CHE-371 Fall 2008

Homework #3

1. The partition function for a monatomic van der Waals gas is given below. Derive expressions for the energy and heat capacity for a monatomic van der Waals gas. Compare the heat capacity to the heat capacity for a monatomic ideal gas.

$$Q(N,V,T) = \frac{1}{N!}\left(\frac{2\pi m k_B T}{h^2}\right)^{3N/2} (V - Nb)^N e^{aN^2/Vk_BT}$$

2. Derive an expression for the probability that a harmonic oscillator will be found in the v^{th} state. Calculate the probability that the first few vibrational states are occupied for HCl at 300K. Use $\tilde{\upsilon}$ found in Table 5.1 of McQuarrie and Simon.
3. The energies and degeneracies of the two lowest electronic states of atomic iodine are found below. What temperature is required so that 2% of the atoms are in the excited state?

Energy / cm-1	**Degeneracy**
0	4
7603.2	2

4. Exercises 1, 2 in "A Summary of Statistical Thermodynamic Calculations" – stat_thermo.mcd – found on the course (section 001) Moodle site. You'll probably want to save it and then open it (rather than download it).