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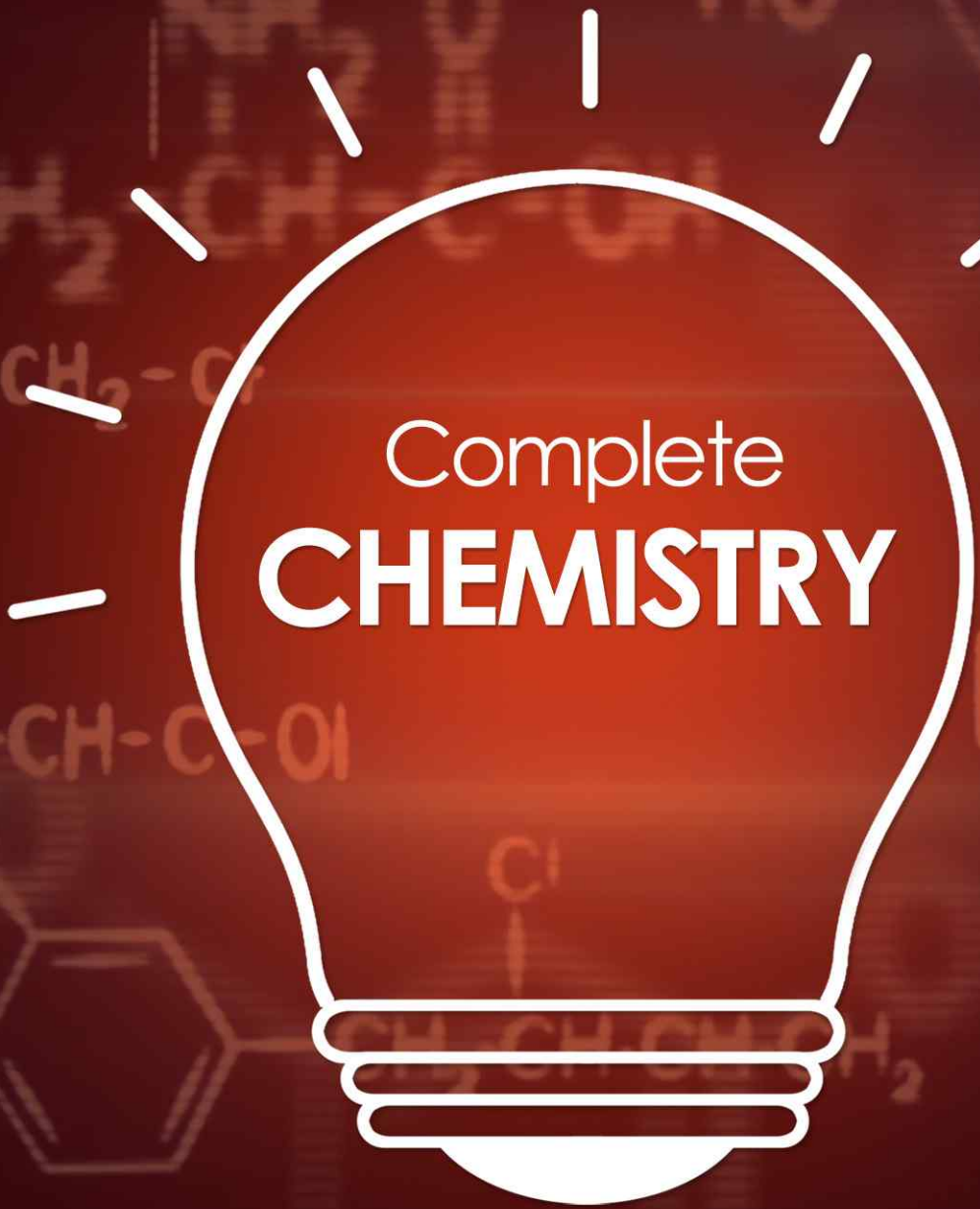


Complete CHEMISTRY

IIT-JEE · NEET · CBSE eBOOKS

CLASS 11&12th

CLASS 12th

Polymers

01. Introduction

Polymers are the compound of very high molecular masses formed by the combination of large number of simple molecules. In Greek, poly means many and meros means units or parts. The process by which simple molecules (i.e. monomer) are converted into polymers is called polymerisation.

$$\text{e.g.}\quad n\underset{\text{Ethylene (Monomer)}}{CH_2=CH_2} \xrightarrow{\text{Polymerisation}} \underset{\text{Polyethylene (Polymer)}}{-(CH_2-CH_2-)_n}$$

