Chapter 15

Polymers

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1 Mark Questions

1. Name the two types of polymeristion.

Ans.The two types of polymerisation are

(a) Addition polymerisation and

(b) Condensation polymerisation.

2. Name some initiators.

Ans.Examples of initiator are –

Benzoyl peroxide, acetyl peroxide, tert – butyl peroxide etc.

3. Name the two type of polyethene.

Ans.Polyethene is of two types –

1) Low Density Polyethene 2) High Density Polythene

4. Write the monomer of Teflon.

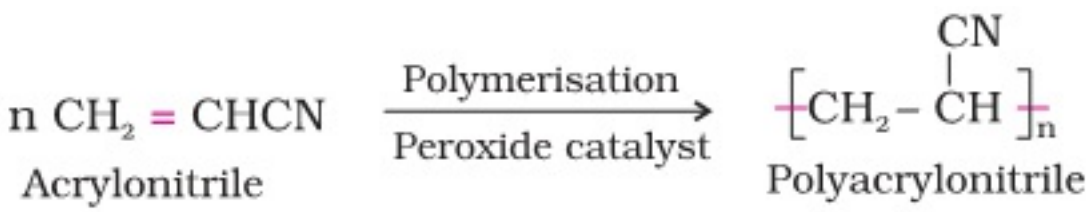
Ans. Teflon

Monomer = Tetrafluoroethene

$CF_2 = CF_2$

5. Give preparation of polyacrylonitrile.

Ans. Polyacrylonitrite



6. Write one use of each – Teflon and polyacrylonitrile.

Ans. Uses:

(1) Teflon is used in making oil seals & for non – stick surface coated utensils.

(2) Polyacrytonitrile is used for wool in making commercial fibres an orlon or acrilan.

7. Classify the following substances as natural, semi – synthetic and synthetic polymer

Ans. Natural polymers: Cellulose, Starch, And Protein

Semisynthetic: Rayon

Synthetic: Plastic, Nylon

8. Give two examples of each (i) linear polymer (ii) Network polymer.

Ans. Linear polymers: Polythene, Polyvinylchloride

Network polymers: Bakelite, Melamine

9. Why is condensation polymerisation also called on step – growth polymerisation?

Ans. Condensation polymerisation produces a distinct functionalized species and is independent of each other. Therefore it is also called step growth polymerisation.

10. Write some examples of condensation polymers.

Ans. Examples of condensation polymers are Nylon-6, 6, Dacron, Nylon 6 etc

11. How is Nylon – 6, 6 different from Nylon -6?

Ans. Nylon – 6, 6 is made of two bifunctional monomers, each having 6 carbon atoms

whereas Nylon – 6 is made from heating only one monomer having 6 carbon atoms.

12. Give the formula of monomer of Nylon – 6.

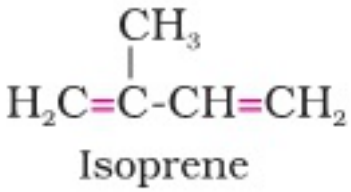
Ans. Monomer of Nylon -6 is caprolactum

13. What is copolymerisation?

Ans. The reaction in which a mixture of more than one monomeric species is allowed to polymerise & form a copolymer is called copolymerisation e.g. Buna -S.

14. What is the monomer of natural rubber?

Ans. Monomer of national rubber is isoprene or 2 – methyl – 1, 3 – butadiene.



Isoprene

15. Give two examples of synthetic rubber.

Ans. Example of synthetic rubber – Neoprene, Buna – N etc.

16. Give one example of biodegradable polymer.

Ans. Biodegradable polymer: PHVB, Nylon – 2 – Nylon -6.

17. Classify following on Homopolymer and copolymer- PVC, Polystyrene, Buna – S, Neoprene, Buna – N, Teflon.

Ans. Homopolymer Copolymer

PVC Buna – S

Polystyrene Buna – N

Neoprene

Teflon

18. Classify following an addition and condensation polymer- Bakelite, Polythene, Nylon – 6, 6, Polyacrylonitrile

Ans. Addition polymer condensation polymers

Polythene Dacron

Polyacrylonitrite Nylon – 6, 6, Bakelite

19.Classify the following as addition and condensation polymers: Terylene, Bakelite, Polyvinyl chloride, Polythene.

Ans. Addition polymers:
Polyvinyl chloride, polythene
Condensation polymers:
Terylene, bakelite

20. Classify the following as addition and condensation polymers: Terylene, Bakelite, Polyvinyl chloride, Polythene.

Ans. Addition polymers:
Polyvinyl chloride, polythene
Condensation polymers:
Terylene, bakelite

21. Explain the difference between Buna-N and Buna-S.

Ans. Buna - N is a copolymer of 1, 3-butadiene and acrylonitrile.
Buna - S is a copolymer of 1, 3-butadiene and styrene.

22. Is $-(NH-CHR-CO)_n-$, a homopolymer or copolymer?

Ans. $-(NH-CHR-CO)_n-$ is a homopolymer because it is obtained from a single monomer unit, NH_2 - CHR - COOH.

