Assignment 6
Physics of Music - 2010
Physics 341

1.a) Deep sea divers can live underwater in a Helium-oxygen mixture, instead of air. (The nitrogen in the air dissolves in the blood under pressure, and is somewhat poisonous. It also comes out of solutions when the diver ascends, causing nitrogen bubbles in the blood, blocking the flow of blood– called the bends.) One diver likes to blow over coke bottles to annoy his mates. What would happen to the note that the bottle would produce in the helium-air mixture? Another diver brings down his guitar to use in the evenings. What effect would the different gas mixture have on his guitar? (Note that Helium-oxygen mixture is much lighter than air, although the compressibility is the same.)

b) What happens to the knee frequency of a given sized "speaker" in such a mixture?

2. Using the standard Fletcher-Mundson curves for the sensitivity of the ear to various frequencies, estimate the length of the "standard" ear canal. (The ear canal can be modeled as a tube with one end closed).

How would you expect this to change if you were in a Helium atmosphere?

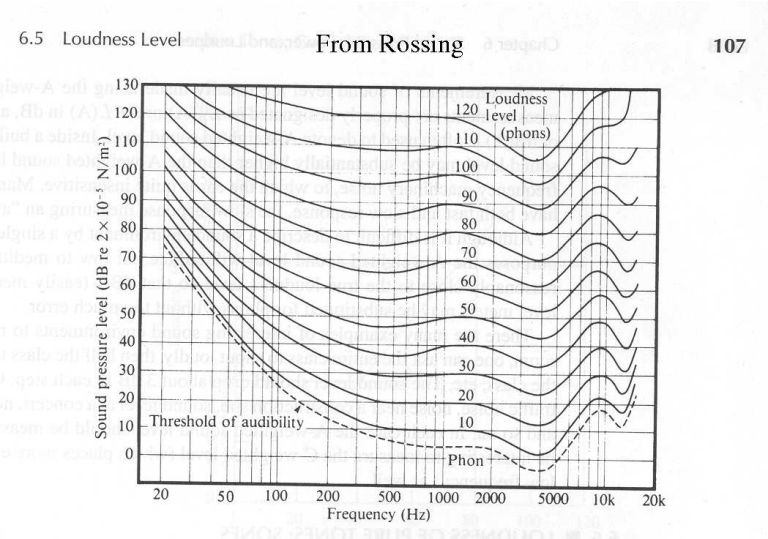

Figure 1

3. Why do drummers have various sticks with which to beat their drums?

4. a) Which modes of a piano string would you expect to be excited– the piano hammer hits the string about 1/7 of the way along the string.

b) Why does the amount of felt covering the piano hammer vary from the bass to the treble end, and how would you expect it to vary? Why?

5. A banjo, a plucked, fretted string instrument, has the bridge resting on a circular thin "drum head" about 40 cm in diameter with no back to the instrument. What effect would you expect this have on the tone of the instrument in comparison with a guitar?

6. Discussion:

The effect of the change in size of a tube on its resonances.

Given a tube full of air (either one end closed or not). If one changes the dimensions of the tube at some point, the modes and especially the frequencies of the modes will change. There is a law to how those frequencies change. If one widens [narrows] the tube at a point near where the pressure has an anti-node (i.e., has maximum oscillation and the velocity has a node) for a given mode, then the frequency of that mode will fall (rise). If one widens [narrows] the tube at a point where the mode has large velocity oscillations (i.e., near the anti-node for the velocity, or node for the pressure), the frequency of the mode rises [falls]. Eg, for a coke bottle, when one narrows the neck, one has narrowed the tube at the end where the velocity is high and pressure is near a node. The frequency of the fundamental (and if fact of all of the modes) falls. Note that if one uniformly increases the diameter of the tube at all points by the same ratio, the two effects cancel, and the mode has the same frequency as before. (A wide pipe has the same resonant frequencies as a narrow tube to first order.)

Question:

What might you expect is the dominant effect of the closed finger holes in a clarinet on the frequency of the lowest note of the clarinet? What about the lowest note in the second register (remember that is where you are playing the "second mode" by damping out the lowest mode with the register hole.) Remember that the walls of the clarinet, made of wood, have a substantial thickness).