Homework 3, HONS 280 (Physics of Sound and Music)
Spring 2020
Due Date – Friday, January 17th, 2020 at beginning of class

As always, turn your legible and complete answers in on separate paper. Remember, I can't give partial credit unless I can follow what you've done. Including words is usually a good thing for you.

Recall that, for any non-dispersive wave, we know that $v_{\text{wave}} = \lambda f$. Also, note that the speed of sound in (dry) air can be approximated with the following equation:

$$v_{\text{air}} \approx (331.3 \text{ m/s}) \sqrt{\left(1 + \frac{\theta}{273.15°\text{C}}\right)}$$

with θ the temperature measured in degrees Celcius. (This equation will be helpful at various points within this homework assignment).

1. Let's start with just making sure we can plug stuff into the equation properly. What would the speed of dry air be if the air temperature is:
   a) 0°C?
   b) 21°C?
   c) -10°C?
2. In a 20 degree Celcius room, what is the wavelength of A-440 (a pitch oscillating at 440 Hz)?
3. What would the wavelength of a 440 Hz wave be underwater? ($c_{\text{water}} \sim 1500$ m/s)
4. What would the frequency in air be for a wave with the same wavelength as your answer to the previous problem? (Assume air at 20°C).
5. Would the pitch generated in the previous question be audible to a human?

6. The highest temperature ever recorded in the US was 56.7°C. The lowest ever recorded in the US was -62.0°C. If you use the equation given above for the speed of sound in air, this gives you speeds of about 364 m/s and 291 m/s, respectively. (The equation given above actually becomes a little inaccurate at these temperatures, but as a first approximation it isn't too horrible). Here's the question.....why don't you have to change your tuning for your favorite radio station – even a little bit – on particularly hot or cold days?

7. What is the wavelength of our local NPR radio station (transmitting at 89.3 MHz) on a normal day (assume 20°C for the temperature)? (Recall that 1 MHz = 1000000 Hz). (Hint – the correct answer is *not* in the neighborhood of 3.8×10^{-6} m).

8. Let us assume that wind instruments (e.g. trumpets, trombones, clarinets, flutes, saxes, etc.) are shaped the way they are so that you can correctly "fit" a wave in their tubing (this is more or less true). If people sense the frequency of wave and the temperature increases, would you need to adjust the length of the tube to be longer or shorter to ensure that the pitch remains the same in the higher temperature environment? Explain your answer. (Assume that the wind instrument shape does not change in the different temperature air – even though that's not totally true).