Vibration Frequencies of Viola Strings

By: Daniel Irvine

Date: April 4th 2007

Table of Contents

Abstract

The viola has four strings that produce musical notes. These strings are steel core chrome flat wound strings. Tension is applied to each string by the turning of the tuners. The strings make sound by plucking and bowing. My hypothesis of this project is that mechanical vibration of the strings produces sound waves. My objective of this project is to test the hypothesis by measuring the fundamental frequency and overtones of each viola string.

Introduction

The viola, once known as the violino, was made before the violin and was made in Italy in the 1500's. People who played the viola enjoyed that they were the top of the violin family, at least historically. Although nothing has been proven, in concerts the viola's job most of the time was pure harmony with a bass role. The viola has thicker strings than the violin. Therefore, the viola is more powerful than the violin, but the cello is louder than both of these stringed instruments because of the length and size of its strings. Gaspara da Salo was a famous cello maker was the one who made the viola and the double bass instrument. In most songs sometimes the viola was there for anxiety. Later on in the eighteen hundreds and the nineteen hundreds violas got better with sound along with the other string instruments. There are different techniques for the viola including happy, beautiful sounds used sometimes used for solos, now the violino is commonly known as the viola.

Figure1. Three-Quarters Viola

Terms

Frequency: - pitch (measured in hertz [Hz]) - the number of cycles of sound pressure waves which occur each second in producing sound

Harmonic: - 1: pertaining to harmony, as distinguished from melody and rhyme
2: marked by harmony; in harmony; concordant.

Octave – an octave difference is twice the frequency than the lower tone.

Overtone –music and acoustical frequency that is higher in frequency than the fundamental.

Pitch: - the word used to describe the relative highness or lowness of a tone, scientifically determined by the number of vibrations per second

Tone: - the basic building material of music; it has four distinct properties: pitch, duration, loudness, and timbre Tranquillo - calm, tranquil

Sound Wave

Sound Waves can travel through air, water, or the ground. Sound Waves can travel through a physical material. Sound Waves cannot travel through space because in space a vacuumed that lax air molecules.

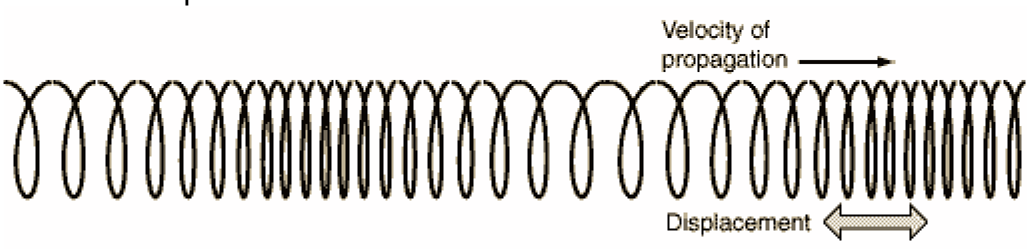


Figure2.

This is image shows a wave traveling along a spring. As the wave moves it compresses and then compresses the spring. This motion is similar to that of a sound wave.

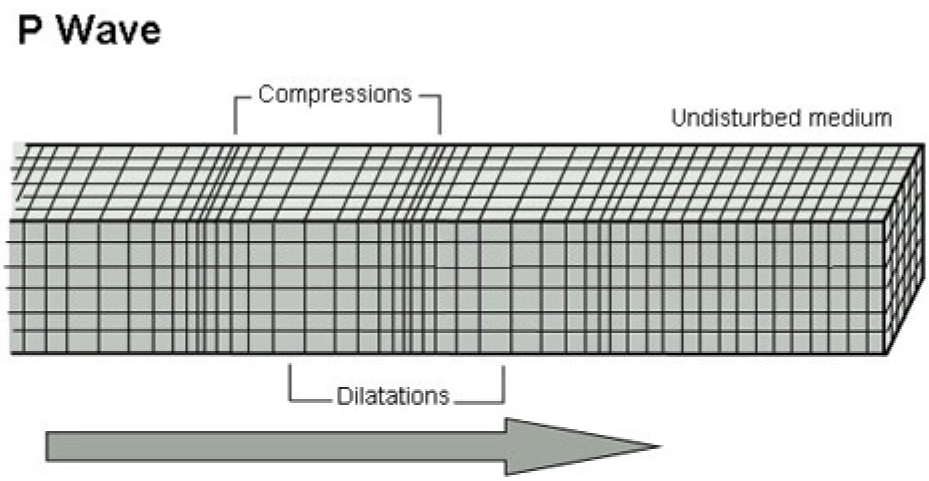


Figure3.