2 Mark Questions

1. Define polymers.

Ans. Polymer are defined a very large molecules having high molecular mass which are formed by joining of repeating structural units on a large scale.

2. Write various uses of polymers.

Ans. Polymers are used in manufacture of plastic buckets, cups and saucers, children's toys, packaging bags, synthetic clothing materials, automobile tyres, insulating materials etc. polymers are the back bone of five major industries – plastics, elastomers, fibres, paints & varnishes.

3. On what basis are polymers classified?

Ans. Polymers are classified on the basis of

(a) Source
(b) Structure
c) Mode of polymerisation
(d) Molecular forces

4. What is the difference between a homopolymer and a copolymer?

Ans.

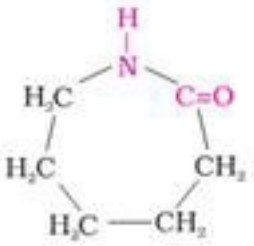
Homopolymer	**Copolymer**
The addition polymers formed by polymerisation of a single monomeric species are known an homopolymers e.g. – polythene	The polymers made by addition polymerisation from two different monomers are known as copolymers e.g. Buna – S

5. Explain the term *vulcanisation* of rubber?

Ans. To improve upon the physical properties of natural rubber a process of *vulcanization is carried out. This process consist of heating a mixture of raw rubber with sulphur and an appropriate additive at a temperature range between 373K to 415K. On vulcanization, sulphur form cross links at the reactive sites of double bonds and thus the rubber get stiffened.*

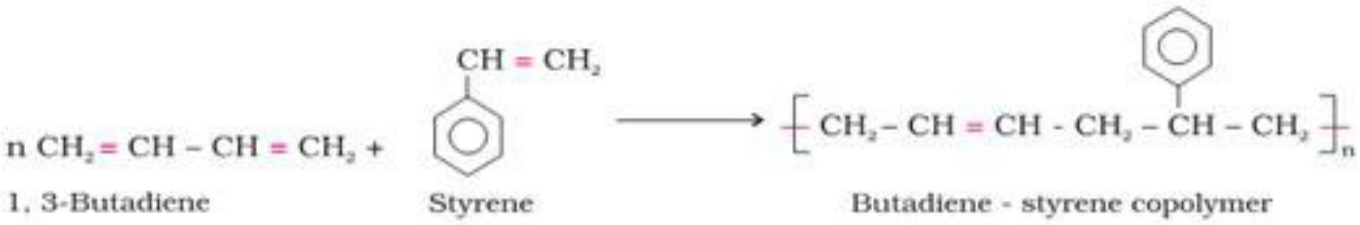
6. Write uses of bakelite and melamine.

Ans. Bakelite is used for making combs, phonograph records, electrical switches, handles. Melamine is used in manufacture of unbreakable crockery.



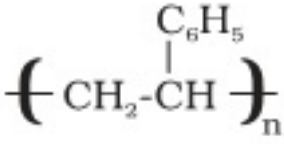
7. Give the monomer and preparation of Buna – S.

Ans. Preparation of Buna – S

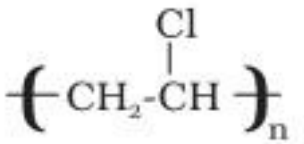


8. Write monomers of polystyrene and PVC.

Ans. Polymer Monomer



1. Polystyrene Styrene,



2. PVC Vinyl Chloride,

9. How are the characteristics of natural rubber modified?

Ans. Natural rubber is soft at high temperatures and brittle at low temperatures. It is soluble in non – polar solvents and non – resistant to oxidizing agents. These properties can be modified by mixing raw rubber with sulphur. & an appropriate additive at a temperature 373K to 415K. This is called venlcanisation.

10. What are polymers?

Ans. Polymers are high molecular mass macromolecules, which consist of repeating structural units derived from monomers. Polymers have a high molecular mass (103 - 107 *u*). In a polymer, various monomer units are joined by strong covalent bonds. These polymers can be natural as well as synthetic. Polythene, rubber, and nylon 6, 6 are examples of polymers.

11. What are natural and synthetic polymers? Give two examples of each type.

Ans. Natural polymers are polymers that are found in nature. They are formed by plants and animals. Examples include protein, cellulose, starch, etc.

Synthetic polymers are polymers made by human beings. Examples include plastic (polythene), synthetic fibres (nylon 6, 6), synthetic rubbers (Buna - S).

12. How do you explain the functionality of a monomer?

Ans. The functionality of a monomer is the number of binding sites that is/are present in that monomer.
For example, the functionality of monomers such as ethene and propene is one and that of 1, 3-butadiene and adipic acid is two.

13. Define the term polymerisation.

Ans. Polymerization is the process of forming high molecular mass (103 - 107 *u*)

macromolecules, which consist of repeating structural units derived from monomers. In a polymer, various monomer units are joined by strong covalent bonds.

