00121

THE OPEN UNIVERSITY OF SRI LANKA
B.Sc DEGREE/STAND ALONE COURSE IN SCIENCE - LEVEL 5
Final Examination– 2015/2016
CHU 3238/CMU 3233 - POLYMER CHEMISTRY
MCQ ANSWER SHEET: Mark a cross (x) over the most suitable answer.
Index No.

	Marks	
Unanswered		
Correct Answers		
Wrong Answers		
Total		

1. | 1 | 2 | 3 | 4 | 5 | 2. | 1 | 2 | 3 | 4 | 5 | 3. | 1 | 2 | 3 | 4 | 5 |

4. | 1 | 2 | 3 | 4 | 5 | 5. | 1 | 2 | 3 | 4 | 5 | 6. | 1 | 2 | 3 | 4 | 5 |

7. | 1 | 2 | 3 | 4 | 5 | 8. | 1 | 2 | 3 | 4 | 5 | 9. | 1 | 2 | 3 | 4 | 5 |

10. | 1 | 2 | 3 | 4 | 5 | 11. | 1 | 2 | 3 | 4 | 5 | 12. | 1 | 2 | 3 | 4 | 5 |

13. | 1 | 2 | 3 | 4 | 5 | 14. | 1 | 2 | 3 | 4 | 5 | 15. | 1 | 2 | 3 | 4 | 5 |

16. | 1 | 2 | 3 | 4 | 5 | 17. | 1 | 2 | 3 | 4 | 5 | 18. | 1 | 2 | 3 | 4 | 5 |

19. | 1 | 2 | 3 | 4 | 5 | 20. | 1 | 2 | 3 | 4 | 5 | 21. | 1 | 2 | 3 | 4 | 5 |

22. | 1 | 2 | 3 | 4 | 5 | 23. | 1 | 2 | 3 | 4 | 5 | 24. | 1 | 2 | 3 | 4 | 5 |

25. | 1 | 2 | 3 | 4 | 5 |

THE OPEN UNIVERSITY OF SRI LANKA

B.Sc. Degree Program –Level 5

Final Examination -2015/2016

CMU3233/CHU3238 -Polymer Chemistry

Date: 21.01.2017 | **9.30am-12.30pm**

Instructions to candidates:

- This paper consists of two parts, Part I (MCQ) and part II (essay type).

- Part I consists of 25 MCQs, recommended time to complete this part is 1 hour.

- Part II consists of six essay type questions. You are expected to answer **four** questions among six. Recommended time to complete this part is 2 hours.

For MCQs

- Answer all questions.
- Choose the most correct answer to each question and mark a cross" X" over the answer on the given answer sheet.
- Use a PEN (not a pencil) in answering.
- Any answer with more than one cross will not be counted.
- 1/6th marks will be deducted for each incorrect answer
- The use of a non – programmable electronic calculator is permitted.

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PART I (35 marks)

01. What is the functionality of OH-CH₂-CH₂-COOH monomer?

1) 1   2) 2   3) 3   4) 5

02. What polymerization method can be applied to polymerize vinyl esters?

1) Cationic   2) Anionic   3) Free radical   4) Anionic and Cationic
5) Free radical and anionic

03. What statement is **true** about step growth polymerization?
1) Three basic steps are involved in polymerization.
2) Repeating units are added one at a time.
3) Monomer concentration drops steadily throughout the reaction.
4) By products such as H₂O are formed.
5) Polymer molar mass changes little throughout the reaction.

04. HClO₄ can be used as a
1) cationic initiator   2) anionic initiator   3) free radical initiator   4) inhibitor
5) Zeiglar Natta catalyst.

05. Ethylene and polyethylene have
1) same physical properties.   2) same melting points.   3) same boiling points.
4) same solubility.   5) different properties from each other.

06. Above flow temperature (T_f), the polymer is in the
1) glassy state.   2) rubbery state.   3) visco-elastic state.   4) solid state.
5) visco-fluid state.

07. Degree of crystallinity (χ) can be expressed as

1) $\chi = \dfrac{Density of \{semicrystalline - 100\% amorphous\} polymer}{Density of \{100\% crystalline - 100\% amorphous\} polymer}$

2) $\chi = \dfrac{Density of \{100\% crystalline - semicrystalline\} polymer}{Density of \{100\% crystalline - 100\% amorphous\} polymer}$

3) $\chi = \dfrac{Density of \{100\% amorphous - semicrystalline\} polymer}{Density of \{semicrystalline - 100\% amorphous\} polymer}$

4) $\chi = \dfrac{Density of \{100\% crystalline - 100\% amorphous\} polymer}{Density of \{semicrystalline - 100\% amorphous\} polymer}$

5) $\chi = \dfrac{Density of \{semicrystalline - 100\% crystalline\} polymer}{Density of \{100\% crystalline - semicrystalline\} polymer}$

08. Density of semi crystalline polymers can be determined using
1) Dilatmetry.   2) Viscometry.   3) X-Ray diffraction   4) Cryoscopy
5) End group analysis.

