

CHAPTER 14

POLYMERS

Syllabus

- Copolymerization, some important polymers : natural and synthetic like polythene, nylon, polyesters, bakelite, rubber. Biodegradable and non-biodegradable polymers.

Chapter Analysis

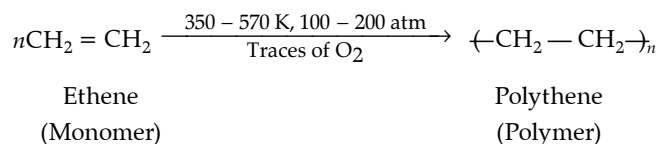
List of Topics	2016		2017		2018
	D	OD	D	OD	D/OD
Polymerization of ethene	1Q (3 marks)*	-	-	-	-
Identification/Structure of monomers in polymers	1Q (3 marks)*	1Q (3 marks)#	1Q (3 marks)	1Q (3 marks)	-
Properties of Polymers	1Q (3 marks)*	1Q (3 marks)#	-	-	-
Vulcanization of Rubber	-	1Q (3 marks)#	-	-	-

- * One question of 3 marks was asked. First choice have questions on Polymerization of Ethene, Identification of Monomers in polymer and arrangement of polymers in their increasing Intermolecular Forces.
- #One question of 3 marks on Vulcanization of Rubber, Identification of Monomers in polymer and arrangement of polymers in their increasing Intermolecular Forces was asked.

On the basis of above analysis, it can be said that from exam point of view, Identification/Structure of monomers in polymers and Properties of Polymers are the most important topics of the chapter.

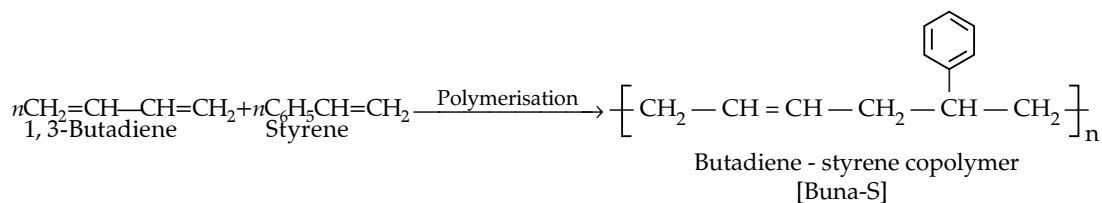
Revision Notes

- **Polymers** : Polymers are defined as the high molecular mass macromolecules, which consists of repeating structural units derived from the corresponding monomers.
- **Polymerisation** : The process by which monomers are converted into polymers is called polymerisation.

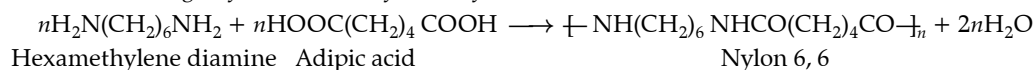


- **Natural Polymers** : They are found in nature, mostly in plants and animals *e.g.*, proteins, natural rubber etc.
- **Synthetic Polymers** : These are man-made polymers prepared in the laboratory. *e.g.*, polythene, teflon, nylon etc.
- Copolymerisation is a polymerisation reaction in which a mixture of more than one monomeric species is allowed to polymerise.
- **Copolymers** : The polymers made by addition polymerisation from two different monomers.





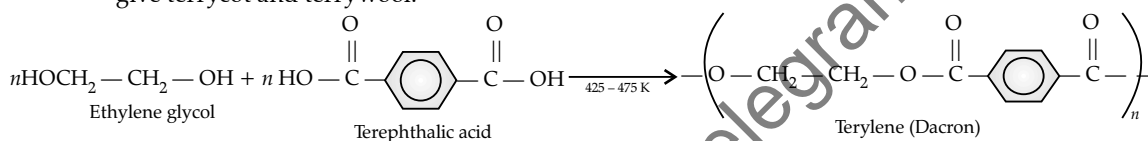
- **Condensation Polymers :** These polymers are formed by the repeated condensation reactions between different bifunctional or trifunctional monomer units usually with elimination of small molecules such as water, alcohol, hydrogen chloride etc. *e.g.*, nylon 6, 6 and nylon, terylene etc.



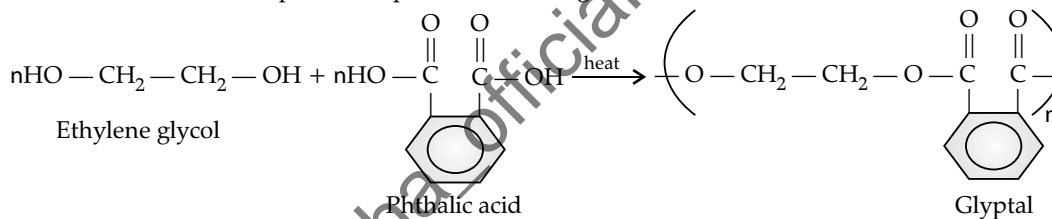
- **Condensation Polymers :**

(a) **Polyesters :** These are polymers having large number of ester linkages. *e.g.*,

(i) **Terylene :** It is resistant to action of chemical and solvent. It has a low moisture absorbing power. It is also called **dacron**. It is used in dress materials like sarees. It is used as a blend with cotton and wool to give terrycot and terrywool.

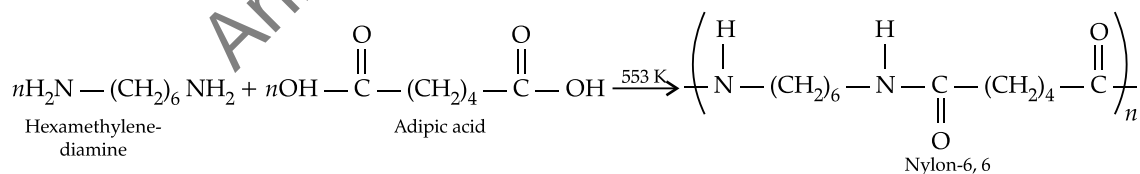


(ii) **Glyptal or alkyl resin :** These are three dimensional cross-linked polymers. It is tough and flexible. It is used in adherent paints, lacquers and building materials like asbestos and cement.

