Standing Waves & Resonance

Resonance and standing waves can occur in the strangest places. For instance, those who like to sing in the shower may have noticed that there are certain sounds or notes that are louder than the others and seem to reverberate within the shower stall. These resonant frequencies are from the set of harmonic frequencies unique the shower stall and are determined by the size, shape and material of the stall.

If we model an average shower stall with the dimensions 1.2 *m* x 0.8 *m* x 2.2 *m* (*l* * *w* * *h*), this system produces harmonic frequencies just like an *open pipe*. **NOTE**: Because the shower is a closed volume, this forces nodes to occur at the boundary of the shower walls. (*The reason one hears the sound is that the voice creates an anti-note of a particular frequency at the roughly the same location as a persons ears.*)

From the dimensions given above and using the equation of the harmonic series for a wave on a string ($f_n = n f_1$):

Assignment:

Find the range of possible standing wave frequencies that can be produced within this shower stall if we model the range of the human voice as 130 Hz to 2000 Hz:

a) without water running (*speed of sound* = 343 *m/s*)

b) with water running (*speed of sound* = 355 *m/s*)

NOTE: This is a 3 dimensional problem, so there will be a different set of harmonics in each of the 3 directions for both parts *a* and *b*.

* Use the attached table to compile your results.

Determine the Fundamental Frequencies (*Use the Open Pipe Model***)**:

	L (*no water*)	L (*water*)	W (*no water*)	W (*water*)	H (*no water*)	H (*water*)
f_1						

Calculations for the Fundamental Frequencies:

Use the Harmonic Series relation for an open pipe to determine the rest of the harmonic frequencies.

NOTE: Do **NOT** include harmonic frequencies that do not fall in the range 130 Hz < f < 2000 Hz.

	L (*no water*)	L (*water*)	W (*no water*)	W (*water*)	H (*no water*)	H (*water*)
f_1						
f_2						
f_3						
f_4						
f_5						
f_6						
f_7						
f_8						
f_9						
f_{10}						
f_{11}						
f_{12}						
f_{13}						
f_{14}						
f_{15}						
f_{16}						
f_{17}						
f_{18}						
f_{19}						
f_{20}						
f_{21}						
f_{22}						
f_{23}						
f_{24}						
f_{25}						