2023

CHEMISTRY — HONOURS

Paper : DSE-B-3

(Polymer Chemistry)

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***question no.*** **1** and ***any eight*** questions from the rest.

1. Answer ***any ten*** questions : 1×10

(a) What is the number average molecular weight of a polymer formed from equimolar mixture of adipic acid and ethylene glycol at a conversion rate of 99.5%?

(b) Write down the magnitude of four different average molecular weights $\overline{M_n}$, $\bar{M}_w$, $\bar{M}_v$ and $\bar{M}_z$ in increasing order.

(c) Which molecular weight determination method should be used to determine the *z*-average molecular weight ($\bar{M}_z$)?

(d) Which of the following is the correct unit of viscosity of a polymer?

(i) Pa·s (ii) Pa/s

(iii) Pa/s^2 (iv) Pa/s^3

(e) Which monomer is used in the synthesis of poly (vinyl alcohol)? Write down the corresponding reaction.

(f) What is the solubility parameter of a polymer having cohesive energy density (E_{coh}) 43870 $Jmol^{-1}$ and molar volume (V) 136 cm^3 mol^{-1}?

(g) What is the difference between an alternating copolymer and a block polymer?

(h) What is the functionality of 1, 4-divinyl benzene in reactions involving addition across carbon-carbon double bond?

(i) Give an example of the following polymers :

(i) Cyclic Polymer

(ii) Linear Polymer.

(j) What are the good solvents and poor solvents for a polymer?

(k) What is conducting polymer? Give one example.

(l) Which polymer is formed by the polymerization of ω-amino caproic acid using water as catalyst?

2. (a) Define degree of crystallinity of a polymer. Derive an equation relating the degree of crystallinity of a semi-crystalline polymer to the sample density and densities of the crystalline and amorphous components.

   (b) Calculate the entropy of mixing, when equal amount (100 gm) of toluene and polystyrene of molecular weights 92.14 gm mol^{-1} and 1.2×10^5 g mol^{-1} respectively are mixed to form a polymer solution. 3+2

3. (a) Discuss various types of van der Waals interactions among polymer molecules.

   (b) Write down the overall scheme for free radical polymerization and hence show that the rate of polymerization depend directly on the monomer concentration and on the square root of the rate of initiation. 2+3

4. (a) How can you prepare phenol-formaldehyde resins? Write down all necessary chemical reactions.

   (b) Two miscible polymers A and B are blended in weight ratio 30 : 70. If the glass transition temperature (T_g) of the polymer A is $-50^{\circ}C$ and that of polymer B is $100^{\circ}C$, then find the T_g of the blend. 2+3

5. Write short notes on : 2½×2

   (a) Coordination polymerization

   (b) Emulsion polymerization.

6. Explain the relationship among the following properties regarding the structure of the polymer : 5

   (a) Solubility

   (b) Crystallinity

   (c) Glass transition temperature.

7. (a) Write down the difference between chain growth and step growth polymerization.

   (b) Compare termination mechanisms in cationic and free radical polymerization based on kinetics. 2+3

8. Derive the following expressions for the entropy of mixing of a polymer solution when n_2 moles of polymer is added to n_1 moles of a solvent, using Flory-Huggins Model :

$$\Delta S_{mix} = -R\left[n_1 ln\Phi_1 + n_2 ln\Phi_2\right],$$

   where Φ_1 and Φ_2 are the volume fractions of the solvent and polymer respectively. 5

9. (a) How can you classify polymers on the basis of their (i) Thermal response, (ii) Tacticity?

   (b) If a polymer sample contains an equal number of moles of species with degree of polymerization $n = 1, 2, 3, 4, 5, 6, 7, 8, 9$ and 10, what are the number average and weight average degree of polymerization? 2+3

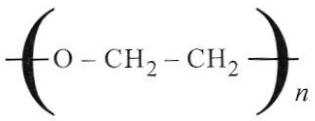
10. (a) How can you determine the molecular weight of a polymer from the Viscosity measurement?

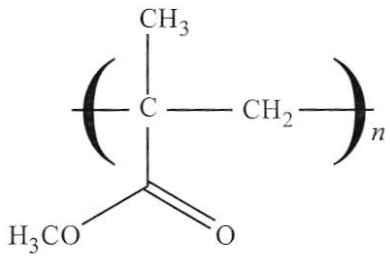
(b) Why most of polymers exhibit LCST rather UCST behaviour at low temperature? 3+2

11. Name a polymer which is used in construction. Discuss about its preparation, properties and application. 5

12. (a) What is the polydispersity index of a polymer sample containing 200 molecules each of molecular weight 10,000 $gmol^{-1}$, 300 molecules each of molecular weight 30,000 $gmol^{-1}$ and 500 molecules each of molecular weight 50,000 $gmol^{-1}$?

(b) Write down the IUPAC nomenclature of the following polymers :

(i) 

(ii) 

3+2

13. Derive the following relation for the polyesterification of a di-acid and a di-ol, assuming step polymerization.

$$\frac{1}{(1-p)^2} = 2C_0^2 kt + 1$$

(where p is the extent of reaction and C_0 is the initial concentration of the di-acid and di-ol). 5