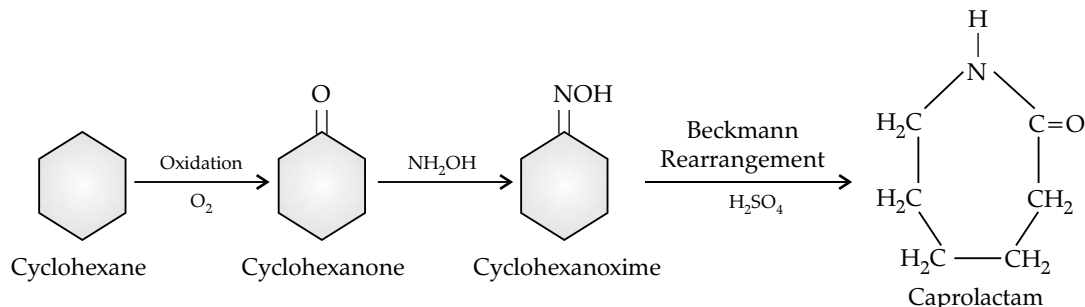


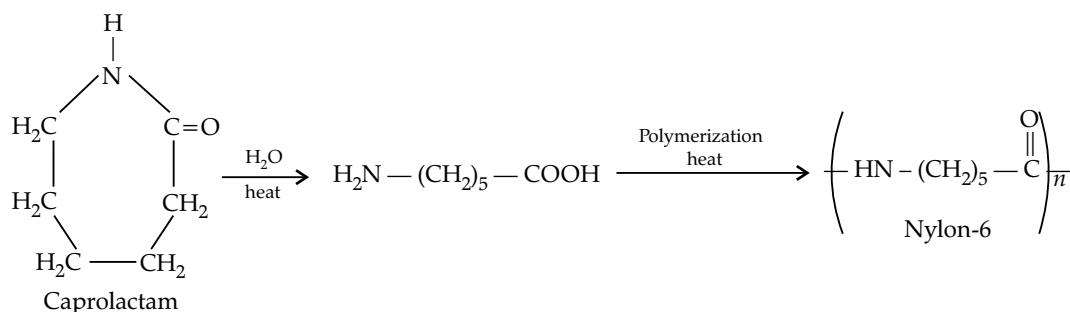
(b) **Polyamides :** Those polymers which have large number of amide linkages are called polyamides, *e.g.*,

(i) **Nylon-6, 6 :** It can be cast into sheets or fibres. Nylon fibres have high tensile strength. They are tough and resistant to abrasion. They are also elastic in nature. It is used to make bristles of toothbrush, climbing ropes, fishing nets and parachute fabrics. It is a condensation polymer of adipic acid and hexamethylene diamine.

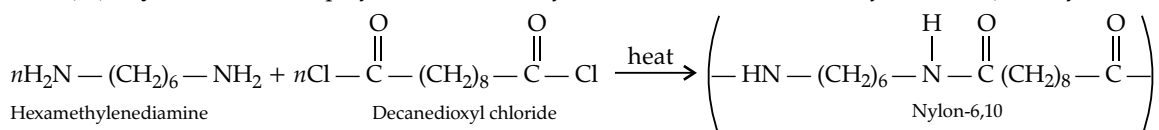


(ii) **Nylon-6 :** It can be cast into sheets and fabrics. It is tough and strong.

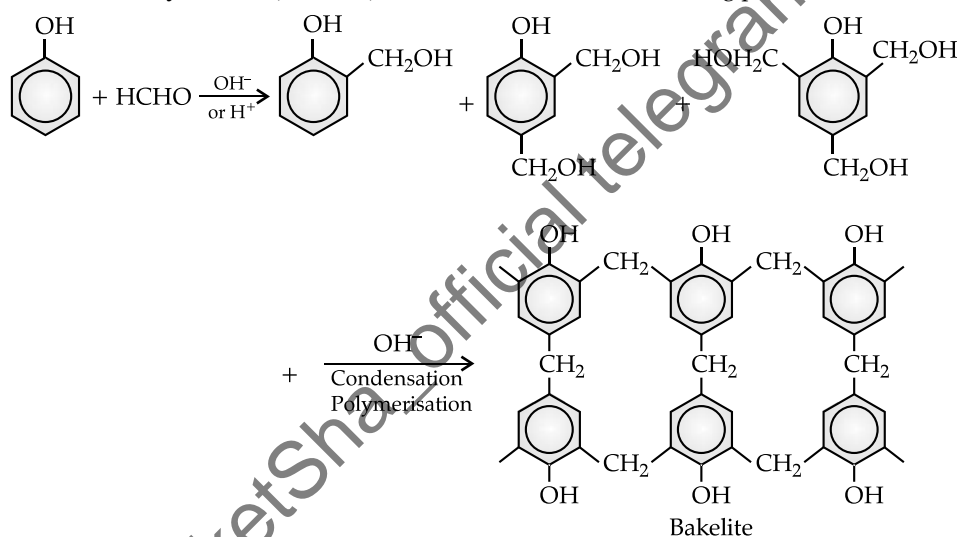




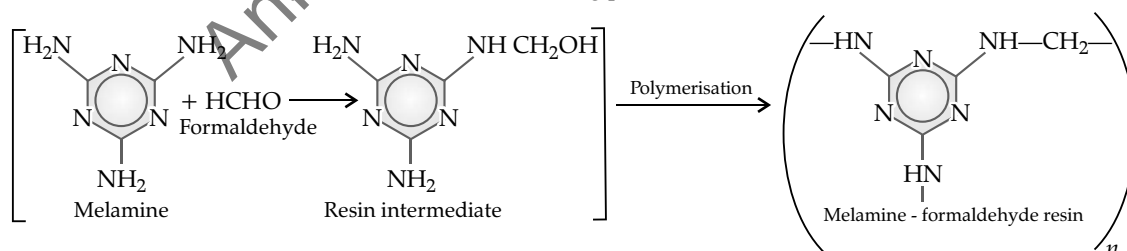
(iii) **Nylon-6, 10** : It is a polymer of hexamethylenediamine and decanedioyl chloride (sebacoyl chloride).



