Creating A PanFlute With Math

Formal Lab

The purpose of this experiment was to create a panflute in C major scale, using the formula $Length = \frac{Vs}{4f}$. First 7 lengths were found using the formula and a spreadsheet was used a reference to find the correct frequency corresponding to the note. The notes were C, D, E, F, G, A, B and the corresponding frequencies needed were 261.6 Hz, 293.3 Hz, 329.6 Hz, 349.2 Hz, 391.9 Hz, 440.0 Hz, 493.8 Hz. The corresponding error percentages for each pipe were 1.37%, 1.80%, 0.48%, 2.06%, 0.48%, 0.45%, 5.51%, for an average percentage error of 1.73%. To build a panflute, each length was marked with a marker on the pipe and then sawed off and smoothed, after they were taped in order of the notes and then each pipe was tested on Audacity to compare the frequencies and how accurate they were to what they were supposed to be.

Darwin
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Due date of the lab: June 19, 2023

Introduction

The purpose of this experiment was to determine if the equation Length = v/4f, works accurately to make a panflute, which operates by having different closed length ended pipes. A different length makes a different frequency or a different note. 7 notes were made for this panflute in C major scale, the notes used were C, D, E, F, G, A, B. After the software Audaucity was used to see how accurate the frequency was and the percentage errors were calculated and low percentage errors were achieved, the average percent error was 1.73%. At the end to confirm that the experiment was successful a small tune called *Another One Bites The Dust,* The tune wwas played properly which proved the experiment was a success.

Hypothesis

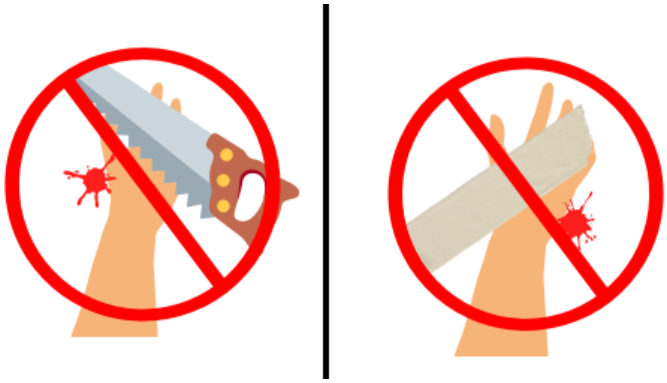
The hypothesis is that each note will be determined fairly accurately (with the equation Length = v/4f) with a low percentage error, and that at the end of building the panflute a song will be played successfully.

Apparatus and Materials

→ small carpentry saw
→ 1/2" inch PVC pipe
→ Sand paper
→ Tape
→ Ruler or Meter stick
→ Marker
→ Table
→ Wood plank
→ Audacity (version 3.3.3)

Safety Precautions

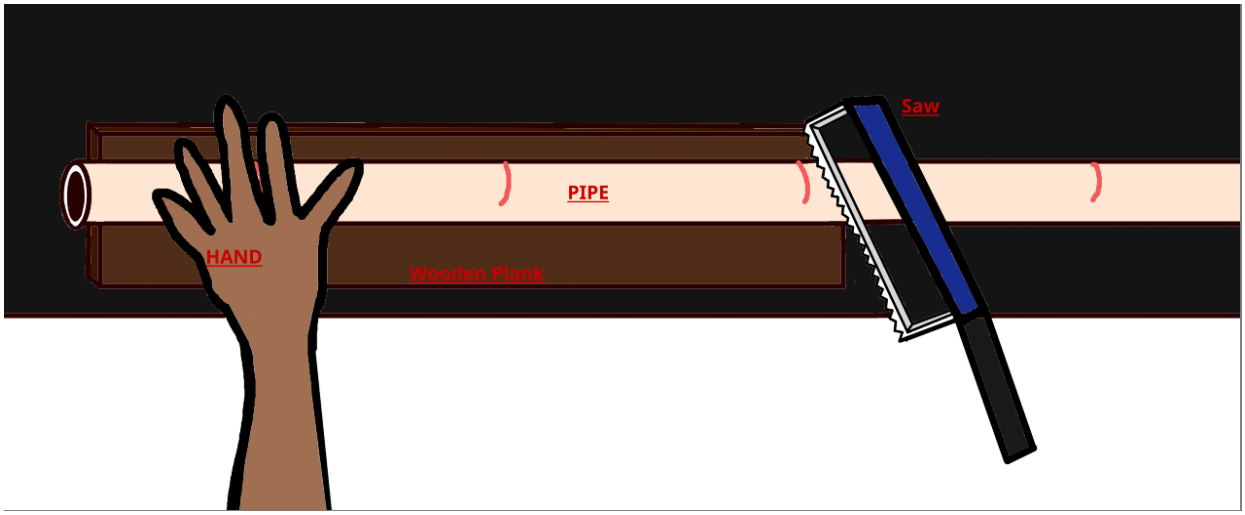
During this experiment a carpentry saw and sand paper were used. Safety precautions taken when building the pan flute were to not put your hand underneath the saw or on the other end when sawing because a hand could get sawed off. It is also important to to not use the sand paper on your skin because it could damage or remove your skin.



