

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 1817]

Adiabatic cooling of spins

Consider an ideal gas whose N atoms have mass m , spin $1/2$ and a magnetic moment γ . The kinetic energy of a particle is $p^2/(2m)$ and the interaction with the magnetic field B is $\pm\gamma B$ for up/down spins.

- (a) Calculate the entropy as $S(T, B) = S_{kinetic} + S_{spin}$.
- (b) Consider an adiabatic process in which the magnetic field is varied from B to zero. Show that the initial and final temperatures T_i and T_f are related by the equation:

$$\ln \frac{T_f}{T_i} = \frac{2}{3N} [S_{spin}(T_i, B) - S_{spin}(T_f, 0)]$$

- (c) Find the solution for $\frac{T_f}{T_i}$ in the large B limit.
- (d) Extend (c) to the case of space dimensionality d and general spin S .