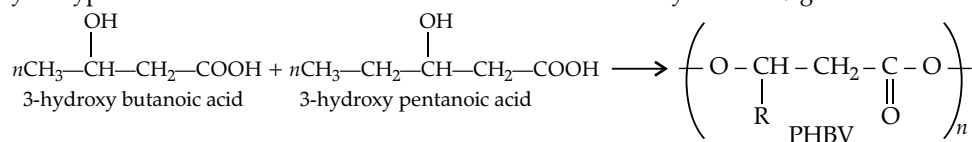
(c) **Phenol-formaldehyde resin (Bakelite)** : It is heat resistant thermosetting plastic.



(d) **Melamine-formaldehyde resin** : It is thermosetting plastic which is unbreakable.



- **Low density polyethene** : It is produced by free radical polymerisation at high temperature (200°C) and high pressure about 1000 – 2000 atm. It is a branched chain polymer.
 - **High density polyethene** : It is produced by polymerisation of ethene in presence of Ziegler-Natta catalyst at temperature below 100°C and pressure 6-7 atmosphere. It is a linear polymer.
 - **Biodegradable polymers** : Those polymers which are biodegradable, *i.e.*, decomposed by micro-organisms and do not cause water pollution, *e.g.*, PHBV, Poly (Glycolic acid) and Poly (Lactic acid) etc.
- (i) **PHBV (Poly-β-hydroxybutyrate-co-β-hydroxy valerate)** : It is a copolymer of 3-hydroxybutanoic acid and 3-hydroxypentanoic acid in which the monomers are connected by ester linkages.



The properties of PHBV vary according to ratio of both the acids. 3-hydroxybutyric acid provides stiffness and 3-hydroxypentanoic acid provides flexibility to copolymer. It is used in speciality packaging, orthopaedic devices and even in controlled drug release. It is biodegradable.

(ii) Poly (Glycolic acid) and Poly (Lactic acid) are biodegradable polymers and used in sutures. Dextron was the first bioabsorbable suture made from biodegradable polyesters for post-operative stitches.

➤ **Non-biodegradable polymers:** Those polymers which do not degrade in environment and accumulate in the form of waste, e.g., polythene, polystyrene, etc. They consist of long chains of carbon and hydrogen atoms joined by strong interatomic bonding making it hard for microbes to break the bonds and digest them.

➤ **Natural, Synthetic and Condensation Polymers :**

Natural Polymers

S. No.	Polymer	Monomer	Class	Uses
(i)	Cellulose	β -Glucose	Biopolymer	Occurs in cotton, cell wall
(ii)	Starch	α -Glucose	Biopolymer	Food material storage in plants
(iii)	Proteins	Amino acids	Biopolymer	Essential for growth
(iv)	Nucleic acid	Nucleotides	Biopolymer	Essential for life perpetuation
(v)	Rayon (Artificial silk)	β -Glucose	Processed cellulose	Fabrics, surgical dressings
(vi)	Natural rubber	<i>cis</i> -Isoprene (<i>cis</i> -2-methyl-1, 3-butadiene)	Natural polymer Elastomer	Used for tyres after vulcanisation
(vii)	Gutta percha	<i>trans</i> -Isoprene	Elastomer	Rubber like material

Synthetic Polymers

S. No.	Polymer	Monomer	Class	Uses
(i)	Polyethene	Ethene ($\text{CH}_2 = \text{CH}_2$)	Addition and Chain growth	Electrical insulator, packing materials, films, bottles etc.
(ii)	Polypropene	Propene ($\text{CH}_2 = \text{CH} - \text{CH}_3$)	Addition and Chain growth	Storage battery tanks
(iii)	Polystyrene	Styrene ($\text{C}_6\text{H}_5 - \text{CH} = \text{CH}_2$)	Addition and Chain growth	In combs, plastic handles, toys
(iv)	Polyvinyl chloride (PVC)	$\text{CH}_2 = \text{CHCl}$ Vinyl chloride	Addition and Chain growth	Pipes, raincoats, vinyl floorings
(v)	Polytetrafluoroethene (PTFE) (Teflon)	$\text{CF}_2 = \text{CF}_2$ Tetrafluoroethene	Addition and Chain growth	Non-stick kitchenwares, electrical insulator
(vi)	Polymonochlorotrifluoroethene	$\begin{array}{c} \text{Cl} \\ \\ \text{F} - \text{C} = \text{CF}_2 \end{array}$ Monochlorotrifluoroethene	Addition and Chain growth	Non-stick kitchenwares
(vii)	Polymethyl methacrylate (PMMA) (Perspex, Lucite or Acrylite)	$\text{CH}_3 - \text{C}(\text{COOCH}_3) = \text{CH}_2$ Methyl methacrylate	Addition and Chain growth	Substitute of glass and decorative material
(viii)	Polyethyl acrylate	$\text{CH}_2 = \text{CH} - \text{COOC}_2\text{H}_5$ Ethyl-2-propenoate	Addition and Chain growth	Lacquers, films, house piping
(ix)	Polyvinyl acetate	$\text{CH}_2 = \text{CH} - \text{O} - \text{COCH}_3$	Addition and Chain growth	Floor coverings and fibres
(x)	Vinylite	Vinyl chloride and vinyl acetate	Addition and Chain growth	Vinyl floorings
(xi)	Polyacrylonitrile or Acrylane (orlon)	$\text{CH}_2 = \text{CH} - \text{C} \equiv \text{N}$ Vinyl cyanide (Acrylonitrile)	Addition and Chain growth	It closely resembles wool
(xii)	Buna-S	1, 3-Butadiene and styrene	Addition and Chain growth	Automobile tyres
(xiii)	Buna-N	1, 3-Butadiene and acrylonitrile	Addition and Chain growth	Used for storing oil and solvents



