POLYMERS

1. Polymer: GIST

It is a very large molecule having molecular mass 10^3 - 10^7 g mol^{-1}. They are formed by joining together repeating structural units.

2. Classification of Polymers:

(a) Based On Source:

(i) Natural: Found in plants and animals, e.g. Proteins, cellulose, natural rubber, silk, wool.

(ii) Synthetic: Man-made e.g. Nylon, polyster, neoprene, Bakelite, Teflon, PVC, polystyrene.

(b) Based On Structure:

(i) Linear Polymers: this consist of long and straight chain repeating units e.g. Polythene (HDPE), PVC, nylon, polyester.

(ii) Branched Polymers: This contain linear chains having some branches e.g. amylopectin, glycogen etc.

(iii) Cross Linked Polymers: Strong covalent bonds are present between various linear polymer chains. E.g. Bakelite, urea- formaldehyde polymer, melamine, formaldehyde polymer etc.

(c) Based On Mode Of Polymerization:

(i) Addition Polymers: These are formed by the repeated addition of monomer molecules possessing multiple bonds, e.g., polythene, polypropene, polystyrene, PMMA (polymethyl metha crylate)

(ii) Condensation Polymers: These are formed by the repeated condensation reaction of different bifunctional or trifunctional monomers, with the elimination of small molecules like water,HCL,NH_3, alcohol etc. e.g. Bakelite,nylon,polyster,urea- formaldehyde resin.

(d) Based On Molecular Forces:

(i) Elastomers: Forces of interaction between polymer chains is weakest, e.g. natural rubber, neoprene, vulcanized rubber.

(ii) Fibers: Strong hydrogen bonds are present between the polymer chains. They have high tensile strength e.g., nylon.polyster, silk, wool, orlon, rayon etc.

(iii) Thermoplastics: They are linear/slightly branched chains molecules capable of repeated softening on heating and hardening on cooling,e.g., polythene,PVC, polystrene, polypropene.

(iv) Thermosetting Plastics: They are cross-linked or heavily branched molecules, which on heating undergo extensive cross-linkages and become infusible, e.g., bakelite,urea formaldehyde resin.

(e) Based On Growth Of Polymerization: Depending upon the mechanism of Polymerization, polymers are classified as

(i) Addition Polymers Or Chain Growth Polymers:

They follow mostly free radical mechanism.

(ii) Condensation Polymers or Step Growth Polymers because they are formed in gradual steps.

Polymer	Monomer	Uses
(i) Polyethene	Ethene	Insulation of wires, toys, manufacture of dustbins etc.
(ii) Polytetra Fluroethene(Teflon)	Tetrafluoroethene	Oil seal and Gasket and non Stick kitchen wares
(iii) Polyarcylonitrile	Acrylonitrile	Substitute for wool
(iv) Terylene or Decron	Glycol + Terephthalic Acid	Ropes, safety belts, tyre -cord , sails of boats, saree and dress material
(v) Nylon-6,6	Hexamethylenediamine + Adipic acid	Stocking, socks, ropes, Parachutes, fabrics, bristles of tooth brush
(vi) Nylon-6	Caprolactum	Tyre-cords, Ropes, fabrics
(vii) Novolac	Phenol + Formaldehyde	Used for binding glue, laminated wooden p
(viii) Phenol Formaldehyde resin	Formaldehyde + Phenol	Combs,records, switches boards
(ix) Melamine polymers	Melamine + Formaldehyde	Manufacture of unbreakable crockery
(x) Buna-S Copolymer	1,3-Butadiene + Styrene	Autotyres floor, tiles foot-wear componer
(xi) Natural rubber	2-methyl-1,3-butadiene	Used for tyres
(xii) Neoprene	2-chloro-1,3-butadiene	Conveyor belts, gasket , hoses
(xiii) Buma-N	1,3-butadiene + acrylonitrile	Resistance to action of petrol. Make oil seals,tank linings etc.
(xiv) (PHBV) poly-β hydroxybutyrateco-β- hydroxyl valerate (biodegradable)	3-hydroxybutanoic acid + 3-hydroxypantanoic acid	Packaging orthopaedic devices
(xv) Nylon-2-nylon-6	Glycine + aminocaproic acid	It is biodegradable step growth Polymer
(xvi)Poly(glycolicacid) Poly(lactic acid) (dexton) (biodegradable)	Glycolic acid + lactic acid	Sutures ,ie,for stitching wounds after operation. Biodegradables

VSA (1 marks)

1.Name a natural elastomer.

Ans . Natural rubber.