14. In which classes, the polymers are classified on the basis of molecular forces?

Ans. On the basis of magnitude of intermolecular forces present in polymers, they are classified into the following groups:

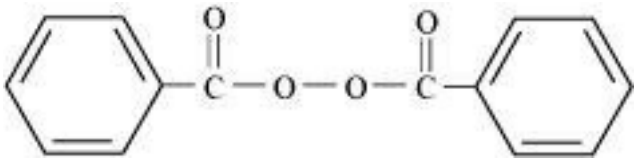
(i) Elastomers
(ii) Fibres
(iii) Thermoplastic polymers
(iv) Thermosetting polymers

15. Write the free radical mechanism for the polymerisation of ethene.

Ans. Polymerization of ethene to polythene consists of heating or exposing to light a mixture of ethene with a small amount of benzoyl peroxide as the initiator.
The reaction involved in this process is given below:

16. Write the name and structure of one of the common initiators used in free radical addition polymerisation.

Ans. One common initiator used in free radical addition polymerization is benzoyl peroxide. Its structure is given below.



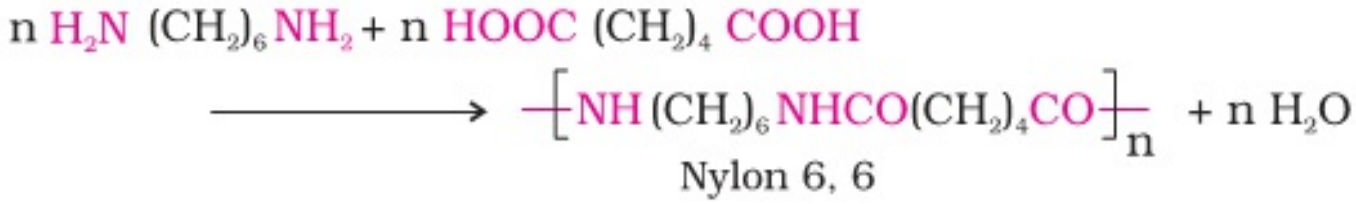
17. Write the monomers used for getting the following polymers.
(i) Polyvinyl chloride (ii) Teflon (iii) Bakelite
Ans.(i) Vinyl chloride $\left(CH_2 = CHCl\right)$
(ii) Tetrafluoroethylene $\left(CF_2 = CF_2\right)$
(iii) Formaldehyde (HCHO) and phenol $\left(C_6H_5OH\right)$

3 Mark Questions

1. How are addition polymers different from condensation polymers?

Ans.Addition Polymers: - They are formed by the repeated addition of monomer molecules possessing double or triple bonds e.g. polythene

Condensation polymer:- They are formed by repeated condensation reaction between two different bifunctional or trifunctional monomeric unit, with elimination of small molecules such as water e.g. Nylon – 6, 6.



2. What is the basic difference between following pairs:

(a) Elastomers and fibres

(b) Thermo setting polymer & thermo plastic polymers.

Ans. (a)

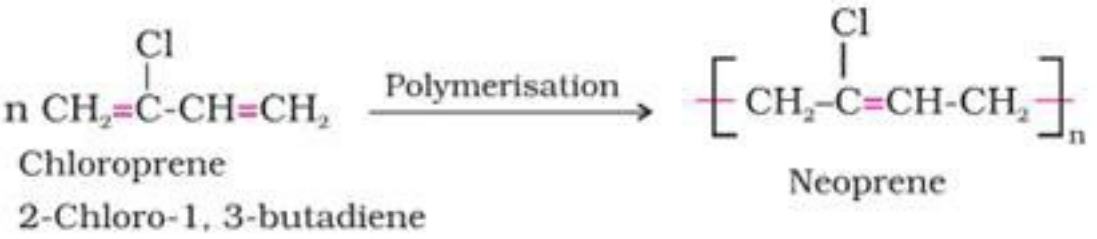
Elastomers	**Fibres**
1. These are rubber like solids with elastic properties 2. The polymer chains are held together by weakest intermolecular forces e.g. Buna – S	1. There are thread forming solids with high tensile strength 2. The polymer chains are closely packed due to strong intermolecular forces like Hydrogen bond e.g. Nylon – 6, 6

(b)

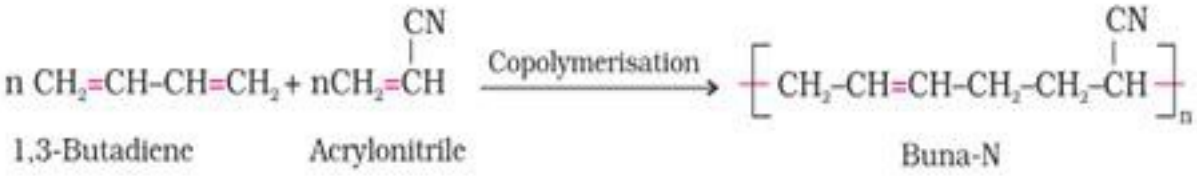
Thermoplastic	Thermosetting polymers
1. They are linear or slightly branched molecules. 2. They are capable of repeatedly softening on heating and hardening on cooling e.g. PVC.	1. They are cross – linked or heavily branched molecules. 2. They undergo extensive cross linking on heating & can not be reversed e.g. bakelite.