(xiv)	Neoprene	2-Chloro-1, 3-butadiene (Chloroprene)	Addition and Chain growth	Insulation, conveyor belt
(xv)	Thiokol	1, 2-Dichloroethene and sodium polysulphide	Condensation polymer	Rocket propellant
(xvi)	Poly- β -hydroxybutyrate-co- β -hydroxyvalerate (PHBV)	$\begin{array}{c} \text{OH} \\ \\ \text{CH}_3-\text{CH}-\text{CH}_2-\text{COOH} \end{array}$ $\begin{array}{c} \text{OH} \\ \\ \text{CH}_3-\text{CH}_2-\text{CH}-\text{CH}_2-\text{COOH} \end{array}$	Condensation Polymer	As packaging, orthopaedic and in controlled drug release.
(xvii)	Nylon-2-Nylon-6	Glycine ($\text{H}_2\text{NCH}_2\text{COOH}$) and aminocaproic acid $\text{H}_2\text{N}(\text{CH}_2)_5\text{COOH}$	Condensation polymer	Biodegradable polymer

S. No.	Polymer	Monomer	Class	Uses
1.	Polyesters (Terylene) Dacron	Terephthalic acid and ethylene glycol	Condensation and step growth	Ropes, safety belts, tyre cards.
2.	Glyptal (Alkyd resin)	Phthalic acid and ethylene glycol	Condensation and step growth	Binding material, paints and lacquers
3.	Nylon-6	Caprolactam (cyclic amide)	Condensation and step growth	Fibre, plastic, tyre-cords and ropes
4.	Nylon-6, 6	Adipic acid and hexamethylenediamine	Condensation and step growth	Stockings, shirts, ropes
5.	Bakelite	Phenol and formaldehyde	Condensation and step growth	Electric switches and switch-boards
6.	Melamine formaldehyde resin	Melamine and HCHO	Condensation and step growth	Crockery
7.	Urea formaldehyde resin	Urea and HCHO	Condensation and step growth	Crockery and laminated sheets

Know the Terms

- **Plasticizers** : These are the substances which are added in the formation of polymers in order to alter their physical properties.
- **PMMA** : It represents polymethylmethacrylate polymer.
- **PAN** : It represents polyacrylonitrile polymer.
- **PTFE** : It represents polytetrafluoroethylene polymer.
- **PCTFE** : It represents polychlorotrifluoroethylene polymer.

? Very Short Answer-Objective Type Questions (1 mark each)

A. Multiple choice Questions:

Q. 1. Which of the following polymers of glucose is stored by animals?

- (a) Cellulose (b) Amylose
(c) Amylopectin (d) Glycogen

[R] [NCERT Exemp. Q. 1., Page 217]

Ans. Correct option : (d)

Explanation : Glycogen is a polymer of glucose found in liver, brain and muscles of animals. Cellulose is a polymer found in plant while amylose and amylopectin are structural units of starch.

Q. 2. Which of the following is not a semisynthetic polymer?

- (a) cis-polyisoprene (b) Cellulose nitrate
(c) Cellulose acetate (d) Vulcanised rubber

[R] [NCERT Exemp. Q. 2., Page 217]

Ans. Correct option : (a)

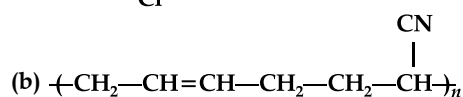
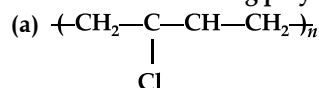
Q. 3. The commercial name of polyacrylonitrile is

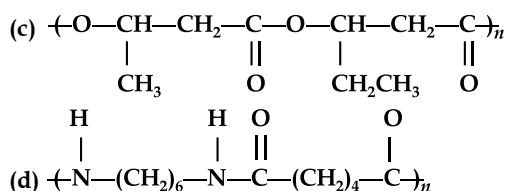
- (a) Dacron (b) Orlon (acrilan)
(c) PVC (d) Bakelite

[R] [NCERT Exemp. Q. 3., Page 217]

Ans. Correct option : (b)

Q. 4. Which of the following polymer is biodegradable?





[A] [NCERT Exemp. Q. 4., Page 217]

Ans. Correct option : (c)

Q. 5. Which of the following statements is not true about low density polythene?

- (a) Tough
(b) Hard
(c) Poor conductor of electricity
(d) Highly branched structure

[U] [NCERT Exemp. Q. 6., Page 218]

Ans. Correct option : (b)

Explanation : Low density polythene is tough but not hard (its flexible) and a poor conductor of electricity. It has a highly branched structure.

B. Match the following :

Q. 1. Match the species given in Column I with those mentioned in Column II.

Column I (Polymers)	Column II (Chemical name)
(a) Nylon 6	(i) Polyvinyl chloride
(b) PVC	(ii) Polyacrylonitrile
(c) Acrilan	(iii) Polycaprolactam
(d) Natural rubber	(iv) Low density polythene
(e) LDP	(v) cis-polyisoprene

[NCERT Exemp. Q. 39, Page 222]

Ans.

Column I	Column II	Explanation
(a)	(iii)	Nylon 6 is only made from one kind of monomer, a monomer called caprolactam.
(b)	(i)	Polyvinyl chloride (PVC), a synthetic resin made from the polymerization of vinyl chloride.
(c)	(ii)	Acrilan is an addition polymer made from the monomer named acrylonitrile (cyanoethene).
(d)	(v)	Polyisoprene, polymer of isoprene (C ₅ H ₈) that is the primary chemical constituent of natural rubber, of the naturally occurring resins balata and gutta-percha, and of the synthetic equivalents of these materials.