This is a seismic P wave. A P wave is a sound wave that travels through the Earth. The P wave is one of several types of earthquake waves.

Experiments and data

Procedure

First we played notes on my viola bowed and plucked and we recorded the sound waves using a microphone. The mike had its own built in sound card and it had its own USB cord that plugged into the computer. Audacity software helped me measure the vibration the viola. Then we made graphs of the sound waves. We made two kinds of graphs for each sound wave, one graph was called a time history graph, and the time history graph shows the sound pressure versus time, the shape of the wave form is a sine wave. The second type of graph was a spectral graph, the spectral graph shows the tones in terms of frequency, the first tone is called the fundamental frequency, the higher tones are called overtones or harmonics, the blend of frequency's gives a pleasing sound to each viola string.

Figure4.

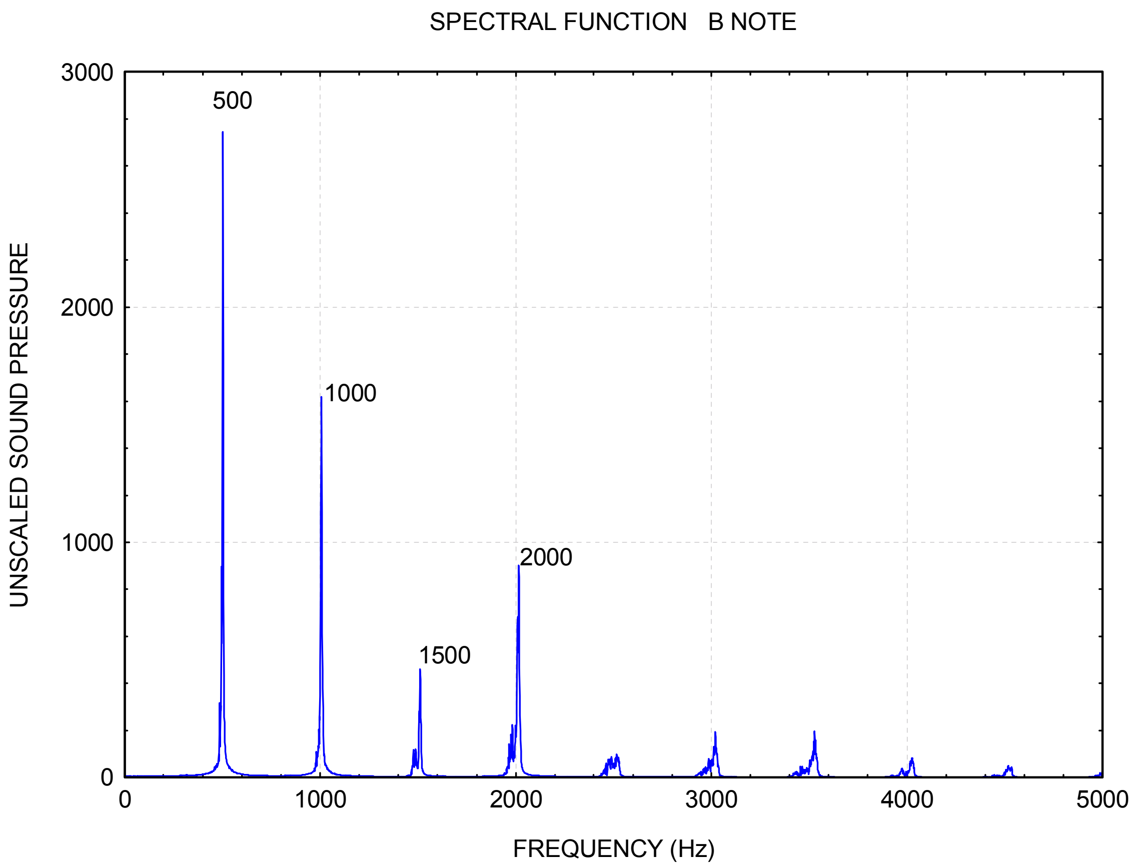


Figure5.Figure6.

