

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 5024]

Pressure of Lenard Jones gas

A gas of N particles is confined in a box of volume V at temperature of T . The two-body interaction between the particles is given by the Lenard Jones expression:

$$u(r) = \frac{a}{r^{12}} - \frac{b}{r^6}$$

Note that this interaction is characterized by a length scale r_0 and an energy scale ϵ_0 that correspond to the position and the depth of the potential.

- (a) Find an expression for the pressure via the Virial theorem, assuming that the moments $\langle r^n \rangle_T$ are known.
- (b) Using the Virial expansion, find an explicit expression for the pressure assuming low temperatures.
- (c) Using the Virial expansion, find an explicit expression for the pressure assuming high temperatures.
- (d) Comparing your answers to items (a) and (c) deduce explicit expressions for the $n = -6$ and for the $n = -12$ moments. Express your result in terms of (V, r_0, ϵ_0, T) .