(e)	(iv)	Low-density polyethylene (LDPE) is a thermoplastic made from the monomer ethylene.
-----	------	--

C. Answer the following:

[AI] Q. 1. Which of the following is natural polymer. Buna-S, Protein, PVC ? [R] [CBSE OD 2014; DDE]

Ans. Protein. 1
[CBSE Marking Scheme 2014]

Q. 2. Based on molecular forces what type of polymer is neoprene ? [R] [CBSE OD 2014]

Ans. Elastomer. 1
[CBSE Marking Scheme 2014]

Q. 3. Which of the following is a fibre : Nylon, Neoprene, PVC ? [R] [CBSE OD 2014]

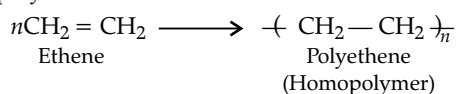
Ans. Nylon. 1
[CBSE Marking Scheme 2014]

Q. 4. Give one example of condensation polymer. [R] [CBSE OD 2013]

Ans. Nylon-6, 6. 1

Q. 5. Define the term homopolymerisation giving an example. [R] [CBSE Delhi 2012]

Ans. Homopolymerisation : The polymers formed by the polymerisation of single monomeric species are known as homopolymers and the process is known as homopolymerisation. e.g., formation of polyethene. 1



Q. 6. Draw the structure of the monomer for the following polymer :

(i) Polypropene. [R] [CBSE Delhi 2012]

Ans. (i) CH₂ = CH-CH₃ (Propene) is the monomer for polypropene. 1

Q. 7. Is $\left(\text{---} \text{CH}_2 - \underset{\text{Cl}}{\text{CH}} \text{---} \right)_n$ a homopolymer or copolymer ?

[A] [CBSE OD 2013]

Ans. Homopolymer, because it contains single type monomer unit. i.e., CH₃-CH₂ undergoes

polymerisation. 1

Commonly Made Error

- Students get confused between a homopolymer and a copolymer. Understand each with the help of examples for better clarity.

[AI] Q. 8. Is $\left(\text{---} \text{CH}_2 - \underset{\text{C}_6\text{H}_5}{\text{CH}} \text{---} \right)_n$ a homopolymer or copolymer ?



[A] [CBSE OD 2013]



Ans. It is a homopolymer because single type of monomer unit *i.e.*, $C_6H_5 - CH = CH_2$ undergoes polymerisation. 1

Q. 9. Write the name of the biodegradable polymer used in orthopaedic devices.

[R] [CBSE SQP 2018-2019]

Ans. Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) 1

[CBSE Marking Scheme 2018]

[AI] Q. 10. Why are rubbers called elastomers ?

[A&E] [NCERT Exemplar; KVS]

Ans. Rubber are stretched on application of force and come to its original position after the force is removed. Therefore, these are called elastomers. 1

Q. 11. Which factor imparts crystalline nature to a polymer like nylon ?

[U] [NCERT Exemplar]

Ans. Strong intermolecular forces like hydrogen bonding and linear structure lead to close packing of polymer chains that imparts crystalline character. 1

? Short Answer Type Questions

(2 marks each)

Q. 1. Define the thermoplastic and thermosetting polymers. Give one example of each.

[R] [CBSE OD 2013; DDE]

Ans. **Thermoplastics** : Thermoplastics are the ones in which intermolecular forces of attraction are intermediate of those of elastomers and fibres. $\frac{1}{2}$
e.g., Polythene, Polypropylene, PVC. $\frac{1}{2}$

Thermosetting polymers : Thermosetting polymers are the ones on which heating change irreversibly into hard, rigid and infusible materials are called thermosetting polymers. $\frac{1}{2}$

e.g., Phenol-formaldehyde (bakelite) resins, melamine formaldehyde resins. $\frac{1}{2}$

[AI] Q. 2. What is biodegradable polymer ? Give an example of a biodegradable aliphatic polyester.

[R] [CBSE OD 2013]

Ans. **Biodegradable polymers** : Biodegradable polymers are polymers which contain functional groups similar to the functional groups present in biopolymers but are degradable and does not pose hazard to atmosphere *e.g.*, (PHBV). 1

Poly β -hydroxybutyrate-co- β -hydroxy Valerate (PHBV) : It is obtained by the copolymerization of 3-hydroxy butanoic acid and 3-hydroxypentanoic acid. 1

Q. 3. Write the names of monomers used for getting following polymers.

[R] [CBSE OD Set-1 2014]

(i) Bakelite, (ii) Neoprene.

Ans. (i) Phenol and Formaldehyde. 1

(ii) 2-Chloro-1, 3-butadiene (or Chloroprene) 1

[CBSE Marking Scheme 2014]

Q. 4. Write the name of monomers used for getting the following polymers :

(i) Terylene

(ii) Nylon 6, 6

[R] [CBSE OD 2014]

Ans. (i) Ethylene glycol (Ethane-1, 2-diol) and terephthalic acid (Benzene-1, 4-dicarboxylic acid) 1

(ii) Hexamethylenediamine and adipic acid. 1

[CBSE Marking Scheme 2014]

Q. 5. Write the name of monomers used for getting the following polymers :

(i) Teflon (ii) Buna-S

[R] [CBSE OD 2014]

Ans. (i) Tetrafluoroethene 1

(ii) 1, 3-Butadiene and styrene. 1

[CBSE Marking Scheme 2014]

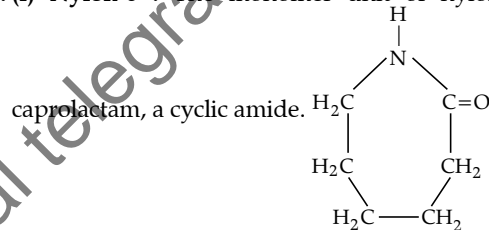
[AI] Q. 6. Draw the structure of the monomer for each of the following polymers :

(i) Nylon-6

(ii) Polypropene

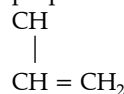
[R] [CBSE Delhi 2014]

Ans. (i) Nylon-6 : The monomer unit of nylon-6 is



1

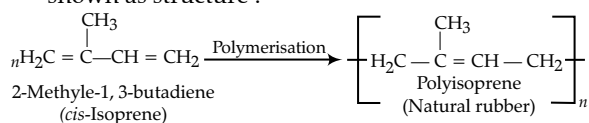
(ii) Polypropene : The monomer unit of polypropene is propene. 1



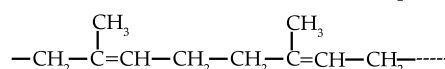
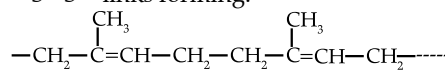
Q. 7. A natural linear polymer of 2-methyl-1, 3-butadiene becomes hard on treatment with sulphur between 373 K and 415 K and —S—S— bonds are formed between chains. Write the structure of the product of this treatment?

