Reading Assignment 11/14

(due: Friday, November 14, 9 am)

Read: §7.1

1.: What is the equivalent to the Boltzmann factor if you allow the number of particles to vary (so μ const. instead of N const.)?

2. Comments: What of this reading did you find most difficult and what did you find most interesting? Any other comments?

Homework #29 due Nov. 14:

1. Assume that a system's energy can be written as $E_{\text{tot}} = E_1 + E_2 + \ldots + E_N$ and the partition function is

$$Z_{\text{tot}} = \sum_{s_1} \sum_{s_2} \cdots \sum_{s_N} e^{-E_{\text{tot}}/kT},$$

i.e. due to different energy contributions to a single particle and/or distinguishable particles. Show that for any function $X(s_i)$, i.e. only dependent on s_i and no other $s_{j \neq i}$, that for the average follows

$$\overline{X(s_i)} = \frac{\sum\limits_{s_i} X(s_i) e^{-E(s_i)/kT}}{\sum\limits_{s_i} e^{-E(s_i)/kT}}$$

One example for this would be for a system of $i = 1, 2, \ldots, N$ particles with velocities $(v_{x,i}, v_{y,i}, v_{z,i})$ and

$$E_{\text{tot}} = \frac{1}{2} m_1 v_{x,1}^2 + \frac{1}{2} m_1 v_{y,1}^2 + \frac{1}{2} m_1 v_{z,1}^2 + \frac{1}{2} m_1 v_{x,2}^2 + \frac{1}{2} m_1 v_{y,2}^2 + \frac{1}{2} m_1 v_{z,2}^2 + \ldots + \frac{1}{2} m_1 v_{x,N}^2 + \frac{1}{2} m_1 v_{y,N}^2 + \frac{1}{2} m_1 v_{z,N}^2$$

we can follow

$$\overline{v_{x,i}^4} = \frac{\sum\limits_{v_{x,i}} v_{x,i}^4 e^{-v_{x,i}^2/2kT}}{\sum\limits_{v_{x,i}} e^{-v_{x,i}^2/2kT}}$$

2. problem 6.45