Problem Set #3

Due Wednesday, May 6 by 5pm to Dickinson 104

1. What is the mathematical relationship between the fundamental frequency of a vibrating string and its various harmonics? How about for a vibrating air column?
2. In class, the Chladni plates created a pattern in sand. Explain what the pattern of sand represented and why, when we pinched parts of the Chladni plates, the pattern of sand changed.
3. An electric tuning fork with a frequency of 80 Hz sets a string vibrating in 6 nodes and 5 antinodes. The tension in the string is 6.27 N and the string has an overall length of 114.5 cm*.
    a. Draw a sketch of the above vibration.
    b. In which harmonic (e.g. fundamental frequency, first overtone, etc.) is the string vibrating?
    c. What is the wavelength of the wave *in meters*?
    d. What is the speed of the wave on the string *in m/s*?
    e. What is the mass per unit length of the string in kg/m?
4. A steel wire in a piano has a length of 0.700 m and a mass of 4.30×10^{-3} kg. To what tension must this wire be stretched in order that the fundamental frequency vibration corresponds to middle C on the equal-tempered scale?
5. If a bugle were straightened into a long, straight tube, its length would be 2.65m long.
    a. Calculate the frequencies of the first six harmonics, assuming both ends are open. Assume the speed of sound to be 350 m/s?
    b. To what notes on the musical scale do these belong? (See Table 14.5 in your book)
6. Review the four scales listed in your book in Chapter 14 (Pythagorean, just diatonic, chromatic, equal-tempered). Now, go find information about an instrument that uses a completely different scale, such as a Southeast Asian instrument. Describe, in a level of detail comparable to that of your book, how the scale is constructed. Your description should include (but is not limited to): the frequency ratios between adjacent notes, the absolute calibration of the system (e.g. an "A" is 440 Hz in all the scales presented so far), and a bit on the history of the system.

* Note: For the purposes of this problem, it is fine to assume that the string length and the distance between the two fixed points at the end of the string is the same; it's close to true, anyway.