

Problem 1. What is the partition function and probability of a state for a system with constant T , N and p , the pressure? Explain this result in the context of a Legendre transform.

Problem 2. Consider the DNA unbinding problem discussed in class. We formulate a more detailed model with an additional energy associated with an unbound base pair next to a bound base pair. The energy is

$$E_j = E_0 + (1 - \delta_{0j})E_q + jE \quad (1)$$

for the state with j unbound base pairs. Here, the δ_{ij} is a Kronecker delta function ($\delta_{ij} = 1$ if $i = j$, $\delta_{ij} = 0$ if $i \neq j$) and $E_q \geq 0$ is a constant energy. Calculate the probability that N base pairs are unbound and the average energy $\langle E_j \rangle$. How does this addition energy E_q affect the unbinding behavior of the DNA?