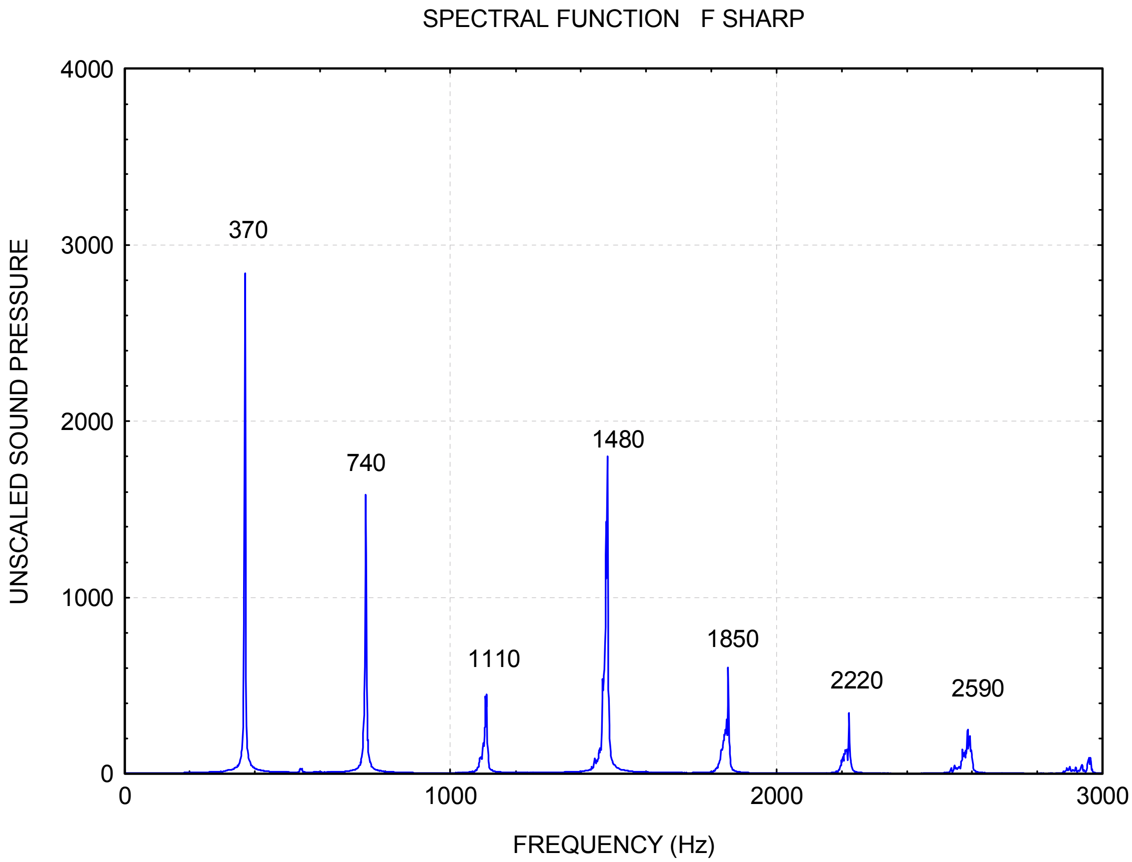

SPECTRAL FUNCTION F SHARP
UNSCALED SOUND PRESSURE
FREQUENCY (Hz)
0
1000
2000
3000
4000
370
740
1110
1480
1850
2220
2590

Figure7.