[A] [NCERT Exemp. Q. 20., Page 221]

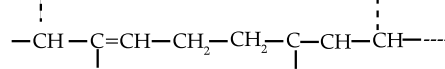
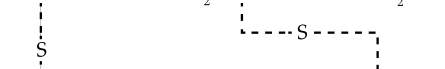
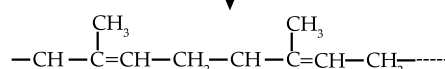
Ans. Vulcanised rubber is the product of this treatment. It can be represented through the following reaction shown as structure :



When it is heated with S at 373–415 K, it results into —S—S— links forming.



Natural linear, polymer
Sulphur ↓ Heat (373-415 K)



Vulcanized rubber

2

Q. 8. (i) To have practical applications, why are cross links required in rubber?

[A&E] [NCERT Exemp. Q. 30., Page 221]

(ii) Why does cis-polyisoprene possess elastic property? [A&E] [NCERT Exemp. Q. 31., Page 221]

Ans. (i) Cross links bind the planar polymer sheets thus increasing its elastomeric properties which

helps the polymer to retract to its original position after the force is released. This makes the rubber hard, tough and highly elastic with greater tensile strength. 1

(ii) Cis-polyisoprene molecule consists of multiple chains held together by van der Waals interactions and has a coiled structure. Thus, it can be stretched like a spring and shows elastic properties. 1

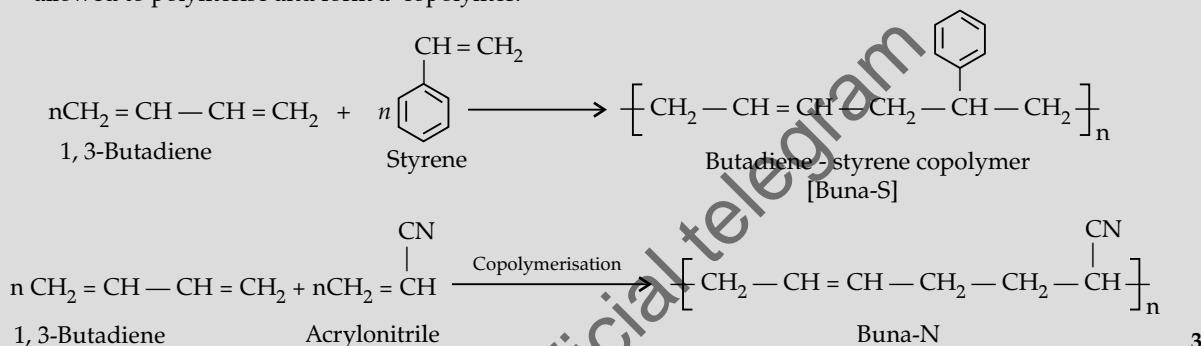


Long Answer Type Questions-I

(3 marks each)

[AI] Q. 1. Explain the term 'copolymerization' and give two examples of copolymerization. [R] [CBSE Comptt. OD 2015]

Ans. Copolymerisation is a polymerisation reaction in which a mixture of more than one monomeric species is allowed to polymerise and form a copolymer.



(or any other correct example)
[CBSE Marking Scheme 2015]

Answering Tip

- While giving examples, draw the structure of the compounds.

[AI] Q. 2. Write the names and structures of the monomers of the following polymers :

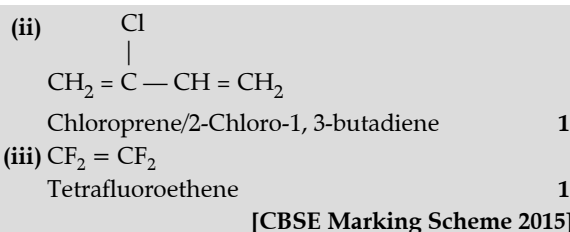
(i) Buna-S

(ii) Neoprene

(iii) Teflon.

[R] [CBSE Comptt. Delhi 2015]

Ans. (i) $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$ and $\text{C}_6\text{H}_5\text{CH}=\text{CH}_2$
1, 3-Butadiene Styrene 1



Q. 3. Write the names and structures of the monomers of the following polymers :

(i) Nylon-6, 6

(ii) PHBV

(iii) Neoprene

[R] [CBSE Delhi 2015]

Ans.

	Polymer	Name of monomer	Structure of monomer	
(i)	Nylon 6, 6	Hexamethylene diamine and Adipic acid	$\text{NH}_2-(\text{CH}_2)_6-\text{NH}_2$ $\text{COOH}-(\text{CH}_2)_4-\text{COOH}$	1
(ii)	PHBV	3-hydroxybutanoic acid 3-hydroxypentanoic acid	$\text{CH}_3-\text{CH}(\text{OH})-\text{CH}_2-\text{COOH}$ $\text{CH}_3-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2-\text{COOH}$	1

(iii)	Neoprene	2-chloro - 1, 3 - butadiene	$\begin{array}{c} \text{CH}_2 = \text{C} - \text{CH} = \text{CH}_2 \\ \\ \text{Cl} \end{array}$	1
-------	----------	-----------------------------	---	---

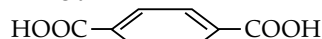
Q. 4. Write the names and structures of the monomers of the following polymers :

(i) Terylene

(ii) Buna-S

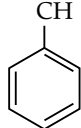
(iii) Neoprene [CBSE OD 2015]

Ans. (i) Ethylene glycol $\text{HO}-\text{CH}_2-\text{CH}_2-\text{OH}$ $\frac{1}{2} + \frac{1}{2}$



Terephthalic acid

(ii) 1,3 butadiene $\begin{array}{c} \text{CH}_2 = \text{CH} - \text{CH} = \text{CH}_2 \\ | \\ \text{CH} = \text{CH}_2 \end{array}$ $\frac{1}{2} + \frac{1}{2}$



Styrene

(iii) Chloroprene $\text{CH}_2 = \text{C}(\text{Cl})-\text{CH} = \text{CH}_2$

(Note : Half mark for name/s and half mark for structure/s in each case) $\frac{1}{2} + \frac{1}{2}$

Commonly Made Error

- Drawing incorrect structures of monomers.

