



Roll No.

**PRESIDENCY UNIVERSITY
BENGALURU**

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem. 2019-20

Date: 30.09.2019

Course Code: PET 406

Time: 01:00PM to 02:00PM

Course Name: POLYMER TECHNOLOGY

Max Marks: 40

Program: B.Tech (PET) & VII OE

Weightage: 20%

Instructions:

- i. All questions are compulsory.
- ii. Assume the missing values (if any).

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries two marks. (5Qx2M=10M)

1. Define any 2 of the following - (C.O.NO 1) [Knowledge]
a) Oligomers b) Polymerization c) Degree of polymerization
2. What is step growth polymerization? (C.O.NO 1) [Knowledge]
3. Amorphous polymer and crystalline polymers are two types of thermoplastic polymers. What is the difference between the polymers? (C.O.NO 1) [Knowledge]
4. Why does a monomer require minimum functionality of two to form a polymer? (C.O.NO 1) [Knowledge]
5. What are polymers? Mention some industrial / field uses of polymers. (C.O.NO 1) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries five marks. (4Qx5M=20M)

6. What is chain growth polymerization? What are the important steps involved in chain growth polymerization? (C.O.NO.1) [Knowledge]

7. Define conversion factor. Also derive the relation between conversion factor and degree of polymerization for step growth polymerization reaction?
(C.O.NO.1) [Comprehension]
8. How does degree of polymerization varies with conversion factor for step growth and chain growth polymerization. Explain with reason. (C.O.NO.1) [Comprehension]
9. Define addition polymerization and condensation polymerization.
(C.O.NO 1) [Knowledge]

Part C [Problem Solving Questions]

Answer the Question. The Question carries ten marks. (1Qx10M=10M)

10. A 10 gm polymer solution of polyethylene has four type of polymer chains. The molecular weight and weight contribution for the following is as follows-

Weight(gm)	Molecular weight
1	11000
2	12000
4	18000
3	23000

- a) Determine no. average molecular weight. [2.5M]
- b) Determine weight average molecular weight. [2.5M]
- c) Explain the term polydispersity index and find its value for given solution. [5M]
(C.O.NO. 1) [Application]



SCHOOL OF ENGINEERING

Semester: VII

Course Code: PET 406

Course Name: Polymer Technology

Date: 30/09/2019

Time: 01:00PM to 02:00PM

Max Marks: 40

Weightage: 20

Extract of question distribution

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
1	1	1	2	=	2							2
2	1	1	2	=	2							2
3	1	1	2	=	2							2
4	1	1	2	=	2							2
5	1	1	2	=	2							2
6	1	1				5	=	5				5
7	1	1				5	=	5				5
8	1	1				5	=	5				5
9	1	1				5	=	5				5
10	1	1							10	=	10	10
	Total Marks				10			20			10	40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

[I hereby certify that All the questions are set as per the above guide lines. Mr. Anmol Bhargavi]

