

**Q1: Explain the terms polymer and monomer.**

**Solution:**

Polymers can be defined as huge molecular mass macro-molecules made of repeating monomer-derived structural units. Polymers consists of a huge molecular mass of ( $10^3 - 10^7u$ ). Numerous units of monomers are combined together in one polymer by covalent bonds. The polymers either be both natural and synthetic. Examples of polymers include rubber, polyethene, and nylon 6, 6. Simple and reactive molecules, called monomers, fuse together in large groups by covalent bonds to produce polymers.

**Examples of monomers: propene, ethene, vinyl chloride, and styrene.**

**Q2: What are natural and synthetic polymers? Give two examples of each type.**

**Solution:**

Polymers naturally found are known as Natural Polymers. Natural polymers are formed from animals and plants. Diverse natural polymer examples are protein, starch, cellulose, etc.

Polymers which are human-made are known as Synthetic Polymers. **Various examples of synthetic polymers are synthetic rubbers (Buna-5), synthetic fibres (nylon 6, 6), plastic (polythene).**

**Q3: Distinguish between the terms homopolymer and copolymer and give an example of each.**

**Solution:**

HOMO-POLYMER	CO-POLYMER
<p>The polymerisation of a single monomer results in the creation of polymers called homo-polymers. Or put it another way, the repeating units of homo-polymers are formed from one monomer.</p> <p><b>Example: homopolymer of ethane is polythene.</b></p>	<p>Co-polymers are polymers whose repeat units are obtained from two-type monomers. <b>Examples: Co-polymer of styrene and 1, 3 – butadiene is Buna – S.</b></p>

**Q4: How do you explain the functionality of a monomer?**

**Solution:**

The functionality of a monomer may be defined as the total number of bonding sites, which are in this particular monomer.

For example, adipic acid and 1, 3-butadiene is two, and that of propene and ethene is one

**Q5: Define the term polymerisation.**

**Solution:**

The mechanism of high molecular mass formation (  $10^3 - 10^7u$  ) macro-molecules, consisting of repeated structural units formed from monomers, is known as polymerization. There are several monomer units in a polymer that are joined by tight covalent bonds.

**Q6: Is ( NH-CHR-CO )<sub>n</sub> a homopolymer or copolymer?**

**Solution:**  $(-NH-CHR-CO-)_n$  is a **homo-polymer**, the reason being that it is derived from a single monomer unit,  $NH_2-CHR-COOH$ .

**Q7: Determine the groups where the polymers are graded according to molecular forces?**

**Solution:**

Polymers are classified into groups given below based on the intermolecular magnitude of forces present in polymers:

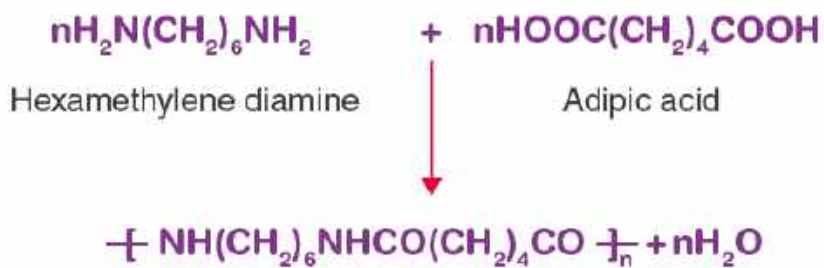
- (a) Fibres
- (b) Elastomers
- (c) Thermosetting polymers
- (d) Thermoplastic polymers

**Q8: How can you differentiate between addition and condensation polymerisation?**

**Solution:**

**Condensation Polymerisation:** The process in which the polymers are formed by the repeating condensation reactions between the two different bifunctional or trifunctional monomers. In this process, molecules such as hydrochloric acid or water are eliminated.

For example, nylon 6, 6 is the result of adipic acid and hexamethylenediamine polymerization of the reaction condensation.



Nylon 6, 6

**Addition Polymerisation:** The process in which the monomers having double or triple bonds are added repeatedly to form polymers.

