Physics 3180 (Thermal Physics) Name: ______________________________
spring 2020

Problem Set 1

(due Monday, January 13, 10:30 am)

Note: The problems for this course will vary greatly in length, style, and difficulty. Some will be of the familiar "short calculation" type that you saw in introductory physics, where the answer consists of a number (usually expressed to about three significant figures). But you'll also find plenty of other types: thought questions that require verbal answers; rough estimations where one sig. fig. is plenty; and derivations whose answer is not a number but a formula. This diversity of problem styles reflects the diversity of types of thinking that physics requires.

1. **For formal written solution:** Problem 1.16, page 8.

Additional problems:

(Although your solutions to the rest of these problems needn't be as carefully written as the previous one, please try to write them up with enough clarity for a student at your level to follow every step. This almost always means including plenty of English in your solutions, to explain your logic and assumptions. You needn't be formal or verbose—just clear.)

2. The TV weatherman says that tomorrow will be twice as hot as today. What's wrong with this statement? (Hint: Think about the different possible temperature scales.)
3. Problem 1.12, page 8. This is a "rough estimate" problem, in which you needn't calculate anything to better than 10% accuracy.
4. How many moles of water are in a cup? (Be sure to say what you mean by a cup.)
5. Run the Interactive Molecular Dynamics simulation (physics.weber.edu/schroeder/md/). After playing with it for a while, and reading all the instructions (especially the part about units), set it up as follows: Set the number of atoms (N) to approximately 100 and the volume (V, actually an area in two dimensions) to approximately 5000. Add or remove energy until the temperature (T) remains stable at approximately 1.0. Then record the pressure (P) and compute the ratio PV/NkT (be careful with units!). What is this ratio for an ideal gas, and how does your result compare? Repeat (using the same N and V) for $T \approx 0.5$ and $T \approx 0.3$, being sure to remove enough energy for the system to equilibrate at these temperatures. Describe the way in which this system's behavior differs from that of an ideal gas, and explain the reason for this difference, noting the visual appearance of the system at each temperature.
6. Calculate the rms speed of an oxygen molecule at room temperature.
7. Problem 1.28, page 20. (Be sure to read the previous page for a review of the information needed to solve this problem.)
8. A mole of air in a closed container is initially at 300 K. Suppose that you now add 1000 J of heat to the air, without doing any work on it. After you are finished, what is the total thermal energy of the air? What is its final temperature?
9. Problem 1.32, page 23.
10. Problem 1.33, page 23.