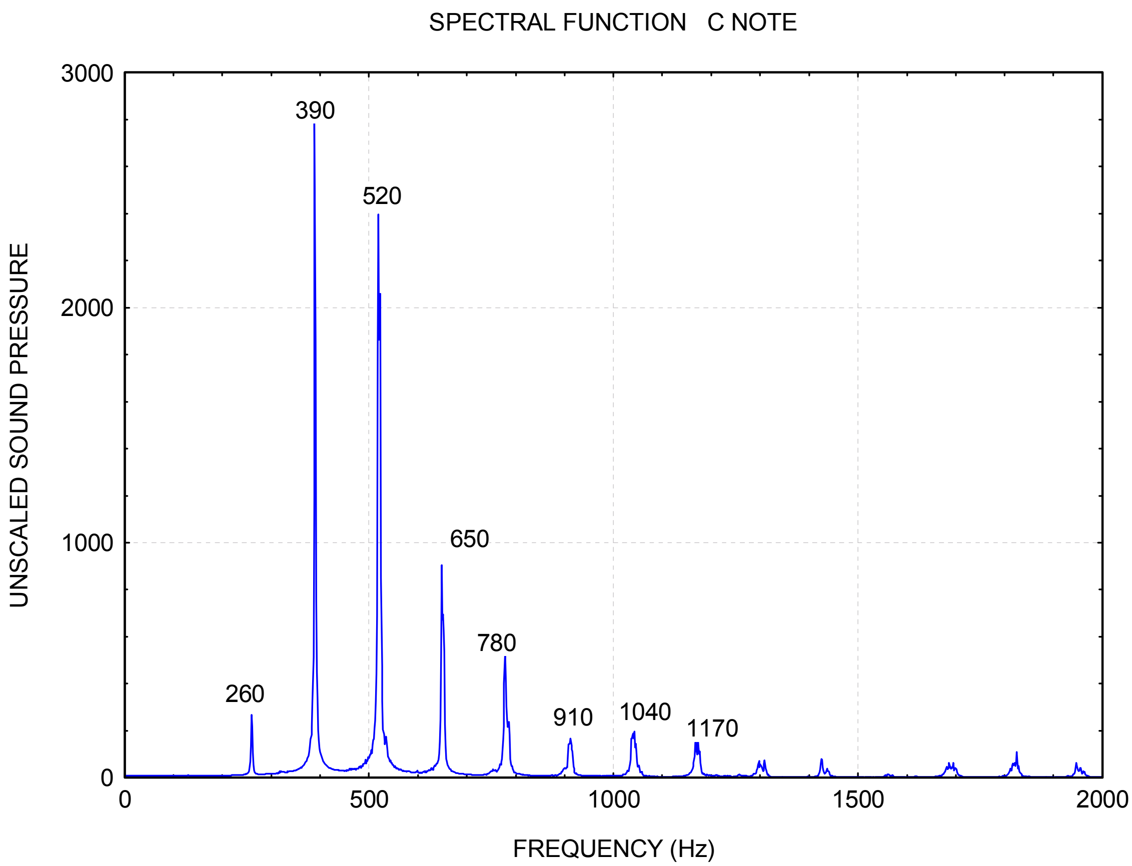

SPECTRAL FUNCTION C NOTE
3000
2000
1000
0
UNSCALED SOUND PRESSURE
390
520
650
780
260
910
1040
1170
0
500
1000
1500
2000
FREQUENCY (Hz)

Figure8.

