

Prep Notes	
Materials	6 small-mouth bottles of similar size, filled with increasing amounts of water metal spoon water
Teacher Background	<p>The bottle organ in today's project is a percussive instrument. When you strike it with a spoon, it vibrates, and the vibrations make the sound. When little or no water is in the bottle, the vibration is faster and thus the sound is a higher pitch (higher frequency). When much water is in the bottle, it dampens the glass' ability to vibrate, causing it to vibrate more slowly, which produces a lower pitch (lower frequency) tone.</p> <p>You can also make music by blowing across the tops of the bottles. In this case, the air is what vibrates, and the tables are turned: less water in the bottle means more air, and more air in a chamber will vibrate with a longer fundamental wavelength (like a longer string), which is a lower frequency – a lower pitch. More water in the bottle leaves less air space, which translates to a shorter wavelength, which is a higher frequency – a higher pitch. (Another way of looking at it is: the air compresses and decompresses in its space – the higher the water, the smaller the remaining air vibration space, thus the smaller the wavelength that fits in that space, thus the higher the frequency / pitch, as smaller wavelengths = higher pitches.) Technically, this (air pipe organ) would be a “closed-end air column” instrument. Real pipe organs, as well as some wind instruments like clarinets, employ closed-end air columns. (Others, like the tin whistle and flute, are “open-end air column” instruments, since air is allowed to escape the “far” end of the instrument.)</p>
Opener Ideas	Musical instrument discussion: some have strings, some use mallets or hammers (percussions), and some use air flow (reeded woodwinds and brass).
Grammar	<ul style="list-style-type: none"> • Vibrate: fluctuate or “wobble” back and forth very quickly (demo: “twang” a ruler, as in VC experiment #163, or pluck a rubber band) • Wave: a model for showing and measuring the movement (propagation) of sound through a medium • Frequency: the speed of the vibration, measured as the “width” of the wave humps, measured in vibrations per second (Hertz, or Hz)
Scientific Method	
Observations	...about the bottles, the different amounts of water in them, etc. Or about musical instruments, as in “opener ideas”, above
Question	Does more water or less water in a bottle cause it to create higher pitches when struck?
Hypotheses	“more water” or “less water”
Experiment (Procedure)	<ul style="list-style-type: none"> • Pour increasing amounts of water in the bottles • Gently tap the bottles with a metal spoon • Observe the differences in the pitches • <i>Optional:</i> blow across the tops of the bottles and observe the differences in the pitches
Results	Tapping the emptier bottles produces higher pitches; blowing across the emptier bottles produces lower pitches.
Conclusions	The water in the bottle dampens the vibration of the glass when you tap it, so more water = lower pitch when tapped. The air remaining in the bottle is responsible for the pitch when you blow across the top, so more water = less air = higher pitch when blown.

More

For older students/siblings, consider <http://www.physicsclassroom.com/class/sound/Lesson-5/Open-End-Air-Columns> and <http://www.physicsclassroom.com/class/sound/Lesson-5/Closed-End-Air-Columns> as physics/math resources.