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	: 2023/2024
Date	: 2023.10.26
Time	: 1.30 p.m. – 3.30 p.m.
Duration	: 2 hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 4 essay questions in 3 pages. **Answer all questions.**
3. Answering of each essay question should commence from a new page.
4. Non programmable calculators are permitted.
5. Having any unauthorized documents/ mobile phones in your possession is a punishable offense.
6. Use a blue or black color pen to answer the questions.
7. Clearly state your index number on all the pages of your answer script.

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01). (i) (a) Name two commercially available examples each for free radical, cationic and anionic initiator.

(b) Write down the initiation step for free radical, cationic and anionic initiation separately for CH_2=$CHCH_3$ using one of the initiators mentioned in (i) (a).

(15 marks)

(ii) "There are four main ways of termination in **free radical** polymerization". Name and explain three of them with examples. (15 marks)

(iii) (a) What are copolymers? By giving an example for each, explain different types of copolymers.

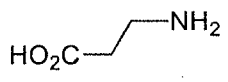
(b) State an advantage of using copolymers? (15 marks)

(iv) Briefly explain the "bulk polymerization". List two advantages and two disadvantages of bulk polymerization. (15 marks)

(v) Draw the **structures** of the polymers synthesised from following monomers.

(i) 2-Methyl-1,3-butadiene

(ii)  + ethylene glycohol

(iii) 

(iv) PhOH + large excess of HCHO

(32 marks)

(vi) Average molar mass of polyisoprene is 20,400 g/mol.
Calculate the average degree of polymerization of this polymer. (08 marks)

02).

(i) Explain the difference between homopolymers and heteropolymers? Give one example for each of these types. (10 marks)

(ii) State whether the following polymers can show optical isomerism? (5 marks)
(a) Polymer I - $[CH_2CH_2]_n$ (b) Polymer II - $[CH_2CHR]_n$ (c) Polymer III - $[CH_2CR`R]_n$

(iii) Name the three types of tacticity that have been defined in polymer chemistry. State the crystallizability of each of these three types? (10 marks)

(iv) Draw the chemical structures and explain **all possible** isomers that can be generated during the polymerization of 1,3-butadiene considering both 1,2 / 3,4 and 1,4 additions separately. Comment on their isomer types. (30 marks)

(v) What is glass transition temperature? (5 marks)

(vi) The glass transition temperature of a newly synthesized symmetrical semi-crystalline polymer has been found as 503 K. Find the melting point of this polymer.

(10 marks)

(vii) Classify the following polymers as thermoplastic and thermoset. State four differences of thermoplastics and thermosets? (10 marks)
Polystyrene, Bakelite, Polyesters, Melamine formaldehyde, PVC, Nylon.

(viii) Which of the following polymers have the highest glass transition temperature value out of the given pair of polymers. Explain the reason for the difference in glass transition temperatures in each of the given pairs separately.
(a) Polypropylene and poly(vinyl biphenyl).
(b) Polyethylene and poly(hex-1-ene)
(c) Polypropylene (PP) and poly(vinyl alcohol) (PVA)
(d) Polyethylene and cellulose nitrate (20 marks)

03). (i) Briefly explain the following techniques in relation to the determination of polymer molar masses.

(a) Gel permeation chromatography (GPC)
(b) End group analysis (20 marks)

(ii) Calculate the number average molar mass of a polyester sample of 0.8734 g which is neutralized by 5.10 cm^3 of 0.1242 mol dm^{-3} of alcoholic KOH solution. (30 marks)

(iii) Three different mass fractions were separated from a sample 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 in g mol^{-1}
A	300	3.00×10^2
B	100	1.00×10^2
C	200	2.00×10^2

(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)

04). (i) Write down the chemical reaction to indicate the hydrogenation of styrene-butadiene rubber? (15 marks)

(ii) Write down the chemical reaction to indicate the formation of chlorinated rubber from natural rubber. (20 marks)

(iii) List down the four main chemical ingredients used in conventional rubber vulcanization process that is widely used in the tire manufacturing industry. State the functions of these chemicals separately. (20 marks)

(iv) In a particular rubber vulcanization batch, 68 parts of natural rubber has been mixed with 32 parts of sulphur mistakenly. What do you expect as the product of this batch? Explain your answer. (10 marks)

(v) Write down the possible degradation products that can be formed in natural rubber due to ozone. How can this effect be minimized? (20 marks)

(vi) Write down two properties that you expect from a latex preservative? Give two examples of latex preservatives. (15 marks)