PHYC - 505: Statistical Mechanics Homework Assignment 1

due date (in class) Sep 15, 2016. No late submissions will be accepted.

1. A magnetic field B is applied to a system of a large number N of noninteracting spins each of magnetic moment μ at temperature T. Calculate (display analytic expressions) and plot (not merely sketch, do this with some graphing package)

   (a) the magnetization as a function of T at two given values of B,

   (b) the magnetization as a function of B at two given values of T,

   (c) the heat capacity of the system as a function of temperature T for a given value of B.

   Do each of these in a 1-dimensional, 2-dimensional, and 3-dimensional systems, carefully watching differences if any. The first of these is the system treated in class. For all three you have to evaluate appropriate integrals if necessary and express in terms of special functions such as hyperbolic, Bessel, etc.

   The basis of all your calculations should be the Boltzmann weight $\exp(-E/kT)$ and the expression for the energy for a spin as $E = -\mu B \cos\theta$ where θ is the angle between the directions of spin moment and the magnetic field.

2. Read up from elementary books of your choice on thermodynamics, write down the first law of thermodynamics, and explain what you understand by entropy, free energy, and chemical potential. The answer should be not more than half a page.