

PHYC - 505: Statistical Mechanics

Midterm Exam 1

Thursday, March 6, 2014

11:00 am - 12:15 pm

You may use a one-sided $8\frac{1}{2} \times 11$ cheat sheet. The total points for this exam are 30.

- 10 pts. Calculate (do not merely state) the partition function of a harmonic oscillator of mass m and frequency ω (i) classically, and (ii) quantum mechanically. From your result also evaluate the entropy of N such non-interacting oscillators as a function of temperature.
- 10 pts A 2-dimensional polarizable material consists of a large number N of non-interacting electric dipoles each of moment μ , which can be aligned within the plane in ONLY 4 different ways with respect to an applied electric field E : two of them parallel to the field (directed along and opposite to the field, respectively) and two of them perpendicular. Neglect the kinetic energy of the dipoles (consider the entire energy to be given by the interaction of the dipoles with the field) and calculate (i) the electric polarization (total dipole moment in the direction of the field) and (ii) the specific heat of the system at temperature T .
- 10 pts Consider a 2-dimensional solid in which there are wave motions having the dispersion relation $\omega = Aq^r$ between the frequency ω and the wave number q , where A and r are constants. Show in detail that the specific heat of such a solid at low temperatures goes as T^s where T is the temperature, and obtain the relation between s and r .