Review Questions

1. What are rotational isomeric states?
2. What are the properties of a freely-jointed chain?
3. Define the characteristic ratio of a polymer.
4. Without any consideration of the excluded volume interaction, how does the mean radius of gyration of a chain depend on the degree of polymerization?
5. Describe briefly the Kuhn chain model.
6. What are the essential properties of a Gaussian chain?
7. What is the probability distribution function for a Gaussian chain (with N Kuhn segments) to have a particular value of the end-to-end distance?
8. Derive the free energy of a Gaussian chain with a given end-to-end distance.
9. Derive an expression for the tensile force required to maintain a particular end-to-end distance for a Gaussian chain?
10. What is excluded volume interaction?
11. How do you modify the answer to Question #8 by accounting for the intrachain excluded volume effect?
12. Derive an expression for the coil radius in a good solvent.
13. Give an experimental methodology, based on scattering studies, to determine the degree of polymerization and the radius of gyration.
14. In general the radius of gyration is proportional to νth-power of the degree of polymerization. Give representative values of ν for different experimental conditions.
15. What is excluded-volume screening?
16. How does the radius of gyration of a flexible polymer depend on molar mass in the melt?
17. What is the Stokes-Einstein law?
18. How does the diffusion coefficient of the center of mass of a polymer coil depend on molar mass in dilute solutions?
19. How does the intrinsic viscosity of an infinitely dilute polymer solution depend on the molar mass of the polymer?
20. Define overlap concentration.
21. What is hydrodynamic screening?
22. How does the diffusion coefficient of the center of mass of a polymer coil depend on molar mass in semidilute solutions where entanglements are negligible?
23. Describe briefly the reptation model of polymer dynamics.
24. How does the diffusion coefficient of the center of mass of a polymer chain depend on molar mass in melts for (a) below the entanglement point, and (b) above the entanglement point?
25. How does the viscosity of an entangled polymer melt depend on the molar mass? Compare the prediction from the reptation theory with experiments.
26. Write down the free energy density of a polymer blend, based on the Flory-Huggins theory.
27. What is the chi parameter in the Flory-Huggins theory, and what is its physical basis?

28. If chi is sufficiently large, phase separation arises. Considering two-component systems, draw typical phase diagrams for (a) small molecular mixtures, (b) polymer solutions, and (c) polymer blends. How is the coexistence curve constructed?
29. Mention a few strategies for compatibilizing two kinds of polymers.
30. What is the difference between macrophase separation and microphase separation?
31. Based on your answer to Question #9, derive a formula for the force required to stretch a rubber uniaxially from the initial dimension (Lo, Lo, Lo) to the final dimension (Lx, Ly, Lz). Assume that there are m elastically effective chains in the rubber and that the rubber is incompressible.
32. When a rubbery network is swollen in a suitable solvent, we get a swollen gel. What are the key quantities that determine the final volume of the gel?
33. Describe qualitatively the glass transition.
34. Describe qualitatively the brittle-to-ductile transition.
35. Describe briefly the phenomenon of crazing.
36. What is the molecular origin of the phenomenon of necking?
37. When polymers are crystallized, thin lamellae form. Why do you think that the lamellar thickness is so small in comparison with the molecular length?
38. Sketch the temperature dependence of the growth rate of a polymer crystal. Discuss the dominant features in this sketch.
39. Under what experimental conditions, do the shish-kebab morphology arise?