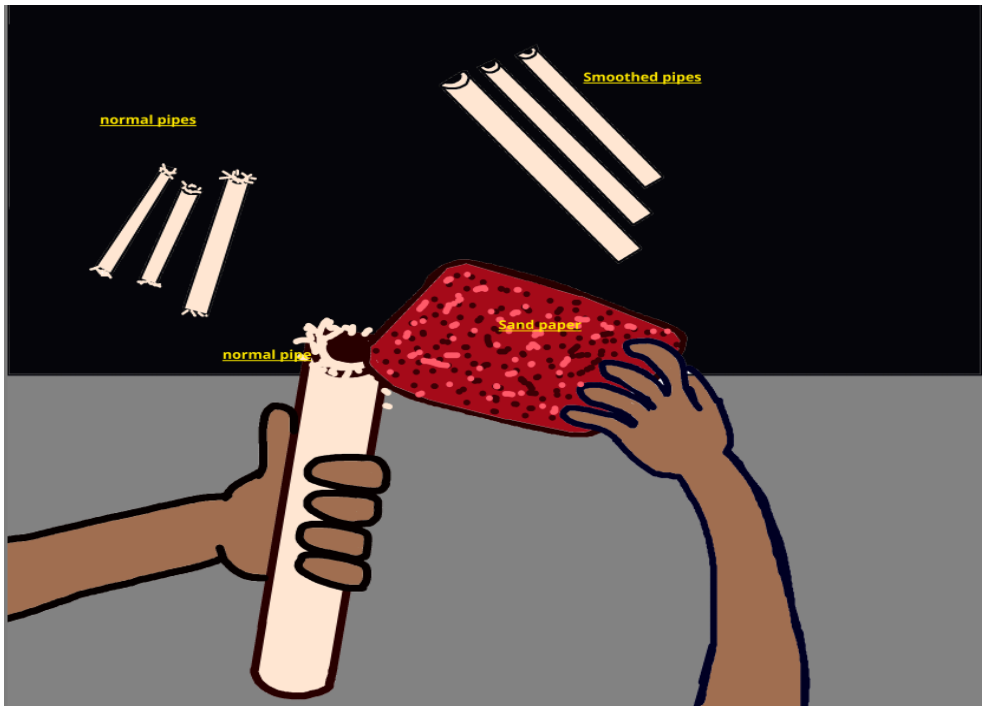
Procedure

1. The equation Length = v/4f was used to determine the length needed for each note, a database was used to find the frequency needed.
2. 1 long PVC pipe was bought at Home Depot.
3. The pipe was laid down on a table.
4. With a ruler or meter stick, each length needed for a specific note (Frequency) was measured. The notes being C, D, E, F, G, A and B.
5. The seven measured parts were marked with a marker.
6. Each part that was marked was sawed off on top of a wood plank to not damage the table.
7. Each of the seven pipes was smoothed on each side with sandpaper until very smooth.
8. One end of each pipe was taped over two times to make a closed end.
9. The seven pipes were laid from longest to shortest in order
10. The pipes were then taped together a few times so they can all be held together.
11. Each pipe was blown while recording on Audacity
12. Each blow was selected on Audacity and the frequency was compared with the accepted frequency for each note.

