FY8201 / TFY8 Nanoparticle and polymer physics I
EXERCISE 3

Aim of the exercise: Give a quantitative understanding of some properties of a chain molecule, using realistic parameters. Give physical knowledge of the phenomenon entropy springs.

A) A chain molecule consists of 100 uncorrelated segments (segment vectors) each of length 10 nm at 27 ^{o}C. Apply equations from the lecture notes and calculate for the chain molecule:

i) contour length,
ii) average end-to-end vector,
iii) average end-to-end distance,
iv) average quadratic end-to-end distance,
v) maximal stretch ratio,
vi) radius of gyration,
vii) spring stiffness (spring constant) when changing the end-to-end distance of the molecule.

B) A one-dimensional Rouse chain has springs which are all equal and obey one of the spring potentials i) or ii) below. The potensials are given as function of the length l of each individual spring.
In each case calculate the spring stiffness (spring constant) of the chain.

i) $U_1 = \frac{k_S}{2}(l - l_{\max}/2)^2$.
This is a traditional spring potential, and you can approximate the entropy of the chain to zero,

ii) $U_2 = \begin{cases} 0 & \text{when} \quad l \in [0, l_{max}] \\ \infty & \text{else} \end{cases}$,
i.e. each spring has a maximal length and within this length no spring stiffness.