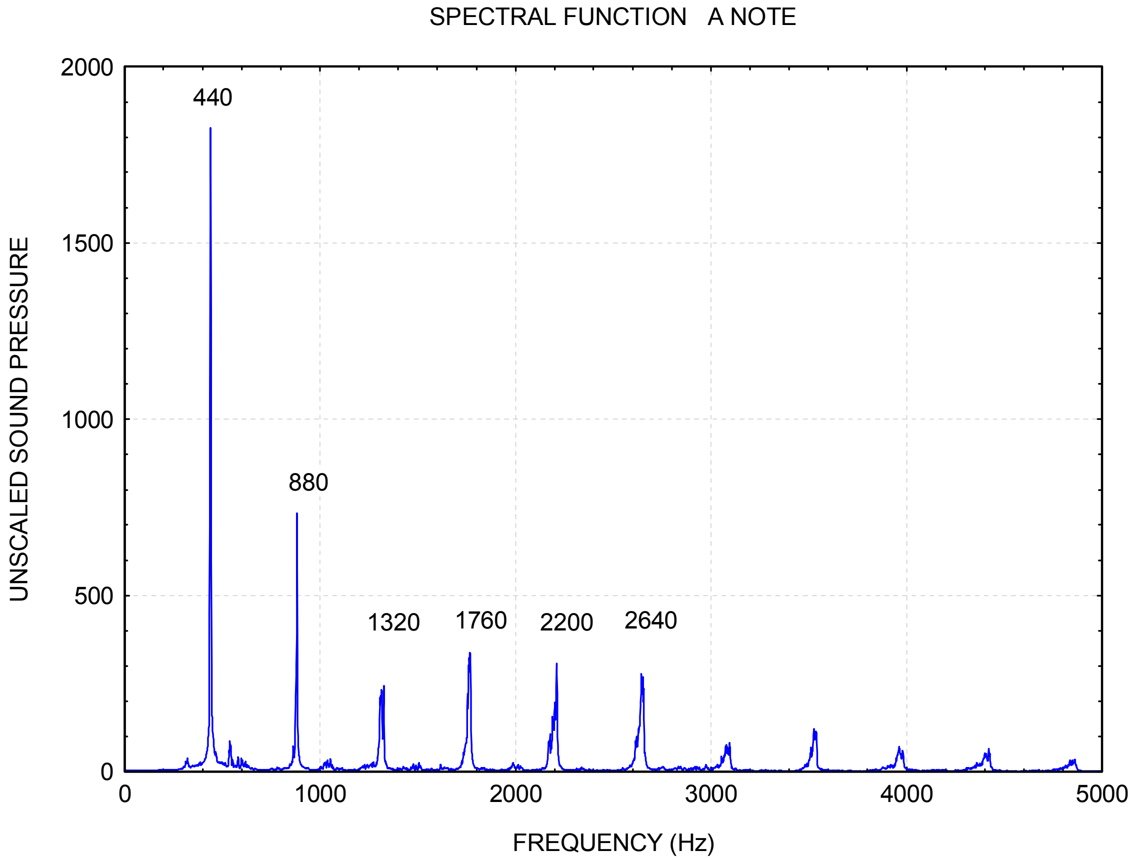


Figure9.

