

Chapter 15: Polymer

Exercise

Question 15.1 Explain the terms polymer and monomer.

Answer :

Polymer- A polymer molecule may be defined as a number of repeating chemical units held together by covalent bonds. In other words, a high molecular mass macromolecule that consists of repeating structural units derived from monomers.

Example- PVC, Teflon, Polyester, epoxy, polyethylene are examples of polymer.

Monomer - Small molecules are called monomers and the process in which they combine to form larger compounds is called polymerization. We can also say that a simple molecule capable of undergoing polymerization and leading to the formation of the corresponding polymer.

Example - Glucose, vinyl chloride, amino acid, ethylene are examples of monomer.

Question 15.2 What are natural and synthetic polymers? Give two examples of each type.

Answer -

Natural polymer- Those polymers which are isolated from natural substances are called natural polymers, they are also called biological polymers.

Example : Rubber, wool, cellulose, starch and proteins are natural polymers.

Synthetic polymer- These polymers are made. The polymers which are formed by polymerization of compounds having low molar mass are called synthetic polymers.

Example- Polyethylene, PVC, Nylon 6,6 (Synthetic fibers), Buna-S (synthetic rubber)

Question 15.3 Distinguish between the terms homopolymer and copolymer and give an example of each.

Answer -

Homopolymer	Copolymer
The polymers obtained as a result of polymerization of monomer molecules of the same type are called homopolymer.	If different types of monomer atoms combine to form a polymer, then they are called copolymers.
Often have a simple structure	Have a complex structure
Polythene, polystyrene, P.V.C etc.	Styrene butadiene rubber, vinyl acetate etc.

Question 15.4 Do you explain the functionality of a monomer?

Answer :

In chemistry, polymers are called macromolecules. Along with this, the heat in which a large number of molecules combine with each other to form a large molecule of high importance.

Also, functionality of a monomer is the number of bonding sites present in the monomer. Also, functionality holds different meanings in different aspects of chemistry.

Example: Ethane and propene have the functionality of one each and the monomer 1,3-Butadiene and adipic acid have the functionality of two each.

Question 15.5 Define the term polymerization.

Answer :

In polymerization , we can say that any process in which relatively small molecules it's called monomer .In terms of polymerization the process by which monomer are transformed into a polymer is called polymerization . It makes many of the materials in living organisms including proteins , cellulose , nucleic acid , etc. and it is production of a given polymer is generally associated with one method or the others.

Question 15.6

-NH-CHR-CO-nHomopolymer or copolymer.

Answer:



Is a homopolymer because the repeating structural unit has only one type of monomers.

Question 15.7 In which classes, the polymers are classified on the basis of molecular forces?

Answer:

on the basis of molecular forces there are four types of polymers . which are given below

Fibers: It is a subset of man-made fibers,those are based on synthetic chemicals (which are often from petrochemical sources) rather than arising from natural materials by a purely physical process. These type of fibers are made from polyamide nylon. Ex:Silk

Elastomers:These are high polymer . In which, due to weak bonds, the chain segment can be operated on a small length, but due to the network structure, the chain is not able to move. So they can be lengthened by stretching them up to a limit, but due to the net structure, they come back to their original position.Ex:Rubber

Thermoplastic: These polymers are those polymers that do not have any cross links between the keys, they soften on heating and can also be brought into the shape. These actions can be repeated over and over again.Ex: Polythene , nylon

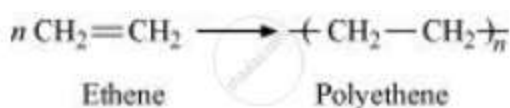
Thermosetting:On heating these polymers, chemical changes take place in them, due to which they are converted into hard and insoluble substances. After that it never come back own original position .Ex:Bakelite

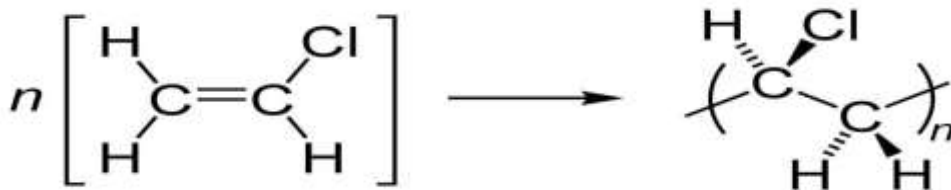
Question 15.8How can you differentiate between addition and condensation polymerization?

