Statistical Mechanics

February 2, 2005

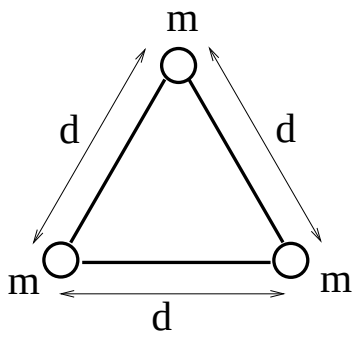
Work 2 of the 3 problems. Please put each problem solution on a separate sheet of paper and put your name on each sheet.

Problem 1

(Curran)
An immersion heater of power $J = 500\,W$ is used to heat water in a bowl. After 2 minutes, the temperature increases from $T_1 = 85\,^oC$ to $T_2 = 90\,^oC$. The heater is then switched off for an additional minute, and the temperature drops by $\Delta T = 1\,^oC$. Estimate the mass m of the water in the bowl. The thermal capacity of water is $c = 4.2 \cdot 10^3 J/(kg\,K)$.

Problem 2

(Vasiliev)
Consider an ideal gas composed of N absolutely rigid (i.e. no vibrations) planar equilateral triangular molecules. The molecules are made of identical atoms of mass m, separated by distance d. The gas is held at constant volume V and temperature T. **(a)** Find the partition function of a single molecule, assuming that $T >> \hbar^2/md^2k_B$. **(b)** Starting from the total partition function, calculate the internal energy and specific heat of this gas at high temperature. Show that your result is consistent with the equipartition theorem.



Problem 3

(Urquidi)
Consider a quantum mechanical rotor with moment of inertia I whose center of mass is spatially fixed.

a.) Give the spectrum of energies with the associated degeneracies, and construct the partition function for this system.

b.) Construct the first four terms of the high temperature expansion of this partition function using the Euler-MacLaurin summation formula 23.1.30 in Abramowitz/Stegun. Hint: Consult also pages 804, 806 and 809 there.