Answering Tip

- Practice drawing of monomeric structures.

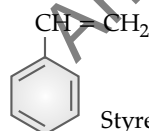
Q. 5. Write the names and structures of the monomers of the following polymers :

(i) Polystyrene, (ii) Dacron, (iii) Teflon.

[CBSE Delhi 2013; DDE]

Ans. (i) Polystyrene : Monomer : Styrene (vinyl benzene) $\frac{1}{2}$

Structure :

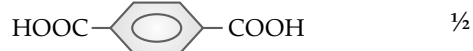


Styrene

(ii) Dacron : Monomer : Ethylene glycol



and Terephthalic acid



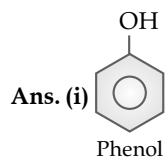
(iii) Teflon : Monomer : Tetrafluoro ethene



Q. 6. Write the names and structures of the monomers of the following polymers :

(i) Bakelite (ii) Nylon-6 (iii) Polythene

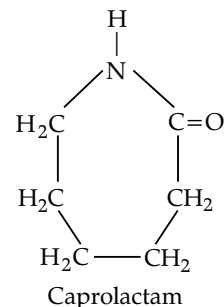
[CBSE Delhi 2013; DDE]



HCHO
Formaldehyde

$\frac{1}{2} + \frac{1}{2}$

(ii)



Caprolactam

$\frac{1}{2} + \frac{1}{2}$

(iii) $\text{CH}_2 = \text{CH}_2$ (Ethene) $\frac{1}{2} + \frac{1}{2}$

Q. 7. Write the structure of the monomers used for getting the following polymers :

(i) Dacron

(ii) Melamine-formaldehyde polymer

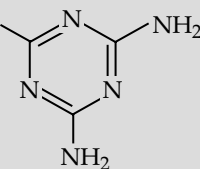
(iii) Buna-N [CBSE Delhi Set-1 2017]

Ans. (i) $\text{HOCH}_2\text{CH}_2\text{OH} + \text{HOOC}-\text{C}_6\text{H}_4-\text{COOH}$

$\frac{1}{2} + \frac{1}{2}$

(ii) $\text{H}_2\text{N}-\text{C}_6\text{H}_3(\text{NH}_2)_2-\text{N}$

$\frac{1}{2} + \frac{1}{2}$



+ HCHO

(iii) $\text{CH}_2 = \text{CH}-\text{CH} = \text{CH}_2 + \text{CH}_2 = \text{CHCN}$ $\frac{1}{2} + \frac{1}{2}$

[CBSE Marking Scheme 2017]

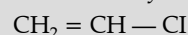
Q. 8. Write the structures of the monomer used for getting the following polymers :

(i) Polyvinyl chloride (PVC)

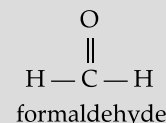
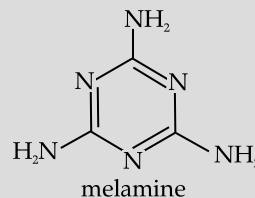
(ii) Melamine-formaldehyde polymer

(iii) Buna-N [CBSE OD Set-2 2017]

Ans. (i) Monomer of PVC is vinyl chloride



(b) Monomer of melamine formaldehyde polymer are melamine and formaldehyde



(iii) The monomers of Buna-N are buta-1, 3 - diene and acrylonitrile



buta - 1, 3 - diene

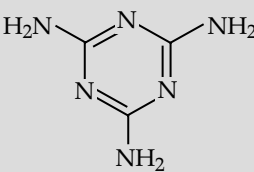
acrylonitrile 3

[CBSE Marking Scheme 2017]

Q. 9. Write the structures of the monomer used for getting the following polymers :

- (i) Teflon
 (ii) Melamine-formaldehyde polymer
 (iii) Neoprene [R] [CBSE OD Set-3 2017]

Ans. (i) $\text{CF}_2=\text{CF}_2$ 1

(ii)  1

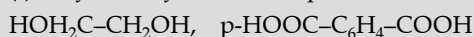
and + HCHO

(iii)  [CBSE Marking Scheme 2017] 1

[R] Q. 10. Write the names and structure of the monomer of the following polymer :

- (i) Terylene
 (ii) Teflon
 (iii) Nylon-6,6 [R] [CBSE Foreign Set-1 2017]

Ans. (i) Ethylene Glycol and Terephthalic acid $\frac{1}{2} + \frac{1}{2}$



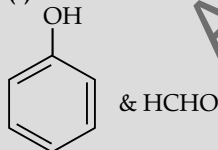
(ii) Tetrafluoroethene, $\text{CF}_2=\text{CF}_2$ $\frac{1}{2} + \frac{1}{2}$

(iii) Hexamethylenediamine and adipic acid
 $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$, $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ $\frac{1}{2} + \frac{1}{2}$
 [CBSE Marking Scheme 2017]

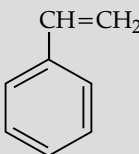
[R] Q. 11. Write the names and structure of the monomer of the following polymer :

- (i) Bakelite
 (ii) PVC
 (iii) Buna-S [R] [CBSE Foreign Set-2 2017]

Ans. (i) Phenol & Formaldehyde $\frac{1}{2} + \frac{1}{2}$



(ii) Vinyl Chloride, $\text{CH}_2=\text{CHCl}$ $\frac{1}{2} + \frac{1}{2}$
 (iii) 1,3-Butadiene & styrene

$\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$ and  $\frac{1}{2} + \frac{1}{2}$
 [CBSE Marking Scheme 2017]

Q. 12. Write the names and structure of the monomer of the following polymer :

- (i) Neoprene
 (ii) Buna-N
 (iii) PHBV [R] [CBSE Foreign Set-3 2017]

Ans. (i) Chloroprene, $\text{CH}_2=\text{C}(\text{Cl})-\text{CH}=\text{CH}_2$ $\frac{1}{2} + \frac{1}{2}$