Answer:

Addition polymerization:The polymer which results from repeated addition of monomer is called addition polymer. In this, there is no deletion of any other molecule with the addition of monomer units. This type of polymer is formed from the derivatives of ethane unsaturated compounds. This action has no sub product.

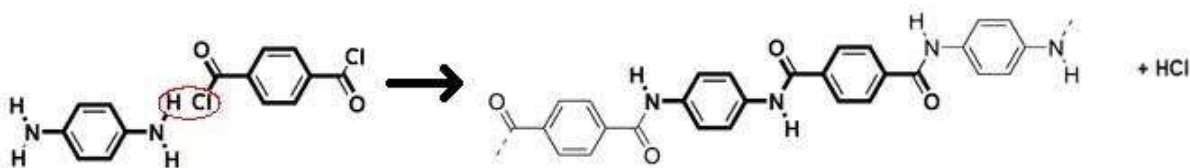
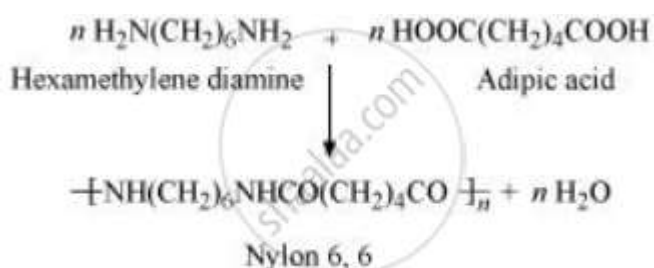
Ex:





Condensation polymerization: If the chemical reaction of the monomer unit results in the formation of a polymer as well as elimination of H_2O , NH_3 , HCl molecules. This type of polymer is called condensation polymerization or step reaction polymerization.

Ex:

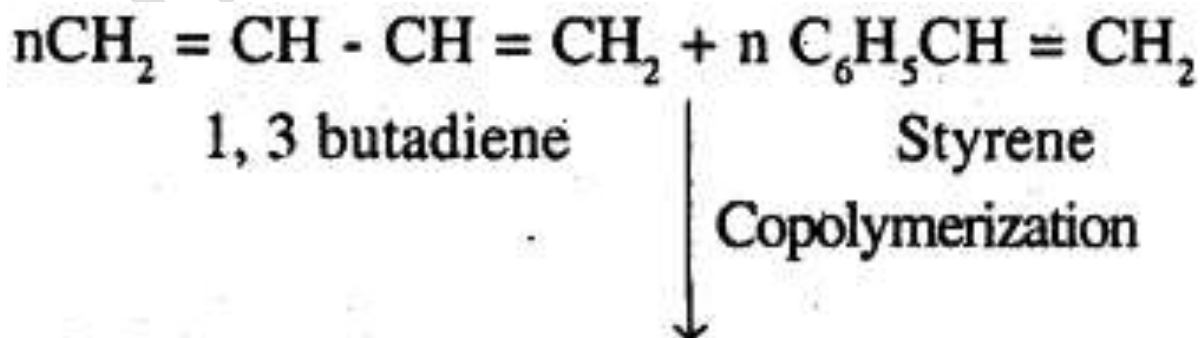


Question 15.9 Explain the term copolymerization and give two examples.

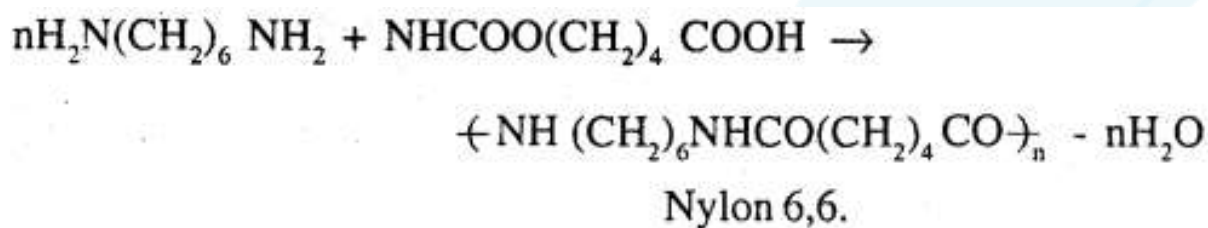
Answer :

In copolymerization formation of polymer from two or more different monomeric units is called copolymerization. In this polymer multiple units of each monomer are present in a copolymer. The process of forming Buna-S from 1,3-butadiene and styrene is an example of copolymerization. Example is given below.

