Assignment XII, PHYS 150 (Physics of Sound and Music)
Musical Scales and Temperament, Sound Recording, The Saxophone Family, and Bowed String Instruments
Due 4/11/14

This homework assignment has material from class lecture as well as from presentations given by your classmates. You may wish to go use the links near this assignment on the course webpage (http://larsenml.people.cofc.edu/phys150_spr14.html) to find materials supplied by your classmates that should aid in solving these problems. If you gave one of the presentations, *you still have the answer the associated questions.* Good luck.

Sound Recording

(See chapter 22 for additional help if needed).

1) Magnetism is a complicated phenomena. One of the reasons that understanding recording with magnetic media like tape can be confusing is because magnetic material exhibit a hysteresis phenomena. Physicists usually refer to something that exhibits a hysteresis phenomena as a material with "memory". Explain. (You may have to use Dr. Google to help with this one).

2) What two materials are typically used as the magnetic materials in audio tapes?

3) For simplicity, let's say that the gap head size in a tape playback head is $2\mu m$ (or, in other words, 2×10^{-6} m). Let us also say that, with a gap head size this large, you can only detect wavelengths at least $8\mu m$ long with any real fidelity.

    a) What is the highest frequency you could resolve decently with this setup if the tape is moving at 1 7/8 inches per second? (Note, there are 0.0254 meters in an inch).

    b) What would the tape speed have to be to match the frequency response of a high-quality MP3 recording, where a frequency of 22050 Hz must be resolvable?

The Saxophone Family

(See chapter 12.8 or the course webpage for additional help if needed).

4) In a word or two, explain what the bore-shape of a saxophone resembles.

5) Briefly explain how the keys influence the sounded pitch on a saxophone.

6) Why don't sax players typically use mutes (like brass players do)?

7) There are more notes in the chromatic scale than a sax player has fingers. How can a sax player deal with this?

Bowed String Instruments

(See the first half of chapter 10 or the course webpage for additional help if needed).

8) In comparing the Viola de gamba vs. Violin pictures on Brett's presentation, name at least 3 visual differences between the two instruments. (Slide 3)

9) Your textbook talks about the resonances of the guitar body. The discussion there is modestly technical, but let's take a step back and think about modeling it a bit more crudely. Recall that the resonant frequency of a Helmholtz resonator can be written as:

$$f = \frac{v}{2\pi}\sqrt{\frac{a}{V\ell}}$$

where v is the speed of sound in air, a is the area of the next, ℓ is the length of the neck, and V is the volume of the resonator. A guitar isn't shaped exactly like a typical Helmholtz resonator, but let's see if it gives a reasonable answer here. Assume that ℓ is equal to the thickness of the wood (about 2.5 mm according to your text), and use a reasonable value for a (the area of the sound hole on a guitar) and v (the speed of sound in air). What would the volume of the guitar body have to be in order to get a fundamental resonance at the lowest string (tuned to E_2). Comment on whether this seems reasonable.