

### Assignment 10

1. For a certain system, the energy of each state  $s$  is given by

$$E_s = k_B T \left[ C_s + \frac{3}{2} N \ln \left( \frac{\beta}{\beta_0} \right) - N \ln \left( \frac{V}{V_0} \right) \right]$$

where  $\beta_0$  and  $V_0$  are constants and  $C_s$  is a constant whose value depends on the state.

- Write out the partition function for this system.
  - Calculate the average internal energy for this system as a function of  $(N, V, T)$ .
  - Calculate the average pressure for this system as a function of  $(N, V, T)$ .
  - Calculate the average chemical potential for this system as a function of  $(N, V, T)$ .
  - Find the Helmholtz free energy
  - Find the Entropy.
2. The partition function of a single molecule can be found by multiplying the contributions due to its 1) translational motion  $Z_t$ , 2) rotational motion  $Z_R$  and 3) vibrational motion  $Z_v$ . In the high temperature limit such  $kT \gg \hbar\omega$  find an expression for the average energy per molecule using:

$$Z_t = \left( \frac{2\pi m}{h^2 \beta} \right)^{3/2}$$

$$Z_R = \frac{2I}{h^2 \beta}$$

$$Z_v = \frac{1}{h\omega \beta}$$