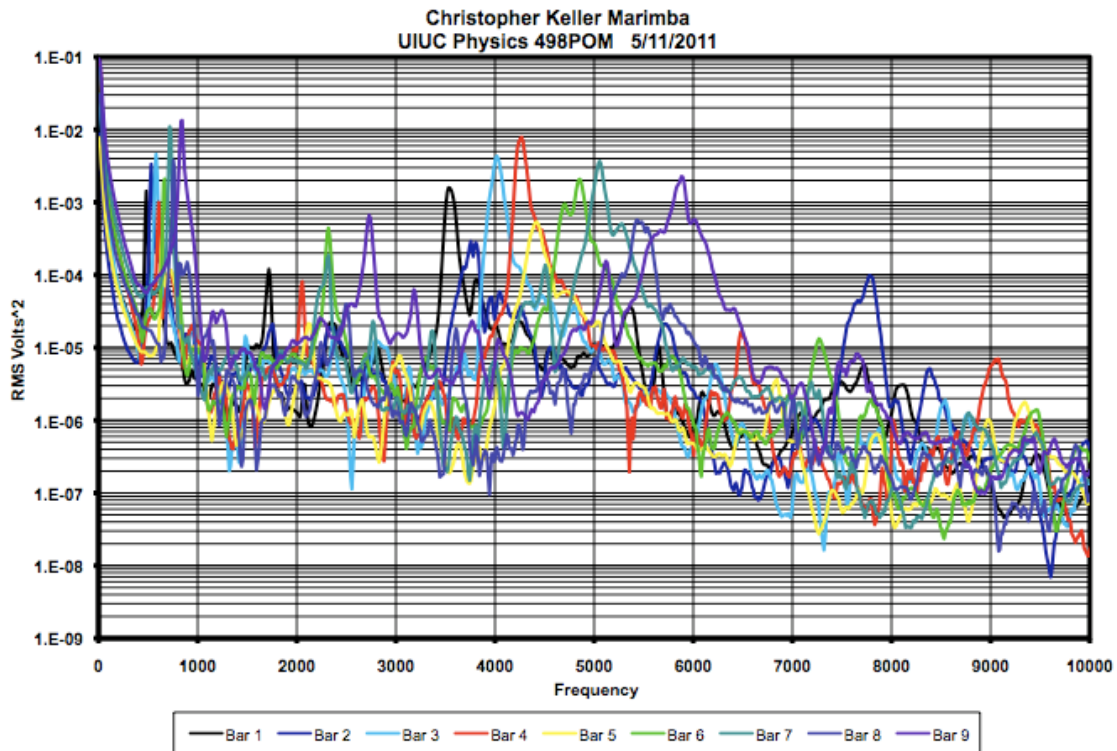
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Highest:

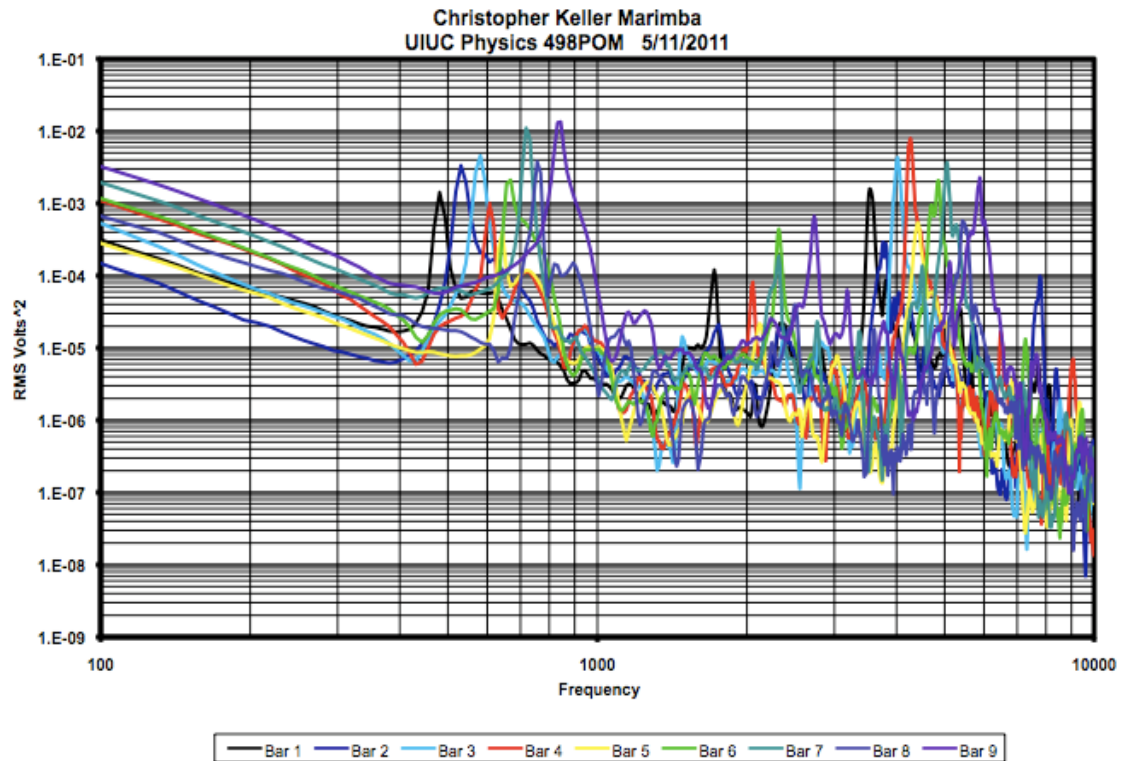
Testing: Frequency Measurements

Each note on the marimba corresponds to a standard note with a standard frequency. Since the notes do not resonate enough to determine the frequency, the average of each note was taken. By striking the note hundreds of times, the computer was able to compute an average frequency of each note. Initially, they were measured on a 10KHz range, but once it was discovered that (thankfully), they all fell within 1 KHz, they were all retested at that range as well. The results were interesting to say the least. For initial clarification, Bar 1 represents the lowest frequency going upwards to Bar 9, which has the highest. On a logarithmic Volts² scale (at 10KHz) versus Frequency, the results were difficult to really determine much. The main thing noticed on this graph, was the shoulders on the higher pitched notes. This meant that these notes did not produce a very constant or exact

note.

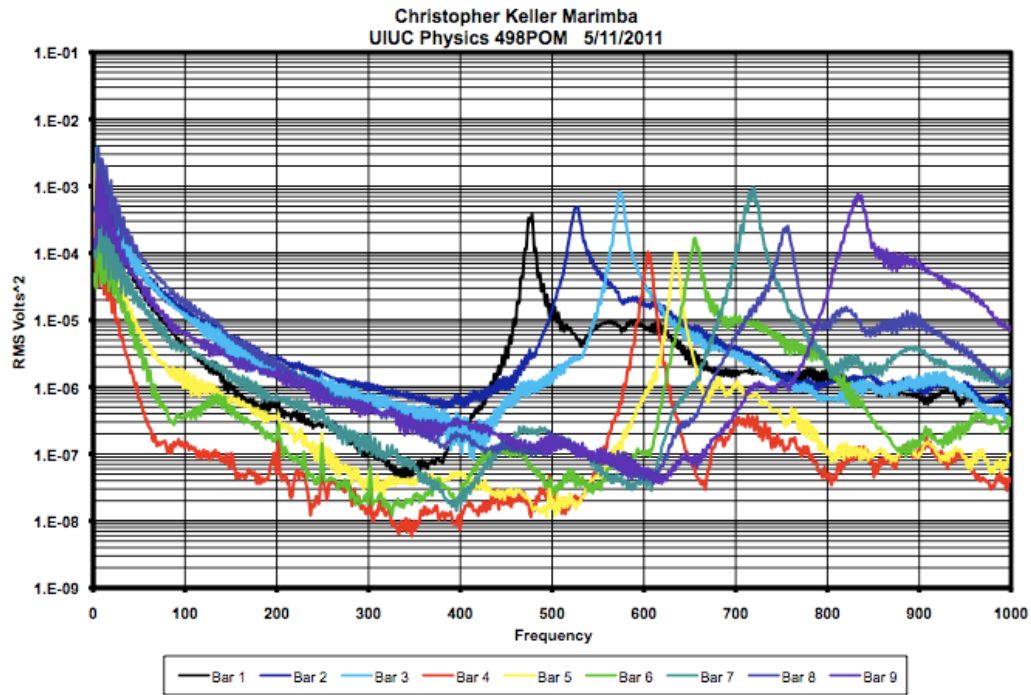


The next graph that was done was a logarithmic Volts² scale (at 10KHz) versus a logarithmic Frequency. The more interesting part about this one was the initial area from 0-1000 Frequency (which will be shown in more detail in the next section). The exact and different notes produced were more clearly seen at the frequencies in the hundreds than in the thousands, which was to be expected. Towards the larger end of the frequency scale, the notes pretty much just jumbled together, making any real accurate statements and determinations pretty impossible. As seen below, the nine different notes come to nine very different and specific peaks. These peaks, which represent the specific note of each bar, would be more easily calculated in the next graph, since the range is far more specific to the actual data that was collected.



