

College of Science.
Department of Chemistry

Final Exam
Academic Year 1443-1444 Hijri- First Semester

Exam Information معلومات الامتحان		
Course name	Physical Chemistry of Polymers	
Course Code	CHEM 330	
Exam Date	2022-11-17	1444-04-23
Exam Time	08: 00 AM	
Exam Duration	2 hours	ساعتان
Classroom No.	1 B 43 Build. 5	
Instructor Name	د. عمار تيفزه	

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Section No.		رقم الشعبة
Serial Number		الرقم التسلسلي

General Instructions:

تعليمات عامة:

- Your Exam consists of PAGES (except this paper)
- Keep your mobile and smart watch out of the classroom.
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- عدد صفحات الامتحان صفحة. (باستثناء هذه الورقة)
- يجب إبقاء الهواتف والساعات الذكية خارج قاعة الامتحان.
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هذا الجزء خاص بأستاذ المادة

This section is ONLY for instructor

#	Course Learning Outcomes (CLOs)	Related Question (s)	Points	Final Score
1	Definition and classification of polymers	1-4	4	
2	Polymers and copolymers Nomenclature, structure and microstructure of polymers	5-8	4	
3	Polymer crystallinity	9-12	4	
4	Polymerization reactions	13-22,26-29-30,32	19	
5	Techniques of polymerization	31	1	40
6	Techniques used to determine the average molecular weights	33-34	5	
7	Thermal properties of polymers	23-25	3	
8				

Multiple-Choice Questions (32 x 1 = 32 points)
Except for questions 17 and 34 : 4 points for each

For each Multiple-Choice Question (MCQ), choose the correct answer and place the corresponding letter in the table of the first page:

1- Polymers are

- | | |
|--------------------|--------------------------------|
| (a) micromolecules | (b) macromolecules |
| (c) a and b | (d) mixtures of micromolecules |
-

2- Calculate the average molecular weight of a poly(dimethylsiloxane) if the molar mass of its monomer is 74 g/mol and the polymerization degree is 2367

- | | |
|-------------------|------------------|
| (a) 31.986 g/ mol | (b) 500 |
| (c) 165300 g/mol | (d) 175200 g/mol |
-

3- Which of the following is Tetramers?

- | | |
|--|--|
| (a) $-\text{[CH}_2\text{-CH-Cl]}_3-$ | (b) $-\text{[Si(CH}_3\text{)}_2\text{O]}_3-$ |
| (c) $-\text{[Si(CH}_3\text{)}_2\text{O]}_4-$ | (d) $-\text{[O-CH}_2\text{-CH}_2\text{]}_2-$ |
-

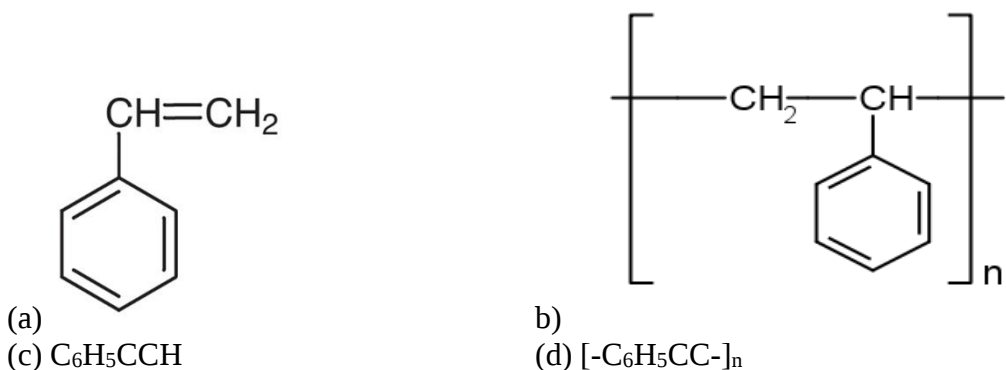
4- Which of the following is a correct statement?

- (a) Polymer chains are linked by primary bonds
 - (b) Polymer is **never** used as a synonym for ‘plastic’ or rubber
 - (c) All plastic are polymers, but not all polymers are plastics or rubber
 - (d) Polymers are formed by repeated linking of the huge molecules called “monomers”
-

5- Which of the following copolymers is the copolymer in which the main chain is formed from one type of monomer A and branches are formed from another monomer B?