Reviewers' Comments



SCHOOL OF ENGINEERING

SOLUTION

Semester: VII

Course Code: PET 406

Course Name: Polymer Technology

Date: 30/09/2019

Time: 1:00 PM to 2:00 PM

Max Marks: 40

Weightage: 20

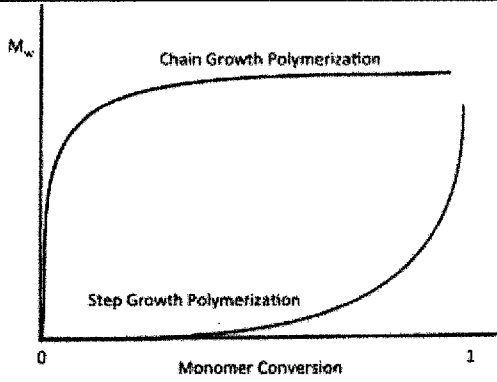
Part A

(5Q x 2M = 10M)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	a) <u>Oligomers</u> are low molecular weight polymers comprising a small number of repeat units whose physical properties are significantly dependent on the length of the chain. b) <u>Polymerization</u> - It is the process of conversion of substances having low molecular weight (monomers) into substances having high molecular weight. c) <u>Degree of polymerization</u> - The number of structure units present in a polymer is called degree of polymerization.	1+1	2 min
2	Step-growth polymerization refers to a type of polymerization mechanism in which bi-functional or multifunctional monomers react to form first dimers, then trimers, longer oligomers and eventually long chain polymers.	2	2 min
3	Addition polymerization – It occurs by a chain reaction in which one carbon-carbon double bond adds to another and monomers continue to react with the end of the growing polymer chain. Condensation polymerization – Small molecules react with each other to form larger structural units while releasing smaller molecules as a byproduct, such as water or methanol.	1+1	2 min
4	<u>Chain initiation</u> is the process of initially generating an active site (such as radical and ions) in a chain polymerization. <u>Chain propagation</u> involves addition of new monomers at the active site to increase the length of polymer chain. <u>Chain termination</u> refers to process of removing active center in the chain, resulting in the termination of chain propagation. It is different from chain transfer.	2	2 min
5	A polymer is a long-chain molecule that is composed of a large number of repeating units of identical structure. This repeating unit can be a single monomer or a combination of monomers. Some major uses of polymer in industry involves- fibers, plastics, elastomers, gels, coatings, adhesives, etc.	2	2 min

Part B

(4Qx 5M = 20M)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
6	The total number of bonding sites or functional groups present in a monomer molecule is called the functionality of the monomer. A monomer requires to have a minimum functionality of two because it enable the monomer to be attached to more than one monomer/molecule, thus forming a long chain molecule i.e polymer.	5	5 min
7	$X_n = N_o/N$ (N_o - no. of polymer chain; N – no. of functional group) $P = (N-N_o) / N$ $X_n = 1/(1-P)$	5	5 min
8	 <p>Degree of polymerization - The number of structure units present in a polymer is called degree of polymerization.</p> <p>Degree of polymerization increases very quickly for chain growth polymerization as compared to step growth polymerization. As a result a high molecular weight polymer is obtained in very early stage of chain growth polymerization. But in case of step growth polymerization, only oligomers exist at initial stage and polymers are made at very end of the reaction.</p>	5	5min
9	Amorphous polymers are those in which the polymer chains are present in a random fashion, entangled with each other. While the crystalline polymers have the polymer chain oriented in single direction. It is very difficult to generate a pure crystalline polymer, mostly they are semi-crystalline in nature.	5	5min

Part C

(1Q x 10M = 10M)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
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10	<p>a) No. average molecular weight = $\frac{\sum NiMi}{\sum Ni}$ = 16387</p> <p>b) Weight average molecular weight = $\frac{\sum NiMi^2}{\sum NiMi}$ = 17600</p> <p>c) Poly dispersity index - The polydispersity index (PDI) or heterogeneity index, is a measure of the distribution of molecular mass in a given polymer sample. It is mathematically defined as ratio of weight average molecular weight and no. average molecular weight. PDI = 1.07</p>	2.5+2.5+5	15 min
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**PRESIDENCY UNIVERSITY
BENGALURU**

SCHOOL OF ENGINEERING

TEST – 2

Sem & AY Odd sem 2019-20

Course Code: PET 406

Course Name: POLYMER TECHNOLOGY

Program: B.Tech (MEC,PET) & VII (OE)

Date: 18.11.2019

Time: 01:00 PM to 02:00 PM

Max Marks: 40

Weightage: 20%

Instructions:

- (i) All questions are compulsory.
(ii) Assume the missing values (if any).

