8.08 Problem Set # 4

Feb. 23, 2005
Due March 2, 2005

Problems:

1. Problem 13.1 in K. Huang's book.

2. A surface has N_s sites which can adsorb 1 or 2 atoms. It costs no energy to adsorb 1 atom or 2 atoms. The surface is in contact with a gas of the atoms.

   (a) Assume the gas has a chemical potential μ and a temperature T.
   (i) Find the probabilities for a site to be empty, occupied by one atom, and occupied by two atoms.
   (ii)Find the average number of atoms absorbed on the surface.

   (b) Assume the gas is describe by the van der Waals model. Its free energy is given by

$$A = Nk_BT[\ln(\frac{N\lambda^3}{V - Nv_0}) - 1] + \frac{N^2\bar{v}}{V}$$

   where v_0 and $\bar{v}$ are two constants, N is the total number of atoms in the gas, and $\lambda = \sqrt{2\pi\hbar^2/mk_BT}$. Find the chemical potential of the van der Waals gas as a function of T and $n = N/V$.