2. Write name of a synthetic polymer which is an ester.

Ans. Nylon 6 or Nylon 6,6.

3. Name of monomer of Nylon 6.

Ans. €- Aminocaproic acid

4. Write the monomer units of Bakelite.

Ans. Phenol and formaldehyde.

5. Define a copolymer.

Ans.The polymers made by addition polymerisation from two different monomers are termed as **copolymers**, *e.g.*, Buna-S, Buna-N, etc.

6. Write one use of PVC.

Ans: In manufacture of rain coats& vinyl flooring.

7. Define Polymer.

Ans: Polymer is defined as very large molecules having molecular mass (103-107u). These are also referred to as **macromolecules,**

8. Give an example of thermoplastics.

Ans: Thermoplastics are polythene, polystyrene, polyvinyls, etc.

9. To which class of polymers does Nylon-66 belong?

Ans: ***Polyamides***

10. Name the type of monomers in terylene?

Ans: Ethylene glycol and terephthalic acid.

SA-1 (2 marks)

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

(ii)Neoprene < Polyvinyl chloride< Nylon 6.

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

Ans. (i) addition polymers :Polyvinyl chloride, Polythene.

(ii) condensation polymers: Terylene , Bakelite.

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

Ans. Polymers which disintegrate by themselves over a period of time due to environmental degradation by bacteria,etc.are called biodegradable polymers. e.g. PHBV

4.How can you differentiate between addition and condensation polymerization

Ans. In addition polymerization the molecules of the same monomer or diferent monomers add together on a large scale to form a polymer. The monomers used are unsaturated compounds, *e.g.*, alkenes, alkadienes and their derivatives.

Condensation polymerisation generally involves a repetitive condensation reaction between two bi-functional monomers. These polycondensation reactions may result in the loss of some simple molecules as water,

alcohol, etc., and lead to the formation of high molecular mass condensation polymers. *e.g.* , Nylon 6,6.

5.What is meant by PTFE ?Give its popular name.

Ans.Polytetrafluoroethylene.it is called Teflon.

6.Write chemical name of (Ziegler-Natta catalyst).

Ans: Triethylaluminium and titanium tetrachloride

7.Write down the two differences between thermoplastic and thermosetting plastic and examples.

Ans: Thermoplastic are the linear or slightly branched long chain molecules

capable of repeatedly softening on heating and hardening on cooling. These polymers possess intermolecular forces of attraction intermediate between elastomers and fibres. Some common thermoplastics are polythene, polystyrene, polyvinyls, etc.

Thermosetting plastic polymers are cross linked or heavily branched molecules, which on heating undergo extensive cross linking in moulds and again become infusible. These cannot be reused. Some common examples are bakelite, urea-formaldelyde resins, etc.

8.Differentiate Novolac and Bakelite on the basis of structure.

Ans: A linear product of ***Phenol - formaldehyde polymer*** is **Novolac,** used in paints.

Novolac on heating with formaldehyde undergoes cross linking to form an infusible solid mass called **bakelite**. It is used for making combs, phonograph records, electrical switches and handles of various utensils.

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

Ans: the addition polymers formed by the polymerisation of a single monomeric species are known as **homopolymers**, *e.g.*, polythene.

The polymers made by addition polymerisation from two different monomers are termed as **copolymers**, *e.g.*, Buna-S, Buna-N, etc.

10. How will you differentiate between LDP and HDP?

Ans: ***Low density polythene*****:** It is obtained by the polymerisation of ethene under high pressure of 1000 to 2000 atmospheres at a temperature of 350 K to 570 K in the presence of traces of dioxygen or a peroxide initiator (catalyst).

Low density polythene is chemically inert and tough but flexible and a poor conductor of electricity.e.g., squeeze bottles, toys and flexible pipes.
High density polythene: It is formed when addition polymerisation of ethene takes place in a hydrocarbon solvent in the presence of a catalyst Ziegler-Natta catalyst at a temperature of 333 K to 343 K and under a pressure of 6-7 atmospheres.

HDP consists of linear molecules and has a high density due to close packing. It is more tougher and harder. It is used for manufacturing buckets, dustbins, bottles, pipes, etc.

SA-II (3 marks)

1. Write the names of monomers of the following polymers:
   (i) Nylon 6,6 (ii) Neoprene(iii) Buna –N

Ans. (i) hexamethylenediamine and adipic acid.

(ii) chloroprene.

(iii)1, 3 – butadiene and acrylonitrile.

