8.08 Problem Set # 1

Feb. 2, 2005
Due Feb. 9, 2005

Problems:

1. Problem 12.1 in K. Huang's book

2. Problem 12.3 in K. Huang's book. But instead answer the following questions:
   (a) How many states are there when the length of the chain is L. (Assume the ceiling does not block the chain.)
   (b) Find the entropy and the energy of the chain when the length of the chain is L. (Assume N is large and $L \ll Na$.)
   (c) Find the temperature T of the chain when the length of the chain is L.
   (d) Find the length of the chain in terms of T. Show that the length of the chain is proportional to the force mg for a fixed T and a small force.

3. Problem 12.3 in K. Huang's book. But assume $m = 0$ and answer the following questions:
   (a) Find the partition function $Q(L)$ when the length of the chain is L and the chain is in contact with a heat bath of temperature T.
   (b) Find the free energy of the chain $A(T, L)$. (Assume N is large and $L \ll Na$.)
   (c) Find the tension τ of the chain: $\tau = \frac{\partial A}{\partial L}$. Show that the length of the chain is proportional to the tension τ for a small tension.
   (d) When we pull the chain, we do work. but the internal energy of the chain is always zero: $U = 0$. Where does the energy go? Do we still have energy conservation?

4. Problem 12.4 in K. Huang's book