

Reading: On Tuesday we will discuss interfacial effects and nucleation in phase transitions. Then we will turn to phase transitions and the associated critical phenomena in spin systems. This is a major topic upon which much of modern statistical physics research is based. For spin system, please read, in order, Pathria, chapter 12, sections 1 & 2, and chapter 11 section 5–13.

Note: Let's please decide the final exam date this week. The officially scheduled time is Wed. 12/20 at 12:30m. Please be aware that I normally give a 3-hour exam.

Problems: Due Tuesday Nov. 21. Please note that I assigned some of these problems last year. Please don't consult with 2nd-year students.

1. Pathria 9.3.
2. (Huang 2.1) What is the boiling point of water at the top of Mt. Evans, Colorado (approximate elevation 14,400 ft.)?
3. Consider a spin- $\frac{1}{2}$ Ising chain with periodic boundary conditions in which there is an interaction of strength J_1 between nearest neighbors and an interaction of strength J_2 between second neighbors. The Hamiltonian is

$$\mathcal{H} = -J_1 \sum_{i=1}^N \sigma_i \sigma_{i+1} - J_2 \sum_{i=1}^N \sigma_i \sigma_{i+2}$$

with $\sigma_{N+1} = \sigma_1$ and $\sigma_{N+2} = \sigma_2$. (a) Using the transfer matrix, compute the partition function of this Ising chain for arbitrary J_1 and J_2 . (b) At $T = 0$, determine the ground state of the system for $J_1 > 0$ (ferromagnetic) and for arbitrary values of J_2 . Give a physical interpretation of your results.

4. (Plischke and Bergersen, 3.7) Consider the spin-1 Ising model on a periodic ring. This is defined by the Hamiltonian

$$\mathcal{H} = -J \sum_{i=1}^N \sigma_i \sigma_{i+1},$$

with $\sigma_i = 0, \pm 1$, $\sigma_{N+1} \equiv \sigma_1$ for periodic boundary conditions, and $J > 0$. Compute the partition function of this system and the internal energy as a function of temperature. The solution to the latter requires differentiation of the root of a cubic equation. You may wish to do this numerically.