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries three marks. (5Qx3M=15M)

1. What is suspension polymerization technique? [3]
(C.O.NO 1) [Knowledge]
2. What is the effect of temperature on mechanical properties of polymer? [3]
(C.O.NO 2) [Knowledge]
3. Define glass transition temperature. [3]
(C.O.NO 2) [Knowledge]
4. Describe the following polymer additives- [3]
a) Colorants b) Blowing agents c) Plasticizer
(C.O.NO 3) [Knowledge]
5. Name the basic polymer processing techniques. Which polymer processing technique can be used to form a rod shaped product? [3]
(C.O.NO 3) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. (3QX5M=15M)

6. Bulk polymerization technique has maximum yield. Why? [5]
(C.O.NO 1) [Comprehension]

7. Explain the importance of critical molecular weight in formation of amorphous polymers. [5]

(C.O.NO 2) [Comprehension]

8. Why does blend polymers provide good strength to weight ratio? [5]

(C.O.NO 3) [Comprehension]

Part C [Problem Solving Questions]

Answer the Question. The Question carry ten marks.

(1QX10M=10M)

10. Laboratory preparation of two polymer, polymer A and polymer B, is required. Produced polymers have different structural configuration as shown in figure. Analysis of thermal transition property for polymer A found that it has high glass transition temperature.

(C.O.NO 2, C.O. NO 3)

[Comprehension]

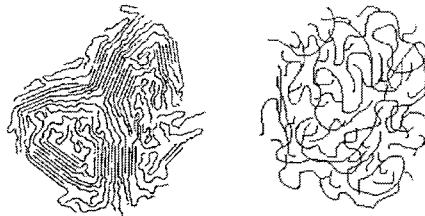


Figure : Polymer A

Polymer B

- Classify polymer A & B as amorphous or semi-crystalline. Also state the reason for this classification. [3]
- What will be the effect of increasing crystalline nature, on mechanical properties, in both the polymers? [3]
- Suggest the type of additives required to- [2]
 - Decrease the glass transition temperature of polymer A
 - Provide desired color to the polymer A
- Name the polymer processing techniques that can be used to convert polymer A into a sheet like structure. [2]



SCHOOL OF ENGINEERING

Semester: VII

Course Code: PET 406

Course Name: Polymer Technology

Date: 18/11/2019

Time: 01:00PM to 02:00PM

Max Marks: 40

Weightage: 20

Extract of question distribution

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type		Thought provoking type			Problem Solving type			Total Marks
			[Marks allotted]	Bloom's Levels	[Marks allotted]	Bloom's Levels		[Marks allotted]			
				K		C		C			
1	1	1	3	3						2	3
2	2	1	3	3						2	3
3	2	1	3	3						2	3
4	3	1	3	3						2	3
5	3	1	3	3						2	3
6	1	1			5	5				5	
7	2	1			5	5				5	
8	3	1			5	5				5	
9	2,3	1						10	10	10	
	Total Marks			15		15			10	40	



SCHOOL OF ENGINEERING

SOLUTION

Semester: VII

Course Code: PET 406

Course Name: Polymer Technology

Date: 18/11/2019

Time: 1:00 PM to 2:00 PM

Max Marks: 40

Weightage: 20

Part A[Memory Recall Question]

(5Q x 2M = 10M)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	Uses water as solvent with water insoluble monomer and initiator. Thus, polymer is produced in heterogeneous medium. The dispersion is maintained by continuous agitation and the droplets are prevented to coalesce (unite or merge) by adding small quantity of stabilizers. The product separated out in the form of spherical pearls or beads of polymer. So this technique is also known as pearl or Bead polymerization.	3	2 min
2	Increase in temperature causes the polymer to become more soft and ductile as the temperature is increased. Decrease in temperature causes the substance to be more hard and brittle. (With graph)	3	2 min
3	Glass transition temperature is the maximum temperature at which free motion of entangled chains of amorphous polymer ceases. It is represented as T_g and is defined for amorphous polymer only. Polymer will be in solid state at any temperature below the glass transition temperature.	3	2 min
4	a) Colorants – These are the additives which provide desired color to the polymer product. These include soluble dyes or pigments. b) Blowing agent – These are the additives which are used to provide foamy structure to the polymer products. This can be done by physical transformation of additives or due to chemical reaction. c) Plasticizer - These are the polymers additives that are used to reduce the glass transition temperature of a polymer product. These further help to reduce the modulus and thus brittleness of the polymer product.	1+1+1	2 min
5	Basic polymer processing techniques are- Extrusion Molding Calendering Coating	3	2 min