Ex:



In other example we know that Nylon 6,6 is also a copolymer formed by hexamethylene diamine and adipic acid. The reaction is given below.



Question 15.10 Write the free radical mechanism for the polymerization of ethene.

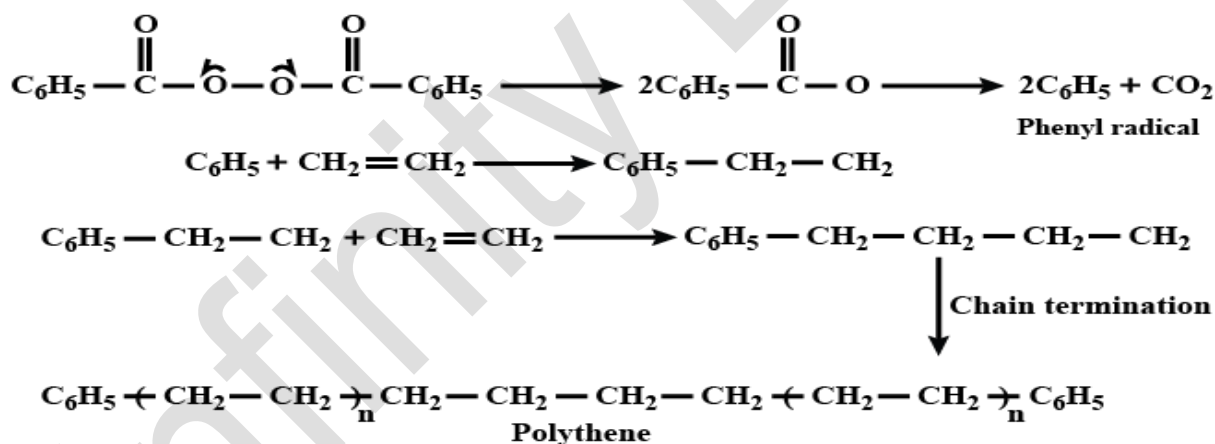
Answer:

Chain initiation step:

In this step the decomposition of benzoyl peroxide gives benzoyl free radicals which further gives phenyl free radicals after that phenyl free radical adds to double bond of ethene and generates a new free radical.

Chain Propagation step: In this step the newly generated free radicals add to another ethene molecule to form larger free radical. Now this process repeats several times.

Chain termination step: After whole process in this last step two free radicals combine to form polythene. Finally we get polythene from ethene.

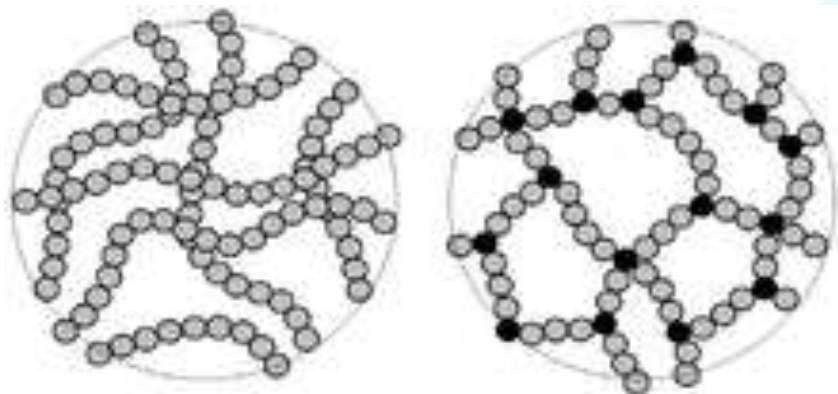


Question 15.11: Define thermoplastics and thermosetting polymers with two examples of each.

