



The Open University of Sri Lanka

B Sc Degree/ Stand Alone courses in Science – Level 5

Final Examination – 2006/2007

CHU 3238/CHE 5238 – Polymer Chemistry – Paper II

Duration : 3 hours

Date : Saturday 28th April 2007

Time : 1.30 pm – 4.30 pm

Gas Constant (R)	=	8.314 J K ⁻¹ mol ⁻¹
Avogadro Constant (L)	=	6.023 x 10 ²³ mol ⁻¹
Planck Constant (h)	=	6.63 x 10 ⁻³⁴ Js
Velocity of light (C)	=	3.0 x 10 ⁸ ms ⁻¹
Atmospheric Pressure (π)	=	10 ⁵ Pa (Nm ⁻²)
Faraday constant (F)	=	96,500 C mol ⁻¹
Log _e (X)	=	2.303 log ₁₀ (X)

Instructions to candidates:

Answer any **four questions** out of six.

If more than four questions are answered **only the first four answers** will be marked.

The use of a **non-programmable** calculator is permitted.

- 1.(a) Write chemical equations for the major steps in polymerization of Styrene by free radical and cationic initiators.
- (b) What are the major differences of the above two and which method results high molar mass?
- (c) (i) What are the products formed when maleic anhydride react with glycol
(ii) If the above polymer is dissolved in Styrene and allowed to react with Benzoyl peroxide what is the structure of the final polymer formed?
Comment on the final product on the following;
- solubility
 - can it be recycled
- (iii) What would be the end product if this is heated to a high temperature for an hour.
2. (a) Describe how accelerators increase the rate of vulcanization reaction in the presence of ZnO and Stearic acid (reaction mechanism is not necessary)
- (b) (i) Explain what do you mean by the ceiling temperature of a polymer
(ii) Mention one of its application.
- (c) It is observed that styrene-butadiene co-polymer ($\delta = 16.5$) is insoluble in pentane ($\delta = 14.5$) and ethyl acetate ($\delta = 18.6$), but soluble in a 1:1 mixture of the two solvents. Explain.
- (d) Define ideal solution and show why polymer solution can never be ideal at extreme dilution.
3. (a) Write down the structure of the polymers formed when, a monomer
(i) of two reactive sites is polymerized,
(ii) with three or more reaction sites is polymerized,
with suitable reagents. Give one example for the above two.
- (b) Comment on the differences between above two polymers with respect to,
(i) solubility,
(ii) heat resistivity,
(iii) chemical resistivity
- (c) If the molar mass of the block co-polymers $(\text{CH}_2-\text{CH}_2)_n (\text{CH}_2-\text{CH}(\text{C}_6\text{H}_5))_m$ is 1.840 kg/mol and n and m ratio is 2:3 what is the value of n and m?

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4. (a) Small amount of the monomer terephthalic acid ($\text{HOOC-C}_6\text{H}_5\text{-COOH}$) is added during polymerization of nylon 6,6. Give reasons for the above.
- (b) Explain why polymerization of monomers by free radical initiator are carried out under inert gas atmosphere.
- (c) List the common preservatives used in latex industry.
- (d) Give reasons for the differences between synthetic isoprene rubber and natural rubber.
- (e) Write down the key steps involved in the oxidation of polypropylene by O_2 .
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5. (a) The weight fraction of four molecules of molar masses 10, 20, 30 and 40 kg/mol are in the ratio 0.2, 0.3 and 0.4. Calculate the number average molar mass \overline{M}_n and weight average molar mass \overline{M}_w .
- (b) Comment on the shape of the molar mass distribution curve and its physical properties.
- (c) Suggest without detail one method which can be used to determine \overline{M}_n , \overline{M}_w and \overline{M}_v . Give reasons for your suggestions.
- (d) Write down the assumptions used in the derivation of kinetic chain length of a polymer by free radical polymerization (derivation of mathematical expression are not required).
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6. (a) Explain the effect of the functional group X of the polymer $-\text{CH}_2-\underset{\text{X}}{\text{CH}}-$ on
- Glass transition temperature T_g
 - Melting temperature T_m
- (b) (i) Explain briefly how you convert amorphous to crystalline polyethylene and vice versa.
(ii) List the main differences of crystalline and amorphous polyethylene.
- (c) (i) Draw the structure of cis and trans polybutadiene.
(ii) Compare the elasticity, hardness and solubility of these two polymers.
- (d) Arrange the following monomers in the order of increasing T_g .
Polypropylene, polyvinyl alcohol, polystyrene
Give reasons for your answer.