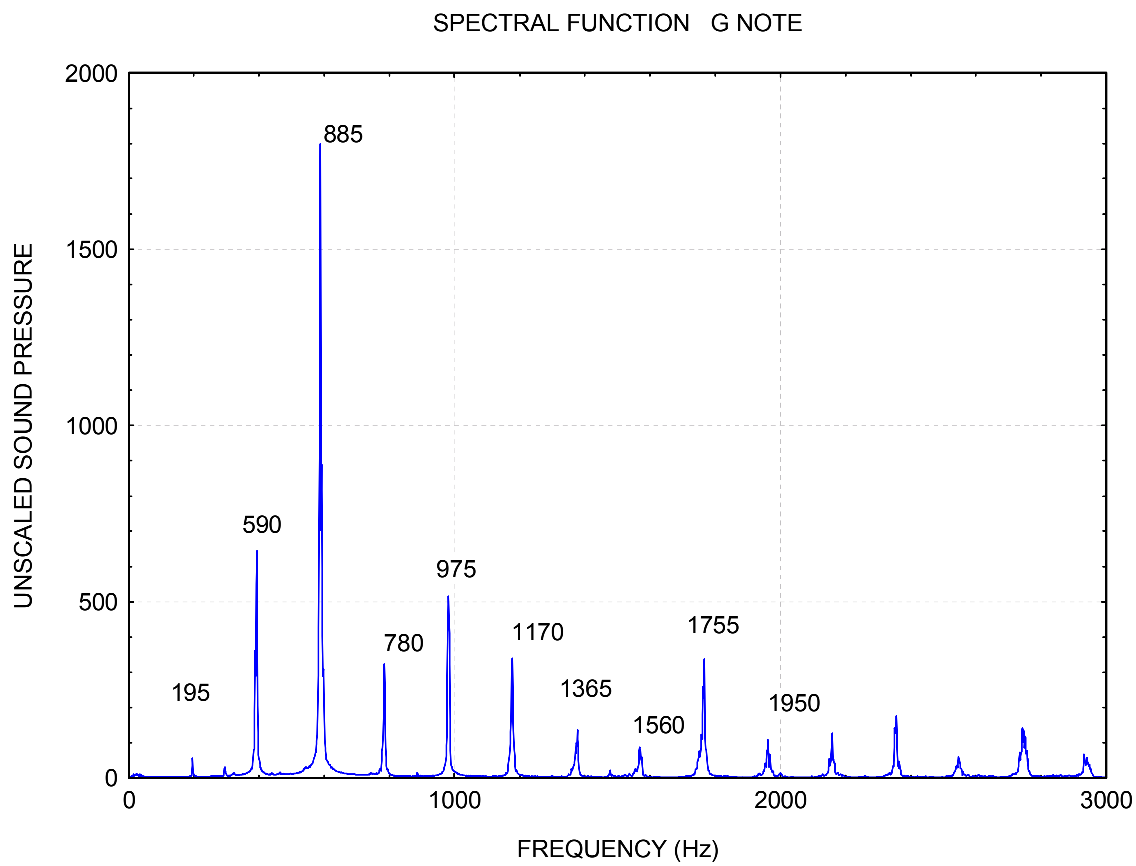

SPECTRAL FUNCTION G NOTE
UNSCALED SOUND PRESSURE
FREQUENCY (Hz)
2000
1500
1000
500
0
0
1000
2000
3000
885
590
975
780
1170
195
1365
1755
1560
1950

Figure10

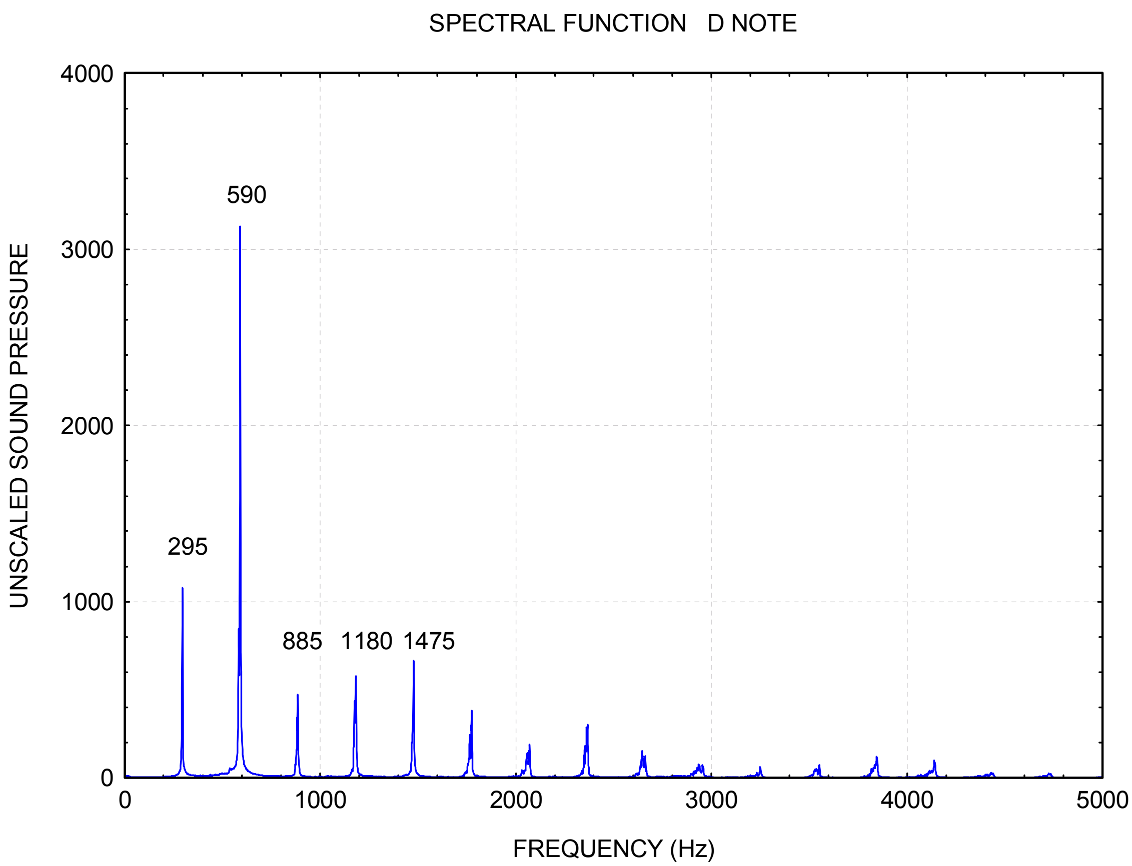
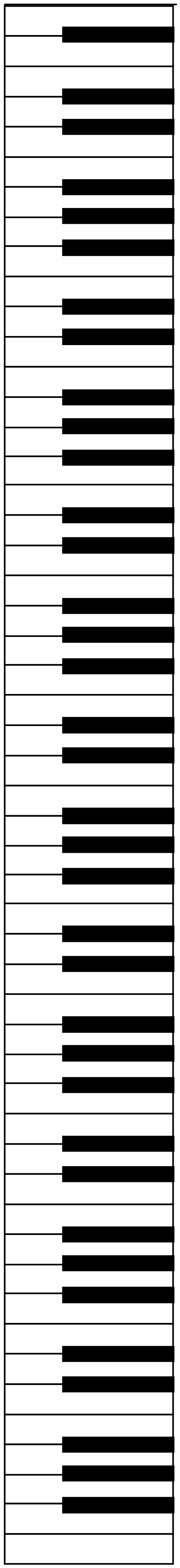

