"Pop bottle" physics. *Constructing a musical scale "by ear"*

.

_____ _____ _____ _____

Band member 1 band member 2 band member 3 band member 4

This activity will test your ability to construct a musical scale "by ear". Musical scales, starting with any "fundamental" note, are mathematically sequenced. The actual sequence depends on where you start and what culture you grew up in. To read more about this, please see the website: http://www.phy.mtu.edu/~suits/scales.html

All-class activity: Determine the velocity of sound today.
Use this space to follow along as your instructor uses a sequence of tuning forks held over a "column of air" to determine the wavelength for each tone and then the speed of sound itself. (note: this value can change from day to day by a tremendous amount).

Your group's calculation of the speed of sound today_____

The class average of todays speed of sound = _____ m/sec (use this one for today's calculations).

Begin the experiment: Creating a "Pan flute" with soda pop bottles.
Starting with any, random bottle, blow across it and listen to the tone (frequency). Then, using your ear, fill the remaining bottles with water such that when you blow across them, you end up with a musical scale (pentatonic scale, i.e., a standard "major scale")

Using your first, empty bottle, determine the wavelength of the tone you are hearing (note: $\lambda = 4d$ don't forget to convert to meters!)

Bottle one air column height = _____cm = _____m

"Fundamental" wavelength of bottle one (bottle height.x4) = _____m

Using the wave-speed formula, determine the frequency of your first bottle's tone. _____ = f_1

Using your calculated f_1 from above, please determine your predicted frequency series here.

Interval	Ratio	Predicted series
Unison	***1.0000***	_____ = f_1
do		
Major Second	***9/8 = 1.1250***	_____ = f_2
rey		
Major Third	***5/4 = 1.2500***	_____ = f_3
me	***4/3 = 1.3333***	_____ = f_4
Fourth		
fa		
Fifth	***3/2 = 1.5000***	_____ = f_5
so		

Using this area, please calculate the ***measured air column heights and calculated frequencies*** from your collection of tuned bottles.

Bottle #	column height, d (m)	4d = λ Wavelengths here	V = λf Frequencies here
1	From above:		
2			
3			
4			
5			

Error analysis:. Using the two sets of frequencies on the pervious page, compare your “ear tuned frequency” to the predicted frequency.

Bottle number	*Ear tuned frequency*	*Formula predicted* frequency	% error.
1			No error for first bottle.
2			
3			
4			
5			

Using the “on-line” ***equal tempered scale*** http://www.phy.mtu.edu/~suits/notefreqs.html identify which notes you *were actually playing*… eg.. A_4 = 440, C_5 = 523.5, etc. and write them into the appropriate cells.

Bottle # 1	*Freq*. =	Note =
2	*Freq*. =	
3	*Freq*. =	
4	*Freq*. =	
5	*Freq*. =	

For a extra credit (up to five lab points!) ..take a cell phone video.. post to youtube.. send link to Clark! (bclark@tamdistrict.org)
Video must contain:

- ***a) a majority of your group***
- ***b) some sort of recognizable song (either self composed or familiar)***
- ***c) a short “discussion” introducing the viewer to the “theory” of musical notes and how we have evolved to appreciated musical harmonies.***
- ***d) a discussion of how you measured the wavelength and frequencies of your bottles.***