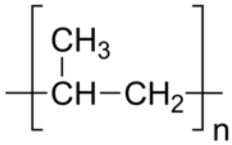
1. Name all possible isomers for polypropylene



(5 pts)

Positional isomerism:
- head-to-head
- head-to-tail

Stereo isomerism:
- Isotactic
- Syndiotactic
- Atactic

2. Light scattering has been measured on PB in a solution using laser with λ=633 nm, refractive index of a solution n=1.5. The following values of Kc/R_Θ in units [10^{-6} mol/g] have been obtained:

C [mg/ml]	Θ=30°	Θ=90°
0.5	1	1.35
2.0	1.75	2.1

Please, calculate molecular weight, Rg and second virial coefficient B for the PB molecule in the solution. (10 points)

We use the equation $\mathbf{Kc/R_\Theta = (1 + q^2R_g^2/3)/M_w + 2Bc}$
First, extrapolating to c=0, we can estimate the second virial coefficient from the slope
B=(0.75/3)=**$0.25*10^{-3}$ [ml*mol/g^2]**
And use the values at c=0 to analyze the q-dependence (**$q=4\pi n Sin(\Theta/2)/\lambda$**):
At Θ=30°: $q^2 \approx 0.55*10^{-4}$ [nm^{-2}]; $Kc/R_\Theta = 0.75*10^{-6}$ [mol/g]
At Θ=90°: $q^2 \approx 4.41*10^{-4}$ [nm^{-2}]; $Kc/R_\Theta = 1.1*10^{-6}$ [mol/g]

Extrapolating these values to q^2=0, we estimate **$M_w \approx 1.43*10^6$ [g/mol]**.
The slope of the q^2 dependence gives us estimate of $R_g^2 \approx 0.0907*10^{-2}*3*M_w \approx 3891$ nm^2.
So, **$R_g \approx 62$ [nm]**

3. Calculate unperturbed equilibrium R_g of polystyrene with molecular weight 104,000, assuming bond length 0.154 nm and characteristic ratio 9.5. (5 pts)

$$R_g = \sqrt{\frac{2\frac{M}{m_o}C_\infty l^2}{6}} = 0.154nm\sqrt{\frac{1000*9.5}{3}} \approx 8.67nm$$

4. A polymer with N=100 segments in a solution has a critical temperature T_C=20ºC. Assuming the effective χ parameter has only temperature dependent term, χ=B/T with B>0 (meaning A=0), estimate the temperature range where solution is miscible at any concentration for the same chain with N=400. (10 pts)

Using the known Tc=293K, and the equation for Tc: $T_c = \dfrac{B}{\frac{1}{2}\left(1+\frac{1}{\sqrt{N}}\right)^2 - A}$

we can estimate the coefficient B for N=100: B≈177K

Using the estimated B, we know now the χ parameter and can calculate Tc for any molecular weight using the same equation. For N=400, **Tc≈321K**, it will be miscible at T > 321K.

Bonus question (only after answering the main 4 questions):

5. If you want to get random copolymer with ~1:1 ratio of monomers 1 and monomers 2 in the chain, what should be the ratio of monomers concentration in the solution, if $r_1=r_2=0.15$? Please, explain. (3 pts)

   Using the equation for F_1 (page 12 of the notes parts 2-3), one can calculate the ratio $f_1/f_2=1$. It means that the mole ratio of monomers should be 1:1, i.e. **$f_1=f_2=0.5$**.
   The same can be obtained from the plot on the same page.