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 2041]

Gas in gravitation confined between adhesive plates

A classical ideal gas that consists of N mass m particles is confined between two horizontal plates that have each area A, while the vertical distance between them is L. The gravitational force is f oriented towards the lower plate. In the calculation below fix the center of the box as the reference point of the potential.

The particles can be adsorbed by the plates. The adsorption energy is $-\epsilon$. The adsorbed particles can move along the plates freely forming a two dimensional classical gas. The system is in thermal equilibrium, the temperature is T.

1. Calculate the one particle partition function $Z(\beta, \mathsf{A}, L, f)$ of the whole system.
   Tip: express the answer using sinh and cosh functions.

2. Find the ratio N_A/N_V, where N_A and N_V are the number of adsorbed and non-adsorbed particles.

3. What is the value of this ratio at high temperatures.
   Express the result using the thermal wavelength λ_T.

4. Find an expression for F_V in the formula $dW = (N_V F_V + N_A F_A)dL$.
   Tip: the expression is quite simple (a single term).

5. Find a high temperature approximation for F_V.
   Tip: it is possible to guess the result without any computation.

6. Find a zero temperature approximation for dW.
   Tip: it is possible to guess the result without any computation.