

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 1510]

Boltzmann approximation from the canonical ensemble

Given N particle gas with uniparticle state density function $g(E)$.

In the grand canonical ensemble, in Boltzmann approximation, the results we get for the state functions $N(\beta\mu), E(\beta\mu)$ are

$$N(\beta\mu) = \int_0^\infty g(E) dE f(E - \mu)$$

$$E(\beta\mu) = \int g(E) dE E \cdot f(E - \mu)$$

Where $f(E - \mu) = e^{-\beta(E - \mu)}$ is called the Boltzmann occupation function.

In this exercise you need to show that you get those equations in the framework of the approximation $Z_N \approx \frac{1}{N!} Z_1^N$. For that, calculate Z , that you get from this proximity for Z_N and derive the expressions for $N(\beta\mu), E(\beta\mu)$.