Homework 6, HONS 280 (Physics of Sound and Music)
Spring 2020
DUE Friday, February 14th.

Although we've talked about most of these ideas during class, there are some questions that will require you to look at figures from the book and/or read some sections of the text not explicitly discussed in class.

Note that not *too* much of this homework involves computation. As such, I expect you to turn in TYPED answers to this homework.

1. What is Fechner's law?
2. Are the acoustical low frequencies detected by the hairs in the basilar membrane that are (a) closest to or (b) furthest from the stapes?
3. Spend a paragraph or two discussing how we would view the world differently if our senses acted on a linear instead of a logarithmic scale.
4. What is a critical band?
5. If we take the notion of "quality factor" from resonance and apply it to critical bands for hearing, we can define a new variable:

$$\tilde{Q} = \frac{f_\circ}{\Delta f}$$

   where $f_\circ$ is the center frequency of the band, and Δf is the critical bandwidth associated with that center frequency.

   a) Use the information in a figure in your textbook to approximate $\tilde{Q}$ for $f_\circ = 100$ Hz, $f_\circ = 500$ Hz, $f_\circ = 1000$ Hz, $f_\circ = 5000$ Hz, and $f_\circ = 10000$ Hz.
   b) Use your answers to part (a) to explain how critical bands *seem* narrower at higher frequencies, despite the fact that the actual size of the frequency band (in Hz) actually increases at higher frequencies.

6. Explain why you sound differently when you hear yourself talking vs. when you hear a recording of yourself.
7. Let us say you have two speakers located at two different locations. Let us assume the speakers are reasonably far apart. What is the minimum difference in ear-speaker distance from speaker 1 and ear-speaker distance from speaker 2 in order for direct sound transmission from them to sound like separate sources? (Hint – check p. 90 of your text and read up on the "precedence effect").
8. An eardrum can (very crudely) be modeled as a circular membrane with radius about 4 mm. During normal conversation, the sound pressure variations reaching your eardrum are about 10 milliNewtons per meter squared (0.01 per meter squared). What, then, is the total force on the ear during a normal conversation? (To gain some sense of perspective, a paperclip has a mass of nominally 1 gram, so it applies a force of 0.01 Newtons when sitting on a table-top).