Music 170 assignment 6

1. A car is moving toward you at 60 miles per hour. Its horn is blowing at 440 Hz. By how many half tones does the sound rise above 440 Hz because of the car's motion?

2. Suppose the same car has the same horn blowing, but now you hear a pitch of 400 Hz. Assuming the car is moving directly away from you, how fast is it moving (in miles per hour)?

3. A sound has a wavelength of 4 feet. What is its frequency?

4. If two sounds are a perfect fifth apart, what is the ratio of their wavelengths?

5. Suppose that ten feet away from a loudspeaker the SPL is 60 dB. (and that the speaker is the only object making sound nearby). What is the SPL 20 feet away from the loudspeaker?

6. A 440-Hz. sinusoid is traveling in a plane wave in the x direction. Two microphones are placed at $x = 0$ and $x = 1$ foot, respectively. What is the phase difference, in radians, between the signals picked up by the two microphones?

Project: *frequency response of a bandpass filter*

This project shows how to measure the frequency response of a filter, whether it's a designed one (as in this case) or it's something that acts as an unintentional filter (such as a loudspeaker that doesn't have a flat frequency response—and, in fact, none of them do.)

The filter we'll measure is the bandpass filter supplied in the music 170 library (called "bandpass"). It's a classical filter design that appears often in digital audio applications.

To measure it, make a "sinusoid" object and pass it through a "bandpass" object. Make two "meter" objects, and connect one to the output of the oscillator (so that you see what you're inputting to the filter) and one to the filter output so you can see how the two levels differ.

If you want to save time later, you can slightly complicate the patch by inserting a multiplier between the oscillator and its two connections (with a constant to multiply it by) so that you can adjust the oscillator's output to a round number in dB; but this isn't necessary to finish the project.

We're interested in two settings of the filter: the center frequency should be 1000 Hz, and the value of "Q" set to 10 and to 20. For each of these two filter settings do the following:

Set the oscillator's frequency to a series of values separated from 1000 by half octaves:

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31, 44, 62, 88, 125, 176, 250, 353, 500, 707, 1000,
1414, 2000, 2828, 4000, 5656, 8000
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With these numbers evenly spaced on the horizontal axis (a logarithmic scale), plot on the vertical axis the gain in decibels (the output level of the filter minus the input level). These numbers will all be negative. (Suggestion: find all the 34 values first—each filter's gain at each of the 17 frequencies shown—so that you will know what the bounds of the graph should be.) Draw two traces, one for each of the two filters. Enjoy the fact that at high frequencies you get two nearly parallel lines. How many decibels per octave do the filters' frequency responses drop off by at frequencies above about 2000?