

## 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 4019]

#### Chemical equilibrium volume-polymer

Consider a polymer composed with  $M$  monomers. The polymer is in a gas with temperature  $\beta$  and chemical potential  $\mu$ . The gas molecules can absorb the polymer’s monomers. The connection energy of the gas molecule to the monomer is  $\varepsilon$ . The natural length of a monomer is  $a$ , when a gas molecule is absorbed to it, it’s length is  $b$ .

- (a) Calculate  $Z_N$  for the polymer, and from that, calculate  $Z$ .
- (b) Calculate  $Z$  by the factorization.

Guideline: in paragraph b’ write the polymer’s states in this form  $|n_r (r = 1\dots M) \rangle$  when  $n_r = 0, 1$ . Accordingly, if there is or there is no absorption. Write  $N_{(n_r)} E_{(r)}$ , and show the sum you need to calculate for  $Z$  is factorized.

- (c) Calculate the average length  $L$  of the polymer.

Guideline: Express  $\hat{L}$  through  $\hat{N}$ . Calculate  $N \equiv \langle \hat{N} \rangle$  in two ways:

Way I - to derive from  $Z$  (page

Way II - Express  $\hat{N}$  through  $\hat{n}_r$  and then use the probability theory and the result for  $\langle \hat{n}_r \rangle$ .