TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied and Health Sciences

Department of Pure & Applied Sciences

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY

ACH.4216: POLYMER CHEMISTRY

END OF SEMESTER EXAMINATION

SERIES: DEC 2024

TIME:2HOURS

Pick Date**DATE:**DEC 2024

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attemptquestion ONE (Compulsory) and any other TWO questions.

Do not write on the question paper.

Question ONE

a) Suggest reasons for the following observations

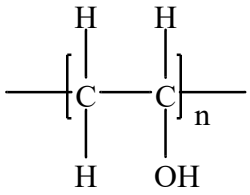
i) Polydisperse polymers have a distribution of molecular weights **(2marks)**

ii) For a substance to act as a condensation monomer it must have at least two reactive sites. **(2marks)**

b) i) Define Glass Transition Temperature (Tg) and explain its significance in polymers **(4 marks)**

ii) Explain the term graft copolymer (**2marks**)

c) Polyvinyl alcohol is used in producing various biomedical items such as contact lenses, wound dressing, and surgical threads. Poly (vinyl alcohol) is represented by the formula



i) Draw molecular structures for tetramers (n=4) of the atactic, isotactic, and syndiotactic forms of poly vinyl alcohol.

(3marks)

ii) Explain how changes in the degree of polymerization affect the properties of poly vinyl alcohol, such as molecular weight, solubility and mechanical strength.

(3marks)

d) Amorphous polymers are more transparent than crystalline polymers. Explain.
. (**4marks**)

e) Describe the kinetics of the termination process by coupling in free radical polymerization.

(**4marks**)

f) i) Explain the difference between addition polymerization and condensation polymerization in the context of fiber production. (**3marks**)

ii) Provide examples of fibers produced through different methods of polymerisation.

(**3marks**)

Question TWO

a) i) Use the table below to calculate sum of molar attraction constant $\sum G$ and the polymer solubility parameters δ for PVC, LDPE, PS and PMMA where molecular weights, densities and the molar attraction constant per unit are given.

(6 marks)

Type of polymers and their repeating unit	Molecular weight, M ($g\ mol^{-1}$)	Sum of molar attraction constant, $\sum G$ ($J^{1/2}\ cm^{3/2}\ mol^{-1}$)	Density, ρ ($g\ cm^{-3}$)	Solubility parameters, δ_2 ($J^{1/2}\ cm^{-3/2}$)
$-(CH_2CHCl)-$ Poly(vinyl chloride)	62.50		1.41	
$-(CH_2CH_2)-$ Low Density Polyethylene	28.00		0.85	
$-CH_2CH(C_6H_5))-$ Polystyrene	104.00		1.05	
$-[CH_2CH(COOCH_3)]-$ Poly(methyl methacrylate)	86.00		1.17	

Assume the following molar attraction constants per unit (G) ($J^{1/2}\,cm^{3/2}\,mol^{-1}$)

$-CH_3$	420
$-CH_2-$	280
-COO-	511
-CH-	140
-O-	137
-CHCl-	611
$-C_6H_5-$	1517

ii) Explain how the solubility parameter of a polymer affects the choice of solvents for the polymer. **(2 marks)**

b) i) Explain the differential scanning calorimetric (DSC) method for determination of Tg of polymers. **(3 marks)**

ii) Sketch a DSC plot for an amorphous polymer and label Tg on this curve. **(3 marks)**

c) i) Calculate the weight average molecular weight of a polymer containing 9 moles of molecular weight 30,000 and 5 moles of molecular weight 50,000.

(3 marks)

i) work out the polydispersity index for the polymer in (i) above **(3 marks)**

Question THREE

a) Describe the determination of polymer molecular weight distribution by gel permeation chromatography. **(6 marks)**

b) i) What is theta state? **(2 marks)**

ii) Give two parameters that constitute a theta state. **(2 marks)**

c) Discuss the thermodynamics of dissolution of a polymer **(5 marks)**

d) Give three advantages and two disadvantages of emulsion polymerisation method **(5 marks)**

Question FOUR

a) i) Explain the term Michel-Levy chart. **(2 marks)**

ii) Provide the significance of birefringence in fibre characterization. **(3 marks)**

b) Outline any three categories of ingredients and their roles in polymers **(6 marks)**

c) With the help of a tree diagram show the classification of natural and man made fibres **(6 marks)**

d) Give three applications of polyamide fibres **(3 marks)**

Question FIVE

a) i) Derive the expression for overall rate of polymerization as a function of conversion in step growth polymerization. **(6 marks)**

ii) Sate two ways of controlling molecular weight in step growth polymerisation reactions **(2 marks)**

b) Describe GPC, FTIR and NMR techniques used to characterize polymers, focusing on their utility in determining polymer structure and properties. Include specific examples of how each technique is applied in polymer chemistry. **(12 marks)**