The Open University of Sri Lanka
Faculty of Natural Sciences- Department of Chemistry
B.Sc. Degree Programme – Level 05
Final examination- Semester I – 2021/2022
CYU5313 – Polymer Chemistry

2nd November, 2022 (Wednesday) **1.30 pm – 3.30 pm**

This question paper consists of 4 essay type questions in 4 pages. Answer all the questions.

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01).

(i) In a hypothetical study it was found that, 300 molecules of 2-butene were linked together to form a polybutene molecule. Find the molecular mass of this polybutene.
(Atomic masses of C=12, H=1) (10 marks)

(ii) Give the names of two common free radical initiators. (5 marks)

(iii) "The propagation of radical polymerization reaction is exothermic."
Scientifically explain the statement. (15 marks)

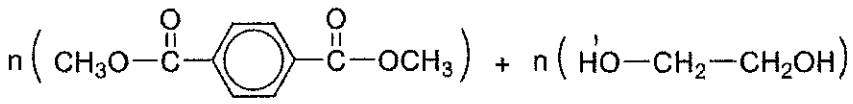
(iv) Termination is the last step of a polymerization reaction. Name two possible ways a termination can happen in a polymerization reaction mixture. (5 marks)

(v) Anionic and cationic polymerization are two important polymer synthesis techniques.
Which of these techniques can be used to polymerize acrylonitrile?
Explain why a cationic or anionic initiator can specifically attack this monomer?
The molecular structure of acrylonitrile is shown below. (15 marks)

$CH_2{=}CH{\cdot}C{\equiv}N$

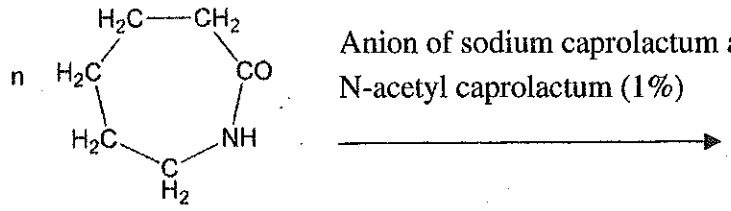
(vi) Write down the balanced chemical equations for the following polymerization reactions?

(a)



(15 marks)

(b)



(15 marks)

(vii) Answer part **(a)** and **(b)** below.
(a) Name four types of copolymers. (5 marks)
(b) SBR (styrene butadiene rubber) is a well-known example of a copolymer. Write down the polymerization reaction of SBR starting from the corresponding monomers. (15 marks)

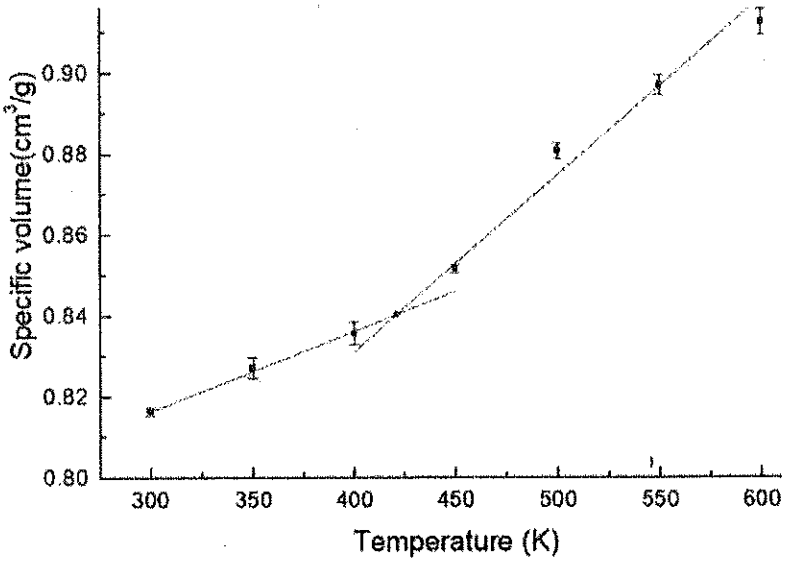
02).

(i) Name the three types of tacticity that have been defined in polymer chemistry. Which of these types can be used to produce stereoregular polymers? (5 marks)

(ii) Draw the chemical structures and explain **all possible** isomers that can be generated during the polymerization of 1,3-butadiene. (25 marks)

(iii) Define the following terms.
(a) Glass transition temperature (T_g)
(b) Flow temperature (T_f) (10 marks)

(iv) The changes of specific volume of a polymer sample at different temperature values were recorded in a particular study using the dilatometer. The corresponding results have been shown in the following graph.
(a) What is the glass transition temperature of this particular polymer? (5 marks)
(b) If this is a symmetrical polymer, then what will be the melting point of this polymer? (10 marks)



(v) Compare the differences of thermoplastics and thermosets? (10 marks)

(vi) High-density polyethylene (HDPE) has a higher density than low density polyethylene (LDPE). Explain the density difference using the microstructures of HDPE and LDPE. (15 marks)

(vii) **(a)** What is **internal** plasticization?
(b) What is the main purpose of adding **external** plasticizers in the industry? (10 marks)

(viii) Explain the reason for the difference in glass transition temperatures of polyethylene (188K) and poly(vinylbiphenyl) (418K). (10 marks)

03). **(i)** Briefly explain the following techniques in relation to the determination of polymer molar masses.
(a) Size-exclusion chromatography
(b) Osmometry method (20 marks)

(ii) Calculate the molar mass of a polyester sample of 1.6782 g which is neutralized by 6.20 cm^3 of 0.1611 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/ g mol^{-1}
1	100	1.00×10^5
2	200	2.00×10^5
3	300	3.00×10^5

(a) Calculate the number average molar mass of the sample. ($\bar{M}n$) (20 marks)
(b) Calculate the weight average molar mass of the sample. ($\bar{M}w$) (20 marks)
(c) Calculate the polydispersity factor. (10 marks)

04). **(i)** Write down the IUPAC name of the monomer of natural rubber? Draw the chemical structure of natural rubber showing its correct geometric isomeric form. (20 marks)

(ii) Briefly explain the latex coagulation process. (20 marks)

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

(iv) This question is about the dry rubber content (DRC) of latex.
(a) What is the DRC of freshly tapped field latex?
(b) What is the DRC of industrial latex after increasing the concentration?
(c) Name three common methods that are used in the industry to increase the DRC of field latex? (15 marks)

(v) Briefly explain the function of adding following chemicals in the rubber vulcanization formula.
(a) N-cyclohexyl-2-benzothiazolesulfenamide (CBS)
(b) Zinc oxide
(c) Stearic acid (15 marks)

(vi) Briefly explain the oxidative degradation mechanism. What types of chemicals that we can use to minimize oxidative degradation? (15 marks)