(ii) 1,3-Butadiene & Acrylonitrile $\frac{1}{2} + \frac{1}{2}$



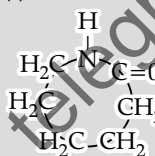
(iii) 3-Hydroxybutanoic acid and 3-Hydroxypentanoic acid
 $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{COOH}$ & $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{COOH}$ $\frac{1}{2} + \frac{1}{2}$

[CBSE Marking Scheme 2017]

Q. 13. Give the formula of monomers involved in the formation of the following polymers :

- (i) Buna-N
 (ii) Nylon-6
 (iii) Dacron [R] [CBSE Comptt. Delhi/OD 2018]

Ans. (i) $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2 + \text{CH}_2=\text{CH}-\text{CN}$ 1



(ii) $\text{HOH}_2\text{C}-\text{CH}_2\text{OH} + \text{HOOC}-\text{C}_6\text{H}_4-\text{COOH}$ 1

(iii) $\text{HOH}_2\text{C}-\text{CH}_2\text{OH} + \text{HOOC}-\text{C}_6\text{H}_4-\text{COOH}$ 1

[CBSE Marking Scheme 2018]

Q. 14. Name the type of reaction involved in the formation of the following polymer from their respective monomers

- (i) PVC.
 (ii) Nylon6.
 (iii) PHBV. [R] [CBSE SQP 2017]

Ans. (i) Addition 1

(ii) Condensation / Hydrolysis 1

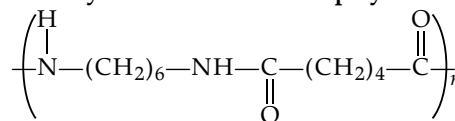
(iii) Condensation [CBSE Marking Scheme 2017] 1

Commonly Made Error

- Most students make mistake in identifying correct type of polymerization reaction.

Q. 15. (i) What is the role of benzoyl peroxide in the polymerization of ethene ?

(ii) Identify the monomers in the polymer :

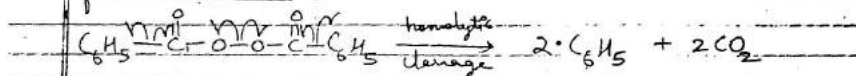


(iii) Arrange the following polymers in the increasing order of their intermolecular forces:
 Nylon-6,6 Polythene, Buna-S

[R + U] [CBSE OD Set-2 2016]

Ans.

17. D) Benzoyl peroxide is the reagent which generates free radical.



The phenyl free radical generated reacts on ethene molecule to generate bigger free radical. This is

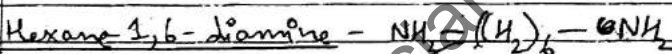
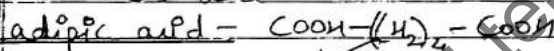
called chain initiation.



$\text{C}_6\text{H}_5-\text{CH}_2-\text{CH}_2\cdot$ reacts on other ethene molecules leading to chain propagation.

ii) The polymer is Nylon-6,6

Monomers are -



iii) Buna S < Polythene < Nylon-6,6

Buna S - Elastomer

Polythene - Thermoplastic

Nylon-6,6 - Fibre

3

[Topper's Answer 2017]

Detailed Answer:

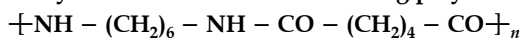
(i) For polymerization of ethene, the source of free radical is required to initiate the chain reaction. These free radicals are produced by the decomposition of benzoyl peroxide. 1

(ii) Adipic acid $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ and hexamethylene-diamine, $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$. 1

(iii) Buna S < Polythene < Nylon-6,6 1

Q. 16. (i) What is the role of t-butyl peroxide in the polymerization of ethene ?

(ii) Identify the monomers in the following polymer :



(iii) Arrange the following polymers in the increasing order of their intermolecular forces :

Polystyrene, Terylene, Buna-S

[R + U] [CBSE Delhi 2016; DDE]

Ans. (i) Radical initiator of chain reaction or as a catalyst 1

(ii) $\text{NH}_2-(\text{CH}_2)_6-\text{NH}_2$ and $\text{HOOC}-(\text{CH}_2)_4-\text{COOH}$

Hexamethylenediamine Adipic acid 1

(iii) Buna-S < Polystyrene < Terylene 1

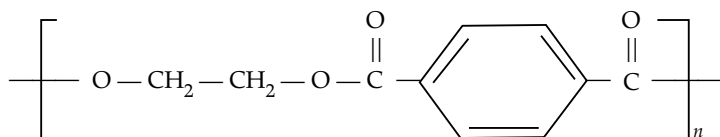
[CBSE Marking Scheme 2016]

Answering Tip

- Use arrows to show electron transfer.

Q. 17. (i) What is the role of Sulphur in the vulcanization of rubber ?

(ii) Identify the monomers in the following polymer :

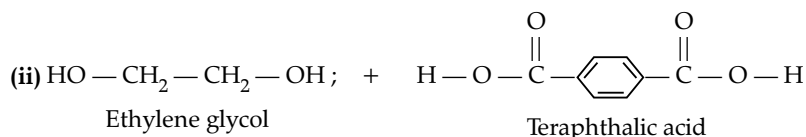


(iii) Arrange the following polymers in the increasing order of their intermolecular forces :

Terylene, Polythene, Neoprene.

[R + U] [CBSE OD 2016]

Ans. (i) The physical properties of rubber can be altered to suit the requirements by adding sulphur in vulcanization of rubber. The process of introducing —S—S— polysulphide crosslinks between the adjacent chains tend to limit the motion of chains relative to each other. 1



(iii) Neoprene < Polythene < Terylene 1

OSWAAL LEARNING TOOLS	
For Suggested Online Videos	
Visit : https://qr.go.page.link/yY1TU Or Scan the Code	Visit : https://qr.go.page.link/wcEYZ Or Scan the Code
Visit : https://qr.go.page.link/9m6JF Or Scan the Code	Visit : https://qr.go.page.link/chNGc Or Scan the Code

