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Boomwhackers

P7-7400

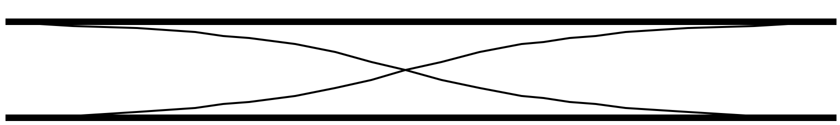
BACKGROUND:

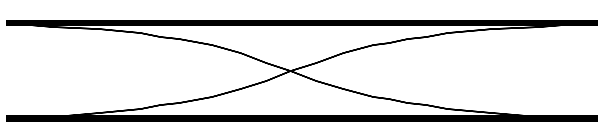
Boomwhackers create distinct tones when whacked against a surface. The tone is determined by the length of the tube. The tubes are cut to the correct lengths to form the eight notes in a C major diatonic scale (C-D-E-F-G-A-B-C).

The tubes create tones in much the same way as other tube-shaped instruments. They filter a particular tone from noise that is introduced into the tube. A clarinet is played by vibrating a reed at one end. The reed does not vibrate at any particular frequency, but produces a range of frequencies (a buzzing noise). The shape of the clarinet and which holes are covered determine which frequency is amplified. Boomwhackers work in much the same way. Whacking the tube produces a noisy sound that contains many frequencies. The tube, because of its length, resonates and amplifies one of the frequencies. Notice, in the figures below, that the resonant wavelength is one that has antinodes at both ends of the tube.

EXPERIMENTS:

1. **Pitch/Wavelength:** Whack two different tubes. Which tube produces the lower tone? How do the lengths of the tubes compare? Longer tubes produce lower tones because they amplify a longer wavelength (lower frequency).

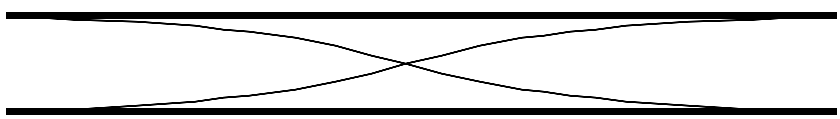


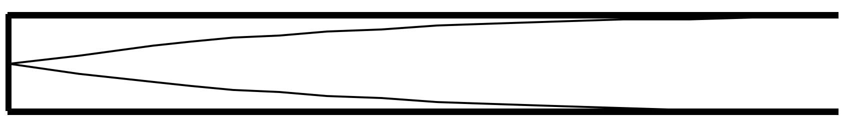


2. **Resonance:** Hum loudly over the end of a tube near and at its natural frequency. The tube will vibrate when you reach its natural frequency, in addition to amplifying the sound.

3. **Resonance 2:** Strike a 256 Hz tuning fork and hold it just inside the end of the longest C tube. The tube will resonate and amplify the 256-Hz tone. Strike the tuning fork again and hold just inside the SHORTEST C tube. The short tube also resonates, because the tuning fork's vibration includes another frequency, 512 Hz. This overtone is much quieter than the fundamental tone, so it is usually not noticed.

4. **Open/Closed Pipe Resonance:** Whack one tube and notice the tone it produces. Cap one end with one of the black caps and whack the tube again. How does the new tone differ from that produced by the open tube? The capped (closed) pipe produces a tone that is exactly one octave lower than the uncapped (open) pipe. The cap forces a node to be at the end of the tube, and the lowest resonant wavelength is twice as long as the wavelength of the uncapped tube. An octave is produced by doubling the frequency (or halving the wavelength) of a sound.





5. **Noise Filtering:** Take the Boomwhackers to a noisy environment, such as a crowded hallway or cafeteria. Put a tube to your ear and listen to the sounds. The tube filters and amplifies the same tone that it produces when it is whacked. If you hold the tube tightly against your head, it becomes a closed tube and will amplify the note an octave lower.

6. **End Correction:** Ideal open pipes amplify a sound whose wavelength matches the length of the pipe. The frequencies of each note are listed below. Calculate the wavelength of each note (wavelength = speed of sound in air / frequency) and compare them to the tube lengths. (For open pipes, the length of the tube is HALF of the wavelength of the fundamental tone. See the diagrams above.) The tubes are a bit shorter than the calculated wavelengths. This is because the vibrating air in the tube does not disperse immediately at the end of the tube. This causes the tube to effectively be slightly longer when it is played.

C 256 Hz	E 320 Hz	G 384 Hz
D 288 Hz	F 341.3 Hz	A 426.7 Hz
B 480 Hz	C 512 Hz	

Thanks to Bob Williamson, Walt Krell, and Clarence Bennett for their experiment ideas.