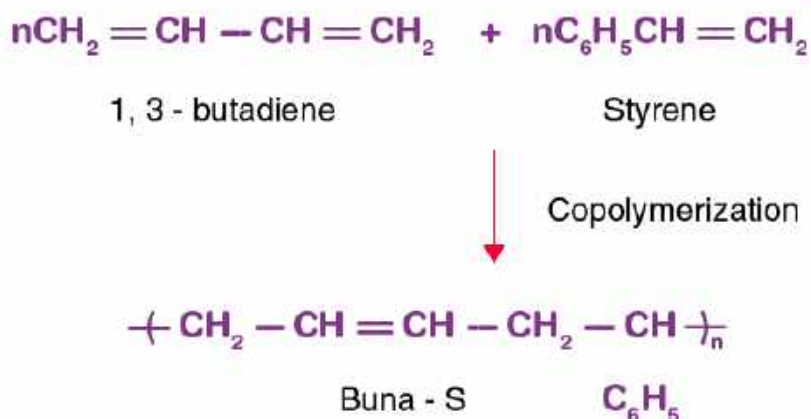
For example, Addition polymerization of ethene leads to the formation of **Polyethene**.



**Q9:** Explain the term copolymerisation and give two examples.

**Solution:**

Co-polymerisation is the mechanism by which polymers are formed from two or more monomeric units. In a copolymer, there are multiple units of every monomer. An example of copolymerization is the process of forming polymer Buna-S from 1, 3-butadiene and styrene.



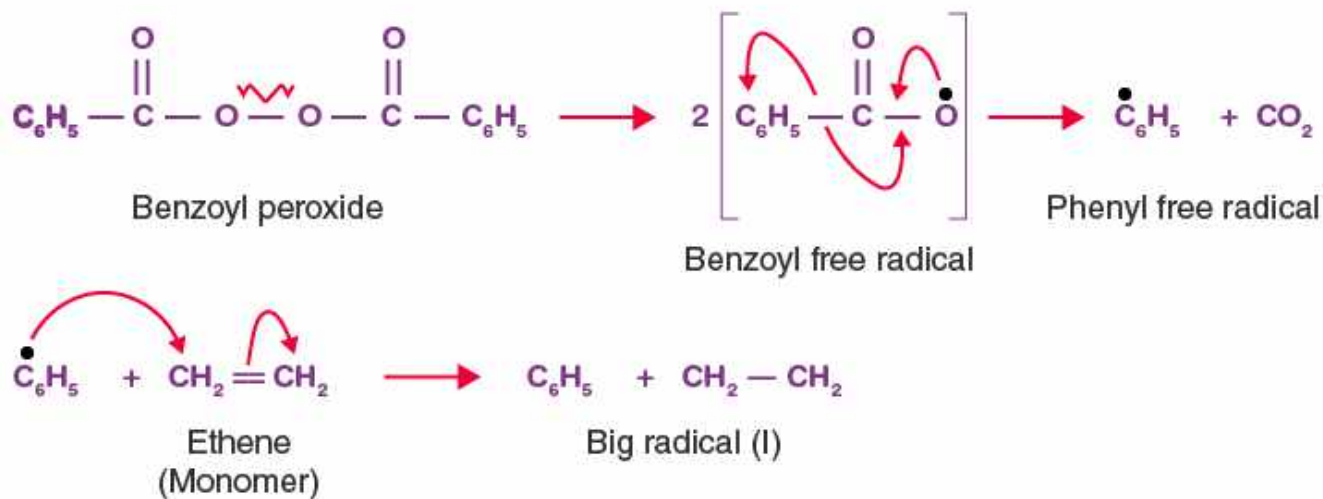
The formation of copolymer Nylon 6, 6 is from adipic acid and hexamethylenediamine.

