Physics 219: Problem Set # 1 (due Jan. 26)

Problem 1:
What is the entropy variation of 1000g of water when raised from freezing to boiling temperature? (Assume a const specific heat of 1 cal/g ^{o}K.)

Problem 2:
a) Write down the Hamiltoanian H of a system of N identical particles with pairwise interaction $\phi(r_i - r_j)$ (where i and j are particle labels) moving within a spherical container of radius R bounded by the walls represented by the potential

$$W(d_i) = - W_0 \ln (d_i /a) , \text{ for } d_i < a$$
$$= 0 , \text{ otherwise}$$

where W_0 is a positive constant and d_i is the distance of i^{th} particle from the wall (and $a \ll R$)

b) The mechanical variable X whose average corresponds to an intensive thermodynamic field can be defined as follows. If Y is the corresponding extensive coordinate (e.g. V, N, etc)

$$X = -\frac{\partial H}{\partial Y}$$

Calculate the mechanical pressure for the Hamiltonian in part (a).

Problem 3:

Suppose the entropy S(U,V) of a system with fixed number of particles is $S(U,V) = aU^2 + b\,UV + c\,V^2$ where a,b,c are constants. Find the temperature and pressure by taking appropriate partial derivatives. Determine the Helmholtz and Gibbs free energies F(T,V) and G(T,p) as explicit functions of their arguments. Verify that, $\left(\frac{\partial F}{\partial T}\right)_V = -S$ and $\left(\frac{\partial G}{\partial p}\right)_T = V$.