Answer :

Thermosetting polymers: it is called as thermoset. These are polymers in which a cross-linking reaction occurs promoting chemical bonding between macro molecule chains and creating three dimensional network. Ex: Bakelite, Polyurethane, Epoxy resin etc.

Thermoplastic polymer: Thermoplastics or thermoplastic polymers are a plastic material which can be moulded or reshaped by heating. This material becomes soft when subjected to heating process. Ex: Polystyrene, Teflon, Acrylic, Nylon etc.

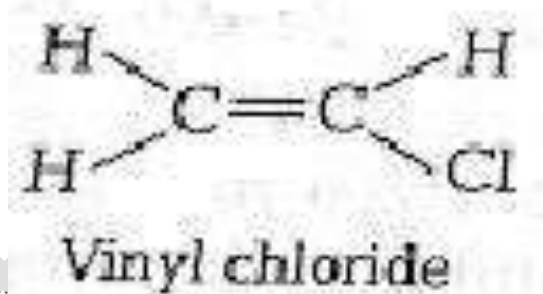


Question 15.12 Write the monomers used for getting the following polymers.

(i) Polyvinyl chloride (ii) Teflon (iii) Bakelite

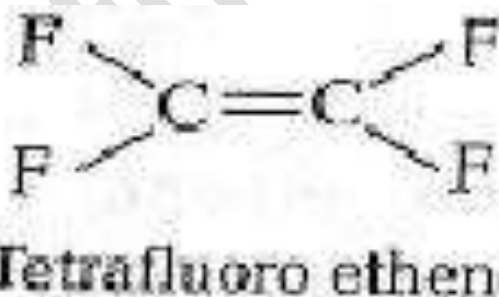
Answer:

Polyvinyl chloride – in polyvinyl chloride monomer name is **Vinyl chloride**



Vinyl chloride structure is given below

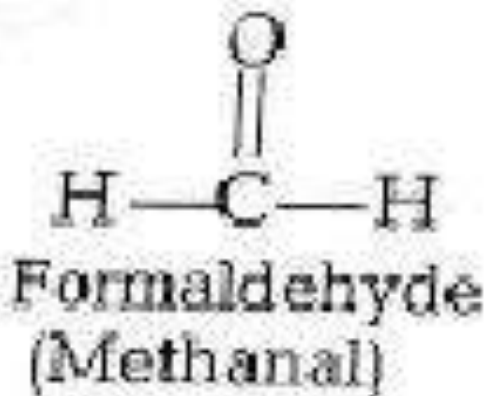
Teflon-In teflon monomer is **Tetrafluoro ethylene**. Tetrafluoro ethylene structure is given below



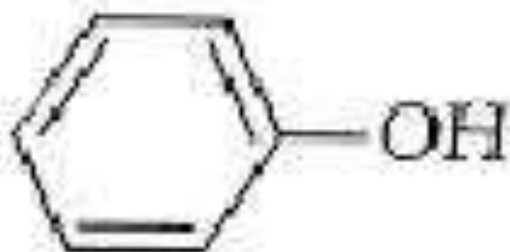
Bakelite -

In Bakelite monomer is **Formaldehyde (Methanal)** and **phenol**. Structure of methanal and phenol is given below.

Question 15.13 Write the name and structure of one of the common initiators used in free radical

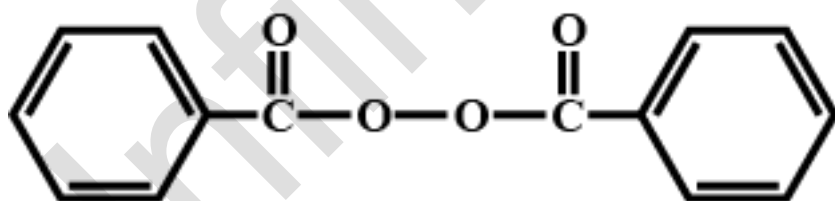


addition polymerization.



