Slide Whistle Lab

Overview
Our goal is to develop some intuition about the creation of consonant musical intervals in columns of air (pipes). We will also observe some of the adjustments that need to be made when applying idealized physical theory to real musical instruments.

Setup
1. Divide yourselves into groups of 3 or 4 students, and write each group member’s name at the top of this page (this is for attendance purposes).
2. Collect the following materials: slide whistle, strip of masking tape, ruler, marker. If your slide whistle begins to fall apart, repair it with some electrical tape.
3. Attach the strip of masking tape along the length of the instrument. You will be making marks on the tape to keep track of slide positions.
4. Take turns warming up with the instrument, getting a feel for its sound while making silly noises in the process. Isopropanol and paper towels are available for disinfecting the mouthpiece.

Procedure
1. Compute the position of the slide that should produce the note $C_5$ (523.25 Hz). All measurements should be made between the slide plunger and the whistle hole (fipple). Mark your predicted location on the masking tape.

   Position: _______________________

2. Using an electric tuner, a classmate with perfect pitch, or a digital spectrum analyzer, determine which slide position is actually closest to $C_5$ and mark it on your tape.

   Position: _______________________

   How does this compare with your prediction? Brainstorm ideas for why there might be a difference (if you have trouble thinking of any, simply raise your hand!)
3. An \textbf{octave} has a frequency ratio of 2:1. Predict the distance between the slide and the fipple that would produce 1 octave above C\textsubscript{5}. Mark the position on your tape.

\begin{center}
\text{Position: ____________________________}
\end{center}

4. Check your prediction by playing both notes in succession. Does the interval sound like an octave? If you had to make adjustments, how large were they?

5. Using your ears, find the slide position that produces a \textbf{perfect fifth} above C\textsubscript{5} (first notes of “Twinkle Twinkle Little Star”) and mark and measure that position.

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\text{Position: ____________________________}
\end{center}

6. A perfect fifth has a frequency ratio of 3:2. What should the slide position be in theory? How does this compare to what you found?

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\text{Position: ____________________________}
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7. A \textbf{perfect fourth} has a frequency ratio of 4:3. Predict the theoretical slide position that should produce a perfect fourth.

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\text{Position: ____________________________}
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8. Find a perfect fourth by ear (“Here Comes the Bride”). How does this position compare to your prediction?

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\text{Position: ____________________________}
\end{center}

\textbf{Followup}

1. Find the first four partials for both notes in a perfect fifth starting at C\textsubscript{5}.

2. Assuming a critical bandwidth of 15\%, will any of these partials create “roughness” with the partials of the other note? Which ones?

3. You will soon learn that the “just” interval for a major third is a ratio of 5/4, while the Pythagorean equivalent is 81/64. Can you distinguish between the two positions that would be necessary to create these intervals on a slide whistle (starting at C\textsubscript{5})?

4. Compute the size of both the just major third and the Pythagorean major third in cents. Which is closer to equal temperament (100 cents)?