Polymer Section of Chem 3102
The Department of Chemistry, The Faculties
The Australian National University
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Practice Exams

1. Explain the role of rotational isomerisation in determining the molecular structure of a linear polymer such as polyethylene.

2. Linear polymers display viscoelastic behaviour, *i.e.* they are solid and liquid-like at different timescales , and are never found in the gas state. Explain this statement in terms of the molecular properties of the chain and contrast with small molecules.

3. What is the difference between a chemical monomer and a statistical monomer ?

4. What is the meaning of the following equation and how is it used to describe the equilibrium stretching of a polymer chain?

$$P(\mathbf{R}) = \Big(\frac{3}{2\pi N a^2}\Big)^{3/2} \exp\Big(-\frac{3R^2}{2Na^2}\Big)$$

5. How is the Freely Jointed Chain model like the ideal gas model ?

6. Explain why the following statement is wrong: No force is required to compress an ideal chain in an infinite slit whose width is less than the size of the ideal chain.

7. Explain how you derive a force law (force, f, versus end-to-end distance, R) for the stretching of a single chain whose $U = h(1/R)$ (internal energy is a function of $1/R$), with $S = g(R^2)$

8. Explain the Guch-Joule effect.

9. If an ideal gas expands adiabatically, its temperature decreases. What is an analogous statement for an ideal chain?

10. Explain how optical tweezers works to trap a transparent bead of diameter 3 microns.

11. Explain how one would measure the force of stretching a polymer using an AFM.

12. Using pictures and equations, contrast the dimensions of a single chain in good, theta, and poor solvents

13. Contrast the range of applicability of the ideal gas model with the ideal chain model

14. Is it possible to have a REAL chain whose distribution of end to-end distance follows a Gaussian with $\langle \mathbf{R} \rangle = 0$ and $\langle R^2 = \mathbf{R} \cdot \mathbf{R} \rangle \sim Na^2$ (as does the ideal chain). Provide at least one example and explain.

15. How does the simple Flory argument of a solvated chain differ from the ideal chain model?

16. What is a theta solvent?

17. Name the assumptions made in deriving the size of a polymer in good solvent, in theta solvent, and in poor solvent

18. Why is the force of pulling the ends of a single chain constant with extension when the chain is in poor solvent?

19. Explain why chains that are end-tethered to a planar surface, in good solvent, stretch away from the surface.

20. How do you make a polymer brush? How do you make a surface covered with polymer in the "mushroom" regime?

21. Explain why the height of a polymer brush scales linearly with the number of monomers and with $\sigma^{1/3}$ where σ is the grafting density?

22. What is a blob?

23. In a melt, how does the size of a single chain scale with number of monomers in a chain and explain

24. Draw physically valid plots of ΔG^m versus composition (at a specified temperature) for (a) completely immiscible solvent/solute pair, (b) completely miscible solvent/solute pair, and (c) a solvent/solute pair that separates into two homogeneous, mixed phases.

25. As the temperature decreases, which chains precipitate out of a polymer solution first, the shortest or longest chains? Why?