	Extrusion is generally used to form a product of rod shape		
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Part B [Thought Provoking Question]

(3Q x 5M = 15M)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
6	In bulk polymerization undiluted monomer is used along with soluble initiator to pure monomer. As no solvent is present, the final product contains only polymer molecule. Thus it is stated that bulk polymerization has maximum yield.	5	5 min
7	Critical molecular weight is defined as the minimum molecular weight that is required to form an amorphous polymer. Below critical molecular weight it is not possible to form a stable entanglements as the polymer chains won't be long enough to remain entangled under varying temperature condition. This may result in very low glass transition temperature or inability to form amorphous polymer.	5	5 min
8	Blend polymers have interpenetrating network structure. In this this type of structure the at least one of the polymer present have cross-linked structure and other polymer is present in between the cross-linked structure. This type of structure is the reason for high strength to weight ratio of blend polymer as for the same amount of polymer molecules strength is increased by the crosslinking and cross networking.	5	5 min

Part C [Problem Solving Question]

(1Q x 10M = 10M)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
9	<p>a) Polymer A is semi-crystalline as it has some of the polymer molecule oriented in specific direction. Polymer B is amorphous as all the polymer chains are present in random fashion.</p> <p>b) If the crystalline nature of the polymers will increase then the polymer product will become more brittle and hard.</p> <p>c) i) Plasticizer ii) colorants</p> <p>d) Extrusion and calendaring.</p>	3+3+2+2	10 min



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**PRESIDENCY UNIVERSITY
BENGALURU**

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 20

Date: 26 December 2019

Course Code: PET 406

Time: 9:30 AM to 12:30 PM

Course Name: POLYMER TECHNOLOGY

Max Marks: 80

Program & Sem: B.Tech (All Program) - VII (OE-II)

Weightage: 40%

Instructions:

- (i) Read the all questions carefully and answer accordingly.
- (ii) Question paper consists of 3 parts.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 6 marks.

(6Qx6M=36M)

1. Discuss chain growth polymerization mechanism. (C.O.No.1) [Knowledge]
2. Fill in the blanks-
 - a) _____ polymerization technique provides polymer beads.
 - b) _____ polymerization technique has maximum yield.
 - c) _____ polymerization technique has uses water as solvent.
 - d) _____ polymerization technique use alcohol as solvent.
 - e) _____ polymer processing technique provides only sheet like structure.
 - f) _____ polymer processing technique can be used for making complex shapes.(C.O.No.1, C.O.No.3) [Knowledge]
3. Define glass transition temperature and melting temperature. (C.O.No.2) [Knowledge]
4. What are crystalline polymers? What is the effect of increasing temperature on mechanical properties of polymer? (C.O.No.2) [Knowledge]
5. Define the following polymerization processing techniques-
 - a) Extrusion
 - b) Blowing agent
 - c) Calendering(C.O.No.3) [Knowledge]
6. Discuss properties of any three biopolymers. (C.O.No.4) [Knowledge]

Part B [Thought Provoking Questions]

Answer both the Questions. Each Question carries 10 marks.

(2Qx10M=20M)

7. Which of the available techniques, for polymer management, can be considered as most environment friendly and economical. Justify your answer.
(C.O.No.4) [Comprehension]
8. Polymers show different mechanical characteristics based on type of structure and composition. Discuss the effect of crystalline nature on these mechanical properties. Also discuss all the possible mechanical characteristics for polymers.
(C.O.No.2) [Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries 12 marks.