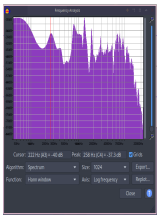
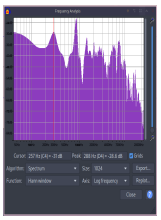
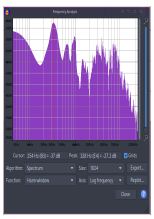
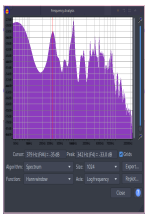
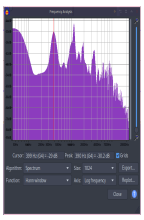
Pipe getting sawed diagram:

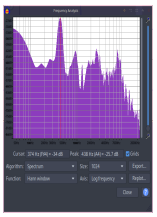
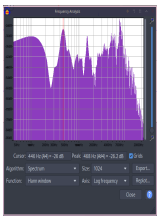


Pipe getting smoothed diagram:



Observations

Note	Frequency Needed (Hz)	Frequency Achieved (Hz)	Percentage Error	Photo Of frequency	Length Needed (Meters)
C	**261.6 Hz**	**258.0 Hz**	$\left(\frac{261.6-258}{261.6}\right) \cdot 100 = 1.37\%$		$0.328 = \frac{343.72}{4 \cdot 261.6}$
D	**293.3 Hz**	**288.0 Hz**	$\left(\frac{293.3-288}{293.3}\right) \cdot 100 = 1.80\%$		$0.292 = \frac{343.72}{4 \cdot 293.3}$
E	**329.6 Hz**	**328.0 Hz**	$\left(\frac{329.6-328}{329.6}\right) \cdot 100 = 0.48\%$		$0.260 = \frac{343.72}{4 \cdot 329.6}$
F	**349.2 Hz**	**342.0 Hz**	$\left(\frac{349.2-342}{349.2}\right) \cdot 100 = 2.06\%$		$0.246 = \frac{343.72}{4 \cdot 349.2}$
G	**391.9 Hz**	**390.0 Hz**	$\left(\frac{391.9-390}{390}\right) \cdot 100 = 0.48\%$		$0.219 = \frac{343.72}{4 \cdot 391.9}$

A	**440.0 Hz**	**438.0 Hz**	$\left(\frac{440-438}{440}\right) \cdot 100$ $= 0.45\%$		$0.195 = \frac{343.72}{4 \cdot 440.0}$
B	**493.8 Hz**	**468.0 Hz**	$\left(\frac{493.8-468}{468}\right) \cdot 100$ $= 5.51\%$		$0.173 = \frac{343.72}{4 \cdot 493.8}$

Percentage error average: 1.73%

Analysis And Discussion

Equation for percentage error:

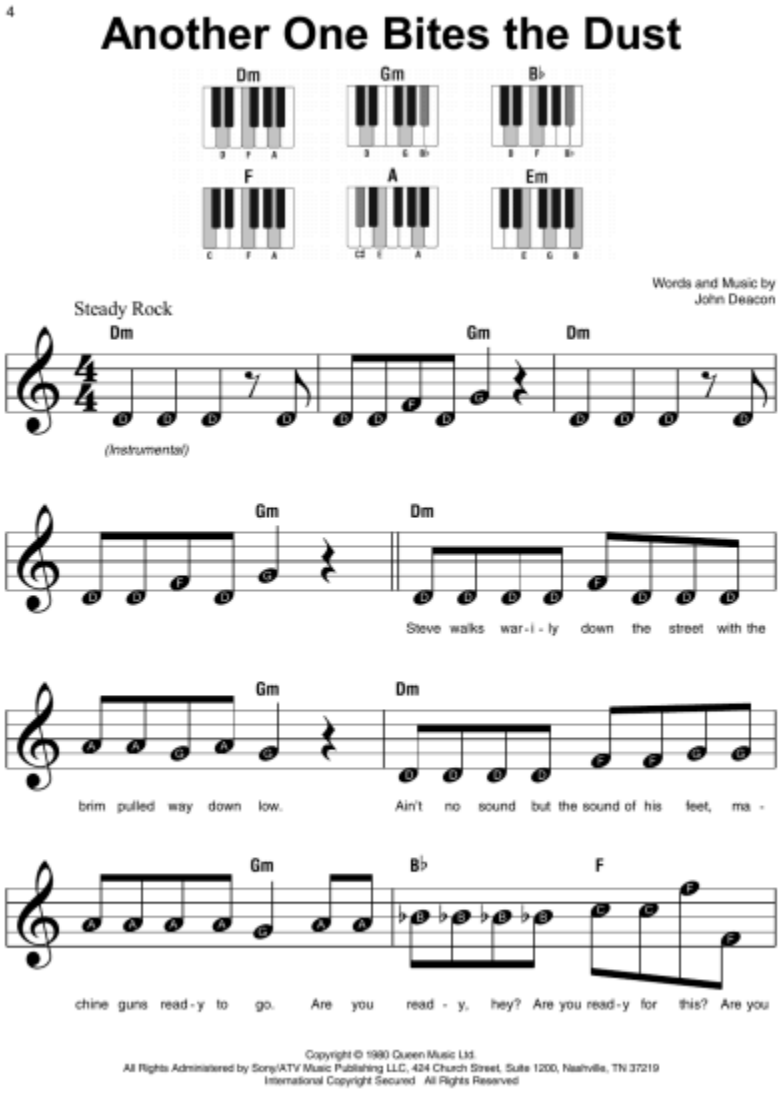
$$\%error = \left(\frac{difference\ between\ accepted\ value\ and\ expirmental\ value}{accepted\ value}\right) \cdot 100$$

