

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 3030]

Charged Bose gas in a divided box

Consider N bosons with mass m , positive charge e , and spin 0. The particles are in a box that is divided into two regions: zero voltage region of volume Ω_0 , and voltage V region of volume Ω_v . Assume that the bosons are condensed in the Ω_0 region. In items (3,5) assume that the gas in the Ω_v region can be treated using the Boltzmann approximation.

- (1) Find the $V = \infty$ condensation temperature $T_c(\infty)$.
- (2) Find the $V = 0$ condensation temperature $T_c(0)$.
- (3) Assuming an intermediate temperature, find the critical voltage V_c below which the bosons are no longer condensed.
- (4) Write an exact expression for the energy $E(T, V)$ of the system
- (5) Write an expression for the heat capacity $C(T, V)$ of the system. Keep only the leading correction in V .

Express the results using the thermal wavelength λ_T , the variables $\Omega_0, \Omega_v, N, T, eV$, and the functions $L_\alpha(z)$ and $\zeta(\alpha)$.