(2Qx12M=24M)

9. Arjun is owner of a factory which produce reusable water bottles. The polymer used for making the bottle is also produced in the factory. The equipments used for polymerization allow for processing of high viscous polymers. So Arjun decided to use polymerization technique that can provide maximum yield for maximum benefit. The produced polymer is then processed to form plastic bottle. During the processing of polymer different type of polymers are added mainly to lower the glass transition temperature of plastic and provide it desired color. Based on the provided information answer the following-
- Which technique of polymerization is used for making polymer? Explain the same technique.
 - What are the additives used for processing of polymers?
 - Which is the most common polymer processing technique used for making bottles? Explain the technique used.
- (C.O.No.1, C.O.No.2, C.O.No.3) [Comprehension]
10. A 9 gm polymer solution of polyethylene has four type of polymer chains. The molecular weight and weight contribution for the following is as follows-

Weight(gm)	Molecular weight
3	12000
3	17000
3	19000

- Determine number average molecular weight.
- Determine weight average molecular weight.
- Explain the term polydispersity index and find its value for given solution.

(C.O.No.1) [Application]



SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type	Thought provoking type	Problem Solving type	Total Marks
			[Marks allotted]	[Marks allotted]	[Marks allotted]	
			Bloom's Levels	Bloom's Levels	[Marks allotted]	
			K	C	C/A	
1	1	1	6			6
2	1,3	1,3	6			6
3	2	2	6			6
4	2	2	6			6
5	3	3	6			6
6	4	4	6			6
7	4	4		10		10
8	2	2		10		10
9	1,2,3	1,2,3			12	12
10	1	1			12	12
	Total Marks		36	20	24	80

K = Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

Reviewer Comment:

Format of Answer Scheme



SCHOOL OF ENGINEERING

SOLUTION

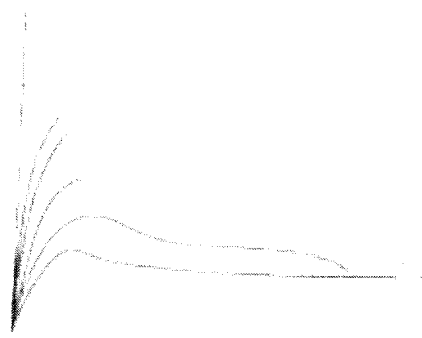
Semester: Odd Sem. 2019-20
Course Code: PET 406
Course Name: Polymer Technology
Program & Sem: B.Tech (PET)-VII Sem

Date: 26.12.2019
Time: 9:30 AM- 12:30 PM
Max Marks: 80
Weightage: 40%

Part A

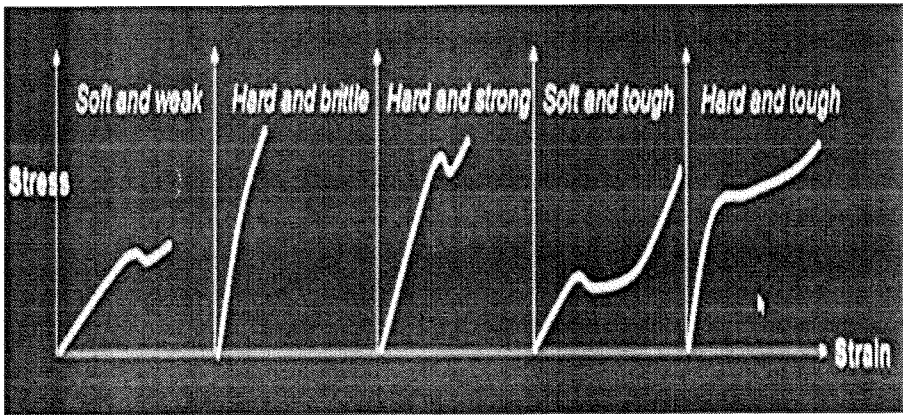
(6Q x 6M = 36Marks)

