WEST BENGAL STATE UNIVERSITY

B.Sc. Honours 6th Semester Examination, 2023

CEMADSE06T-CHEMISTRY (DSE3/4)

POLYMER CHEMISTRY

Time Allotted: 2 Hours | Full Marks: 40

The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.

Answer any *three* questions taking *one* from each group

GROUP-A

(Unit 1, 2 and 3)

1. (a) Briefly outline how the polymers are classified based on (i) thermal response and (ii) crystallinity. 3

   (b) A statistical copolymer formed from addition polymerization of acrylamide (71 gm/mol) and methyl methacrylate (100 gm/mol) has a molar mass of 11,955 gm/mol with degree of polymerization of 150. What is the molar fraction of acrylamide? 3

   (c) Derive an expression for the rate of propagation for chain growth polymerization in terms of monomer and initiator concentration. 4

   (d) Derive an expression for p (extent of reaction) for a system with a functionality f and show that when average degree of polymerization (D_p) goes to infinity $p = 2/f$. 3

2. (a) Describe with suitable example the isotactic, syndiotactic and atactic sequence of a polymer. 3

   (b) You would like to make a polyester with number average molecular weight ($\overline{M}_n$)= 5000 gm/mole by reacting 1 mol butane-1,4 diol and 1 mol of adipic acid. At what value of p should you stop your reaction to obtain this size? 3

   (c) Define thermoplasts and thermosets polymer with examples. 2

   (d) Show that molecular weight of polymer synthesized by cationic polymerization process is independent of the concentration of the initiator. 4

   (e) What is monomer reactivity ratio for copolymerisation? 1

GROUP-B

(Unit 4, 5, 6 and 7)

3. (a) What is a spherulite? 2

   (b) How does XRD pattern of amorphous and crystalline polymers look like? 2

   (c) What are optically active polymers? Write two applications of it. 1+1

(d) Define specific and intrinsic viscosity. Using Mark-Houwink equation for the intrinsic viscosity, $[\eta] = kM^a$, show that viscosity average molar mass of a polymer is $M_v = \left(\frac{\sum_i N_i M_i^{1+a}}{\sum_i N_i M_i}\right)^{1/a}$. 2+3

(e) Why Nylon makes good fibres? Natural rubber and Gutta percha both are naturally occurring polyisoprene but rubber is flexible and Gutta percha is hard. Explain. 3

4. (a) Define crystalline melting temperature (T_m) and glass transition temperature (T_g) of a polymer. What is factor(s) affecting glass transition temperature of polymers? 2+2

(b) Draw the 'Molecular Weight Distribution (MWD)' curve of polymers. What is its significance? 2

(c) Explain the free volume theory in connection with the glass transition temperature of a polymer. Write down the WLF equation explaining the terms involved. 2+2

(d) Calculate the number-average and mass-average molar masses of a polymer sample with the following distribution of molar masses: 4

Ni ⟶	100	250	400	300	200	100
Mi/kg mol^{-1} ⟶	2.0	3.0	5.0	7.0	10.0	15.0

Also, calculate polydispersity index.

What average molar mass would be obtained from measurement of (i) osmotic pressure (ii) light scattering.

GROUP-C

(Unit 8 and 9)

5. (a) The entropy change of mixing of two components (1 and 2) is given by 2+2

$$\Delta S_m = -k(x_1 \ln x_1 + x_2 \ln x_2)$$

where the terms have their usual significance. How is this equation modified for polymers in the Flory-Huggins equation? Give the mathematical forms of volume fractions.

(b) Explain the conditions for the polymer to be soluble in a particular solvent. 2

(c) Give the preparation, structure, properties and uses of the following polymers: $3\frac{1}{2} \times 2 = 7$

(i) High density polyethylene (HDPE)

(ii) Nylon 6.

6. (a) What do you mean by Hildebrand solubility parameter (δ)? Styrene-butadiene copolymer (δ = 16.5) is insoluble in pentane (δ = 14.5) and ethyl acetate (δ = 18.5), but soluble in a 1:1 mixture of the two — Explain. 2+2

(b) Justify that solubility parameter is of dimension of Pascal$^{1/2}$. 2

(c) Give two examples of conducting polymer with structure. How does a conducting polymer conduct electricity? 3

(d) Give the most important applications of the following polymers: 2

(i) Styrene Butadiene Rubber (SBR) (ii) Polyvinylchloride (PVC)

(iii) Poly (methyl methacrylate) (PMMA) (iv) Polycarbonate (PC)

(e) Differentiate between Novolac resin and Bakelite. 2

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