

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

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

CHIN 432: POLYMER TECHNOLOGY

STREAMS: BSC

TIME: 2 HOURS

DAY/DATE: THURSDAY 23/09/2021

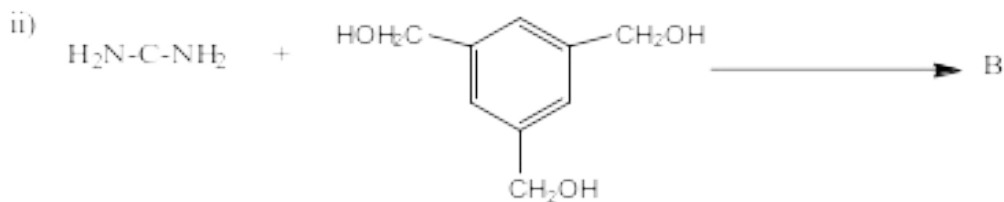
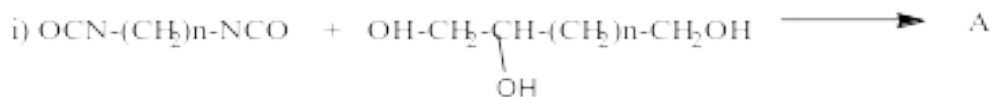
11.30 A.M – 1.30 P.M.

INSTRUCTIONS:

- **ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.**

QUESTION ONE (30 MARKS)

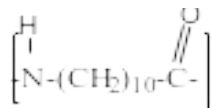
- a) Using a suitable example differentiate between a monomer and a polymer. (3 marks)
- b) Define the following terms briefly (5 marks)
- Degree of Polymerization
 - Oligomers
 - Polymer Chain
 - Functionality of a molecule
 - Liquid Crystalline Polymers
- c) i) Define the molecular weight of a polymer (1 mark)
- ii) What is the molecular weight of polypropylene with a degree of polymerization of 3×10^4 . The formula for the limiting unit is $[-CH_2-CH(CH_3)-]$ (3 marks)
- d) Show the polymer formed by the reaction of the following monomers. Indicate if the resulting polymer is Linear or Branched/cross linked. (4 marks)



- e) Differentiate between the following polymers (6 marks)
- Amorphous or crystalline polymers
 - Homopolymer or copolymer
 - Fibers and elastomers
- f) Explain why chain-transfer reactions reduce the average chain length of the polymer (3 marks)
- g) Give three differences in the distinguishing features of chain and step polymerization mechanisms (3 marks)
- h) Give how ring-opening polymerization differs from condensation and addition polymerization mechanism (2 marks)

QUESTION TWO (20 MARKS)

- a) Differentiate between number-average molecular weight and the weight-average molecular weight (2 marks)
- b) Nylon 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 ($N=14$ $C=12$ $O=16$). (4 marks)

- c) Using a suitable equation, explain why when phthalic acid reacts with glycerol, the reaction leads first to the formation of fairly soft soluble material which on further heating yields a hard, insoluble, infusible material. If the same reaction is carried out with ethylene glycol instead of glycerol the product remains soluble and fusible irrespective of the extent of reaction. (5 marks)

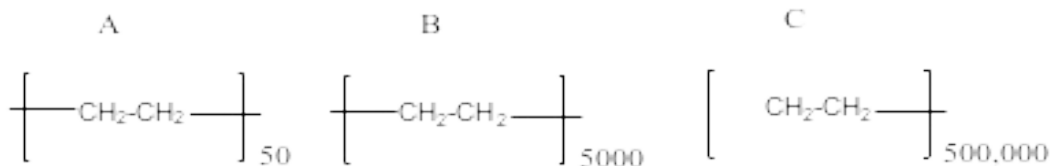
- d) Using a suitable diagram differentiate between condensation and addition polymers (4 marks)

QUESTION THREE (20 MARKS)

- a) Differentiate between the following terms (6 marks)
- i) Thermoplastic and thermosets
 - ii) Bulk polymerization and solution polymerization
 - iii) Suspension polymerization and Emulsion polymerization
- b) Explain why α -methyl styrene polymerizes much less readily than styrene (4 marks)
- c) Write short notes on i) Step-Growth polymerization (3 marks)
ii) Ring Opening polymerization (3 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 pentafluorides as catalyst. Tetrahydropyran is unreactive under polymerization conditions. Explain these observations. (4 marks)

QUESTION FOUR (20 MARKS)

- a) Indicate with reasons which of the following materials will be most suitable for the manufacture of thermoplastic sewage pipes. (4 marks)



- b) 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. (4 marks)
- ii. What is the polydispersity and how many molecules are in 1 gram of polymer.

(3 marks)

c) Give three physical and chemical methods for the determination of the molecular weight of polymers (3 marks)

d) An injection molding machine is rated 100 oz per shot. Calculate. (6 marks)

- i. What is the plasticizing capacity (lb/h) of this machine if the total cycle time is 30 seconds
 - ii. What is the average residence time of the material in the heating cylinder for an inventory weight of 50oz
 - iii. Estimate the plasticizing capacity of the heating cylinder for low density polyethylene
-