**Q10: Write the free radical mechanism for the polymerisation of ethene.**

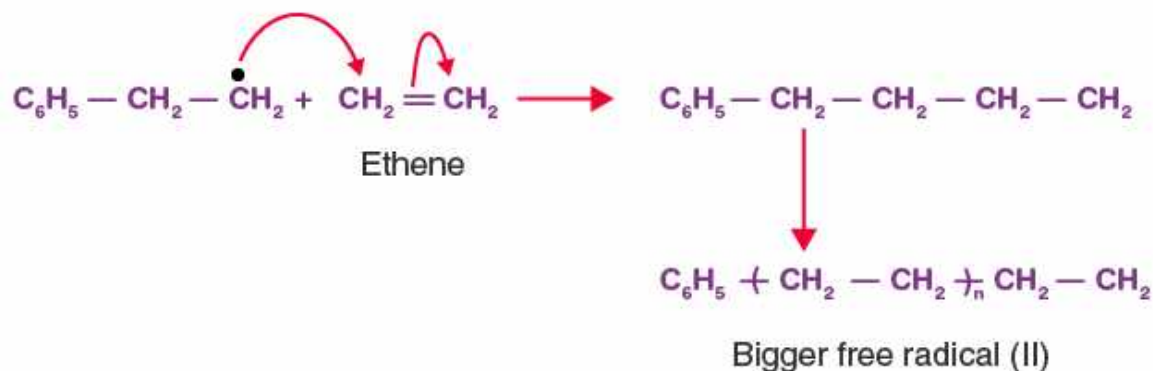
**Solution:**

Ethene polymerization into polythene consists of exposing or heating as the initiator a mixture of ethene with a small amount of benzoyl peroxide to light.

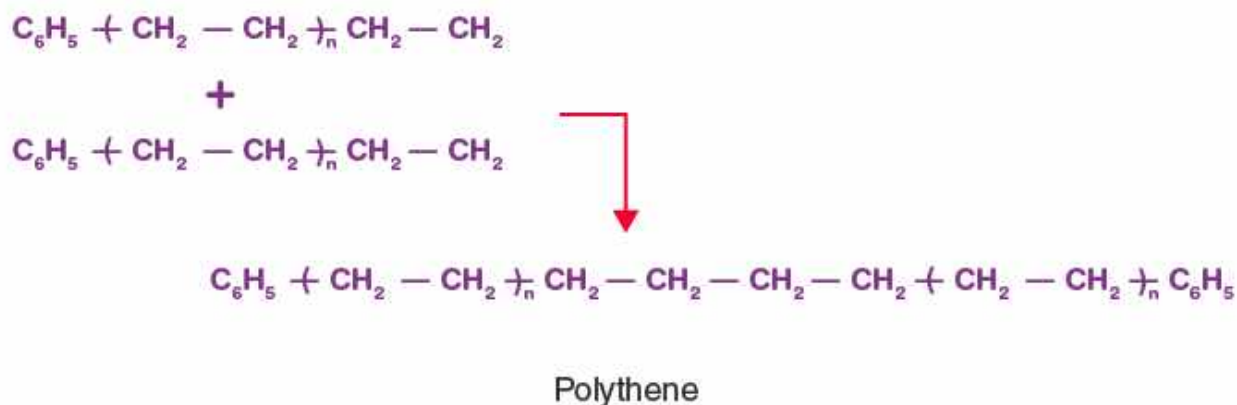
Chain initiation step



### Chain propagating step



### Chain terminating step



**Q 11: Define thermoplastics and thermosetting polymers with two examples of each.**

**Solution:**

Thermosetting polymers are called polymers which are cross-linked or strongly branched polymers which are hardened during the moulding process. Through heating, they can not be softened yet again.

**E.g., urea-formaldehyde resins, bakelite.**

Thermoplastic polymers are called polymers which are linear, slightly branched long-chain polymers which can be softened and hardened repeatedly when heated.

E.g., polystyrene, polythene.

**Q 12: Write the monomers used for getting the following polymers.**

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

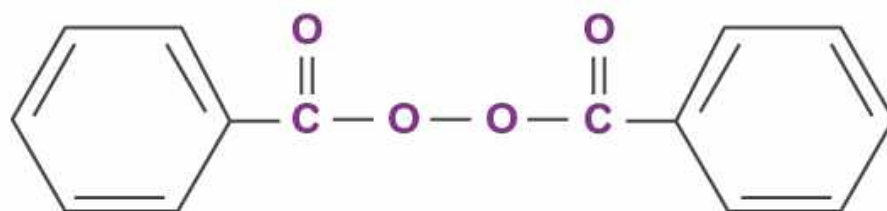
**Solution:**

- (1) Vinyl chloride (  $CH_2 = CHCl$  )  
 (2) Tetrafluoroethylene (  $CF_2 = CF_2$  )  
 (3) Phenol (  $C_6H_5OH$  ) and Formaldehyde (HCHO)

**Q 13: Write the name and structure of one of the common initiators used in free radical addition polymerisation.**

**Solution:**

Benzoyl peroxide is one of the common initiator's name and structure used in free radical polymerization.

