PHYSICS 114 Contemporary Physics II – Homework 2

In all problems involving solutions to problems involving equations, leave your solution in "equation" form until the last step.

1. Suppose we have two blocks composed of 5 harmonic oscillators each and have 4 quanta in each initially. After bringing them together, what is the probability of having all the energy move to one of the blocks?

   A useful approximation for calculating entropy of a macrostate is the stirling approximation:

   $$lnN! = NlnN - N \tag{1}$$

2. Suppose we have a block consisting of N oscillator
   (a) Write down the equation for the number of microstates as a function of the number of quanta q that we put into the block.
   (b) Write down an expression for the entropy using the stirling approximation .
   (c) Write down an expression for the entropy in terms of energy E. (That is use the expression $E = q\hbar\omega$).
   (d) Write down an analytical expression (by taking the derivative of the above expression) for the temperature.

3. Probable energy states for molecules at room temperature
   (a) Suppose we have an system that has the following allowed electronic energy states: 1 ev, 1.5 ev, 3.0 eV, 10eV. What is the probability of the system to be at each of these energy states at 298K, 1000K?
   (b) Suppose we have a system that has the following allowed rotational energy states: $1.1 * 10{-}3$ ev, $1.3 * 10{-}3$, $1.5 * 10{-}3$ eV. What is the probability of populating these rotational states at 300K and 5000K?
   (c) From the above analysis what rotational and electronic states are you likely to find a typical molecule in at room temperature?

Problems 11: P.54 (do this first), P.43, P.51, P.52