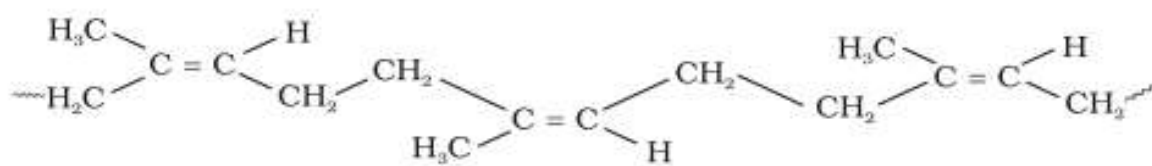
Phenol

Answer: The name of the common initiators used in free radical addition polymerization is Benzoyl peroxide. Benzoyl peroxide helps to generate free radical in chain initiation step which is the first step of the reaction in Addition polymerization reaction. Thus it acts as a free radical generating initiator catalyst.



Question 15.14 How does the presence of double bonds in rubber molecules influence their structure and reactivity?

Answer: We know that natural polymer is a linear polymer of isoprene 2-methyl-1,3 butadiene and is also called as Cis-1,4 polyisoprenes. Due to the cis configuration about the double bond. It is difficult to come closer for effective compactness due to the weak intermolecular attraction (Vander walls). Thus natural rubber has a coiled structure and it can be stretched like spring.



Natural rubber

Question 15.15 the main purpose of vulcanization of rubber.

Answer: The main purpose of rubber has many flaws in following ways .there are some important points is given below.

- (i)It becomes soft at high temperature and brittle at low temperature (<283K).
- (ii)T is show very high water absorption capacity.
- (iii)Also soluble in a non-polar solvent and Poor resistant to the attack of oxidizing agents.

All above points we can find that to improve all these physical properties we do vulcanization of rubber. During this process, sulphur cross-links are formed, which makes it hard, tough with high tensile strength.

Question 15.16What are the monomeric repeating units of Nylon-6 and Nylon 6,6?

Answer:

The monomeric repeat unit of Nylon-6 Polymer is caprolactum NH-(CH₂)₅-CO

And the monomeric unit of Nylon 6,6

Polymer is derived from the two monomer hexamethylene diamine N-(CH₂)₆-NH-CO(CH₂)₄-CO



And adipic acid

Question 15.17Write the names and structures of the monomers of the following polymers:

- (i)Buna-S (ii) Buna-N
- (iii) Dacron (iv) Neoprene

Answer:

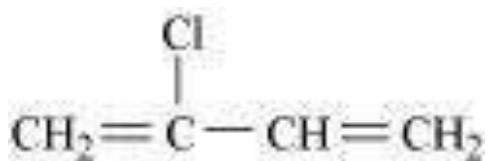
(i)In Buna-S the monomer name is 1,3-Butadiene and styrene. Both of monomer's structure is given below-



(ii)In Buna-N the monomer name is 1,3-Butadiene and Acrylonitrile. Both of monomer's structure is given below-



(iii)In Neoprene the monomer name is Chloroprene . This monomer's structure is given below-



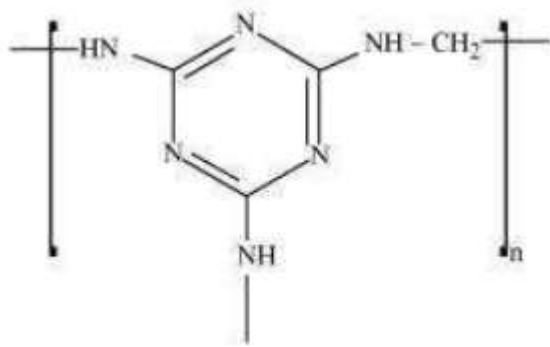
(iv) In Dacron the monomer name is Ethylene glycol and Terephthalic acid. Both of monomer's structure is given below-



Question 15.18 Identify the monomer in the following polymeric structures.