3. How are neoprene & Buna – N prepared? Which one is a copolymer?

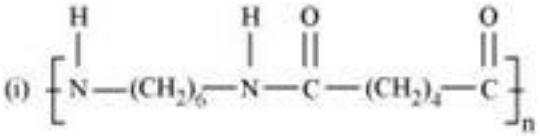
Ans. Preparation of Neoprene-

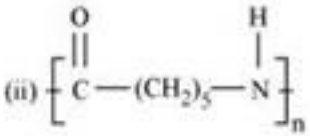


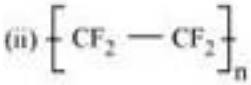
Preparation of Buna – N.



4. Write the names of monomers of the following polymers:



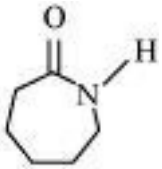




Ans. (i) Hexamethylenediamine $\left[H_2N-(CH_2)_2-NH_2\right]$ and adipic acid

$\left[HOOC-(CH_2)_4-COOH\right]$

(ii)



Caprolactam

(iii) Tetrafluoroethene $\left(CF_2=CF_2\right)$

5. Arrange the following polymers in increasing order of their intermolecular forces.

(i) Nylon 6, 6, Buna-S, Polythene.

(ii) Nylon 6, Neoprene, Polyvinyl chloride.

Ans. Different types of polymers have different intermolecular forces of attraction. Elastomers or rubbers have the weakest while fibres have the strongest intermolecular forces of attraction. Plastics have intermediate intermolecular forces of attraction. Hence, the increasing order of the intermolecular forces of the given polymers is as follows:

(i) Buna - S < polythene < Nylon 6, 6

(ii) Neoprene < polyvinyl chloride < Nylon 6

6. Explain the terms polymer and monomer.

Ans. Polymers are high molecular mass macromolecules composed of repeating structural units derived from monomers. Polymers have a high molecular mass (103 - 107 *u*). In a polymer, various monomer units are joined by strong covalent bonds. Polymers can be natural as well as synthetic. Polythene, rubber, and nylon 6, 6 are examples of polymers.

Monomers are simple, reactive molecules that combine with each other in large numbers through covalent bonds to give rise to polymers. For example, ethene, propene, styrene, vinyl chloride.

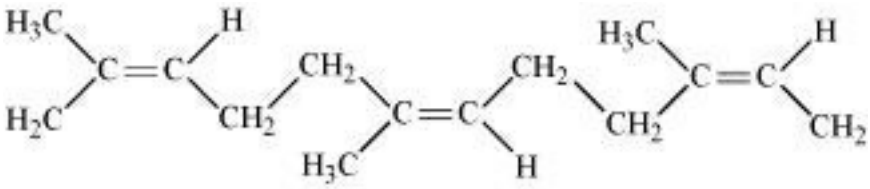
7. Define thermoplastics and thermosetting polymers with two examples of each.

Ans. Thermoplastic polymers are linear (slightly branched) long chain polymers, which can be repeatedly softened and hardened on heating. Hence, they can be modified again and again. Examples include polythene, polystyrene.

Thermosetting polymers are cross-linked or heavily branched polymers which get hardened during the molding process. These plastics cannot be softened again on heating. Examples of thermosetting plastics include bakelite, urea-formaldehyde resins.

8. How does the presence of double bonds in rubber molecules influence their structure and reactivity?

Ans. Natural rubber is a linear cis-polyisoprene in which the double bonds are present between C_2 *and* C_3 of the isoprene units.



Natural rubber

Because of this cis-configuration, intermolecular interactions between the various strands of isoprene are quite weak. As a result, various strands in natural rubber are arranged randomly. Hence, it shows elasticity.

9. What are the monomeric repeating units of Nylon-6 and Nylon-6, 6?

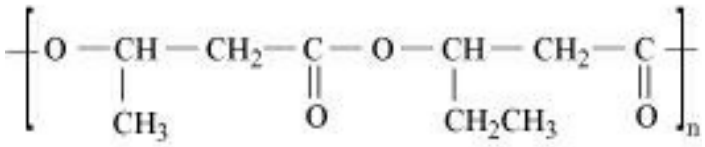
Ans. The monomeric repeating unit of nylon 6 is $\left[NH-(CH_2)_5-CO\right]$, which is derived from Caprolactam.

The monomeric repeating unit of nylon 6, 6 is $\left[NH-(CH_2)_6-NH-CO-(CH_2)_4-CO\right]$, which is derived from hexamethylene diamine and adipic acid.

10. What is a biodegradable polymer? Give an example of a biodegradable aliphatic polyester.

Ans.A polymer that can be decomposed by bacteria is called a biodegradable polymer.

Poly-β-hydroxybutyrate-CO-β- hydroxyvalerate (PHBV) is a biodegradable aliphatic polyester.