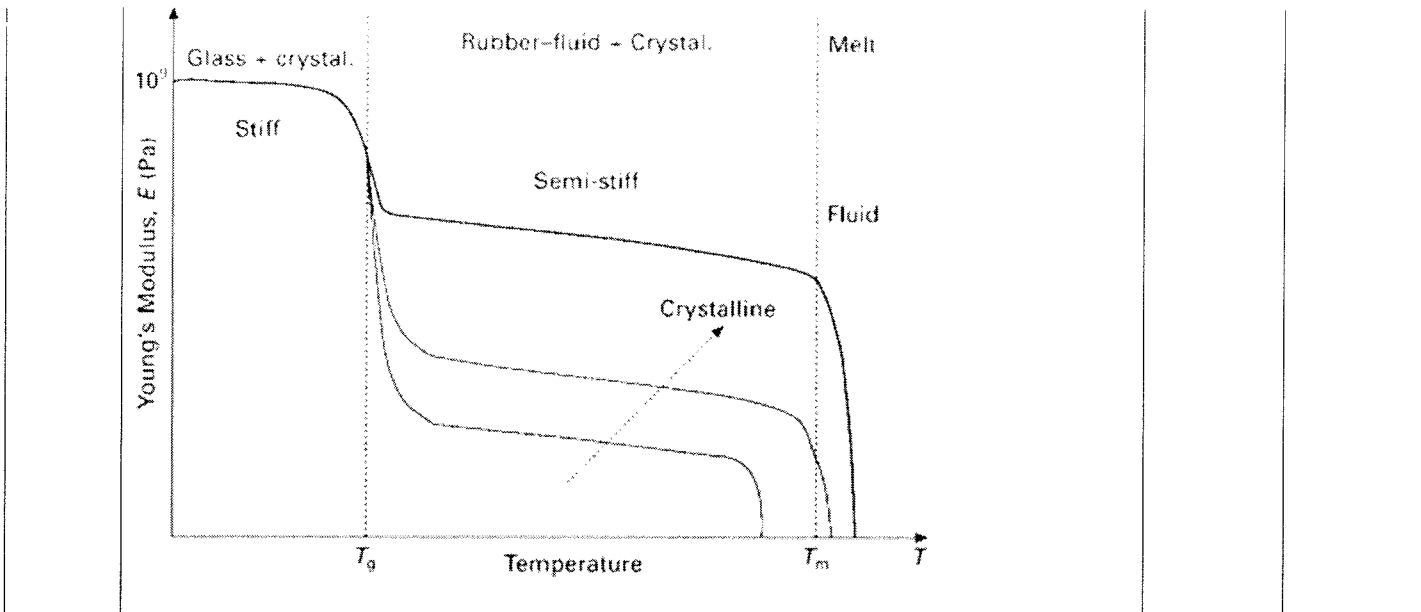
Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	<p><u>Chain initiation</u> is the process of initially generating an active site (such as radical and ions) in a chain polymerization.</p> <p><u>Chain propagation</u> involves addition of new monomers at the active site to increase the length of polymer chain.</p> <p><u>Chain termination</u> refers to process of removing active center in the chain, resulting in the termination of chain propagation. It is different from chain transfer.</p>	2 X 3	10 min
2	<ul style="list-style-type: none">a) Suspension polymerizationb) Bulk polymerizationc) Suspension and emulsion polymerizationd) Solution polymerizatione) Calenderingf) Molding	1 X 6	10 min
3	<p>Glass transition temperature is the maximum temperature at which free motion of entangled chains of amorphous polymer ceases. It is represented as T_g and is defined for amorphous polymer only. Polymer will be in solid state at any temperature below the glass transition temperature.</p> <p>Melting temperature is the temperature at which the crystalline product leaves its crystalline nature and converts back to liquid, on further increase of temperature</p>	3 X 2	10 min
4	<p>Crystalline polymers are comprised of uniform rigid chain packing. The crystal structure lacks both the sorption sites as well as the mobility of the chains to allow high mass transfer of gas molecules. These polymers are more brittle in nature as compared to amorphous polymers.</p>	6	10 min

