3.020 – Thermodynamics of Materials Recitation 8

Problem 1

a) Consider a system that has 4 particles and 2 available energy states. How many microstates does this system have? Describe all the macrostates, how many macrostates does this system have? Which macrostate is the most likely? Plot the probability of the macrostates for this system as a function of n_2/N_0 (with n_2 the number of particles in state 2 and N_0 the total number of particles). Add to this plot the probability curve for a system that has a very large number of particles but the same amount of available energy states. What is the peak value of this curve?

b) Consider again the system that has 4 particles and 2 available energy states. Now, calculate the configurational entropy of every macrostate and interpret the results. How does the entropy link with the probabilities calculated in part (a)?

c) Consider again the system that has 4 particles and 2 available energy states, but now we will assign energy values to the states according to the following equation: $\varepsilon_i = \varepsilon_0 + a(i-1)\varepsilon$ with a a constant and ε_i in J/particle. Calculate the partition function of the system. Also, calculate the equilibrium distribution of the particles n_1 and n_2 for both very small a values (e.g. small energy differences between the energy levels) and very large a values (e.g. large energy differences between the energy levels). Compare these results with (a)-(b). What is the impact of the temperature?

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