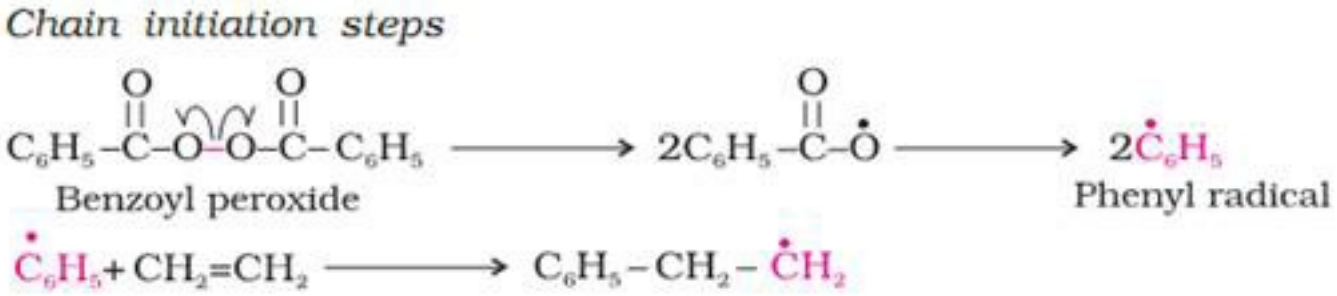
PHBV

5 Mark Questions

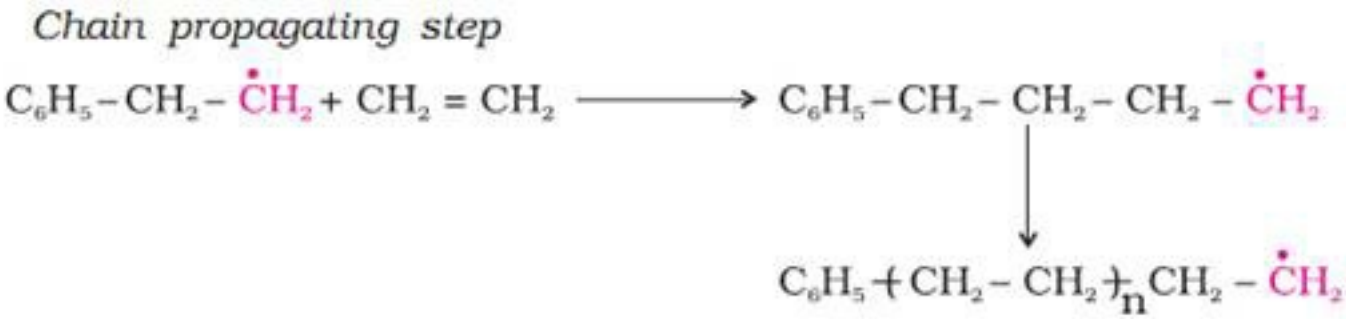
1.Explain the mechanism of polymerisation of ethene.

Ans.Polymerisation of ethene takes place by free radical mechanism. It follows a three step mechanism:-

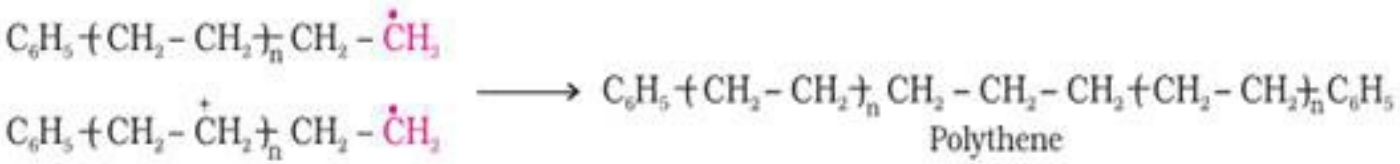
<u>Step I</u>: chain initiating step formation of phenyl free radical.



<u>Step II</u>:



<u>Step III</u>: Chain termination step



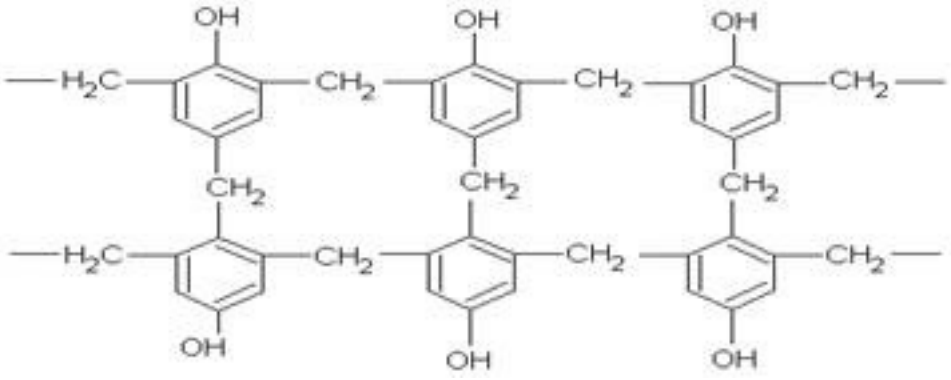
2.Differentiate between LDP and HDP.

Ans.

