

1. Let the density of ideal Maxwell-Boltzmann gas to be n . Calculate the probability distribution of the distance from a given molecule to its nearest neighbour. What is the expectation value of this distance?
2. Find the partition function of a mixture of 2 ideal Maxwell-Boltzmann gases, and calculate the mixing entropy. Show that the Gibbs function G and the pressure p of the mixture are additive; i.e. these are sums of the component gas quantities.
3. DNA-molecule chain can be described by a “zipper” with N links. The energy of the link is 0 if it is closed and ϵ if it is open. The chain can open from one direction only, so that link number s can open only if all links $(1, 2, \dots, s - 1)$ are already open. Show that the partition function is

$$Z = \frac{1 - e^{-\beta(N+1)\epsilon}}{1 - e^{-\beta\epsilon}}.$$

Calculate the number of open links N_{open} as a function of β .