

CHUKA



UNIVERSITY

## UNIVERSITY EXAMINATIONS

FOURTH YEAR EXAMINATION FOR THE AWARD OF DEGREE  
OF BACHELOR OF SCIENCE IN INDUSTRIAL CHEMISTRY

CHIN 432: POLYMER TECHNOLOGY

STREAMS: BSC (INDUSTRIAL CHEM)

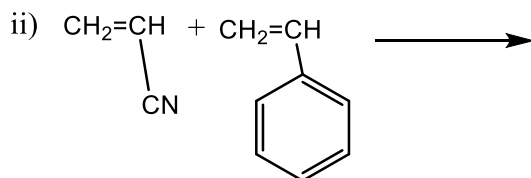
TIME: 2 HOURS

DAY/DATE: WEDNESDAY 15/04/2020

8.30 A.M. – 10.30 A.M.

**INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS****QUESTION ONE (30 MARKS)**

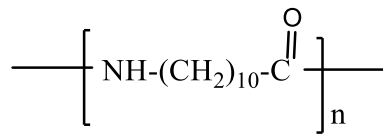
- a) Using an example differentiate between a monomer and a polymer (2 marks)
- b) Explain the following terms briefly:
- Degree of polymerization (2 marks)
  - Oligomers (2 marks)
  - Molecular weight of a polymer (2 marks)
- c) Find the molecular weight of polypropylene with a degree of polymerization of  $3 \times 10^4$  (3 marks)
- d) Show the polymer formed by the reaction of the following monomers. Indicate whether the resulting polymer is linear or branched/crosslinked (4 marks)



- e) Differentiate between the following terms
- i) Suspension polymerization and emulsion polymerization (2 marks)
  - ii) Natural and synthetic polymers (2 marks)
  - iii) Amorphous or crystalline polymers (2 marks)
  - iv) Fibers and elastomers (1 mark)
- f) Explain why toluene and xylene have approximately the same cohesive energy density but xylene is a more convenient solvent for polyethylene (2 marks)
- g) Explain the following observation that screw-machine made end products generally have better physical properties than the same products made from plunger-type machines (3 marks)
- h) Explain why non-ferrous metals are used in injection molds for cavity and core components but must be properly supported on steel forms (3 marks)

**QUESTION 2 (20 MARKS)**

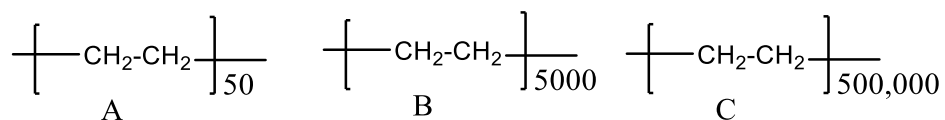
- a) Nylon 11 has the following structure



- . If the number average degree of polymerization  $X_n$  for nylon is 100 and  $M_w=120,000$ , what is its polydispersity (5 marks)
- b) Differentiate between the following :
- i) Homopolymer and copolymer (2 marks)
  - ii) Random and alternating copolymer (2 marks)
  - iii) Thermoplastics and thermosets polymers (2 marks)
- c) Write short notes on ring-opening polymerization (2 marks)
- d) Ethylene oxide polymerizes readily to high conversions under either anionic or cationic conditions. Tetrahydrofuran can be induced to polymerize in the presence of phosphorous or antimony pentafluoride as catalysts. Tetrahydropyran is unreactive under the polymerization conditions. Explain these observations (4 marks)
- e) Using a diagram explain the following terms i) isotactic ii) syndiotactic iii) atactic (3 marks)

**QUESTION THREE (20 MARKS)**

- a) Using an equation explain why when phthalic acid reacts with glycerol, the reaction leads first to the formation of a fairly soft soluble material which on further heating yield a hard insoluble, infusible material. If the same reaction is carried out with ethylene glycol, the product remains soluble and fusible irrespective of the extent of the reaction (4 marks)
- b) i) Explain the term conformation of a polymer (1 mark)  
 ii) Give three factors that determine polymer conformations (3 marks)
- c) Explain briefly which of the following materials will be most suitable for manufacture of thermoplastic sewage pipe (4 marks)



- d) Explain the following terms briefly
- i) Anionic polymerization (2 marks)  
 ii) Step-growth polymerization (2 marks)
- e) Give two differences between chain and step polymerization (2 marks)
- f) Draw the general structure of polycarbonate polyesters (1 mark)

**QUESTION FOUR (20 MARKS)**

- a) Discuss the three basic steps of free-radical polymerization (6 marks)
- b) Explain why  $\alpha$ -methyl styrene polymerizes much less readily than styrene (3 marks)
- c) Write short notes on the following (4 marks)
- i) Cationic polymerization  
 ii) Coordination polymerization
- d) The following data were obtained in a determination of the average molecular weight of a polymer

Molecular weight	Weight (g)
60,000	1.0
40,000	2.0
20,000	5.0
10,000	2.5

- i) Compute the number average and the weight average molecular weights

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- ii) What is polydispersity of the polymer and how many molecules are in 1 gram of the polymer (2 marks)
- e) Give four methods for determining the molecular weight of polymers (2 marks)
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