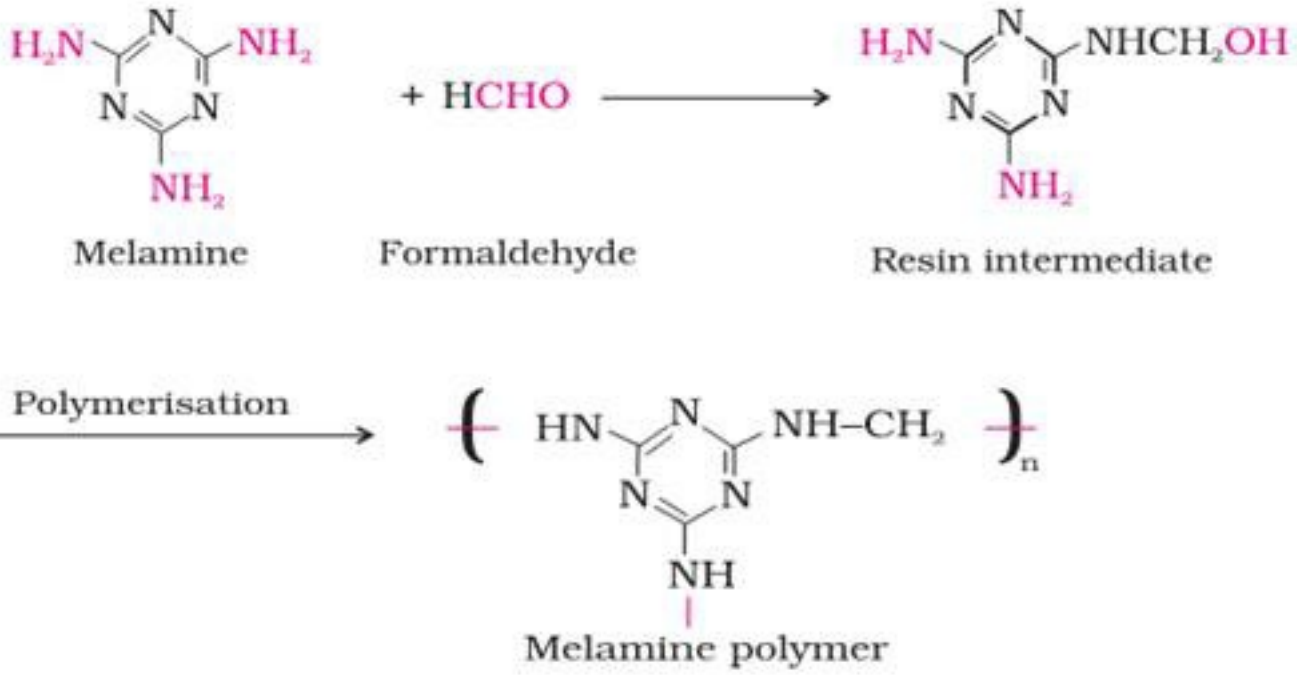
(LDP) Low Density Polythene	(HDP) High Density Polythene
1. It is obtained by polymerisation of ethane under pressure of 1000 to 2000 atm. & temperature of 350K to 570K. 2. It is prepared in the presence of dioxygen or a peroxide initiator. 3. It has highly branched structure. 4. It is chemically inert, tough and flexible. 5. It is a poor conductor of electricity. 6. It is used in toys, flexible pipes etc.	1. It is formed when polymerisation takes place in a hydrocarbon solvent in presence of a catalyst e.g. Ziegter-natta catalyst at 333K-343K and 6-7atm pressure. 2. It requires Ziegler – Natta catalyst. 3. It has a linear structure. 4. It in more tougher and harder. 5. It is used for making buckets, dustbins, pipes etc.

3. What are Bakelite and Melamine? Give their structures.

Ans.Bakelite – It is phenol – formaldehyde polymer.



Melamine – It is melamine – formaldehyde polymer

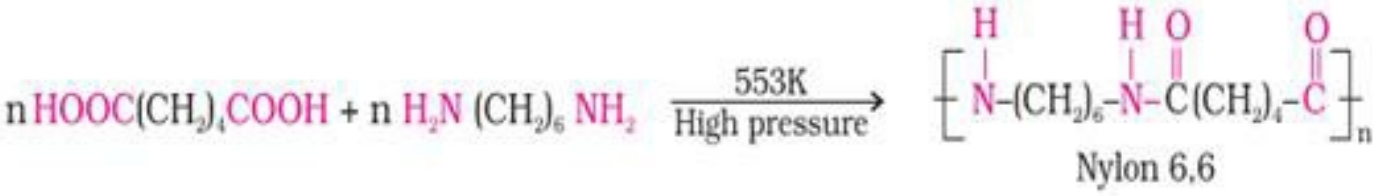


4.Give monomers and preparation of Nylon – 6, 6 and Dacron.

