Polymer Physics　Exam #1　　　2008. 10. 13

Name_____________________

1. Explain the difference between conformation and configuration of polymer chains. (15)

2. (a) Describe the meaning of number-average molecular weight and weight-average molecular weight. (10)

   (b) Write down the methods of measuring the number-average molecular weight and weight-average molecular weight. (10)

3. We dissolved some polymer in 100ml of butanone and measured the flow times at 25℃ in an Ubbelhode capillary viscometer. The results are

Pure butanone	100 s
0.01 g/cm^3 solution	105.3 s
0.03 g/cm^3 solution	116.6 s
0.05 g/cm^3 solution	128.4 s
0.07 g/cm^3 solution	141.1 s
0.10 g/cm^3 solution	161.5 s

(a) Examine whether the above experiment was carried out properly. Provide plausible theoretical grounds for your answer. (10)

(b) Using the Mark-Houwink-Sakurada relation, determine the viscous average molecular weight. (K=39, a=0.58) (10)

4. Using the following table of data for Hc/R(θ) of a polystyrene in benzene at for concentrations and five angles, to determine $\mathbf{M_w}$ and $\mathbf{R_g}$. (15)

10^6 x Hc/R(θ) (mol/g)

c (mg/ml)	**$\sin^2(\theta/2)=1/8$**	**$\sin^2(\theta/2)=1/4$**	**$\sin^2(\theta/2)=3/8$**	**$\sin^2(\theta/2)=1/2$**
0.5	1.92	2.03	2.14	2.25
1.0	2.35	2.46	2.57	2.68
1.5	2.78	2.89	3.00	3.31
2.0	3.21	3.32	3.43	3.54

5. (a) Describe the physical meaning of "Like dissolves Like" (10)

(b) Define the Flory interaction parameter (χ) in terms of solubility parameter difference. (10)

(c) Estimate the Flory interaction parameter between polystyrene and polybutadiene at room temperature if the solubility parameter of polystyrene is δ_{PS}=1.87 x 10^4 $(Jm^{-3})^{1/2}$ and that of polybutadiene is δ_{PB}=1.62 x 10^4 $(Jm^{-3})^{1/2}$. For simplicity assume $v_0 \approx 100Å^3$ (15)

6. In a graph of the composition dependence of the free energy of mixing, show the relationship between the stability and the shapes of graphitic curves. (15)

7. (a) Draw a phase diagram (temperature on the y axis and polymer volume fraction on the x axis) for a solvent – polymer system having a UCST and obeying the Flory-Huggins theory. (10)

(b) Label the theta temperature and the critical point, and the upper critical solution temperature. (10)

(c) If N=10,000 what are the values of χ_c and $\Phi_{2,c}$? (10)

8. (Challenge) Chemical potential difference between pure solvent and polymer solution is

$$\mu_1 - \mu_1^{\ 0} = RT[\ln \phi_1 + (1 - \frac{1}{N})\phi_2 + \chi {\phi_2}^2]$$

(Φ_1: solvent volume fraction, Φ_2: polymer volume fraction, N: number of lattice sites of the polymer, χ: Flory-Huggins parameter)

(a) Derive $\mu_1 - \mu_1^{\ 0} = RT[-\frac{\phi_2}{x_2} + (\chi - \frac{1}{2}){\phi_2}^2]$ when solution is dilute. (Hint: $\ln(1-x) \cong -x - \frac{x^2}{2}$) (10)

(b) Describe the state of the solution when χ=1/2. (15)

(c) Using $\mu_1 - \mu_1^{\ \circ} = \int_{P_0}^{P_0+\pi} \frac{\partial \mu}{\partial P} dP$ in osmometry, derive A_2 (second virial coefficient). (20)

9. Please suggest or comment how we can make this lecture more interesting, enjoyable, and fruitful. (10)