09. Consider following polymers.

a) Polyethylene.   b) Polypropylene oxide.   c) Polystyrene

Which of the following polymer/s is/are optically active?

1) a only.   2) b only.   3) c only.   4) a and b only.   5) b and c only.

10. Viscosity of a dilute solution depends on

1) polymer molar mass only.   2) rate of mixing only.   3) nature of the polymer only.

4) nature of the solvent only.   5) all of above.

11. End group analysis is used to determined

1) weight average molar mass.   2) number average molar mass.   3) specific viscosity.

4) intrinsic viscosity.   5) relative viscosity.

12. Consider following statements about Gel Permeation Chromatography?

a) It is a separation technique.   b) Chromatographic column is filled with non-porous beads.

c) Use to obtain a poly dispersed system.

The correct statement/s is/are

1) a only.   2) b only.   3) c only.   4. a and b only.   5. all of above.

13. In molar mass distribution curve, relative portions of various average molar masses of a poly dispersed polymer sample can be represented as

1) $\bar{M}_n > \bar{M}_V > \bar{M}_w$ 2) $\bar{M}_w > \bar{M}_V > \bar{M}_n$ 3. $\bar{M}_n = \bar{M}_V = \bar{M}_w$

4) $\bar{M}_V > \bar{M}_w > \bar{M}_n$ 5. $\bar{M}_V = \bar{M}_w > \bar{M}_n$

14. Consider following statements regarding ZnO in rubber vulcanization process.

a) It is compatible with rubber.   b) Can be used as an activator.

c) Can be used as an accelerator.

The correct statement/s is/are

1) a only.   2) b only.   3) c only.   4. a and b only.   5. all of above.

15. Polymer degradation may occur by

1) heat.   2) radiation.   3) mechanical stress.   4) atmospheric oxygen.

5. all of above.

16. What statement is **true** about cure reactions?

1) They are irreversible reactions.

2) Pre-polymers having reactive functional groups undergo these reactions.

3) Final product obtained are insoluble.

4) Formation of phenol-formaldehyde is one example.

5) All of above.

17. What statement is **not true** about polystyrene?
1) It is produced by free radical polymerization.
2) It is produced by coordination polymerization.
3) It has a low softening point.
4) It is insoluble in aromatic hydrocarbons.
5. It is widely used as a packing material.

18. Extent of polymerization is given by

1) $1 - \dfrac{N_0}{N}$ 2) $1 + \dfrac{N_0}{N}$ 3) $1 - \dfrac{N}{N_0}$ 4) $1 + \dfrac{N}{N_0}$ 5) $\dfrac{N}{N_0} - 1$

19. A-B represents a monomer having a COOH group (A) and OH group (B). When extent of polymerization is 95%, the number average degree of polymerization is,

1) 35   2) 30   3) 25   4) 20   5) 15

20. Rate equation for anionic polymerization of styrene is

1. $\dfrac{-d[M]}{dt} = \dfrac{k_{tr}[NH_3]}{k_p[I][M]}$ 2. $\dfrac{-d[M]}{dt} = \dfrac{k_i[M]^2}{k_p[NH_3]}$ 3. $\dfrac{-d[M]}{dt} = \dfrac{k_i k_p[I][M^2]}{k_{tr}[NH_3]}$

4. $\dfrac{-d[M]}{dt} = \dfrac{k_p[NH_3]}{k_i[I]}$ 5. $\dfrac{-d[M]}{dt} = \dfrac{k_{tr}[I]^2[M]}{k_i\|NH_3\|}$

21. Rate equation for cationic polymerization is
1. 1st order w.r.t monomer concentration.
3. 1st order w.r.t. catalyst concentration.
5. independent of catalyst concentration.
2. 2nd order w.r.t. monomer concentration.
4. 0th order w.r.t. monomer concentration.

22. Beilstein test is used to identify
1) HDPE   2) PP   3) PVC   4) LDPE   5) PE

23. What statement is **true** about Raman spectroscopy?
1) It is a very popular method than IR spectroscopy in polymer characterization.
2) Raman spectra are indicative of asymmetric bond stretching and bending.
3) It can be used to determine the composition of copolymers.
4) It can be used to identify tacticity of PP.
5) It can be used to determine the crystallinity of polymers.

24. Melt flow index (MFI) of a given polymer is **not** affected by
1) Molecular weight distribution.   2) The degree of chain branching.   3) Crystallinity.
4) Viscosity.   5) Type of inter molecular forces.

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25. Consider following parameters obtained from a thermogram of a given polymer.
a) The enthalpy of crystallization and melting.   b) Glass transition temperature.
c) Intrinsic viscosity.

The correct parameter/s is/are
1) a only.   2) b only.   3) c only.   4) a and b only.   5. none of above.