3.How are polymers classified on the basis of structure?
Ans.On the basis of structure, the polymers are classified as below:
(i) Linear polymers such as polythene, polyvinyl chloride,HDP etc.
(ii) Branched chain polymers such as low density polythene,LDP,etc.
(iii) Cross linked polymers such as bakelite, melamine, etc.

4. Write the monomers of the following polymers:
   (i) Buna-N (ii) Teflon(iii) Neoprene.
Ans.(i) 1, 3 – butadiene and acrylonitrile (ii) ***tetrafluoroethene (iii)*** chloroprene.

6. Write use of each orion and Nylon-6.
Ans: use of orion is clothing as a substitute for wool& for Nylon-6.
use of Nylon-6 is as fibrics

8. Explain elastomeric polymers & Fibres
Ans: These are rubber – like solids with elastic properties. In these elastomeric polymers, the polymer chains are held together by the weakest intermolecular forces. These weak binding forces permit the
polymer to be stretched. A few 'crosslinks' are introduced in between the chains, which help the polymer to retract to its original position after the force is released as in vulcanised rubber. The examples are buna-S, buna-N, neoprene, etc.
Fibres are the thread forming solids which possess high tensile strength and high modulus. These characteristics can be attributed to the strong intermolecular forces like hydrogen bonding. These strong forces also lead to close packing of chains and thus impart crystalline nature. The examples are polyamides (nylon 6, 6), polyesters (terylene), etc.

9 . What is the function of sulphur in vulcanisation of rubber?
Ans: Sulphur introduces sulphur bridges.So it is become more tensile strength,elasticity and resistance to abrasion etc.

10. Write **Commercially Importants of following Polymers**
(1) Polypropene (2) Polystyrene (3) Glyptal
Ans: (1) Manufacture of ropes, toys, pipes, fibres, etc.
(2)As insulator, wrapping material, manufacture of toys, radio and television cabinets.
(3) Manufacture of paints and lacquers.

HOTS QUESTIONS
VSA (1mark)

1.What is the main constituent of bubble gum?

Ans - Styrene-butadiene copolymer (SBR).

2.What is a plasticizer?

Ans; The substances which are added to increase the softness of hard polymers.

3.Draw the structures of the monomer of PAN.

Ans: CH_2=CH-CN

4.Give the name of polymer which is used for making non- stick utensils.

Ans: Teflon(CF_2=CF_2)

5.What is the % of sulphur using during in vulcanization of rubber ?

Ans: 3% to 5%

SA-I(2 marks)

1.Give the common and the IUPAC name of the monomer of natural rubber.

Ans: cis-Isoprene & 2-methyl-1,3-butadiene

2.Discuss the two main purpose of vulcanization of rubber.

Ans: (i)It makes the rubber hard.

(ii)It is more elastic.

(iii)It has more wear and tear resistance.

3.Explain the term ***Thermosetting polymers*** and give one example.

Ans: ***Thermosetting polymers:***These polymers are cross linked or heavily branched molecules, which on heating undergo extensive cross linking in moulds and again become infusible. These cannot be reused. Some common examples are bakelite, urea-formaldelyde resins, etc.

4. Why should one always use purest monomer in free radical polymerisation?

Ans: Impurities of other substances if present,may inhibit or hinder the chain propagation.

5.How is dacron obtained from ethylene glycol and terephthalic acid?

Ans: It is the condensation product of ethylene glycol and terephthalic acid

Carried out at 420 to 460K in the presence of catalyst mixture of zinc acetate and antimony trioxide.

SA-II(3 marks)

1.What does the following polymers stand for ?

(i)PVC (ii) DOP(iii) PAN

Ans: (1) Polyvinylchloride

(2)Dioctylphthalate

(3) Polyacrylonitrile

2. Why is Bakelite a thermosetting polymer?

Ans: It is a cross-linked polymer. On heating it sets permanently into a solid.It can not be remoulded by heating again.

3.A regular copolymer of ethylene and vinyl chloride contains alternate monomers of each type.What is the weight percent of ethylene in this copolymer?

Ans: the weight percent of ethylene in this copolymer

[28/(28+62.5)]*100

30.93%

acid polymerisation

4.C_6H_{10}=NOH → A → B Give the products A& B.

A=€- Aminocaproic acid

B=nylon-6

5.(i) Give an example of a synthetic rubber.

(ii) Mention main advantage of synthetic rubber.

(iii)Arrange the polymers in the increasing order of tensile strength, Nylon-6, Buna-S,Polythene.

Ans: (i) synthetic rubber is Buna-S

(ii) It is used for making oil seals, tank linings.

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