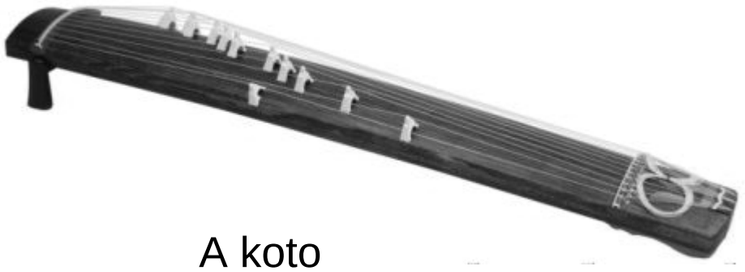
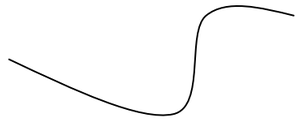


A koto

Koto Strings



Some string

Overview

A musical instrument manufacturer is keen to develop a range of mini or half-sized stringed or wind instruments which exhibit the same characteristics as the full sized versions.

Background

In a normal koto, there are 13 strings with movable bridges. These bridges are moved to appropriate tuning positions before playing, giving thirteen different available notes at any time. Each string is plucked which causes the string to vibrate the air molecules around it. These air molecules can, in turn, cause the other strings to vibrate sympathetically at their resonant frequency which creates overtones in the sound.

Three factors affect the frequency a note produces when plucked:

Tension
Length
Density

$$f_1 = \frac{\sqrt{\frac{T}{m/L}}}{2L}$$

T = string tension
m = string mass
L = string length

Frequency is in Hertz, tension is in Newtons, not to be confused with new tons which are also called tonnes, mass is in thousandths of a kilogram and length is in kilomillimetres.

Experiment

My original method failed due to lack of decent equipment so I revised the method. This is it:

I decided to use a vibration generator to create vibrations in the string and observe when it vibrated most.

One end of the string to be tested, which was 0.71mm in diameter and one metre long, was be tied round a vibration generator hooked up to a signal generator.

The other end was extended over a pulley. A 70g weight was suspended from the end.

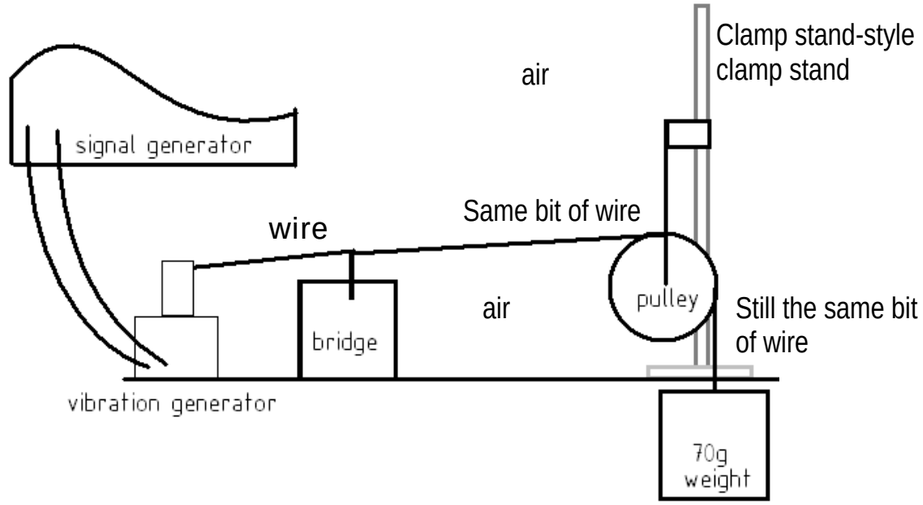
A movable bridge was placed under the string and position far to one end.

A frequency was generated to cause the string to vibrate, starting with a frequency of 110Hz. The bridge was moved slowly along the wire until the string vibrates the most.

The distance from the frequency generator to the bridge was noted and the experiment repeated for the other 12 frequencies in the octave.