Ans. Preparation

(i) Nylon – 6, 6

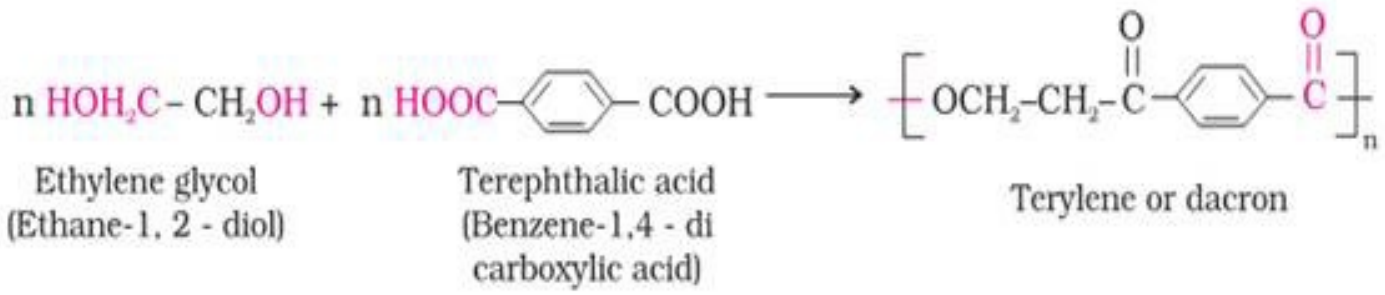
Monomers: Hexamethylene diamine Adipic acid.



(ii) Dacron

Monomers: Ethylene Glycol

Terephthalic acid



5. How are polymers classified on the basis of structure?

Ans. Polymers are classified on the basis of structure as follows:

1. Linear polymers:

These polymers are formed of long straight chains. They can be depicted as:

For e.g., high density polythene (HDP), polyvinyl chloride, etc.

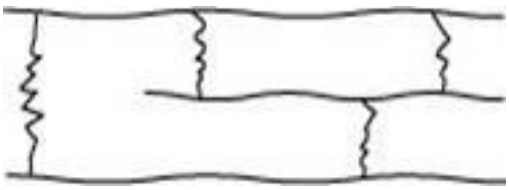
2. Branched chain polymers:

These polymers are basically linear chain polymers with some branches. These polymers are represented as:

For e.g., low density polythene (LDP), amylopectin, etc.

3. Cross-linked or Network polymers:

These polymers have many cross-linking bonds that give rise to a network-like structure. These polymers contain bi-functional and tri-functional monomers and strong covalent bonds between various linear polymer chains. Examples of such polymers include bakelite and melmac.



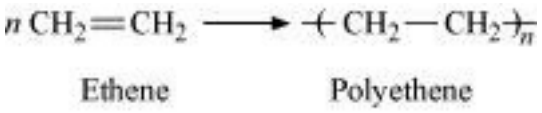
6. Distinguish between the terms homopolymer and copolymer and give an example of each.

Ans.

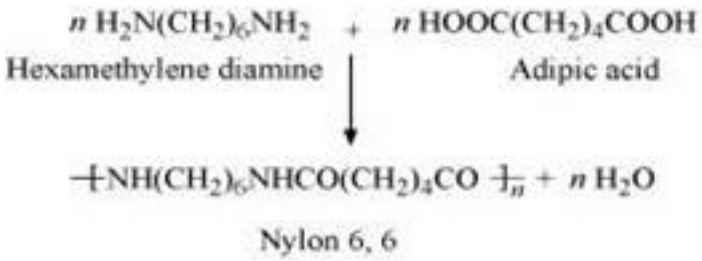
Homopolymer	Copolymer
The polymers that are formed by the polymerization of a single monomer are known as homopolymers. In other words, the repeating units of homopolymers are derived only from one monomer. For example, polythene is a homopolymer of ethene.	The polymers whose repeating units are derived from two types of monomers are known as copolymers. For example, Buna - S is a copolymer of 1, 3-butadiene and styrene.

7. How can you differentiate between addition and condensation polymerisation?

Ans. Addition polymerization is the process of repeated addition of monomers, possessing double or triple bonds to form polymers. For example, polythene is formed by addition polymerization of ethene.

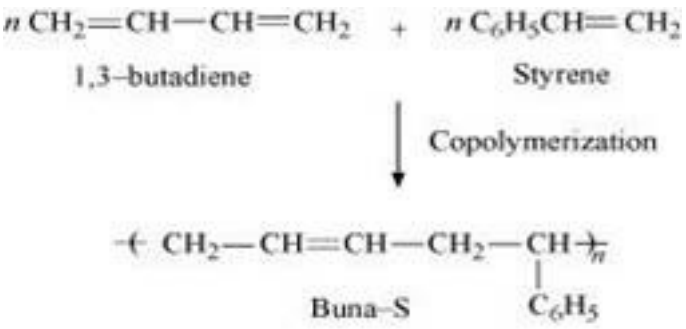


Condensation polymerization is the process of formation of polymers by repeated condensation reactions between two different bi-functional or tri-functional monomers. A small molecule such as water or hydrochloric acid is eliminated in each condensation. For example, nylon 6, 6 is formed by condensation polymerization of hexamethylenediamine and adipic acid.

