

Physics of Music
Physics 341
Assignment 4

- 1) In the graph of dB versus frequency,
 - i) What frequencies correspond to -30dB? To -5dB?
What pitches (including names) correspond to these frequencies?
 - ii) What dB correspond to 1700 Hz? 400Hz? 6500Hz? What pitches correspond to these frequencies? (use the nearest letter name, including $\sharp$ or $\flat$)

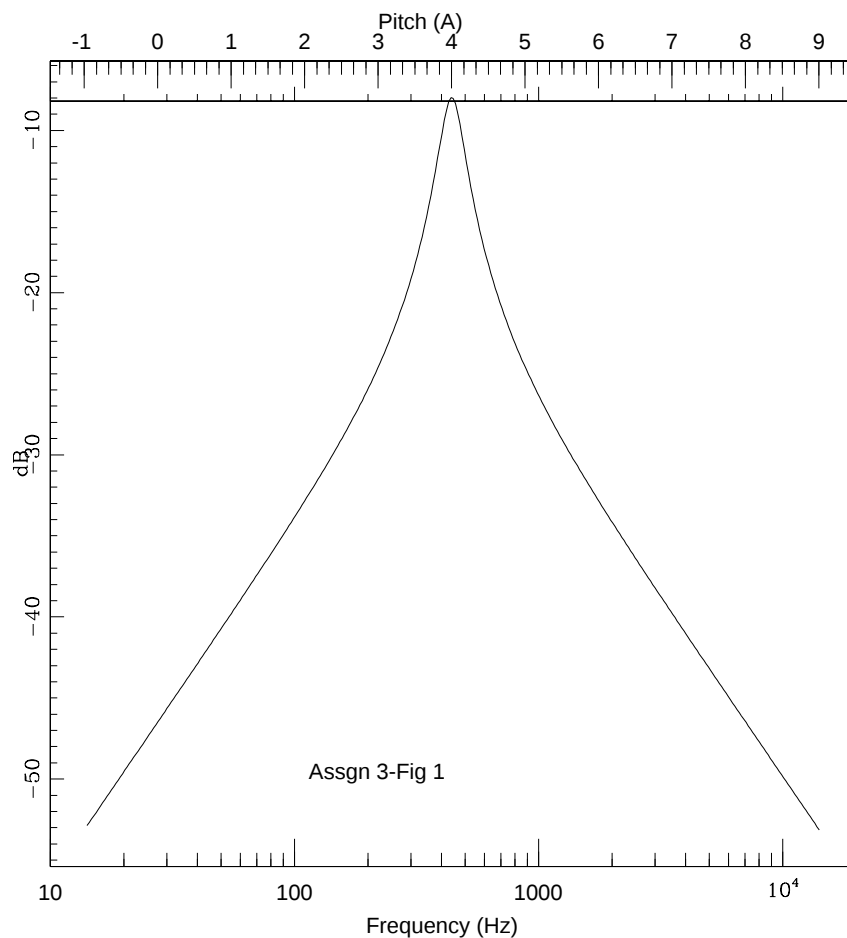


Figure 1

Note that this graph is the graph of the "resonance response" of the energy (not amplitude) of an oscillator to an external driving force which has the same amplitude at each frequency. Note the 6 dB per octave fall off in the energy on either side of the resonant frequency (which occurs at 440 Hz).

2) I want to tune one string 2 Hz below another. How could I do this by listening to the two strings together?

3) The critical band is the range of frequencies around which the vibration on the basilar membrane overlaps (ie, if one has two frequencies, the widths of the region which each causes to vibrate overlap with each other). This is taken to roughly be a minor third (ie, if two frequencies differ by less than a minor third, their regions of membrane excitation overlap). Consider the series of harmonics of a note. By which harmonic do successive harmonics have overlapping excitations on the basilar membrane?

4) 1) In graph 1, add the two waves to get the composite wave.

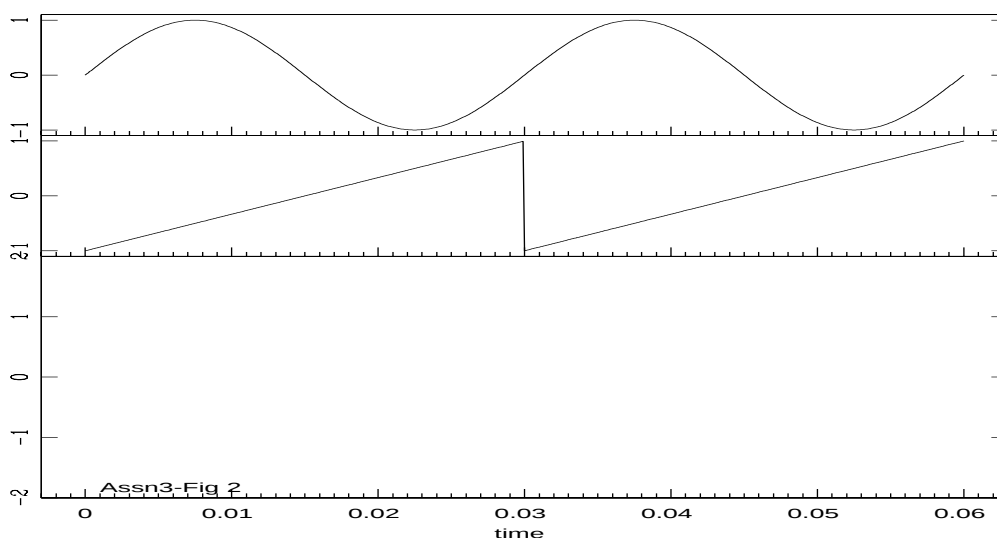


Figure 3

5)a) How much sharper or flatter (give a ratio) is a just major third ($5/4$) to two Pythagorean whole tones?

b) Three major thirds (four semitones) could be said to be an octave (twelve semitones). How mistuned would that octave be if each of those major thirds were just major thirds?

6 a) I attended the Marriage of Figaro a few years ago, and found that hearing the bass while he was singing his lower notes was much more difficult than hearing the tenors and the women. Could there be some Physics reason for this? What is it?

b) Why is an (unpowered) megaphone useful (consider the size of the radiating area)? Why do singers tend to sing with their mouths wide open? (It is not for the looks!)

c) Why, when you scream for help, do you open your mouth wide and scream at a high pitch?

7. Why, when you take off your earphones and lay them on the table, do you suddenly stop hearing the bass, and all you hear is a very tinny high pitched sound?

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