Equation to find length:

$$Length = \frac{334.72}{4f}$$

The frequency and notes achieved through the equation were fairly accurate and the method of creating the instrument worked too, as expected. With a total percentage error average of 1.73%. The percentage errors were the following: C: 1.37%, D: 1.80%, E: 0.48%, F: 2.06%, G: 0.48%, A: 0.45%, B: 5.51%. The lengths were the following: C: 0.328 m, D: 0.292 m, E: 0.260 m, F: 0.246 m, G: 0.219 m, A: 0.195 m, B: 0.173 m. Possible ways to improve this experiment is to use a machine to cut and measure for more accuracy or for the tools used to have more precise measurements. The limitations of this experiment were that that Audacity only has one decimal place, and the measuring tools like a meter stick or ruler only go down to millimeters.

This is the song to test if the experiment was successful



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Another One Bites the Dust

Dm Gm B♭ F A Em

Words and Music by
John Deacon

Steady Rock

Dm Gm Dm

(Instrumental)

Gm Dm

Steve walks war - i - ly down the street with the

Gm Dm

brim pulled way down low. Ain't no sound but the sound of his feet, ma -

Gm B♭ F

chine guns read - y to go. Are you read - y, hey? Are you read - y for this? Are you

Conclusion

This experiment was successful and the notes from the pipes sounded properly as they were supposed to. The purpose of this experiment was to make an instrument and get the appropriate notes (C, D, E, F, G, A, B) or frequencies through using the formula: $Length = \frac{334.72}{4f}$. The frequencies were measured on Audacity and compared to the actual frequencies and the percentage errors were low (Table above shows percentage errors), with an average percentage error of only 1.73 %. To conduct this experiment, the lengths were measures and then a pipe was cut to the appropriate lengths to get the notes, then they were smoothed with sand paper and taped together, the frequencies were compared to the actual frequencies and for further testing a song known as *Another One Bites The Dust* was played on the panflute, and it sounded great, which overall proves the success of the experiment.

Ideas For Further Experimentation

Other experiments that can be performed based on this are making a guitar or panflute with as many notes as possible and using a machine for cutting precision, or to make a panflute with adjustable lengths to get the most precise frequency at different temperatures.

Works Cited

audacityteam. (2022, September 22). Version (3.2.0). *Audacity*. Retrieved June 1, 2023, from https://www.audacityteam.org/

Rick Osgood. (2013, August 27). *Fast Hacks #11 - Build a PVC Pan Flute* [Video]. YouTube. https://www.youtube.com/watch?v=8dZYfWRkBMM

Pan Flutes Spread Sheets Lengths. (n.d.). [Dataset]. https://tcdsb.elearningontario.ca/content/enforced2/22528105-BL_SCI_SPH3U1-01_732443_2223Sem2/MYFILES/06%20-%20CUMULATIVE%20EVALUATION%20PROJECTS/CEP2%20-%20Pan%20Flute/Pan%20Flutes%20Spreadsheet%20Lengths.xlsx?isCourseFile=true&_&d2lSessionVal=MCNuhyhYescm6zVTouKywEp4Y&ou=22528105