These large molecules have relative molecular masses in the range 10^4 –10^6. Where n is as large as 10^5. The number of monomers units in a polymer is called the degree of polymerisation. A polymer formed from one type of monomers is called HOMOPOLYMER.
e.g. Polyethylene (Monomer :- ethylene)
A polymer formed from two or more different monomers is called COPOLYMER or mixed polymer.
e.g. Terylene (Monomers : Ethylene glycol and terephthlic acid)

02. Classification of Polymers

(i) **Classification based upon source :**

(a) **Natural polymers :** Polymers which are obtained from animals and plants are known as natural polymers. Examples of natural polymers are given below.
Polysaccharide — Monosaccharide

(b) **Semisynthetic polymers :** Polymers which are prepared from natural polymers are known as semisynthetic polymers. Most of the semisynthetic polymers are prepared from cellulose.

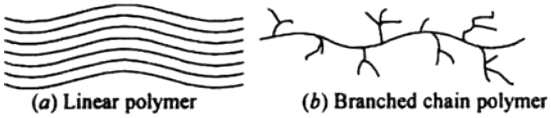
(ii) **Classification based upon shape :**

(a) **Linear polymers :** Polymer whose structure is linear is known as linear polymer. The various linear polymeric chains are stacked over one another to give a well packed structure.
The chains are highly ordered with respect to one another. The structure is close packed in nature, due to which they have high densities, high melting point and high tensile (pulling) strength. Linear polymers can be converted into fibres.

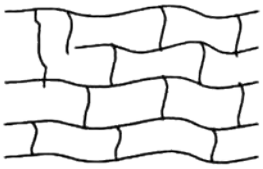
- All fibres are linear polymers. Examples are cellulose, silk, nylon, terylene etc.
- Linear polymers may be condensation as well as addition polymers. Examples are cellulose, polypeptide, nucleic acid, nylon, terylene etc.

(b) **Branded chain polymers :** Branded chain polymers are those in which the monomeric units constitute a branched chain. Due to the presence of branches, these polymers do not pack well. As a result branched chain polymers have lower melting points, low densities and tensile strength as compared to linear polymers. Branched chain polymers may be formed due to addition as well as condensation polymerisation. Examples are amylopectin, glycogen, low density polyethylene and all vulcanised rubbers.

(c) **Cross-linked or three dimensional network polymers :** In these polymers the initially formed linear polymeric chains are joined together to form a three dimensional network structure. These polymers are hard, rigid and brittle. Cross-linked polymers are always condensation polymers. Resins are cross linked polymers.



(a) Linear polymer (b) Branched chain polymer



(c) Cross-linked polymers.

(iii) **Based on synthesis :**

(a) **Addition Polymers :** A polymer formed by direct addition of repeated monomer's without the elimination of any by product molecules. In this type, the monomers are unsaturated compounds and are generally derivative of ethene. The addition polymers have same empirical formula as their monomers.

e.g. $n\left[CH_2=\underset{Cl}{CH}\right] \longrightarrow \left[CH_2-\underset{Cl}{CH}\right]_n$

Vinyl chloride Polyvinyl chloride (PVC)

(b) **Condensation Polymers :** A polymer formed by the condensation of two or more than two monomers with the elimination of simple molecule like - $H_2O/NH_3/HCl/R\text{-}OH$ etc. In this type, each monomer generally contain two functional group.

e.g. $n\ H_2N-(CH_2)_6-NH_2 + n\ HOOC-(CH_2)_6-COOH \xrightarrow{-n\ H_2O} \left[NH-(CH_2)_6-NH-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-\right]_n$

Hexamethylenediamine Adipic acid Nylon-66

(iv) **Based on reaction mechanism :**

(a) **Chain growth polymerization :** There is a series of reaction each of which consume a reactive particle and produce another, similar particle, each individual reaction thus depend upon the previous one. The reactive particle can be free radical, cations or anions. The polymerization start when a molecule of monomers react with an initiator to form an active intermediate. This active intermediate is added to another monomer forming another intermediate. In this way chain propagation continue and ultimately a polymer a formed.

Chain initiating step : $Ph-\overset{O}{\overset{\|}{C}}-O\}O-\overset{O}{\overset{\|}{C}}-Ph \longrightarrow Ph-\overset{O}{\overset{\|}{C}}-\dot{O} \xrightarrow{-CO_2} 2\ \dot{Ph}$

Benzoyl peroxide

Chain propagating step : $CH_2=CH_2 + \dot{Ph} \longrightarrow Ph-CH_2-\dot{C}H_2$

$Ph-CH_2-CH_2 + CH_2 = CH_2 \longrightarrow Ph-CH_2-CH_2-CH_2-\dot{C}H_2$