- (a) Alternative copolymers
 - (b) Graft copolymers.
 - (c) Random copolymers.
 - (d) Sequenced copolymers.
-

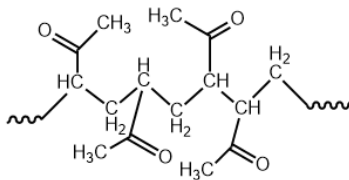
6- The structure of polystyrene is:



7- Poly (oxyphosphohalide) is an example of

- | | |
|-----------------------|------------------------|
| (a) organic polymer | (b) a and c |
| (c) inorganic polymer | (d) nothing from above |
-

8-



The tacticity of this molecule is

- (a) Microstructure Cis
 - (b) Syndiotactic
 - (c) Isotactic
 - (d) Atactic
-

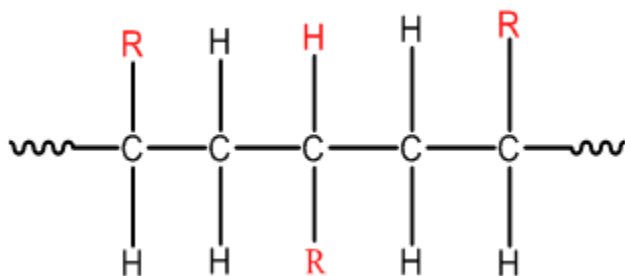
9 - The maximum degree of crystallinity (~ 80 %) is found in polyethylene because polyethylene

- (a) has a bulky substituent
 - (b) is a linear polymer
 - (c) does not have substituents
 - (d) b and c
-

10 -Amorphous polymers is/has

- | | |
|--------------------------------------|--------------------|
| (a) Low-moderate chemical resistance | (b) low elongation |
| (c) Less Soluble | (d) opaque |
-

11-



This polymer is easy to crystallize because it is

- (a) an atactic polymer
 - (b) an isotactic
 - (c) a syndiotactic polymer
 - (d) all of the above
-

12- Crystallinity can be measured by:

- (a) Density measurements
 - (b) X-ray diffraction e.g. powder (XRD)
 - (c) Differential scanning calorimeter (DSC)
 - (d) All the above
-

13- Peroxide is a good example of

- (a) physical initiator for free radical polymerization
 - (b) chemical initiator for free radical polymerization
 - (c) initiator for anionic polymerization
 - (d) all options are wrong
-

14- Among the following initiators which of them is used in the free radical polymerization?

- (a) NaOH
 - (b) HCl
 - (c) Ph-CO-O-O-COPh
 - (d) CH₃-CO-OCH₃
-

15- Among the following initiators, which of them can polymerize acrylic acid through cationic polymerization route.

- (a) NaOH
 - (b) C(CH₃)₃I
 - (c) AlCl₄
 - (d) Ph-CO-O-CO-Ph
-

16- In coordination polymerization, initiators are complex formed from a catalyst + co-catalyst system such as

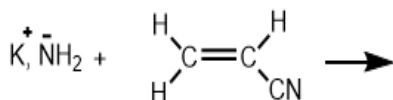
- a) $\text{CoCl}_2/\text{AlCl}_3$
- b) $\text{TiCl}_4/\text{AlCl}_3$
- c) $\text{NaCl}/\text{AlCl}_3$
- d) $\text{Et-Na}/\text{AlCl}_3$

17- Complete the following anionic polymerization where Monomer = $\text{H}_2\text{C}=\text{CH}-\text{CN}$ (Acrylonitrile) and Initiator = KNH_2 (Potassium amide) (4 marks)

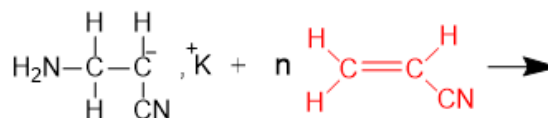
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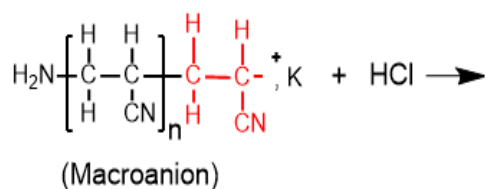
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3-



4-



18- Among the following monomers which of them is/are can be used in the polycondensation?

