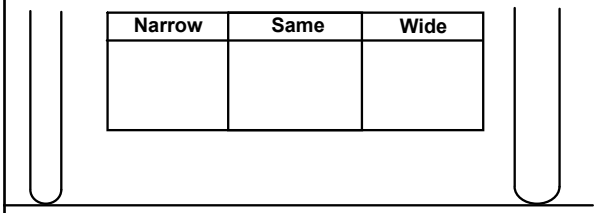
12.6 - Wind Instruments and Sound Characteristics

Now that's a fog horn!

1. Physics Democracy! Mini-Pipe Organ!

Two test tubes of equal length: which will blow a higher note? Explain your vote!



Mini-Pipe Organ Answer!

They're the same! (Or at least really close!)

As far as a uniform tube goes, it's only length (not width) that matters - more later!

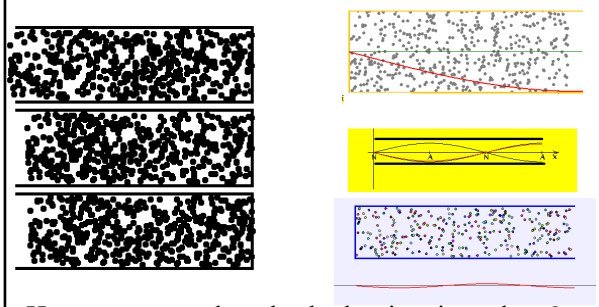
Bottle Demo

Have you ever blown a note on a bottle? Give tubes to students, and water to fill tubes.

Frequency changes with water level: essentially air sloshes back and forth at some frequency, manifesting as sound.

2. Activity: Closed Tube Graphing

For conceptual purposes, graph maximum displacement vs. length for the following (give templates): Go to Templates



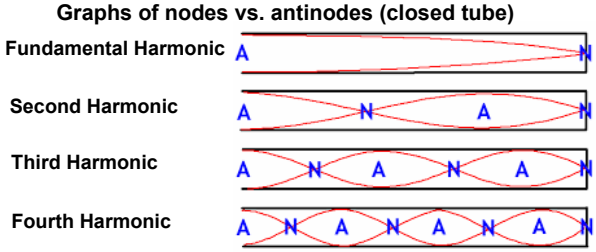
How many wavelengths do the situations show?

Standing Waves in Air Columns

Open ends are antinodes (maximum movement), closed ends are nodes (no movement).

Blowing excites vibrational modes in the air column.

Graphs of nodes vs. antinodes (closed tube)

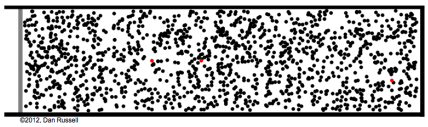


AP Phys 1 Unit 12.6 Notes - Wind Instruments

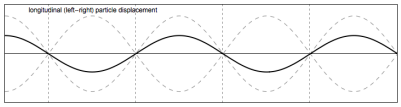
More Closed Tube Graphs

Compression points = nodes,
Maximum displacement = antinodes.

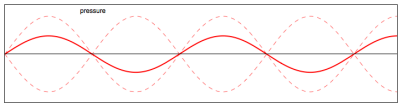
Dots are air particles



Left-right Movement Graph

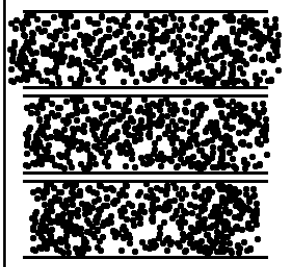


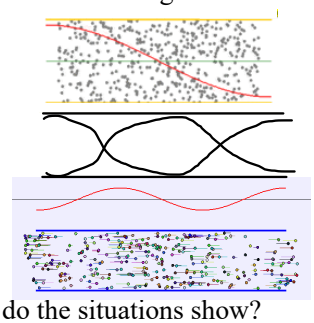
Pressure Graph



3. Activity: Open Tube Graphing

For conceptual purposes, graph maximum displacement vs. length for the following:





How many wavelengths do the situations show?

