Exercises in Statistical Mechanics

Based on course by Doron Cohen, has to be proofed
Department of Physics, Ben-Gurion University, Beer-Sheva 84105, Israel

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 4012]

Classical gas in volume-surface phases equilibrium

An ideal gas composed of point particles with mass m, moves between parallel boards of a capacitor. The surface of each one of them is A and the distance between them is L, as described in the figure.
Force $\vec{f}$ operates on the particles, in vertical direction to the boards, which pushes the particles to the lower board. particles can be adsorbed to the boards. the adsorbed particles move over them freely, and adsorbed potential $-E$ operates on them (when $E > 0$)in addition to force $\vec{f}$.
The system is in balance, in temperature T. Moreover, It's given that the average number of the particles that move between the boards and are not adsorbed over them is N, and their average density is $\bar{n}$.
Assume that the gas particles maintain Maxwell-Boltzman statistics and therefore it's possible to carry out the calculations in the classical statistical mechanics frame.
Express all of your answers with $E, L, \bar{n}, T, f = |\vec{f}|, \mathsf{m}$ and through physical and mathematical constants only.

(a) Calculate $n(x, y, z)$, The density of the particles per volume unit in some point between the boards. Define the coordinate system you use.

(b) Calculate the ratio $\frac{\Phi_+}{\Phi_-}$ between the flow that hits the upper board and the flow that hits the lower board.

(c) Calculate and which are the densities of the particles adsorbed over the upper board and the lower board respectively. Moreover,calculate the ratio .

Guideline: It's possible to make the calculation through the chemical potentials of the gas between the boards and over them.