Index No: 00276

The Open University of Sri Lanka

Faculty of Natural Sciences

B.Sc. Degree Programme

Department	: Chemistry
Name of the Examination	: Final Examination
Course Code and Title	: CYU5313 Polymer Chemistry
Academic Year	: 2024/2025
Date	: 24th November 2024 (Sunday)
Time	: 1.30 p.m. – 3.30 p.m.
Duration	: 2 hours

General Instructions

1. Read all the instructions carefully before answering the questions.
2. This question paper consists of 4 essay questions in 5 pages. Answer all the questions.
3. Write down all the answers in the separate answer script.
4. Nonprogrammable calculators are permitted.
5. Having any unauthorized materials/mobile phones in your possession is a punishable offense.
6. Clearly state your index number on all the pages of your answer script.

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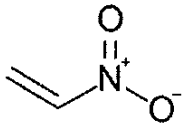
01). (i) (a) The number average molar mass of a particular polybutene sample made of 2 – Butene monomer was found to be 16,800 g mol^{-1}. What is the degree of polymerization in this material? (C-12, H-1) **(15 marks)**

(b) Theoretically a monomer can be polymerized if it contains two or more reactive sites. Even though phenol is a well-known monomer, it contains only one functional group in its structure. Scientifically explain this contradiction. **(15 marks)**

(ii) (a) Monomers which contain inhibitors should be removed before polymerization. Name one possible way of supressing the activity of inhibitors from monomers. **(5 marks)**

(b) Why it is important to conduct free radical polymerization reactions under inert atmosphere? **(10 marks)**

(iii) Nitroethylene undergoes anionic polymerisation but not cationic polymerisation. Scientifically explain this statement. The stricture of nitroethylene is given below. **(15 marks)**



(iv) PET - Poly (ethylene terephthalate) is a widely used commercial polymer. Write down the overall chemical reaction to show the synthesis of PET. **(15 marks)**

(v) Compare 4 differences between chain polymerization and step-growth polymerization processes. **(5 marks)**

(vi) Briefly explain the following two mechanisms of Ziegler-Natta catalyst. **(20 marks)**

(a) Bimetallic mechanism

(b) Monometallic mechanism

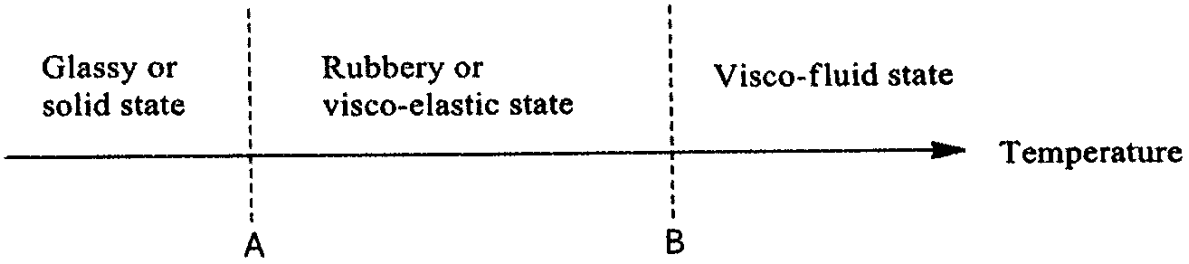
02). (i) Illustrate the chemical structures of four different types of copolymers separately using the monomers "A" and "B" as general examples and name them clearly to state the relevant type of copolymer against each of your illustration. **(10 marks)**

(ii) Compare three differences in physiochemical properties of low-density polyethylene and high-density polyethylene. **(10 marks)**

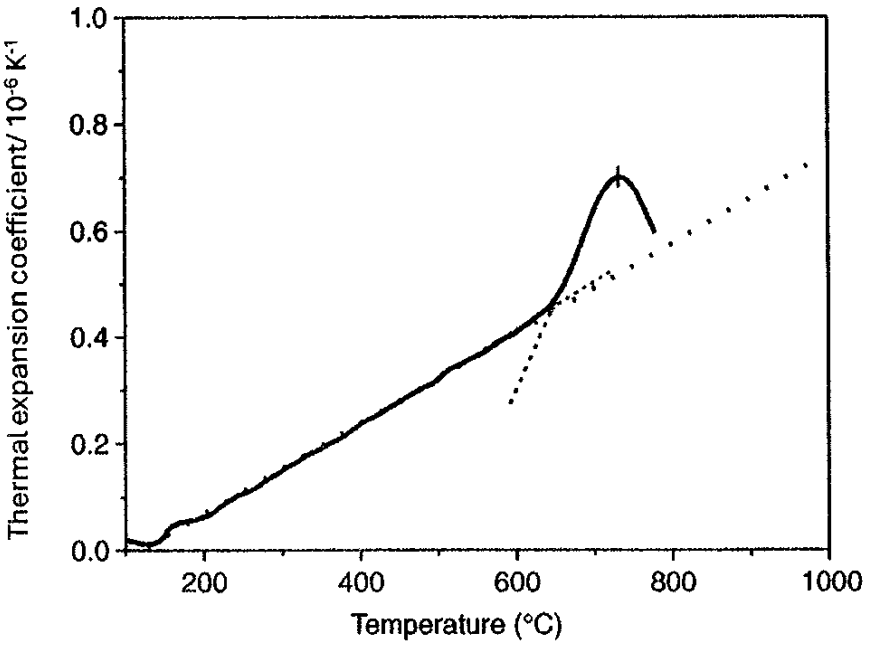
(iii) Name the three types of tacticity that have been defined in polymer chemistry. Comment about the crystallinity and stereoregularity of each of these three types? **(15 marks)**

