Problem Solving Session 2

Consider a polymer adsorbed on a crystal surface. The polymer consists of N monomers, denoted as M, that are bonded in a row by strong chemical bonds (i.e., M – M – M – ... — M). Each monomer can bind to the crystal surface with a rather weak bond. The energy required to break one bond is ϵ where $\epsilon > 0$. Assume one of the end monomers of the polymer is bound more strongly to the surface (for example at a surface defect) but starting from the other end, bonds to the surface can break one after another in a row. Let n be the number of monomer - surface bonds that have broken.

(a) What is the energy of the polymer in terms of the polymer/surface interaction when n bonds have been broken?

(b) Give an expression for the partition function of the molecule considering all possible states of the N bonds. Hint: $\sum_{n=0}^{N} x^n = (1 - x^{N+1}) \sum_{n=0}^{\infty} x^n$

(c) Calculate the average energy, $\langle E \rangle$, and the average number of broken bonds, $\langle n \rangle$, as a function of temperature.

(d) Give an expression for the probability that all bonds to the surface have broken except for the end that is fixed to the surface.