POLYMERS

SOLVED SUBJECTIVE EXERCISE

Very Short Answer Type Questions (1 mark)

1. Explain the term polymer and monomer.

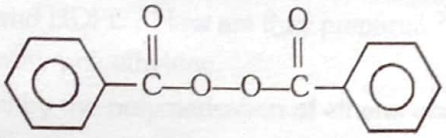
Ans. ***Polymers:*** Polymers are the compound of high molecular mass formed by the combination of large number of simple molecules called monomer.

Monomers: Simple and reactive molecules from which the polymers are prepared either by addition or condensation are called monomers. For example, vinyl chloride, ethene, formaldehyde and acrylonitrile phenol etc.

2. Is $+NH-CHR-CO+_n$, a homopolymer or a copolymer?

Ans. It is a homopolymer because the repeating structural structural unit has only one type of monomer, i.e., NH_2—CHR—COOH.

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

Ans. Benzoyl peroxide, 

4. What does '6, 6' indicate in the name nylon-6, 6?

Ans. The two monomers (adipic acid and hexamethylene) contain 6 carbon atoms each.

5. Write the name and structure of the monomer of neoprene rubber.

Ans. Chloroprene, (2-Chloro-1, 3-butadiene) $CH_2=C(Cl)CH=CH_2$.

6. Why is bakelite a thermosetting polymer ?

Ans. Due to high degree of cross-linking, bakelite cannot be reshaped on heating and hence bakelite is a thermosetting polymer.

7. Write the monomer of teflon? Give its uses.

Ans. Tetrafluoroethene ($F_2C = CF_2$). It is used in making oil seals and gaskets and also used for non-stick surface coated utensils.

8. (i) Name a polymer used to make cups for hot drinks.
(ii) Give an example of step growth polymer.

Ans. (i) Urea formaldehyde resin.
(ii) Nylon-6, 6.

9. What is the difference between nylon-6 and nylon-6, 6?

Ans. Nylon-6, 6 is a copolymer of adipic acid and hexamethylene diamine whereas nylon-6 is polymer of caprolactum.

10. What is the commercial name of PMMA ? What is its use ?

Ans. The commercial name of PMMA (polymethyl methacrylate) is perspex. It is used as a substitute of glass. It is used for making lenses, transparent domes, aircraft windows and sky lights.

11. Name a synthetic polymer which is an ester.

Ans. Terylene or Dacron. It is prepared by condensation polymerization of ethylene glycol and terephthalic acid with elimination of water.

12. What is the main difference in the structure of natural rubber and gutta-percha ?

Ans. Both are polymers of isoprene. Whereas natural rubber is *cis* (polyisoprene) while gutta percha is *trans* (polyisoprene).

13. Define plasticizers.

Ans. Those organic compounds which when added to plastics make them soft and workable are known as plasticizers. e.g., tricresyl phosphate, di-n-octylphthalate.

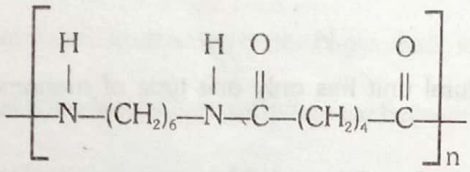
Short Answer Type Questions (2 mark)

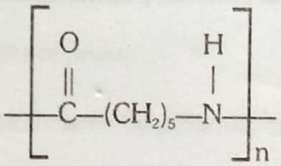
14. Distinguish between the terms homopolymer and copolymer and give an example of each.

Ans. ***Hompolymer:*** Polymers whose repeating structural units are derived from only one type of monomer units are called homopolymers. For example, polythene, PVC, PAN, teflon, polystyerene, nylon 6, etc.

Copolymer: Polymers whose repeating structural units are derived from two or more types of monomer molecules are copolymers. For example, Buna-S, Buna-N, nylon 66, polyester, bakelite, etc.

15. Write the name of monomers of the following polymers:

(i) 

(ii) 

(iii) $+CF_2 - CF_2+_n$

Ans. (i) Hexamethylenediamine [H_2N–$(CH_2)_6$–NH_2] and adipic acid [HOOC—$(CH_2)_4$—COOH].

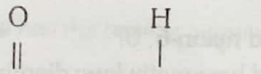
(ii) Caprolactam.

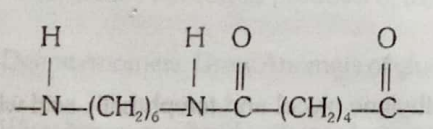
(iii) Tetrafluoroethene, ($F_2C = CF_2$).

