Exercise 2: Polymer Structure in Solution and Molecular Weight Determination

2.1: Consider an ideal polyethylene chain with molar mass m = 10^7 g mol^{-1}. The mean-square end-to-end distance is given by

$$\langle h^2 \rangle = N b^2 C_\infty$$

Assume the monomer length b = 2.5 Å, the coefficient C_∞ = 6.0, and the molar mass of the monomer m_{mon} = 28 g mol^{-1}.
Estimate the root-mean-square end-to-end distance $\langle h^2 \rangle^{1/2}$ for the polymer chain.

What is the maximum length R_{max} = bN of the same polyethylene chain?

2.2: An NMR experiment was performed on a solution of poly(vinyl alcohol) in water at 25ºC to determine the polymer's diffusion coefficient. A value of D = 1.22 x10^{-10} m^2/s is found. Knowing that the viscosity of water at this temperature is 8.90 x10^{-4} kg m^{-1}s^{-1}, calculate R_H.

2.3: The following data were obtained for different solutions of a polymer in a membrane osmometer:

c (g/L)	height difference measured (cm of solvent)
3.2	0.70
6.6	1.82
10.0	3.10
14.0	5.44
19.0	9.3

The temperature is 25 °C and the solvent density is 0.85 g/ml. Determine the molecular weight and second Virial coefficient of this polymer solution. How could you get the theta temperature for this polymer solvent system?

2.4: In an Ubbelohde-viscosimeter the viscosity of a polymer solution liquid was measured. The average time for the solution to pass the capillary in the device was 100 seconds at 20°C. The capillary in the viscosimeter has a diameter of 0.8 mm and the volume that passed through the capillary during the measurement was 10 cm^3. Calculate the kinematic viscosity of the solution! What additional information would you need to calculate the dynamic viscosity of the solution?

2.5: The following data were obtained for polystyrene solutions in butanone at 25 °C in viscosity measurements in an Ubbelohde viscosimeter

conc (g/dL)	t (sec)
0	65.8
0.54	101.2
1.08	144.3
1.62	194.6
2.16	257.0

Determine the intrinsic viscosity and the viscosity average molecular weight of the polymer knowing that K and a for this polymer are 0.039 cm^3 ·mol$^{1/2}$/g$^{3/2}$ and 0.58 respectively.