

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 1047]

Negative temperature

Consider N particles, each fixed in position and having a magnetic moment μ , in a magnetic field H . Each particle has then two energy states, $\pm\mu H$. Treat the particles as distinguishable.

- (a) Evaluate the entropy of the system $S(n)$ where n is the number of particles in the upper energy level; assume $n \gg 1$. Draw a rough plot of $S(n)$.
- (b) Find the most probable value of n and its mean square fluctuation.
- (c) Relate n to the energy E of the system and find the temperature. Show that the system can have negative temperatures. Why a negative temperature is not possible for a gas in a box?
- (d) What happens if a system of negative temperature is in contact with a heat bath of fixed temperature T_0 ?