

POLYMERS

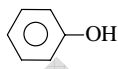
Short Answer Questions:

****1. What is PHBV? How is it useful to man?**

Ans. PHBV is Poly β -hydroxy butyrate-co- β -hydroxy valerate .It is a biodegradable polymer. It is used in speciality packing, orthopaedic devices and in controlled release of drugs.

****2.) Write the names and structures of monomers of the following polymers?**

a..Bakelite and b. Nylon- 6,6.

Ans.	S. No.	Polymer	Monomer
	a.	Bakelite	Phenol [] and Formaldehyde (HCHO).
	b.	Nylon-6, 6	Hexa methylenediamine [$\text{H}_2\text{N} (\text{CH}_2)_6\text{NH}_2$] and Adipic acid [$\text{HOOC} (\text{CH}_2)_4\text{COOH}$]

****3. What is PDI?**

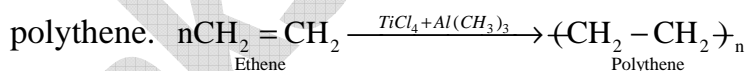
Ans. The ratio between weight average molecular mass and the number average molecular mass of a polymer is called poly dispersity index.

$$PDI = \frac{\overline{M}_w}{M_n}$$

The value of PDI for polymers is in between 1 and 1.5.

***4. What is Ziegler-Natta catalyst? Give its use?**

Ans. TiCl_4 and $\text{Al} (\text{CH}_3)_3$ is Ziegler-Natta catalyst. It is used in the polymerisation of ethylene in to polythene.

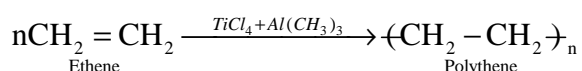


***5. What are addition and condensation polymers? Give example?**

Ans. The polymers formed by the repeated addition of monomer molecules possessing double or Triple bonds are called addition polymers.

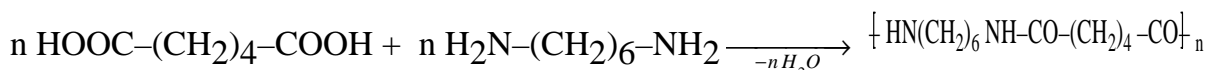
E.g., Polythene, polystyrene... etc.

Equation for polythene preparation is



The polymers formed by the repeated condensation reaction between two different bi- or tri-functional monomeric species are called condensation polymers.

E.g., Terylene, nylon-6, 6 etc. Equation for nylon-6, 6 preparation is



6. What are Elastomers and fibres?

Ans. Elastomers: Rubber like solids in which the Polymer chains are held by very weak Van der Waals forces and show elastic properties are called as elastomers.

E.g.: Buna – N rubber, Buna – S, Neoprene etc.

Fibres: Thread forming solids in which the Polymer chains are held by strong forces like Hydrogen bonding are called fibres.

E.g.: Polyamides, Nylon-6,6, Polyesters. Terylene (or) Dacron.

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

Effect of heat on these polymers is the basis of this classification.

Ans. Thermoplastic polymers: Those polymers (linear or slightly branched long chain molecules), which are capable of softening on heating and hardening on cooling are called thermoplastics.

E.g.: polythene, polyvinyl chloride, polystyrene etc.

Thermosetting polymers: Those polymers (cross linked or heavily branched molecules), which on heating do not soften and cannot be remoulded are called thermosetting polymers. On heating they undergo extensive cross-linking in moulds and become infusible.

E.g.: bakelite, urea- formaldehyde resins etc.

8. How can you differentiate between addition and condensation polymerization?

Ans. Addition polymerization

1. Monomer units have a double bond or triple bond in their molecules. These represent their functionality.
2. It is generally chain growth polymerization.
3. It does not involve the elimination of small molecules like H₂O, NH₃ etc.

Condensation polymerization

1. Monomer units have specific functional groups which represent their functionality.
2. It is generally step growth polymerization.
3. It involves the elimination of small molecules like H₂O, NH₃ etc.

9*) What are the monomeric repeating units of nylon-6 and nylon-6, 6?

Ans. Monomeric repeating units of nylon-6 is $\left[\text{-}\overset{\text{O}}{\parallel}\text{C}\text{-}(\text{CH}_2)_5\text{-}\overset{\text{H}}{\text{N}}\text{-} \right]$ which is derived from caprolactam.

Monomeric repeating unit of nylon-6, 6 is $\left[\text{-}\overset{\text{H}}{\text{N}}\text{-}(\text{CH}_2)_6\text{-}\overset{\text{H}}{\text{N}}\text{-}\overset{\text{O}}{\parallel}\text{C}\text{-}(\text{CH}_2)_4\text{-}\overset{\text{O}}{\parallel}\text{C}\text{-} \right]$ which is derived from monomers hexamethylene diamine and adipic acid.