(ii)

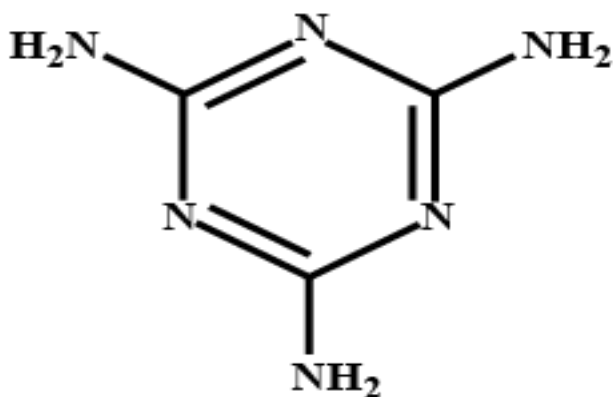


Answer:

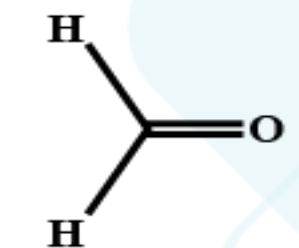
In the first structure the monomer are decanoic and Hexamethylene diamine. Those structure are given below



In the above second structure, the monomers are Formaldehyde and Melamine. Whose structure are given below



Melamine

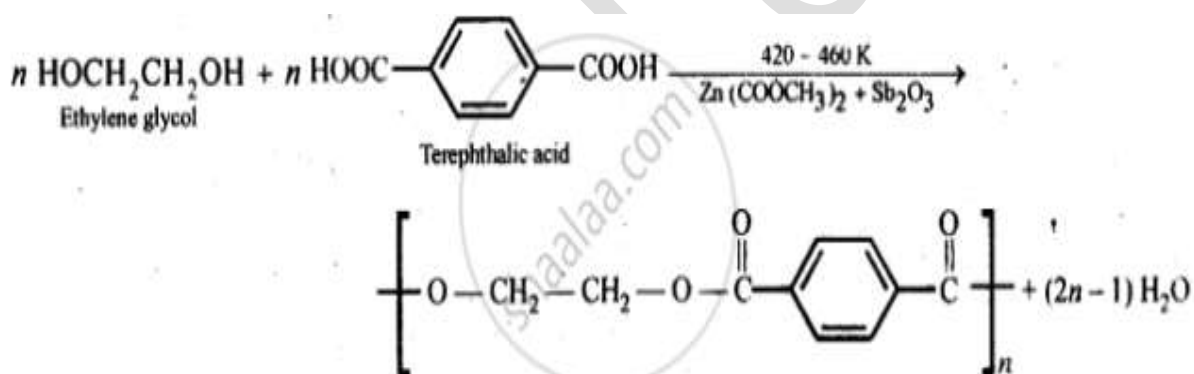


formaldehyde

Question 15.19 How is dacron obtained from ethylene glycol and Terephthalic acid?

Answer:

Dacron is obtained by condensation polymerization of ethylene glycol and Terephthalic acid with the elimination of water molecules. The reaction is carried out at 420-460K. Presence of a catalyst consisting of a mixture of the zinc acetate and antimony trioxide.



Question 15.20 What is a biodegradable polymer? Give an example of a biodegradable aliphatic polyester.

Answer: polymers which disintegrate by themselves over a period of time due to environmental degradation by bacteria etc. These are called biodegradable polymers.

Example of biodegradable aliphatic polyester PHVB is a biodegradable

Intext questions

Question 15.1 What are polymers?

Answer – High molecular mass macro molecule that consists of repeating structural unit derive from monomers.

Ex – PVC , Teflon etc.

Monomer – A simple molecule capable of undergoing polymerization and leading to the formation of the corresponding polymer.

Ex – Propene , Ethene , Vinyl Chloride etc.

Question 15.2 How are polymers classified on the basis of structure?

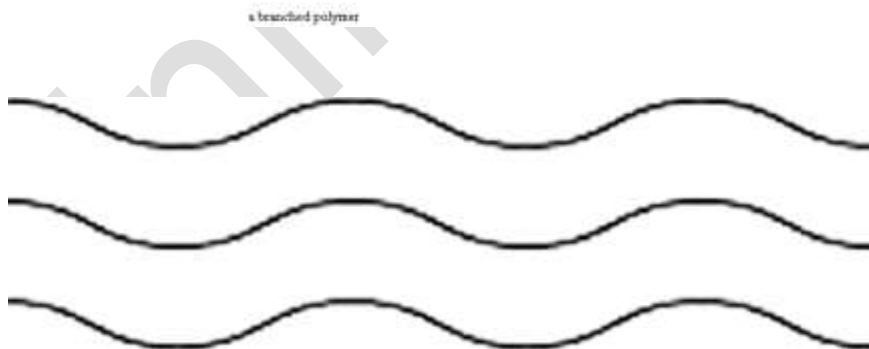
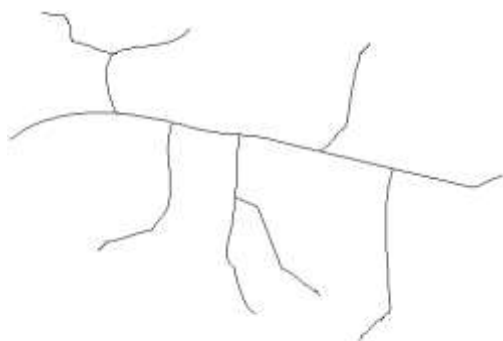
Answer – Based on the structure of the Monomer chain :- This category has the following classification .

