

Exercises in Statistical Mechanics

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This exercises pool is intended for a graduate course in “statistical mechanics”. Some of the problems are original, while other were assembled from various undocumented sources. In particular some problems originate from exams that were written by B. Horovitz (BGU), S. Fishman (Technion), and D. Cohen (BGU).

===== [Exercise 1815]

Cooling by demagnetization

Consider a solid with N non-magnetic atoms and N_i non-interacting magnetic impurities with spin s . There is a weak spin-phonon interaction which allows energy transfer between the impurities and the non-magnetic atoms.

- (a) A magnetic field is applied to the system at a constant temperature T . The field is strong enough to line up the spins completely. What is the change in entropy of the system due to the applied field? (neglect here the spin-phonon interaction).
- (b) Now the magnetic field is reduced to zero adiabatically. What is the qualitative effect on the temperature of the solid? Why is the spin-phonon interaction relevant?
- (c) Assume that the heat capacity of the solid is $C_V = 3Nk_B$ in the relevant temperature range. What is the temperature change produced by the process (b)? (assume the process is at constant volume).