

SCI220 – Foundations of Musical Acoustics
Cogswell Polytechnical College
Fall 2008

Week 2 – Homework
Problem set due 09/09, lab due 09/11

Exercises

1. If a soprano saxophone is 69cm long and the tenor sax plays an octave lower, how long should the tenor sax be?
2. What frequency will sound to your ears one octave below 400Hz? What frequency will be an octave above 400Hz? Two octaves above 400Hz?
3. In a certain set of organ pipes, the speaking length for the note C5 ($f = 524\text{Hz}$) is 30cm. How long a pipe do you expect for C4 ($f = 262\text{Hz}$)? What frequency and what pipe length for C3, one more octave lower?
4. When an organist practices in an unheated church in January the temperature is at 8°C , but when the organ was tuned the temperature was 20°C . Explain whether the pipes will speak with higher or lower than normal frequency. What percentage of change has there been in the speed of sound?
5. A partially open window presents an opening of 20cm wide. What kind of sounds from outside will go across the room in a well-defined beam? What kind will spread evenly throughout the room? Roughly what frequency marks the boundary between the two cases?
6. Sound of frequency $f = 688\text{Hz}$ is sent through two speakers, as in figure 4.13. What are several values for path-length difference $L_1 - L_2$ that will lead to constructive interference? What are the several that will give destructive interference?
7. The speaker S in figure 4.17 can send sound to the listener L not only directly but also by reflection from the hard wall W . (assume no other reflections). The combined sound is just the same as if there were a mirror image speaker S' , with both sending out identical signals. For frequency $f_1 = 172\text{Hz}$, is there constructive or destructive interference at L ? What kind of interference for $f_2 = 85\text{Hz}$?
8. Two organ pipes speak at frequencies 523.0 and 520.6Hz. What is the frequency of beats heard when both sound together?
9. If three instruments play together, with frequencies 440, 438, and 443Hz, what beat frequencies will result?

10. The diameter of a trumpet bell is roughly 10cm. When the trumpet plays middle C ($f = 262\text{Hz}$), does the sound come out in a narrow beam or spread in all directions? Give a clear physical justification for your answer.

Lab Assignment

1. Hit, tap, rub, scratch, and blow on 4–6 different objects. Compare the resulting sounds as to duration, loudness, musical quality (whether it can be used as a “musical” instrument), and high or low pitch. Explain these comparisons in terms of the size and material of the objects, and the methods used to excite them.
2. Carry out an experiment in which you “prove” that bass notes go around corners more effectively than do treble. Measure both sources with a level meter (make sure both sources have the same loudness level at the output). Compare the level of attenuation between the sound reading from a source along a direct path and another at the same distance from the source but around the corner.

Note: group work is acceptable and recommended, if and only if, you write your own homework to submit. Remember to show your work on the problem sets and submit all of your data for the lab.