020606 Final Polymer Properties (300 points total)

1) (120) a) (15) Give **an equation** for c*, in terms of R_F and N.

b) (15) For a polymer solution above c*, **list properties** that you know would depend on the molecular weight. **Explain** your answer.

c) (10) For a polymer in a good solvent, **what three thermodynamic regimes** are defined?

c) (30) Describe how the coil size, R_F, is **mathematically described** in terms of the degree of polymerization, N, and the Kuhn step length, l_k, for each of these regimes in a good solvent.

d) (10) **Rank** the coil size in the three regimes for a good solvent.

e) (10) For a theta solvent, **do the same regimes exist**? Why?

f) (30) Describe how the coil size, R_F, is **mathematically described** in terms of the degree of polymerization, N, and the Kuhn step length, l_k, for each regime in a **theta** solvent.

(75) 2) a) (20) For a persistent chain in a deuterated solvent, **sketch the neutron scattering** log intensity versus log q for the 3 regimes of question 1 a) **and** for the regimes of question 1 e). **Be careful** to correctly account for changes in size described in question 1 and for scaling transitions.

b) (15) What is the **temperature and composition dependence of the persistence length** for the persistent chain? **Explain** your answer.

c) (20) For two polymers with Kuhn step lengths of 7 Å and 40 Å and both with molecular weights of 100,000 g/mole, **how do you expect the melt viscosities to differ**? **Explain** your answer.

d) (20) **Would the osmotic pressure** from dilute solutions of these two polymers differ? **Why**?

(105) 3) a) (15) Give the **spring constant** expected for a single polymer chain from rubber elasticity.

b) (20) For a bulk rubber under tensile loading, how does the **tensile modulus** relate to the spring constant for a single chain?

c) (20) For a bulk rubber subjected to shear loading, how does the **shear modulus** relate to the spring constant for a single chain?

d) (30) **Comment on the following**:

An end linked polymer melt was seen to display non-linear elasticity at moderate strains in tensile measurements. Additionally, the same polymer melt, when not end linked displayed a large coefficient for the second normal stress difference, i.e. when extruded the melt stream expanded normal to the shear direction. These are taken as support for a high degree of orientation of polymer chains under moderate deformation and could be used to calculate a change in entropy of the coils associated with deformation using the orientation function.

e) (20) Explain the difference between the **Rouse model and the dumb bell model in a sketch of the models and by writing the Langevin equations given in class**.
Why is it often said that the Rouse model can be approximated by a simple dumb bell model?