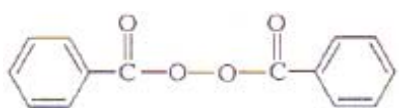
*10. What is a biodegradable polymer? Give an example of biodegradable aliphatic polyester.

Ans. A polymer that is decomposed over a long period of time either by itself or by the action of microorganisms is called a biodegradable polymer. Use of such polymer and their disposal does not create environmental problems.

Example: Poly β-hydroxy butyrate-co β-hydroxy valerate (PHBV)

*11. Write the name and structure of one of the common initiators used in free radical addition polymerization?

Ans. The common initiators used in free radical addition polymerization is Benzoyl peroxide i.e.



12. Explain the difference between buna-N and buna-S.

Ans. Buna-N and buna-S both are synthetic rubbers and copolymers. These two differ in their composition.

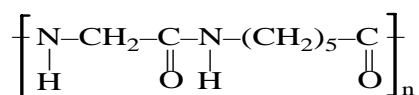
Buna-N: Constituents are buta-1, 3-diene and acrylonitrile.

Buna-S: Constituents are buta-1, 3-diene and styrene.

13. Give the structure of nylon 2–nylon 6.

Ans. Nylon 2–nylon 6 is a biodegradable polymer. It is an alternating copolymer obtained by the condensation of glycine and amino caproic acid. It is chemically a polyamide.

Structure of nylon 2– nylon 6 is given as:



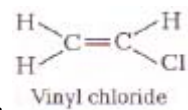
***14. What is vulcanization of rubber?**

Ans. The process of heating raw rubber with sulphur and an appropriate additive at a temperature range 373K to 415K to improve its physical properties is known as vulcanization. During vulcanization sulphur forms cross links at the reactive sites of double bonds and thus rubber gets stiffened.

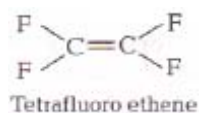
****15. Write the monomers used for getting the following polymers.**

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

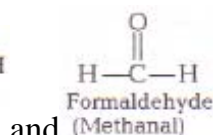
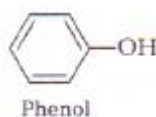
Ans. i. The monomer used in poly vinyl chloride is vinyl chloride i.e.



ii. The monomer used in Teflon is Tetra fluoro ethene i.e.



iii. The monomers used in Bakelite are



and

16. Explain the term copolymerization and give two examples.

Ans. Copolymerization: It is the polymerization reaction in which more than one type of monomers polymerize to form a copolymer.

Examples:

(i) Buna-S: Copolymer of monomers 1, 3-butadiene and styrene.

(ii) Buna-N: Copolymer of monomers 1, 3-butadiene and acrylonitrile.

17. Distinguish between the terms homo polymer and copolymer and give an example of each.

Ans. Homo polymer: a polymer, in which a single type of monomer is used, is called homo polymer.

E.g. Polythene, polystyrene etc.

Copolymer: A polymer in which the monomers are more than one type is called copolymer.

E.g., buna-S, buna-N etc.

18. Give one example for natural, synthetic and semi-synthetic polymers?

Ans.

Natural polymers: Those polymers which are found in plants and animals are called Natural polymers.

E.g., starch, cellulose, proteins etc.

Synthetic polymers: These are synthesized with the help of chemicals in industries

E.g.: polythene, nylon-6, 6, synthetic rubber etc.

Semi synthetic polymers: These are the synthetic derivatives of the natural polymers.

E.g.: Cellulose acetate (Rayon) and cellulose nitrate.

***19. What are Number average and weight average molecular mass of polymers? A polymer contains 10 molecules with molecular mass 10,000 and 10 molecules with molecular mass 100000. Calculate the number average molecular weight?**

Ans. Number average molecular mass (\overline{M}_n);

Let the number of particles of mass M_1 be N_1 , mass M_2 be N_2 , etc., in a polymer.

i. The number average molecular weight of the polymer,

$$\overline{M}_n = \frac{\sum_{n=1}^{\alpha} N_i M_i}{\sum_{n=1}^{\alpha} N_i} = \frac{N_1 M_1 + N_2 M_2 + \dots}{N_1 + N_2 + \dots}$$

ii. The weight average molecular weight of the polymer, (\overline{M}_w) :

$$\overline{M}_w = \frac{\sum_{n=1}^{\alpha} N_i M_i^2}{\sum_{n=1}^{\alpha} N_i M_i} = \frac{N_1 M_1^2 + N_2 M_2^2 + \dots}{N_1 M_1 + N_2 M_2 + \dots}$$

$$\text{Number average molecular mass, } \overline{M}_n = \frac{N_1 M_1 + N_2 M_2}{N_1 + N_2} = \frac{10 \times 10000 + 10 \times 100000}{10 + 10} = 55,000$$