Introduction Chapter:

True or false.

1. Hermann Staudinger is regarded as the father of polymer science for his discovery of the concept of the polymer. Initially he had great difficulty in convincing fellow scientists because he used colligative properties to demonstrate the constancy of molecular weight before and after the chemical modification of a polymer called polyindene. Unfortunately, colligative property measurements were useful only for large molecular weight polymers, but of limited value for small oligomers. This is the reason why he faced difficulty in proving the concept.

2. Fringe micelle model is the model to describe the molecular weight 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 a more randomly coiled molecular chain, which is the amorphous portion. The degree of crystallinity is the fraction of the crystalline portion of the polymer.

3. Polydispersity Index (PDI) is the measure of the breadth of disturbance of the molecular weights in a polymer and is defined as the number average molecular weight divided by the weight average molecular weight. A monodisperse polymer is one with PDI = 1. No polymer is able to achieve precisely PDI = 1.

4. Head-to-head sequence isomers are more favorable than head-to-tail sequence isomers because there is less steric hindrance in the head-to-head sequence.

5. Crystalline polymers melt and amorphous polymers liquify.

Multiple choice. Choose the correct option.

6. Which of the following statements is true?
    a. Isotactic and syndiotactic polymers tend to be amorphous
    b. Atactic and syndiotactic polymers tend to be amorphous
    c. Syndiotactic and isotactic polymers tend to be crystalline
    d. Atactic and isotactic polymers tend to be crystalline
7. Please select the answer which most correlates to an X-Y diblock polymer.
    a. Polymer that shows an average property of both homopolymers.
    b. Polymer that shows properties of both homopolymer X and homopolymer Y. This polymer can be used to make two immiscible polymers of X and Y.

    c. Polymer that shows a property of a homopolymer with chemical repeat units XY.
    d. Polymer that shows properties of only one homopolymer when combined.
8. Which of the following measurement methods does not determine absolute molecular weight?
    a. Chromatography
    b. Light scattering
    c. Osmotic pressure
    d. Boiling point elevation
9. Which macromolecular structure exhibits cross-linking?
    a. Branched
    b. Star
    c. Network
    d. Dendrimer
10. Which of the following statements is false?
    a. LC phase by melting is called lyotropic LC polymers and LC phase in solution is called thermotropic LC polymers
    b. LC chromophores can be placed in the main chain or side chain
    c. LC polymers include lower viscosity within the liquid crystal state in comparison to its non-liquid crystalline state
    d. LC orientations include nematic, cholesteric, and smectic
11. Which of the following statements is true?
    a. Thermoplastics will become permanently solid upon heating
    b. Thermosets will become permanently solid upon heating
    c. Thermoplastics consist of cross-linked networks
    d. An example of a thermoplastic is epoxy resin

Polymer Synthesis Chapter:
Choose the correct option

1. Chain transfer:
    a. Reaction between two free radicals
    b. Reaction of free radical and ionic species
    c. Reaction that propagates forever
    d. Reaction where a free radical is handed to the partner molecule and free radical reaction start from this new molecule
    e. Reaction where a free radical transfer in a chain-like manner
2. Trommsdorff-Norrish effect:
    a. It is caused by the unusual increase in the initiator concentration followed by the temperature increase. Thus the rate of polymerization increases.

