CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)
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Project Number
J1624

Project Title
Whistling Wineglasses: Is Vibration Frequency Linearly Related to Water Volume?

Abstract

Objectives/Goals
Running a wet finger around a wine glass's rim produces a musical tone. The more water in the glass, the lower the tone's frequency is. I predicted that the frequency is linearly related (straight-line graph) to how much water is in the glass.

Methods/Materials
I tested glasses with 333.0 ml capacity, that were 0% full (bottom control), 10%, 20%, on up to 100% full (top control). For each test, I wet my finger and ran it around the rim. I used a tuner to measure pitch and the error in cents (hundredths of a musical half step). I represented pitch as a MIDI number with a fractional part for the cents. I converted those numbers to frequencies, and I plotted and analyzed the results.

Results
The mean vibration frequency decreased as I added water, from 754.4 Hz for an empty glass, to 313.0 Hz for a full glass. The graph of frequency versus volume (percent full) curves downward for small volumes, but is nearly a straight line when the glass is 60% to 100% full. At 60% full, the mass of water (199.8 g) is 1.510 times that of the glass (132.3 g).

Conclusions/Discussion
While my results partially supported my hypothesis, what was most interesting was that the relation between frequency and volume did not become linear until the mass of water was about 1.5 times that of the glass. It may be that for small volumes of water, the frequency is mainly determined by the glass's characteristics, but when the water's mass is greater than that of the glass, the volume of water becomes the most important factor. In follow-up experiments with three other types of glasses, the frequency curve was also nonlinear for low volumes and linear for high volumes, although it became linear at different points for the different glasses.

Summary Statement
As water is added to a wineglass, the frequency of sound made by running a wet finger around the rim decreases nonlinearly for small amounts of water, but it decreases linearly when the water's mass is more than 1.5 times that of the glass.

Help Received
This project was my idea, based on my observation that adding water to a wineglass lowers the pitch of the sound it produces. My father helped me analyze my data, and my mother helped me paste up my poster.