PART II (65 marks)

01. a) i. What is meant by functionality of a monomer?
    ii. Explain the differences among mono functional, bi functional and tri functional monomers by giving examples.
    b) i. What are the different modes of additions in chain polymerization of $CH_2=CH-CH_3$. Explain.
    ii. Which one is the most favored mode of additions among above mentioned modes? Give reasons.
    c) i. What are the constituents of Ziegler-Natta catalyst?
    ii. How does $CH_2=CH-CH_3$ monomer bind to the active center of Ziegler-Natta catalyst through mono metallic mechanism? Explain by drawing the structure of the transition state.
    d) i. What are copolymers?
    ii. "Properties of polymers can be changed by copolymerization with other monomers". Justify this statement by taking appropriate examples.
    e) i. Describe the chemical process of solution polymerization.
    ii. State two major disadvantages of this technique over other polymerization techniques.

02. a) i. What is meant by stereoregular polymers? Give examples.
    ii. Explain different types of stereoisomers arise due to asymmetric carbon.
    iii. "Polypropylene oxide shows optical isomerism". Justify your answer by drawing the structure.
    b) Describe how specific volume of an amorphous polymer varies with temperature.
    c) i. What is meant by glass transition temperature (T_g)? What is the importance of it?
    ii. Tg values of polyethylene and polystyrene are 188K and 373K, respectively. Explain the difference.
    iii. What are plasticizers? Explain the relationship between plasticizers and the glass transition temperature.
    iv. What is the major difference between amorphous and crystalline polymers?
    d) Briefly explain the factors that affect the crystallinity of a polymer?
    e) Polyisobutyl contains two chains of eight repeat units in each unit cell. Unit cell dimension of polyisobutyl is approximately 16Å×11Å×8Å. Calculate the density of 100% crystalline polyisobutyl.

03. a) i. How do you differentiate a monodispersed system from a polydispersed system?
    ii. A polymer sample is made up of a mixture having molar masses 12,000, 90,000 and 60,000 g/mol with molar ratio of 1:2:1, respectively. Calculate the number average molar Mass, $\bar{M}_n$. If the weight average molar mass, $\bar{M}_w$ of above polymer is 120,000 g/mol, calculate the polydispersity factor of the polymer sample.
    b) i. Explain reasons for having slow solubility of polymers compare to simple compounds.
    ii. What is meant by swelling of polymers?
    iii. How do you enhance the swelling process of polymers? Explain.
    iv. "Acrylonitrile is resistant for swelling in organic solvents". Explain.
    c) i. Explain the difference among specific viscosity, intrinsic viscosity and relative viscosity.
    ii. Describe an experimental technique to determine intrinsic viscosity.

04. a) i. What is meant by sulphur vulcanization?
    ii. What are the essential ingredients necessary for above process? Explain their role.
    iii. How do you obtain vulcanized rubber with high degree of monosulphide linkages?
    iv. What are the importances of monosulphide linkages in vulcanized rubber?

  b) i. What is meant by oxidative degradation? How does it happen?
    ii. What precautions can be taken to overcome this degradation? Explain.

  c) i. What is meant by autocoagulation of field latex? How does it happen?
    ii. What is the purpose of adding bases to prevent autocoagulation? Explain.
    iii. What are the common preservatives used in latex industry? Describe their functions.

  d) What do you mean by yellow discolouration? Describe two ways of preventing it.

  e) Write brief accounts on
    i. Thermosets.   ii. Foaming agents.   iii. Fillers.   iv. Antidegredants.

05. a) i. Derive the Modified Carother's equation given below starting from N_A and N_B as initial moles of molecules of the monomers type A-A and type B-B, available in reaction medium respectively. Define the terms in the equation below and consider $N_A < N_B$.

$$X_n = \frac{1+r}{1+r-2rP}$$

    ii. Percentage conversion of diacid-dialcohol polymerization reaction is 99.6%. If 8% of more diacid is used, calculate the degree of polymerization.

  b) How do you differentiate chain length of a polymer from kinetic chain length?

  c) i. What is meant by auto acceleration?
    ii. Describe the kinetic interpretation of above phenomenon.

06. a) i. What is the basis of Infrared spectroscopy?
    ii. How can it be used a qualitative tool to identify polymers? Explain.
    iii. Describe the importance of FTIR as a quantitative tool in polymer chemistry.
    iv. Following table summarizes absorbance values recorded at 2250 cm^{-1} for nitrile stretching and 1600 cm^{-1} for polystyrene ring stretching for number of styrene/acrylonitrile copolymers. For the same copolymer with unknown composition showed stretching frequencies at 2250 cm^{-1} and 1600 cm^{-1} are 0.205 and 0.121 respectively. Calculate the unknown composition of the copolymer.

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% Acrylonitrile concentration	Polystyrene stretching frequency, cm^{-1}	Nitrile stretching frequency, cm^{-1}
10	0.383	0.230
20	0.177	0.223
30	0.120	0.230
40	0.091	0.235
50	0.070	0.227
60	0.059	0.231

b) 75g of Polystyrene is mixed with 10g of plasticizers; the T_g was lowered from 373K to 273K. What would be the expected T_g when the amount of plasticizers increased up to 25g?