



**DEPARTMENT OF CHEMISTRY**  
**FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA**  
**FIRST SEMESTER EXAMINATION 2021/2022 SESSION**  
**COURSE CODE: CHM 315**

**UNITS: 3**

**COURSE TITLE: INTRODUCTION TO POLYMER CHEMISTRY**

**TIME ALLOWED: 2 HOURS 30 MINUTES**

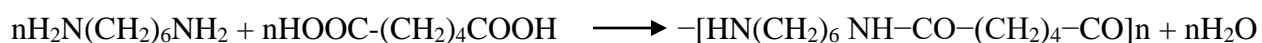
**INSTRUCTIONS: ANSWER FOUR QUESTIONS**

**[H=1, O=16, N=14, C=12]**

**Q1. (a) Give four characteristics each of step and chain growth polymerization (4 marks)**

(b).The classification of polymers as either addition or condensation is considered ambiguous. Explain (6 marks)

(c). Consider the following polymerization reaction;



(i) Identify the polymer formed. (2 marks)

(ii) Calculate the average molecular mass of the polymer.at 99% completion (3 marks)

**Q2. (a) Using structures only, explain the following types of polymers:**

- i. Homopolymer
- ii. Random copolymer
- iii. Block copolymer
- iv. Graft copolymer
- v. Alternate copolymer (5 marks)

(b) (i) Highlight any four limitations of end-group analysis? (2 marks)

(ii) List any three factors complicating end-group analysis. (3 marks)

(c) A 0.5 g sample of unsaturated polyester was reacted with an excess of acetic anhydride.

The acid (-COOH) liberated was titrated with 8.17 cm<sup>3</sup> of 1.02 x 10<sup>-2</sup> moldm<sup>-3</sup> potassium hydroxide solution for complete neutralization. Calculate the molecular mass of the polyester? (5 marks)

**Q3.(a).(i) With the aid of an appropriate diagram, describe concisely the working principle of Gel Permeable Chromatography (GPC) (5 marks)**

(ii) Justify the choice of a cross linked polystyrene as a column material in GPC (3 marks)

(b) Highlight any four drawbacks of GPC. (2 marks)

(c) A hypothetical polymer sample consists of the following fractional distribution.

Weight fraction, $w_i$ ,	0.04	0.23	0.31	0.25	0.13	0.04
Mean Mol Wt, $M_i \times 10^3$	7	11	16	23	31	39

Calculate the weight average molecular weight,  $\overline{M}_w$ . (5 marks)

**Q4. (a).** Concisely explain the following:

(i) Folded chain lamellar model (ii) Extended chain crystals model

(ii) Morphological states of polymer molecules (6 marks)

(b) Mention four ways by which polymer crystallinity can be induced (4 marks)

(c) Explain the textural behaviour of polymers in (i) dilute solution (ii) molten state

(5 marks)

**Q5. (a).** Define the following terms:

i. Configuration ii. Conformation iii. Tacticity (3 marks)

(b). Differentiate between the following pair of terms:

i. Thermoplastics and thermosets.

ii. Stress and strain

iii. Isotactic and syndiotactic (3 marks)

(c) (i) What is the molecular weight of a polyester sample if  $12 \text{ cm}^{-3}$  of  $0.01 \text{ mol dm}^{-3}$  of KOH were required to neutralize 0.25 g of the polymer sample having a  $-\text{COOH}$  end group? (5 marks)

(ii). At a concentration of  $0.0020 \text{ g/cm}^3$ , a polymer exhibited an osmotic pressure height of 0.30 cm in a solvent of  $1.0 \text{ g cm}^{-3}$  density at  $30^\circ\text{C}$ . Given that the second virial coefficient is zero, calculate the number average molecular mass. [Hint:  $R = 8.314 \times 10^7 \text{ ergs mol}^{-1} \text{ K}^{-1}$ ,  $g = 9.8 \text{ m}^{-2}$ ] (4 marks)

