Properties of Polymers Homework #1 Due on 08 Apr 2010

1. Show the structures of 5 major commodity polymers (PE, PP, PS, PVC, and PMMA) and 5 major engineering plastics (polyester, polyamide, polyacetal (POM), polyphenylene oxide (PPO), and polycarbonate (PC)).
2. Memorize the structures and names of the 10 polymers of Problem 1.
3. Do Problems 7 and 10 on p26 of Textbook.
4. Do Problem 1 and 2 on p65 of Textbook.
5. Do problems 1, 3, 4, and 18 on p140-141 of Textbook.
6. Do Example on p85 for PS with molecular weight of 10E5 to make up 20 vol % solution in toluene at 25 °C.
7. Derive Eqn (3.23) from Flory-Huggins Eqn (Eqn (3.22)).

The following questions are collected from the past exams.

8. (a) What do you mean by thermoplastic and thermosetting, respectively?
   (b) Why is a thermosetting resin not soluble in a solvent?
   (c) Why is a semicrystalline polymer not soluble in a solvent?
   (d) Draw a modulus (E, on y-axis) – temperature (T, on x-axis) curve for a thermosetting resin in comparison with a thermoplastic resin.
   (e) Draw a modulus (E, on y-axis) – temperature (T, on x-axis) curve for a semicrystalline polymer in comparison with an amorphous polymer.

9. (a) Does the conformation of a polymer chain change by varying the temperature? If yes, explain how. If no, explain why not. You may use an example.
   (b) Does the *configuration* of a polymer chain change by varying the temperature? If yes, explain how. If no, explain why not. You may use an example.

10. (a) Does a polymer always dissolve in an ideal solution? Why or why not?
    (b) Does a polymer always dissolve in a regular solution? Why or why not?
    (c) Can a polymer solution be an ideal solution? Why or why not?

11. (a) If equal amounts (weights) of monodisperse polymers with molecular weights of 1E4 and 1E5 are mixed, what is M_z of the mixture?
    (b) What would be the intrinsic viscosity of the mixture of (a) in toluene at 25 ^{o}C? Suggest the reasonable values for the parameters you need in the calculation.

12. When a polymer solution behaves like a(n) _____ solution thermodynamically, i.e., when _____ is zero (0), it is said that the solution is in _____ condition. In this condition, concentration is _____ (low, medium, or high), interaction parameter is _____, and _____ in the _____ equation for osmotic pressure is zero (0).

13. Answer the questions using Table 3.1 and 3.2.
    (a) What do you call δ?
    (b) Why is δ of acetone is higher than that of *n*-decane?
    (c) List all the solvents that can dissolve poly(methyl methacrylate).
    (d) Would you expect polystyrene be soluble in poly(methyl methacrylate)? Why or why not?

(e) Actually, polyethylene is not soluble in any solvent in the table. Why?
(f) What would you do to make a polyethylene solution? Explain using thermodynamic terms.
(g) Would the polystyrene of the table be isotactic, syndiotactic, or atactic? Why?
(h) Would the interaction parameter χ of toluene/polystyrene solution be higher or lower than that of toluene/poly(methyl methacrylate) solution? Why?

14. The following dilute solution viscometry data were obtained for poly(methyl methacrylate) in acetone at 20 °C. Using the data and the Table 3.10 given on the last page, answer the following questions.

concentration (g/dL)	0.00	0.25	0.50	0.75	1.00
elution time (s)	250	325	412	513	625

(a) What is the specific viscosity at the concentration of 0.50?
(b) Estimate the intrinsic viscosity. Answer with a unit (dimension).
(c) Estimate the viscosity-average molecular weight. If you could not get the intrinsic viscosity at (b) or not sure of your answer to (b), use the intrinsic viscosity value of 1.0 at the expense of 2 points.
(d) Would this viscosity-average molecular weight be smaller or larger than the z-average molecular weight? Explain.
(e) Does the concentration range chosen in this experiment appear reasonable? How would you judge?
(f) Is the solution used in this experiment in theta condition? How would you judge from your plot (not from the Table 3.10)?
(g) From Table 3.10 which polymer in which solvent is in theta condition? How would you judge?

15. Dilute solution viscometry (DSV) and gel permeation chromatography (GPC) are ‘relative’ methods for measuring average molecular weight of polymers.
(a) Why do they call the methods ‘relative?’
(b) What are the assumptions and conditions in DSV practice to get ‘molecular weight’ from your raw data? List as many as you can.
(c) What do you do in GPC practice to get ‘molecular weight’ from your raw data? Describe it very briefly.