1 – Linear polymers – The structure of polymers containing long and straight chain fall into this category.

Ex – PVC (polyvinyl chloride) is largely used for making pipes and electric cables is an example of a Linear polymers .

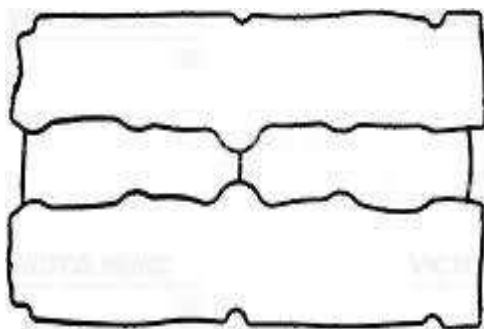
2 – Branched chain polymers :- When linear chain of a polymer form branches , then such polymers are categorized as branched chain polymers.

Ex – Low density Polythene .



3 – Cross- Linked Polymers :- They are composed of bifunctional and trifunctional monomers .They have a strong covalent bond in comparison to other Liner polymers .

Ex – Bakelite and Melamine are examples in this category.

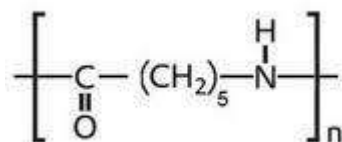


Question 15.3 Write the names of monomers of the following polymers

(I)



(ii)

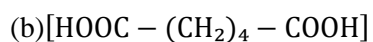
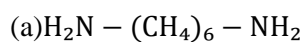


(iii)

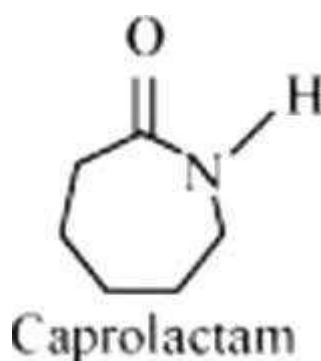


Answer –

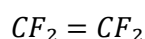
(I) Name of the monomer in the first structure is hexamethylenediamine and adipic



(ii) Monomer in second structure is given below



(iii) Name of the monomer in the third structure is Tetrafluoroethene



Question 15.4 Classify the following as addition and condensation polymers: Terolene, Bakelite, Polyvinyl Chloride, Polythene.

Answer– Addition polymerization – These polymerization does not lead to loss in smaller molecules and generally involve one monomer.

ex– Polyvinyl chloride, polythene .

Condensation polymerization – These polymerization leads to loss of simple molecules and involve two different monomers.

Ex – Terolene and Bakelite

Question 15.5 Explain the difference between Buna-N and Buna-S.

Answer – Buna–N Rubber is also called nitrile butane rubber (NBR) and its monomer is Butan – 1,3diene and acrylonitrile and Buna–S Rubber is also called Styrene Butadiene Rubber (SBR) and it's monomer is Butan – 1,3 diene and Styrene .

Question 15.6: Arrange the following polymers in increasing order of their intermolecular forces.

(I)Nylon6,6 Buna-S, Polythene.

(ii)Nylon – 6, Neoprene, Polyvinyl chloride.

Answer – Intermolecular forces increase due to increase of polarization So accordingly the order of these polymers will be as follows .

(I)Buna–S ,Polythene , Nylon – 6

(ii)Neoprene ,Polyvinyl chloride , Nylon – 6

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