Homework 9

Due Tuesday, May 2, to your TA's mailbox

1. Suppose that the largest pipe in a pipe organ is 16 feet long, and the smallest pipe is 0.25 feet long. The speed of sound in air is 1125 feet per second. What are the fundamental frequencies of these two pipes?[1] These figures are accurate (I believe) for the organ in Setnor Auditorium at Syracuse University.

2. You made observations of the frequencies of the first six resonant modes of the flame-tube in class. Its resonant frequencies do not agree with those that you will calculate in the previous problem, however, because the tube was filled with methane, not air. Using the observations you made, estimate the speed of sound in methane. (**Note:** The tube is 91 cm long.

3. The wave speed in a stretched string is given by $c = \sqrt{\frac{T}{\mu}}$, where T is the tension the string is under, and μ is the linear mass density of the string in kilograms per meter.

   Suppose that the vibrating part of the highest-frequency string on a guitar has a length of 65 cm and a linear mass density of 0.3 grams per meter. This string is usually tuned to a fundamental frequency of 293 Hz. What tension must the body of the guitar apply to the string in order to do this?

4. Draw pictures of the first six resonant modes of a vibrating string. (For a guide to the first four, see the slides from 20 or 25 April.) Using the parameters of the previous problem (fundamental frequency of 293 Hz and vibrating length of 65 cm), calculate the frequencies and wavelengths of these six modes. **Note:** You should use an entire sheet of paper for these drawings.

5. The other strings in a guitar have the same length and about the same tension. Why do they have lower fundamental frequencies? (Hint: What is different about the strings? Look up a photograph of a guitar, and remember that $c = \sqrt{\frac{T}{\mu}}$.)

[1] Organists, even outside the US, still measure pipes in feet.