Pipe Organs

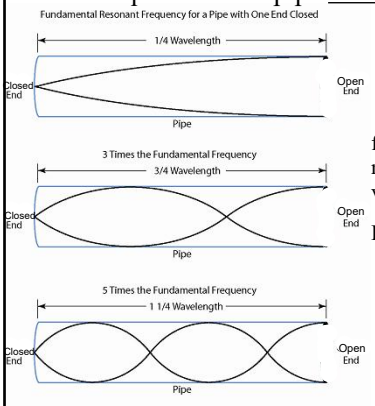
These are instruments that use moving masses of air in open and closed tubes to make sound.

A standing wave is produced within the pipe at the harmonic frequencies of the organ.

This Thing Has Tubes!

Pipe Organ Mathematics

Natural frequencies of a pipe closed at one end:



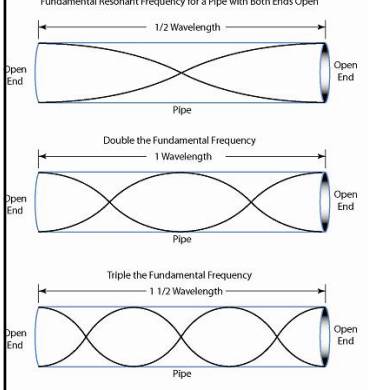
$$f_m = m\frac{v}{4L} = mf_1$$

$$m = 1, 3, 5\ldots$$

f = frequency (Hz or s^{-1})
m = harmonic number (closed)
v = speed of sound in air (compensate for temperature)
L = length of pipe (m)

Pipe Organ Mathematics

Natural frequencies of a pipe open at both ends:



$$f_n = n\frac{v}{2L} = nf_1$$

$$n = 1, 2, 3\ldots$$

f = frequency (Hz or s^{-1})
n = harmonic number (open)
v = speed of sound in air (compensate for temperature)
L = length of pipe (m)

Auto-Tune Your Voice!

Who here has seen Auto-Tune the News?

Inappropriate Video Clip: http://www.youtube.com/watch?v=LnoD3NUux3M

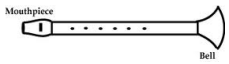
Try singing a continuous vocal scale into these different pipes.

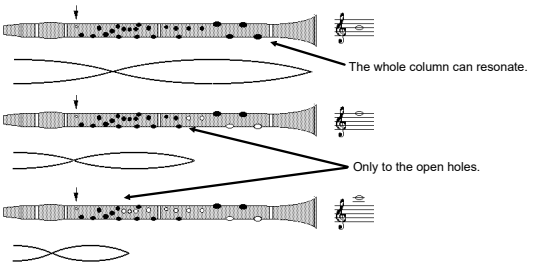
You'll find that some of the notes you try to sing meet great resistance.
The pipe's acoustics actually will auto-tune you!

AP Phys 1 Unit 12.6 Notes - Wind Instruments

Wind Instrument Mechanics

Wind instruments (flutes, clarinets, recorders, piccolos, penny whistles) change the column length (thus frequency) by opening and closing holes in the body of the tube to alter the column length.





Brass Instrument Mechanics

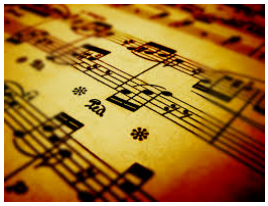
Brass instruments produce different sounds by altering their actual lengths.
Example: Trombones and slide whistles (Bike Pump Demo) move in and out to vary pitch.

Other instruments (french horn, trumpet, tuba), alter frequency by opening valves that open other tube sections.

Cross Section of a Tuba!

Musical Terms

In music, some common words describe sound wave properties:
Overtones: Harmonics.
Loudness: Intensity.
Pitch: Frequency.
Quality: Waveform: The actual shape of sound waves as they are superimposed on each other.



More on Quality

Everyone's voice has a unique sound.
Plotting a voice's waveform shows different overtones from person to person.
These are caused by differences in the vocal structure of people's necks: larynx details, throat shape/length.
Making a pressure vs. time plot enables a voice to become 'visible'.
This plot then can be further broken down into fundamental frequencies and overtones. The result is a vocal signature (like a fingerprint).

A pressure vs. time chart of a waveform.

The dark line is the compilation of the colored lines

Homework

12.6 Problems
Due: Next Class

Finish Unit 12 Review Problems
Scanned Soon!!