	<ul style="list-style-type: none"> • Above glass-transition temp. – polymers become leathery and then rubbery • At higher temperatures, polymers become a viscous fluid, with viscosity decreasing with increasing temperature. 		
5	<p>a) Colorants – These are the additives which provide desired color to the polymer product. These include soluble dyes or pigments.</p> <p>b) Blowing agent – These are the additives which are used to provide foamy structure to the polymer products. This can be done by physical transformation of additives or due to chemical reaction.</p> <p>c) Plasticizer - These are the polymers additives that are used to reduce the glass transition temperature of a polymer product. These further help to reduce the modulus and thus brittleness of the polymer product.</p>	2 X 3	10 min
6	<ul style="list-style-type: none"> • Proteins are large biomolecules, or macromolecules, consisting of one or more long chains of amino acid residues. Proteins perform a vast array of functions within organisms, including catalyzing metabolic reactions, DNA replication, responding to stimuli, and transporting molecules from one location to another. • A polynucleotide molecule is a biopolymer composed of 13 or more nucleotide monomers covalently bonded in a chain. DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) are examples of polynucleotides with distinct biological function. DNA consists of two chains of polynucleotides, with each chain in the form of a helical spiral. DNA provides the storage sites for genetic information within the chromosomes of the cell nucleus. RNA molecules transmit information coded into their structure to their ribosomes where protein synthesis occurs. • Polysaccharides are polymeric carbohydrate molecules composed of long chains of monosaccharide units bound together by glycoside linkages, and on hydrolysis give the constituent monosaccharides or oligosaccharides. They range in structure from linear to highly branched. Examples include storage polysaccharides such as starch and glycogen, and structural polysaccharides such as cellulose and chitin. 	2 X 3	10 min

Part B

(2Q x 10M = 20 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
7	<p>Plastic recycling is the process of recovering scrap or waste plastic and reprocessing the material into useful products. Since the vast majority of plastic is non-biodegradable, recycling is a part of global efforts to reduce plastic in the waste stream</p> <p>Plastics becomes easy to recycle, Besides the invention of new plastic recycling technology, Plastic Recycling protects the environment, It spreads awareness for the environment, It promotes judicious and sustainable use of resources and it creates green jobs.</p> <p>Plastic Recycling saves the Earth, It can help minimize the cutting of trees that are used to make the paper, conserving the forests will help the environment, This is because the trees are known to improve the air, prevent the floods and provide the raw materials and the nourishment.</p> <p>Plastic Recycling conserves the energy, Processing the raw materials that come from the trees and the other natural resources takes more energy than recycling materials, we are minimizing the use of energy that can decrease the pollution, minimize the health risk and help the economy.</p> <p>Plastic Recycling helps in mitigating the global warming and in reducing the pollution, The fossil fuels use that emit such harmful gases will be minimized, And by recycling non-biodegradable waste, The air pollution and greenhouse gas emissions will be reduced</p>	10	20 min
8	 <p>If the crystalline nature of the polymers will increase then the polymer product will become more brittle and hard.</p>	5 + 5	20 min



Part C

(2Q x 12M = 24Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
9	<p>a) In bulk polymerization undiluted monomer is used along with soluble initiator to pure monomer. As no solvent is present, the final product contains only polymer molecule. Thus it is stated that bulk polymerization has maximum yield.</p> <p>b) Colorants – These are the additives which provide desired color to the polymer product. These include soluble dyes or pigments. Plasticizer - These are the polymers additives that are used to reduce the glass transition temperature of a polymer product. These further help to reduce the modulus and thus brittleness of the polymer product.</p> <p>c) Blow molding is the process of forming a molten tube (referred to as the parison or preform) of thermoplastic material (polymer or resin) and placing the parison or preform within a mold cavity and inflating the tube with compressed air, to take the shape of the cavity and cool the part before removing from the mold</p>	4 X 3	20 min
10	<p>a) No. average molecular weight = $\frac{\sum NiMi}{\sum Ni}$ = 15401</p> <p>b) Weight average molecular weight = $\frac{\sum NiMi^2}{\sum NiMi}$ = 16000</p> <p>c) Polydispersity index - The polydispersity index (PDI) or heterogeneity index, is a measure</p>	4 X 3	20 min

	<p>of the distribution of molecular mass in a given polymer sample. It is mathematically defined as ratio of weight average molecular weight and no. average molecular weight. PDI = 1.038</p>		
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