



CALIFORNIA STATE SCIENCE FAIR 2009 PROJECT SUMMARY

Name(s) She'ifa Z. Punla-Green	Project Number J1915
Project Title The Mathematics of Sympathetic Vibrations	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Which notes on a piano can induce sympathetic vibrations on an open string? Mathematical relationships between test note and open string frequencies will be used to predict which notes cause sympathetic vibrations. I predict the three test notes in my sample that are harmonics of the open string will resonate the longest.</p> <p>Methods/Materials Materials used were: a piano, a stopwatch, a frequency chart, and a helper. I depressed a piano key, the damper lifted and the string was "open," or free to vibrate. I played all the notes in one octave higher than the open string. My helper timed the durations of the tone coming from the open string. I averaged and graphed the results.</p> <p>Results The thirteen test keys in each sample caused the open string to resonate. Seven test keys caused brief resonance; the vibration inside the sound box caused the open strings to produce a tone. Three test keys produced tones of intermediate duration, due to the fact that the frequencies of their harmonics were equal to the frequencies of the open strings' harmonics. However, as predicted, three test keys with a frequency equal to a harmonic of the open string produced the longest resonance.</p> <p>Conclusions/Discussion As a musician, I think it is important to understand the physics of sound and hearing. After doing the experiment, I understand why performers should hold their open strings closed, why differing pianos produce varied sounds and "color", and why digital pianos cannot mimic the sound of real pianos.</p> <p>The physics of sympathetic vibration go beyond music. Some scientists believe that "the universe consists solely of waves of motion," or "there exists nothing other than vibrations." An understanding of sympathetic vibrations is a good place to start understanding the physics of the universe, from subatomic particles to the workings of the inner ear to bridge construction to astronomy.</p> <p>Further experimentation would include testing more keys with different frequencies, especially higher notes. I would like to test keys more than one octave higher than the open string to determine when the sympathetic vibration ceases to be audible. Because of the mathematics involved in an even-tempered scale, I am curious to know if I would get the same results for every open string. I would also like to broaden my understanding of the mathematics in music to include chords, intervals, progressions, and</p>	
Summary Statement My project explores the mathematics of sympathetic vibrations on piano strings.	
Help Received Teacher edited work; Father was my helper and helped edit; Mother helped edit; Used the piano at Pacific Union School; Parents helped glue display board.	