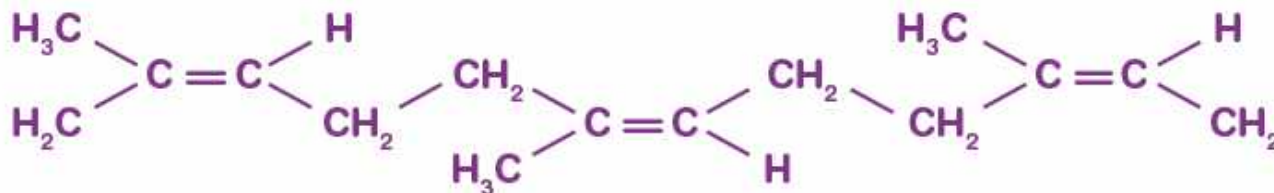


**Q 14: How does the presence of double bonds in rubber molecules influence their structure and reactivity?**

**Solution:**

Natural rubber is a linear cis-polyisoprene consisting of double bonds between the two units of

$C_2$  and  $C_3$   
isoprene .



Natural rubber

Intermolecular interactions between the different isoprene strands are relatively weak because of this cis-configuration. On account of this different natural rubber, strands are arranged randomly. So it's showing elasticity.

**Q 15: Discuss the main purpose of vulcanisation of rubber.**

**Solution:**

Natural rubber is useful, but its use does have problems. The disadvantages of natural rubber are as follows:

1. The natural rubber, at room temperature, is sticky and soft. It gets even softer at elevated temperatures, i.e. greater than 335 K. It becomes brittle at low temperatures, i.e. fewer than 283K. Therefore, natural rubber can only be used to maintain its elasticity at a temperature range of 283 K-335 K.
2. Natural rubber absorbs a large amount of water
3. Natural rubber has low resistance to abrasion and low tensile strength.
4. Natural rubber is soluble in non-polar solvents.
5. Natural rubber is easy to attack by oxidizing agents.

Vulcanization is done primarily to enhance natural rubber properties.

During this process, a mixture of raw rubber with sulphur and a suitable additive is heated to a temperature range of between 373 K and 415 K.

**Q 16: What are the monomeric repeating units of Nylon-6 and Nylon-6,6?**

**Solution:**

Nylon 6 monomeric repeat unit is  $[NH - (CH_2)_5 - CO]$ , derived from Caprolactam. The nylon 6, 6

monomeric repeat complex is  $[NH - (CH_2)_6 - NH - CO - (CH_2)_4 - CO]$ , which is derived from diamine hexamethylene and adipic acid.

**Q 17: Write the names and structures of the monomers of the following polymers:**

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

Polymer		Monomer	Structure of monomer
i	Buna-S	1, 3-butadiene	$\text{CH}_2 = \text{CH} - \text{CH} = \text{CH}_2$
		Styrene	$\text{C}_6\text{H}_5\text{CH} = \text{CH}_2$
ii	Buna-N	1, 3-butadiene	$\text{CH}_2 = \text{CH} - \text{CH} = \text{CH}_2$
		Acrylonitrile	$\text{CH}_2 = \text{CH} - \text{CN}$
iii	Neoprene	Chloroprene	$\begin{array}{c} \text{Cl} \\   \\ \text{CH}_2 = \text{C} - \text{CH} = \text{CH}_2 \end{array}$
iv	Dacron	Ethylene glycol	$\text{HOH}_2\text{C} - \text{CH}_2\text{OH}$
		Terephthalic acid	$\text{COOH} - \text{C}_6\text{H}_4 - \text{COOH}$