SPECTRAL FUNCTION D NOTE
UNSCALED SOUND PRESSURE
FREQUENCY (Hz)
0
1000
2000
3000
4000
5000
295
590
885
1180
1475

Figure 11.



Middle C

A0 27.5
B0 30.868
C1 32.703
D1 36.708
E1 41.203
F1 43.654
G1 48.999
A1 55.000
B1 61.735
C2 65.406
D2 73.416
E2 82.407
F2 87.307
G2 97.999
A2 110.00
B2 123.47
C3 130.81
D3 146.83
E3 164.81
F3 174.61
G3 196.00
A3 220.00
B3 246.94
C4 261.63
D4 293.66
E4 329.63
F4 349.23
G4 392.00
A4 440.00
B4 493.88
C5 523.25
D5 587.33
E5 659.25
F5 698.46
G5 783.99
A5 880.00
B5 987.77
C6 1046.5
D6 1174.7
E6 1318.5
F6 1396.9
G6 1568.0
A6 1760.0
B6 1979.5
C7 2093.0
D7 2349.3
E7 2637.0
F7 2793.8
G7 3136.0
A7 3520.0
B7 3951.1
C8 4186.0

A0# 29.135
C1# 34.648
D1# 38.891
F1# 46.249
G1# 51.913
A1# 58.270
C2# 69.296
D2# 77.782
F2# 92.499
G2# 103.83
A2# 116.54
C3# 138.59
D3# 155.56
F3# 185.00
G3# 297.65
A3# 233.08
C4# 277.18
D4# 311.13
F4# 369.99
G4# 415.30
A4# 466.16
C5# 554.37
D5# 622.25
F5# 739.99
G5# 830.61
A5# 932.33
C6# 1108.7
D6# 1244.5
F6# 1480.0
G6# 1661.2
A6# 1864.7
C7# 2217.5
D7# 2489.0
F7# 2960.0
G7# 3322.4
A7# 3729.3

PIANO KEYBOARD

The number beside each key is the fundamental frequency in units of cycles per seconds, or Hertz.

OCTAVES

For example, the A4 key has a frequency of 440 Hz.

Note that A5 has a frequency of 880 Hz. The A5 key is thus one octave higher than A4 since it has twice the frequency.

OVERTONES

An overtone is a higher natural frequency for a given string. The overtones are “harmonic” if each occurs at an integer multiple of the fundamental frequency.

Wavelength

This project has focused mainly on the frequency of sound waves from viola strings. A sound wave also has a wave length.

The wavelength λ is

$$\lambda = c / f$$

Where ‘c’ is the speed of sound and ‘f’ is the frequency.

The viola string ‘A’ note had its fundamental frequency at 440 Hz. The speed of sound in air under normal conditions is about 343 Meters per second. Thus the wave length of the ‘A’ note is equal to 0.78 meters, or 78 centimeters.

Conclusion

a

Sources

a

Acknowledgements

a