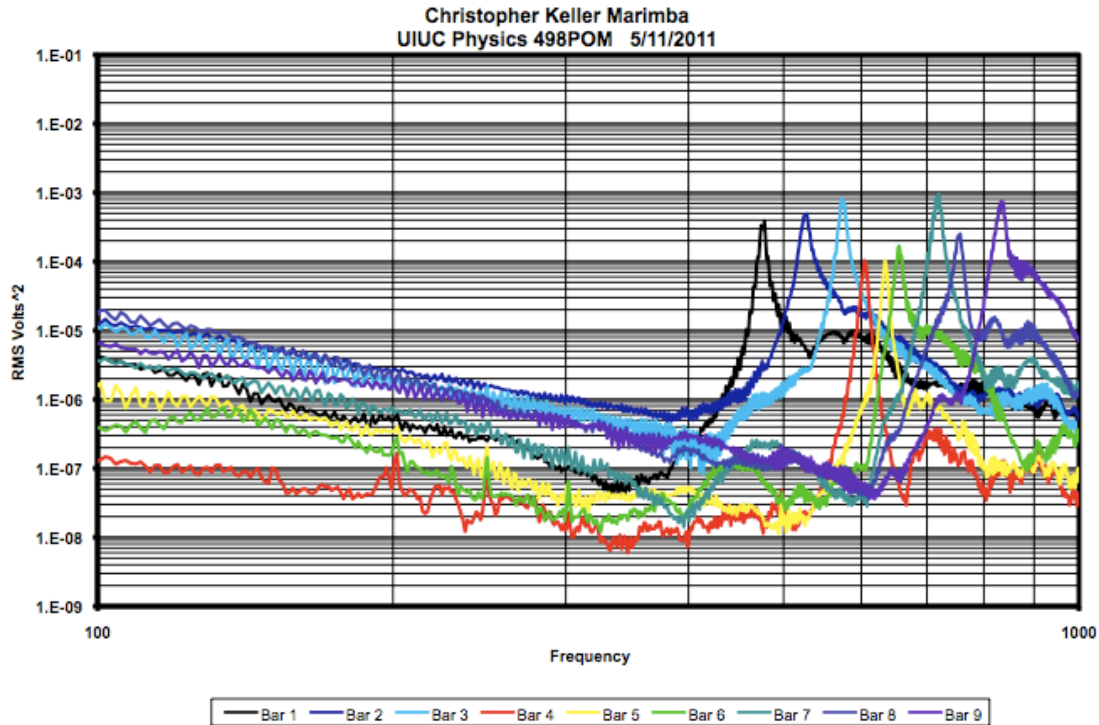
When the scale was reduced to just 1 KHz, the actual data became much more apparent. It was immensely easier to determine the physical qualities of each note, as well as the actual frequencies. Since the frequencies ranged from roughly 460 Hz -860 Hz, the first graph without the logarithmic frequency provided a better depiction of how the notes sounded. The bars, in order from lowest frequency to highest, came out with these measurements: 478 Hz, 528 Hz, 571 Hz, 604 Hz, 634 Hz, 655 Hz, 715 Hz, 753 Hz, and 815 Hz. As seen in the data, the notes did not display a consistent distance between each one, but came out to roughly 40-50 Hz difference between each note. When cross-referenced with a guide, the actual notes can be determined: B^b, C, D, E^b, E^b, E, F, G^b, and G. Luckily, when the notes are sanded, the frequency drops, so a couple corrections to a handful of notes will put

them closer to a real scale. Hopefully, these corrections can be tested again in the fall, and the report can be updated with more accurate notes.



The last graph that was made featured a logarithmic frequency scale (just like the 10 KHz one). This graph was interesting because of the shoulder affect (like noted in an earlier one). The higher the frequency of the note, the more of a prominent shoulder it displayed. This just showed that at high frequencies, the pitch was harder to maintain at an accurate reading. This is most likely caused by the sanding underneath. Since the higher notes required less sanding, the difference that each little bit makes it a big amount. It was difficult to sand exact and smooth curves into the bottom of the bars, so little uneven sections could produce dramatically different sounding notes, which would be a main cause for this shoulder to be produced. This problem could be eradicated by further sanding, and

like noted before, hopefully these corrections will be recorded at a future time, and will be able to be amended onto this report.



Conclusion

Overall, I really enjoyed the entire process. It was very interesting, frustrating and exciting being able to create and test my own musical instrument. With the knowledge obtained from the class, the tests and subsequent graphs that were produced made way more sense than they would have originally. In the end, I wish I could have tested the project sooner, so these tiny corrections could have been made during the school year. I still plan on making these corrections and finding time next semester to determine the difference that they made. If all goes to plan, they should help make the marimba more in tune with the projected notes (A through high B). Hopefully by this time next year, I will have a fully completed and

tuned marimba, which was the initial goal to begin with. In the end, I am proud of the work that was completed and impressed by the tests and results that were run afterwards.

