

Chapter 1 Homework: Introduction

Available points: 50

**1. Define the following terms (6 points)**

- a. Polymer
- b. Oligomer
- c. Copolymer
- d. Polydispersity Index
- e. Thermoplastic
- f. Thermoset

**2. Briefly explain the most significant similarity between dendrimer and star polymer structures. Draw a schematic diagram of both structures. (3 points)**

**3. True or False. Correct the false statements. (12 points)**

- a. \_\_\_ Herman Staudinger originally studied the hydrogenation of benzene.
- b. \_\_\_ Crystalline polymers can melt when heated.
- c. \_\_\_ Staudinger faced difficulty convincing fellow scientists because he used colligative property measurements, which are only useful for large molecular weight polymers.
- d. \_\_\_ A random copolymer is a copolymer of W and Z monomers that shows an average property of homopolymer W and homopolymer Z.
- e. \_\_\_ When cooling a semicrystalline polymer from the melt, it will typically have a much higher degree of crystallinity if it is quenched (rapidly cooled).
- f. \_\_\_ Common examples of thermosets are phenolic resin and epoxy resin.

- g. \_\_\_\_ A thermoplastic polymer will soften and liquefy at a high temperature and a thermoset is permanently solid.
  - h. \_\_\_\_ Atactic and Isotactic polymers tend to be crystalline, while syndiotactic polymers tend to be amorphous.
  - i. \_\_\_\_ Monosubstituted monomers prefer Head-to-Tail sequence isomerization.
  - j. \_\_\_\_ Polymer morphology models include Fringe-Micelle Model, Chain-folded Model, and Spherulite Model.
  - k. \_\_\_\_ Additives are added to polymer products to improve polymer properties including processability, weather resistance, and recyclability.
  - l. \_\_\_\_ Dynamic bonds break when exposed to elevated temperatures and reform upon cooling.
4. **Suppose that a protein sample consists of 45% of molecules of MW = 10,000, 15% of molecules of MW = 14,000, and 40% of molecules of MW = 32,000. What is the z-average molecular weight ( $M_z$ ) and the PDI? Show your work for full credit. (6 points)**

**5. Draw the polymer structures of the following polymers. (2 points)**

a. Poly(ethylene terephthalate)

b. Polycarbonate

**6. Classify the following as a Thermoset, Thermoplastic, or Elastomer and give one example of an application of that polymer (5 points)**

a. \_\_\_\_\_ Polystyrene

i. Ex: \_\_\_\_\_

b. \_\_\_\_\_ ABS Resin

i. Ex: \_\_\_\_\_

c. \_\_\_\_\_ Benzoxazine Resin

i. Ex: \_\_\_\_\_

d. \_\_\_\_\_ Silicone Rubber

i. Ex: \_\_\_\_\_

e. \_\_\_\_\_ Poly(methylmethacrylate)

i. Ex: \_\_\_\_\_

**7. LC polymers can be differentiated in 3 different ways. Explain/describe/draw the following (6 points)**

a. Main-chain LC vs Side-chain LC

b. Viscosity of polymer in LC state vs isotropic state. Why is the viscosity different?

- c. Thermotropic vs Lyotropic polymer

**8. List and describe two principles of green chemistry (4 points)**

Multiple Choice. Circle the correct answer. (2 points)

**9. Which of the following is NOT a copolymer structure?**

- A. Alternating
- B. Block
- C. Branched
- D. Graft
- E. Random

**10. Which of the following is a type of isomer?**

- A. Structural
- B. Sequence
- C. Geometric
- D. All of the above

**11. Correct the statement. If a statement is true, write “True”. (4 points)**

- a. The fringed micelle model is the model to describe the molecular arrangement of a semicrystalline polymer. In this model, well-aligned molecular chains are forming local order representing the crystalline portion of the polymer. Connecting the crystalline portion of the polymer with more randomly coiled molecular chains is the amorphous portion of the polymer. The degree of crystallinity is the fraction of the crystalline portion of the polymer.

- b. At the Goodyear factory in Akron, I want to produce car tires. After completely polymerizing the polybutadiene, I am left with a sturdy hoop. The tire was heated above the glass transition temperature of the butadiene, which was 170 deg K. The polymer softened and eventually melted/flowed around 220 deg K. Therefore, the tire should only be used below the glass transition temperature.