Homework 10 – Thermodynamics of Materials

PHYS 324, Spring 2008, Longwood University

Due: April 7th

1. Consider a system of N non-interacting, distinguishable particles each with two possible energies: $E_1 = 0$ and $E_2 = \frac{A}{V}$, where A is a constant and V is the volume. Determine the following:
   (a) the partition function for the canonical distribution,
   (b) Helmholtz free energy,
   (c) entropy,
   (d) equation of state,
   (e) and the internal energy.
   (You should be able to show that $U = PV$ as in HW 9.3)

2. A relatively small system consists of one mole of particles. Each particle has two states with energies $\varepsilon_1 = 0$ and $\varepsilon_2 = 7.5 \times 10^{-22} J$. The system is in equilibrium with a thermal reservoir at 50 K.
   (a) What is the probability of one atom having ε_1?
   (b) What is the probability of one atom having ε_2?
   (c) Determine the internal energy of the system.

3. For the system described in problem 2, the external constraints are changed quasi-statically (reversibly). As a result ε_2 changes to $\varepsilon_2 = 8.0 \times 10^{-22} J$.
   (a) How much work was done on the system?
   (b) How much heat flowed out of the system?
   (c) What is the new internal energy of the system?
   (d) What the 1st Law obeyed?