ME 3007
HW 1

1. Summarize your present understanding of the properties of macroscopic systems.

2. For a box with two possible sub-boxes (ie, 1 partition), calculate the number of possible microstates for each macrostate n for N = 8 particles. What is the probability that n = 8? What is the probability that n = 4? It is possible to count the number of microstates for each n by hand if you have enough patience, but because there are a total of $2^8 = 256$ microstates, this counting would be very tedious. An alternative is to obtain an expression for the number of ways that n particles out of N can be in the left half of the box. Motivate such an expression enumerating the possible microstates for smaller values of N until you see a pattern.

3. The mean translational energy for an atom in an ideal gas is $(3/2)k_BT$, where T is the absolute temperature and $k_B=1.38\times10^{-23}$ J/K. Assuming the 3D particle-in-a-box solution applies to the translational quantum levels for neon molecules in an ideal gas, determine the order of magnitude of the largest quantum number among n_x, n_y, and n_z for atoms in a system at T=290K. Is this value large or small compared to one?

4. CO_2 is a linear molecule with a carbon atom (m = 1.99×10^{-26} kg) at the center and an oxygen atom (m = 2.66×10^{-26} kg) at each end. The separation between the carbon and oxygen atoms is about 2.77×10^{-10} m. Use the rigid-rotor quantum solution to determine the separation between the first two energy levels for CO_2 molecules in an ideal gas.