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 3021]

Bosons with Spin in magnetic field

N Bosons that have mass m and spin1 are placed in a box that has volume V. A magnetic field B is applied, such that the interaction is $-\gamma B S_z$, where $S_z = 1, 0, -1$, and γ is the gyromagnetic ratio. In items (c-f) assume the Boltzmann approximation for the occupation of the $S_z \neq 1$ states.

(a) Find an equation for the condensation temperature T_c.

(b) Find the condensation temperature $T_c(B)$ for $B = 0$ and for $B \to \infty$.

(c) Find the critical B for condensation if T is set in the range of temperatures that has been defined in item(b).

(d) Describe how $T_c(B)$ depends of B in a qualitatively manner. Find approximate expressions for moderate and large fields.

(e) Find the condensate fraction as a function of T and B.

(f) Find the heat capacity of the gas assuming large but finite field.