General soft matter

1. Discuss the four unifying concepts of soft matter.
2. What is a viscoelastic material? Explain what is meant by shear thinning and shear thickening.

Phase transitions

3. What is the free energy of mixing within the regular solution model?
4. Define the coexistence curve or binodal.
5. Define the spinodal.
6. What is meant by uphill diffusion?
7. Is mixing always energetically favourable in the stable region?
8. In the unstable region, a system is unstable to density fluctuations. What determines the size (length scale) of these fluctuations?
9. Explain differences between homogeneous and heterogeneous nucleation.

Glasses

10. Define a glass and show in a diagram the characteristics of the glass transition.
11. How does the configurational relaxation rate vary in the super cooled regime? Use the terms fragile and strong.
12. Can you give a physical significance to the parameter T_0 in the VFT-equation?

Colloids

13. What is a colloidal dispersion?
14. What is the stokes-Einstein equation?
15. What does a diffusion coefficient tell you?
16. What forces are there on an individual colloidal particle?
17. What forces are there between particles?
18. Discuss way to stabilise a dispersion. How can the interactions be tuned?

Polymers

19. Discuss different architectures for polymers (define atactic, isotactic and syndiotactic arrangements).
20. How can you characterise a polymer without details of the monomer chemistry?
21. What properties makes a polymer a good glass former?
22. What is the end-to-end distance for a polymer with no restrictions (freely jointed chains)? What can you tell about its entropy and internal energy?
23. What is the end to end distance for a real polymer (define a Kuhn segment)?
24. What is the excluded volume effect and how is it explained according to Flory?
25. Explain the coil-globule transition.
26. What is the typical temperature dependence of the Flory interaction parameter χ?
27. Discuss the complex modulus G*.
28. Explain the time-temperature superposition.
29. What are the two main features of the stress relaxation function G(t)? Are there any similarities or differences between same kind of polymers with different degree of polymerisation?
30. Explain the tube model and the theory of reptation.
31. What causes the discrepancy between experiment ($\tau_T \propto N^{3.4}$) and the tube model ($\tau_T \propto N^3$) for the terminal time?
32. Why is there an almost purely elastic behaviour of G(t) for intermediate times?

Gels

33. Explain gel, chemical gel, physical gel, thermosetting gel, sol-gel glasses, vulcanised rubber, weak and strong physical gels.
34. What is the gel fraction?
35. Explain the three concentration regimes in a polymer solution (good solvent).
36. What can one expect about shrinking of coils above c* in good solvents?

Self assembly

37. What is a chain folded lamella?
38. Explain amphiphile and surfactant.
39. What determines optimum head group area of a micelle?
40. What kind of different shapes of aggregates are there and what determines the shape? Can you derive some of the criterions?
41. Why don't polymers generally mix?
42. What happens to a block copolymer with $\chi > 2/N$?