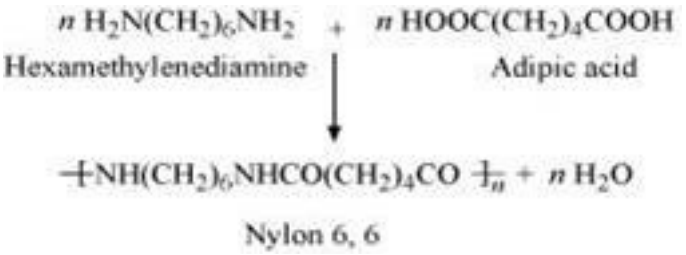


8. Explain the term copolymerisation and give two examples.

Ans. The process of forming polymers from two or more different monomeric units is called copolymerization. Multiple units of each monomer are present in a copolymer. The process of forming polymer Buna-S from 1, 3-butadiene and styrene is an example of copolymerization



Nylon 6, 6 is also a copolymer formed by hexamethylenediamine and adipic acid.



9.**Discuss the main purpose of vulcanisation of rubber.**

Ans. Natural rubber though useful has some problems associated with its use. These limitations are discussed below:

1. Natural rubber is quite soft and sticky at room temperature. At elevated temperatures (> 335 K), it becomes even softer. At low temperatures (< 283 K), it becomes brittle. Thus, to maintain its elasticity, natural rubber is generally used in the temperature range of 283 K-335 K.

2. It has the capacity to absorb large amounts of water.

3. It has low tensile strength and low resistance to abrasion.

4. It is soluble in non-polar solvents.

5. It is easily attacked by oxidizing agents.

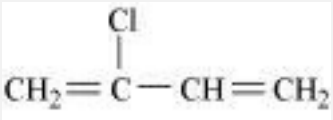
Vulcanization of natural rubber is done to improve upon all these properties. In this process, a mixture of raw rubber with sulphur and appropriate additive is heated at a temperature range between 373 K and 415 K.

10. Write the names and structures of the monomers of the following polymers:

(i) Buna-S (ii) Buna-N

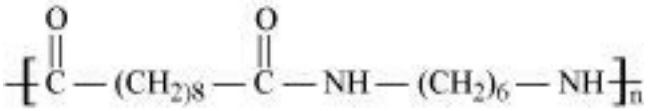
(iii) Dacron (iv) Neoprene

Ans.

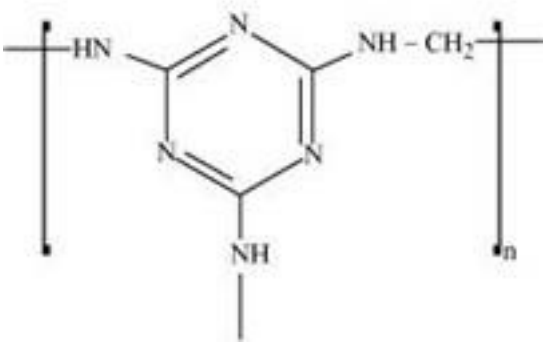
Polymer	Monomer	Structure of monomer
i Buna-S	1, 3-butadiene	$CH_2 = CH - CH - CH_2$
	Styrene	$C_6H_5CH = CH_2$
ii Buna-N	1, 3-butadiene	$CH_2 = CH - CH - CH_2$
	Acrylonitrile	$CH_2 = CH - CN$
iii Neoprene	Chloroprene	
iv Dacron	Ethylene glycol	$HOH_2C - CH_2OH$
	Terephthalic acid	

11. Identify the monomer in the following polymeric structures.

(i)

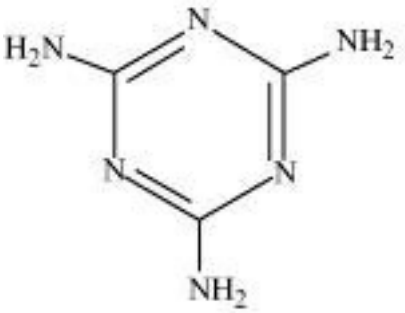


(ii)



Ans.**(i)** The monomers of the given polymeric structure are decanoic acid $\left[HOOC-(CH_2)_8-COOH\right]$ and hexamethylene diamine $\left[H_2N(CH_2)_6NH_2\right]$.

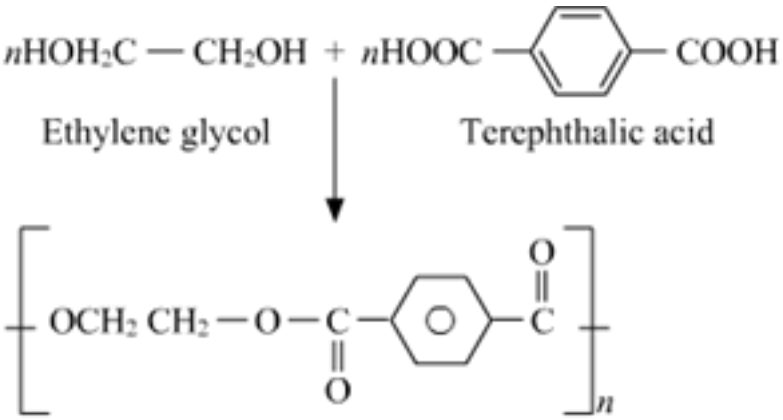
(ii) The monomers of the given polymeric structure are



and HCHO

12.How is dacron obtained from ethylee glycol and terephthalic acid?

Ans. The condensation polymerisation of ethylene glycol and terephthalic acid leads to the formation of dacron.



Terylene or dacron