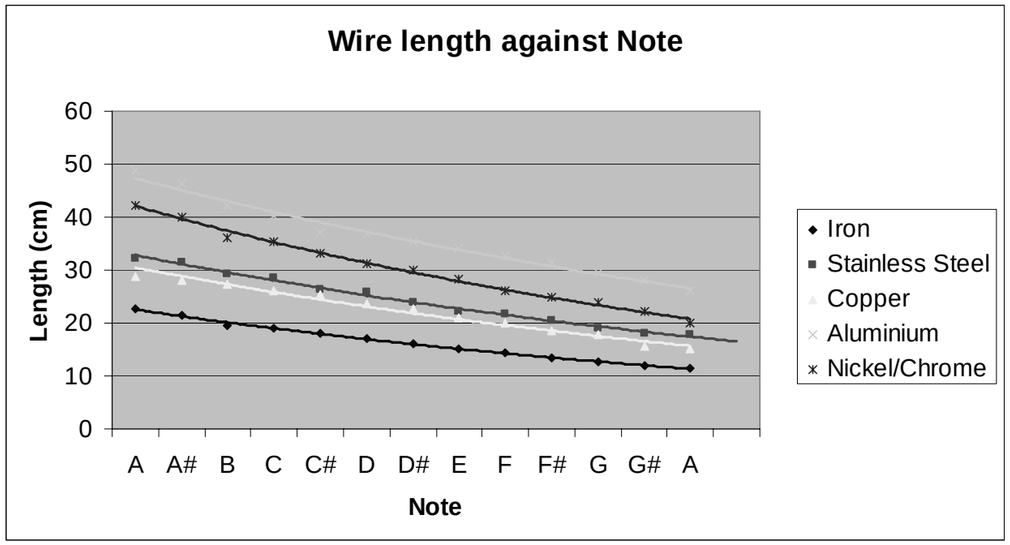
The experiment was repeated if any results seem anomalous.

In this experiment, the tension and thickness were kept constant.



Fact: Because a koto has 13 strings, some people say it is only 0.277 times as good as a 47-string concert harp. These people are wrong though because there are an infinite number of positions for the bridges so a koto is infinitely better than the harp.

Results

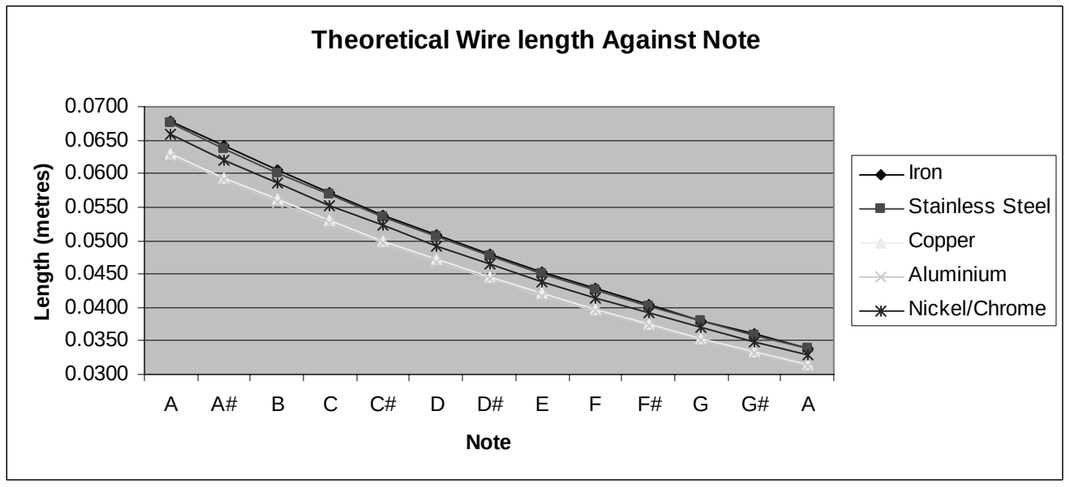


This graph on this page that is located to the left of this body of text is a graph to show the frequency a piece of wire produces when plucked against the length of the piece of wire while varying the type of piece of wire. An exponential line of best fit best fits the line as the data should theoretically exponential.

Fact: Due to the intriguing nature of vibrations, stringed instruments work upside-down.

Analysis

Analysis of the results yields some rather quite very interesting facts. Using the formula on the first page, the hypothetical results to the right of this word are obtained, which seem to contradict the results obtained through the medium of experimentation. Additional, the values on the right are some percent smaller than the real-world results (this can be observed by comparing the values on the up axes). The change may be due to difficulty weighing the wire because it was bendy and hard to get a specific length. As this measurement was unreliable, the results above this textbox are more reliable, though some may argue that the test was imprecise and poorly conducted.



Recommendations

As the tensions in the “mini instrument”, or “minstrument”, would most likely be different from the tensions in the string at the point of testing, the results pertaining to the necessary lengths of the wire are largely irrelevant, as a different tension would mean the lengths of the wires needed to achieve the notes. As such, the tests for different frequencies serve only as slightly varied repeats. Science says that a denser wire would give a lower frequency, so to achieve a set note, a heavy wire would need to be shorter. This is good for a “mini instrument” because the wires need to be as short as possible while producing a note that is not only audible to bats.

The list of densities is as follows, from the densest to the least dense:

Iron, Stainless steel, Copper, Nickel/chrome, Aluminium

Firstly, as an indirect result of this experiment, I would recommend not tightening wires with one’s hands because it hurts.

Secondly and more importantly, I would recommend using iron strings because they can produce low frequencies and iron is reasonably cheap.