   b. It is because the molecular mobility increases due to the temperature rises around the gel point and thus the rate of polymerization increases.
   c. It is caused by the immobilization of the polymer free radical due to the increased viscosity while maintaining the mobility of the monomer.
   d. It is the effect due to the lack of chain transfer mechanism, leading to the increased free radical concentration.
3. Backbiting:
   a. Is an example of intermolecular chain transfer
   b. Is an example of intramolecular chain transfer
   c. Only happen in condensation polymerization
   d. Is based on pentagonal stability
   e. Is a great way to spend a Friday night
4. Intermolecular chain transfer
   a. Is a free radical transfer within one polymer chain
   b. The concentration of free radicals does not change
   c. Involves short chain branching
   d. Can be fixed with an inhibitor
5. What happens when the concentration of monomers increases?
   a. The degree of polymerization decreases
   b. The rate of propagation decreases
   c. The number of chain ends increase
   d. The degree of polymerization increases
6. Retarders
   a. Increases the stability of the free radical
   b. Increases the rate of termination
   c. Stop initiation from happening
   d. Consumes the free radicals
7. Carothers equation
   a. The ratio between the two reactants is always greater than one
   b. Is best used for free radical polymerization
   c. The number average molecular weight can easily be determined
   d. The z average molecular weight can easily be determined

Properties of Polymers Chapter:

Choose the correct option

1. Flory-Huggins χ parameter
   a. Calculates the number of molecules in the system
   b. Calculates the kinetic energy of the system

    c. Takes thermodynamic interactions into account
    d. Is determined by the solvent
2. Radius of Gyration
    a. Can be measured by osmotic pressure
    b. Is the average distance from the center of gravity to the chain segment.
    c. Is larger in a poor solvent
    d. Is hard to measure so end-to-end distance is typically used
3. Flory-Huggins equation
    a. Assumes lattice units have equal size and each unit is occupied by the chemical repeat unit
    b. Assumes that the change in volume due to mixing is zero
    c. Calculates the enthalpy of mixing
    d. Assumes the Gibbs free energy of mixing is zero
4. What is the χ parameter for the θ solvent?
    a. 10
    b. 5
    c. .05
    d. .5
5. The T_g of polymer A is 50°C and the T_g of polymer B is 250°C. What is the T_g of a 50/50 weight ratio mixture of both polymers if they are thermodynamically miscible?
    a. 50°C
    b. Between 70°C and 100°C
    c. 150°C
    d. Above 200°C
6. What is the free volume fraction at T_g?
    a. 5
    b. .5
    c. .25
    d. .025
7. Which of the following χ parameters indicates the two polymers are immiscible?
    a. .78
    b. .1
    c. 0
    d. -.2
8. The molecular weight of dependence on the viscosity on a log-log plot above the entanglement molecular weight?
    a. .1
    b. 1
    c. 3.4
    d. .025

9. Material A has a Young's Modulus of 5 GPA and Material B has a Young's Modulus of 10 GPA, which of the following statements are true?
    a. Material A is tougher
    b. Material B is tougher
    c. Material A is stiffer
    d. Material B is stiffer
10. End to end distance
    a. Assumes a fixed bond distance
    b. Each atom is assumed to be a vector
    c. It is difficult to measure
    d. Can be measured by light scattering
11. Mark-Houwink-Sakurada equation
    a. Relates the molecular weight and the internal viscosity
    b. Dictates that viscosity is the function of temperature
    c. Measures the thermal decomposition
    d. Determines if a solution demonstrates LCST behavior
12. Melting Temperature
    a. Is a second-order transition
    b. Is a first-order transition
    c. Happens in amorphous polymers
    d. Is a transition from liquid to gas
13. Glass Transition Temperature
    a. Is a transition from a rubbery to a liquid state
    b. Decreases as the rigidity of a polymer backbone increases
    c. Has a dependence on molecular weight
    d. Is a first-order transition
14. Gordon Taylor equation
    a. Estimate the viscosity of a polymer solution
    b. Calculates the thermal conductivity of a polymer
    c. Assumes that the change in volume due to mixing is 0
    d. Takes the thermal expansion coefficients of both polymers into account.
15. Asymmetric molecules
    a. Tg=1/3Tm
    b. Tg=2/3Tm
    c. Tm=1/2Tg
    d. Tg=1/2Tm
16. Voigt Model
    a. Has a dashpot and spring in parallel
    b. Has a dashpot and spring is series
    c. Measures stress relaxation

    d. Is the 4-element model
17. G''
    a. Is the dynamic storage modulus
    b. Measures the amount of recoverable energy
    c. Is the dynamic loss modulus
    d. Is related to the elastic behavior of a polymer
18. Time Temperature Superposition
    a. Works for all polymers
    b. Is based on a shift factor
    c. Measures long-term properties

Polymer and Polymer Composite Processing Chapter:

Please select the following processing techniques for the following products.

