UNIVERSIDADE FEDERAL SANTA MARIA
DEPARTAMENTO DE FÍSICA
Programa de Pós-Graduação em Física

List 5

Segundo semestre/2015
FSC 810 Mecânica Estatística

1) Find the entropy S(E,V,N) of a ideal gas of n classical monoatomic particles, with a fixed total energy E, contained in a box of volume V. Deduce the equation of state of this gas, assuming that N is very large.

2) Consider a system of N non-interacting quantum-mechanical harmonic oscilators in three dimensions. Compute the canonical partition function of the system Z(T,N).

3) A "lattice gas" consists of a lattice of N sites, each of which can be empty, in which case its energy is zero, or occupied by one particle, in which case its energy is ε. Each particle has a magnetic moment of magnitude μ which, in the presence of an applied magnetic field H, can adopt two orientations (parallel or antiparallel to the field).
a) Find the canonical partition function for this system.
b) Evaluate the average energy and the magnetization of the system.

4) Using the grand canonical ensemble, evaluate the chemical potential μ (T,P) for a ultrarelativistic gas contained in a box of volume V.

5) Consider a box containing an ideal classical gas at pressure P and temperature T. The walls of the box have N0 absorbing sites, each of which can absorb one molecule of the gas. Let -ε be the energy of an absorbed molecule.
a) Find the fugacity of the gas in terms of the temperature and pressure.
b) Find the mean number of absorbed molecules.

6) Consider a system of non-interacting, identical but distinguishable particles. Using both the canonical and the grand canonical ensembles, find the partition function and the thermodinamic functions U(T,V,N), S(T,V,N) and F(T,V,N) in terms of the single-particle partition function Z_1 . Verify that Ug=Uc, where the subscripts c and g denote the canonical and the grand canonical ensembles respectively. If s and f are the entropy and the Helmholtz free energy per particle respectively, show that, when N is large $(s_g - s_c)/k = -(f_g - f_c)/kT \simeq (\ln N)/N$.

7) Consider a system of identical but distinguishable particles, each of which has two states, with energies ε and -ε avaliable to it. Use the microcanonical, canonical and grand canonical ensembles to calculate the mean entropy per particle as a function of the mean energy per particle in the limit of a very large system. Verify that all three ensembles yield identical results in this limit.