(iv) Using necessary chemical structures explain the all-possible isomers that can be generated from isoprene (2-Methyl-1,3-butadiene) during its polymerization reaction? Out of all isomers which one will have the highest elongation properties? **(25 marks)**

(v) Correctly identify and name the two important polymer thermal transitions "A" and "B" given in the following diagram. **(5 marks)**



(vi) The changes of thermal expansion coefficient value of a particular polymer sample at different temperatures have been shown in the following figure with respect to a particular study.



(a) What is the glass transition temperature of this polymer? **(5 marks)**
(b) If this is a symmetrical polymer, then what will be the melting point of this polymer? **(10 marks)**

(vii) Consider the given pairs of polymers separately. Within the each pair, which one will have the highest glass transition temperature value? Justify your answer.

(a) Polystyrene and poly-p-phenylene
(b) Polypropylene (PP) and poly(vinyl alcohol) (PVA) **(20 marks)**

03). (i) The end group analysis is a widely used analytical technique in determining the molar mass of a polymer.

(a) Briefly explain the end group analysis technique. **(15 marks)**

(b) Can this technique be used to analyze the molar mass of polyethylene? Justify your answer. **(10 marks)**

(c) At the end group analysis, a polyester sample of 0.9510 g was neutralized by 6.00 cm^3 of 0.1 M KOH solution. Calculate the number average molar mass of this given polyester sample. Here the polymer has been dissolved in a suitable solvent and then titrated against a known concentration of alcoholic potassium hydroxide solution using phenolphthalein as the indicator. This polyester type has one terminal carboxylic group in each molecule. **(15 marks)**

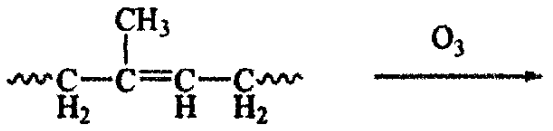
(ii) Three different mass fractions were separated from a sample (A) of polyethylene using the Gel permeation chromatographic technique. The mass distribution of the polymer is summarized in the following table. Assume there are no any other polymer molecules present in this mixture.

Mass fraction	Number of moles	Molar mass of the fraction/ g mol^{-1}
X	500	3.00×10^3
Y	300	1.00×10^3
Z	400	2.00×10^3

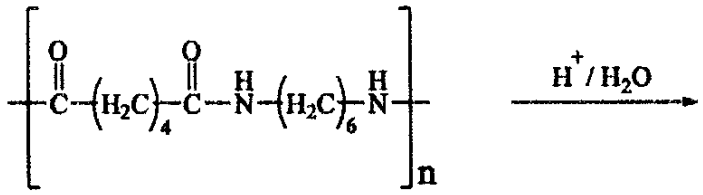
(a) Calculate the number average molar mass of the sample. **(20 marks)**
(b) Calculate the weight average molar mass of the sample. **(20 marks)**
(c) Calculate the polydispersity factor. **(10 marks)**
(d) The poly dispersity factor of another polyethylene sample (B) was found to be 2.31. Out of the two samples A and B which sample will have a broader molar mass distribution curve? (Sample A is the sample given in part (ii) of question number 03. **(10 marks)**

04). (i) Complete the following chemical reactions. **(30 marks)**

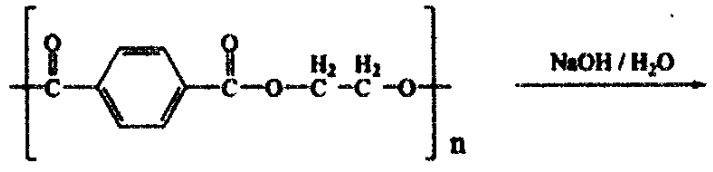
(a)



(b)



(c)



(ii) (a) What is vulcanization? **(10 marks)**
(b) Name the main ingredients of a conventional rubber vulcanization recipe and list down the function of each of the given ingredients. **(10 marks)**

(iii) (a) Compare four differences between thermoplastics and thermosets. **(10 marks)**

(b) Write down one example for each of the given plastic types. Draw the chemical structure of the corresponding monomers of your given examples. **(10 marks)**

1. Amino plastics -
2. Vinyl plastics -
3. Fluoroplastics –

(iv) Briefly explain the following processes/topics. **(30 marks)**

(a) Storage Hardening
(b) Latex coagulation
(c) Yellowing of natural rubber sheets and preventing actions

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