Process techniques:

a. Hand lay-up molding
b. Spray-up molding
c. Compression molding
d. Transfer molding
e. Extrusion
f. Pultrusion
g. Filament Winding
h. Injection molding
i. Reaction injection molding
j. VARTM

Products:

1. Construction helmet (low performance product)
2. Nuclear Submarine (100 m long, 15 m wide)
3. PVC pipe (3 cm diameter, 500 m long)
4. Snowmobile
5. Golf Shaft
6. Jet Fighters Wing (needs to be high strength)
7. Rocket's body (constant cross section)
8. A very small gear used in a miniature, mobile Pokemon toy. Dimensions and precision of the gear is very important as the size of the toy is on the order of a quarter coin.
9. Fishing boat that is 10 m long with great strength to withstand the waves of the rough sea
10. Processing technique for a product requiring a short cycle time

11. A product requiring a closed mold composite that allows the manufacturing of a very large object
12. Processing technique suitable for processing a very intricate shaped object for many thermoplastic polymers
13. Processing techniques that is the most versatile design flexibility for the mold shape of a product using continuous fiber reinforcement

Characterization of Polymers Chapter:

Choose the correct option

1. Dynamic mechanical Analysis (DMA)
    a. Can measure the strength of a solid polymer
    b. It measures viscoelastic properties
    c. The Tan δ peak is the most precise way of determining the T_g of a polymer
    d. You can measure the crosslinking density of a thermoplastic.
2. Fourier transform infrared spectroscopy (FT-IR)
    a. Conne's advantage is also known as the energy throughput advantage
    b. Jacquinot's advantage is also known as the energy throughput advantage
    c. Fellgett's advantage Multiplex advantage
    d. The computer is considered the fourth advantage
3. Differential scanning calorimetry (DSC)
    a. The conversion of a thermosetting polymer, such as epoxy, can be studied
    b. It requires grams of material to operate
    c. It measures the mechanical transitions of a polymer
    d. Crystalline melting shows an endothermic peak whereas T_m shows an exothermic peak

True or false

4. NMR is ideal in determining detailed chemical structure of liquid samples. Using chemical shift concept, one can readily determine the chemical structure of the component in the unknown sample. Despite the fact that each nucleus, such as a proton, has a single Larmar frequency, the surrounding minute difference in electronic environment allows the observed, apparent Larmar frequency to vary slightly, allowing the observation of chemical shift difference for protons in different chemical groups. NMR can also be used to study molecular mobility using relaxation times, such as T_1 and T_2 relaxation.

5. FTIR has three intrinsic advantages, Conne's advantage, Jacquinot's advantage, and the computer. Conne's advantage is a frequency accuracy advantage, Jacquinot's advantage is the energy throughput advantage, and the computer is essential in FT-IR.

6. DSC is a technique to study the thermal transitions of a polymer. It measures the heat required to maintain the same temperature, versus an appropriate reference material that does not undergo transitions in the temperature range being investigated. Every polymer will show a melting point and glass transition temperature indication.

7. DMA can measure the viscoelastic properties of a polymer. It can be used to determine the cross-link density based on the rubber elasticity theory. The region above the T_g is sensitive to the material flow. The G' spectrum of a polymer shows the glassy region, glass transition region, and rubbery region.

8. HPLC works by having a silica gel surface that differentiates between molecules based on their structure. The molecules will interact differently with the gel which causes the separation. This is an example of a purification technique

9. TGA is a technique to determine the Mn, Mw, and Mz of a polymer. It heats the sample up to 800°C and measures the weight as a function of temperature.