- (a) $\text{HO}-(\text{CH}_2)_2-\text{OH}$
- (b) $\text{HOOC}-(\text{CH}_2)_n-\text{COOH}$
- (c) $\text{HO}-(\text{CH}_2)_2-\text{COOH}$
- (d) All of them

19- In the polycondensation of ethylene glycol ($\text{HO}-(\text{CH}_2)_2-\text{OH}$), what is the small molecule eliminated?

- (a) $\text{HO}-\text{OH}$
- (b) HOH
- (c) HOCH_3
- (d) None of them

20- In the polycondensation of monomers containing three functional groups, the polymer obtained is:

- | | |
|--------------|------------------------|
| (a) Linear | (b) Crosslinked |
| (c) Branched | (d) (b) and (c) |
-

21- The catalyst that can be used in the polycondensation reactions is/are:

- | | |
|------------------------------|-----------------|
| (a) H_2SO_4 | (b) NaOH |
| (c) CH_3COOH | (d) (a) and (b) |
-

22- Methyltriolsiloxane, $\text{Si}(\text{OH})_3\text{CH}_3$, is an example of monomer used in polycondensation reaction. The polymer obtained is:

- | | |
|--------------|------------------------|
| (a) Linear | (b) Crystalline |
| (c) Branched | (d) None of the above |
-

23- The melting temperature (T_m) is:

- (a) The limit temperature between the glassy state (solid) and the soft state of the polymer
- (b) The temperature limit between the solid state and the liquid state of the polymer
- (c) The temperature between the gaseous state and the molten state of the polymer
- (d) The temperature between the liquid state and the degradation state of the polymer

24- The glass transition temperature (T_g) is:

- (a) The limit temperature between the glassy state (solid) and the soft state of the polymer
- (b) The temperature limit between the solid state and the liquid state of the polymer
- (c) The temperature between the crystalline state and the molten state of the polymer
- (d) The temperature limit between the soft state and the liquid state of the polymer

25- At temperature higher than T_d (degradation temperature) the polymer become:

- | | |
|-------------|-----------------------|
| (a) gaseous | (b) Crystalline |
| (c) glassy | (d) None of the above |
-

26- Which of the following is/are example(s) of monomer for ring opening polymerization?

- | | |
|------------------|----------------------|
| (a) Benzene | (b) ethylene epoxide |
| (c) caprolactone | (d) Only (b) and (c) |
-

27- Examples of anionic catalysts for ring opening polymerization are:

- | | |
|-----------------------|------------------|
| (a) NaOH | (b) sodium amide |
| (c) Sodium ethanolate | (d) All of them. |
-

28- Ter-butyl iodide, $\text{C}(\text{CH}_3)_3\text{I}$, is an example of:

- (a) Monomer for ring opening polymerization
 - (b) Anionic catalyst for ring opening polymerization
 - (c) Cationic catalyst for ring opening polymerization
 - (d) Carbanion catalyst for ring opening polymerization
-

29- Ziegler-Natta polymerization is:
 (a) Free radical polymerization
 (c) Anionic polymerization

(b) Coordination polymerization
 (d) Cationic polymerization.

30- The reactivity ratio is determined from the reactivity ratios R_A and R_B (of monomers A and B) during the copolymerization reaction. What type of copolymer should be obtained if $R_A = R_B$?

- (a) Alternating copolymer
 (c) Mixture of two homopolymers
 (b) Random copolymer
 (d) Block copolymer.

31- Which statement about **Bulk Polymerization** is true?

- (a) Polymerization don't need initiator
 (c) monomer must be liquid
 (b) Polymerization need polar solvent
 (d) None of the above.

32- Polymerization by precipitation requires the presence of a solvent that dissolves:

- (a) Only monomer
 (c) Only monomer and initiator
 (b) Only initiator
 (d) Only resulting polymer.

33- Determine the average molecular weight (M_w in **kg mol⁻¹**) of a sample constituted of:

Ni	3×10^3	5×10^3	9×10^3
$M_i / \text{g mol}^{-1}$	4×10^4	6×10^4	8×10^4

- (a) 73.1
 (c) 57.6
 (b) 67.0
 (d) 70.5

34- Complete the blank spaces by the following:

Size exclusion chromatography – Osmotic pressure - Light scattering technique - Viscosity

The molecular masses of polymers differ according to the experimental methods used: if

..... is used, then $\overline{M}_n$ is determined, if
 is used then $\overline{M}_w$ is determined, if
 is used then M_v is determined and if
 is used then M_z is determined.