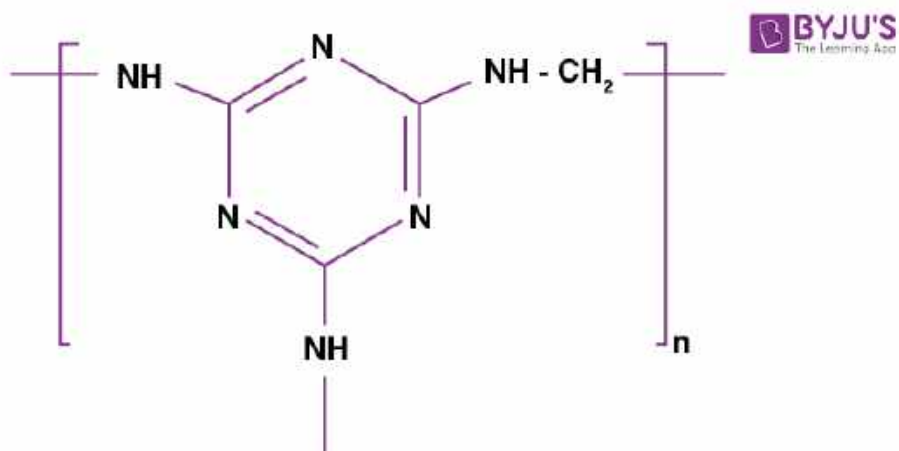
Q 18: Identify the monomer in the following polymeric structures.

(i)



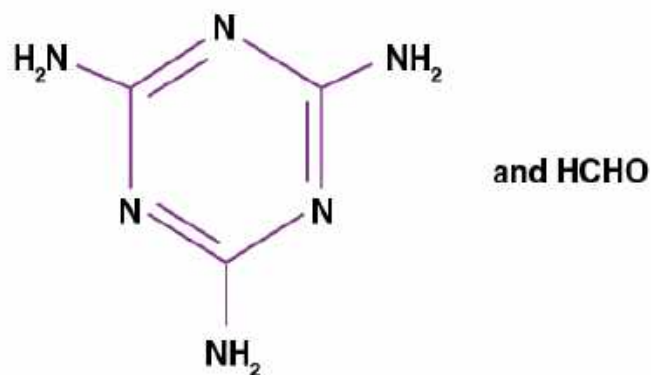


(ii)



**Solution:**

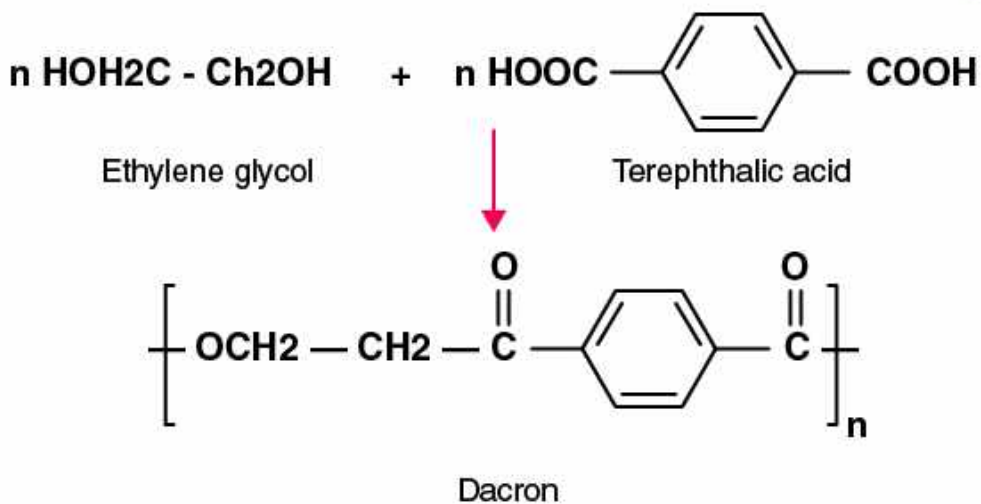
- (i) Hexamethylene diamine is the monomer of the given polymeric structure  $[H_2N(CH_2)_6NH_2]$  and decanoic acid  $[HOOC-(CH_2)_8-COOH]$ .
- (ii) The monomers of the polymeric structure given are:



Q 19: How is dacron obtained from ethylene glycol and terephthalic acid?

**Solution:**

Dacron is formed by the condensation polymerisation of terephthalic acid and ethylene glycol.



**Q 20: What is a biodegradable polymer? Give an example of a biodegradable aliphatic polyester.**

**Solution:**

A polymer which bacteria can decompose is called a Biodegradable Polymer. Poly-β-hydroxybutyrate-CO-β-hydroxyvalerate (PHBV) an example of an aliphatic biodegradable polyester.