16. Discuss the main purpose of vulcanization of rubber.

Ans. Natural rubber becomes soft at high tempearture (> 335 K) and brittle at low temperature (< 283 K) and shows high water absorption capacity. It is soluble in non-polar solvents and is non-resistant to attack by oxidising agents. To improve upon these physical properties, a process of vulcanisation is carried out. This process consists of heating a mixture of raw rubber with sulphur and an appropriate additive at a temperature range between 373 K to 415 K. On vulcanisation, sulphur forms cross links at the reactive sites of double bonds and thus the rubber gets stiffened.

17. What are the monomeric repeating units of Nylon 6 and Nylon 6, 6?

Ans. The monomeric repeat unit of Nylon 6 is  which is derived from caprolactam. The monomeric repeat unit of Nylon 6, 6 is derived from two monomers, hexamethylenediamine and adipic acid and has the following structure:



18. Differentiate the following pair of polymers based on the property mentioned against each.

(i) Novolac and Bakelite (structure).

(ii) Buna-S and Terylene (intermolecular forces of attraction).

Ans. (i) Novolac is a straight chain linear polymer but bakelite is cross linked.

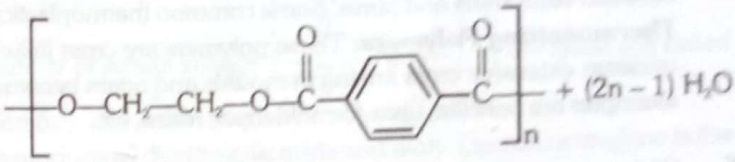
(ii) Buna-S is an elastomer having weak vander Waal's intermolecular forces whereas terylene is a fibre having strong intermolecular hydrogen bonding.

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

Ans. Dacron is obtained by condensation polymerization of ethylene glycol and terephthalic acid with the elimination of water molecules. The reaction is carried out in 420–460 K in presence of a catalyst consisting of a mixture of zinc acetate and antimony trioxide.

Ethyleneglycol

Terephthalic acid



20. What are LDPE and HDPE ? How are they prepared ?

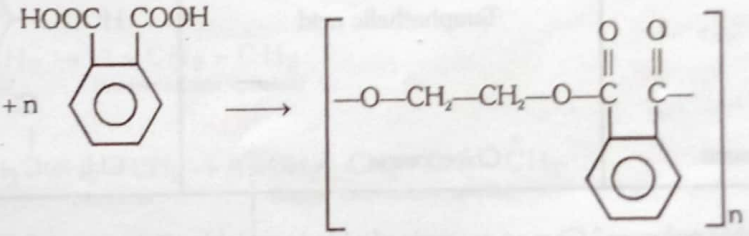
Ans. ***LDPE:*** Low Density polyethylene.

LDPE is obtained by the polymerisation of ethene under high pressuer of 1000 to 2000 atm at 350 K to 570 K temperature in the presence of an initiator.

HDPE: High density polyethylene.

HDPE is obtained when polymerisation is done in the presence of Ziegler Natta catalyst at 333 K to 343 K under 6 – 7 atm pressure.

21. Write equations for the synthesis of the given polymer 'Glyptal'.

Ans. 

22. Write the information asked in the following polymers:

(i) Bakelite-Materials used for preparation.

(ii) PVC-Monomer unit.

(iii) Synthetic rubber-Monomer unit.

(iv) Nylon-6, 6-Materials required for preparation.

Ans. (i) Phenol and formaldehyde.

(ii) Vinyl chloride.

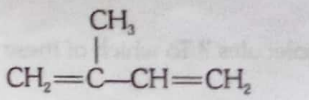
(iii) Chloroprene.

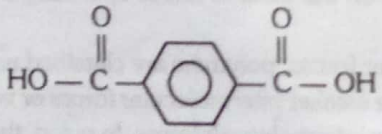
(iv) Adipic acid and hexamethylene diamine.

23. Write the names and the structures of monomers of following polymers:

(i) Natural rubber (ii) Terylene

Ans. (i) ***Natural rubber:*** Isoprene



(ii) ***Terylene:*** $HO-CH_2-CH_2-OH$ and 

Ethylene glycol

Terephthalic acid

24. How do you explain the functionality of a monomer?

Ans. By functionality, we mean the number of bonding sites in a molecule. For instance, the functionality of ethene, propene, acrylonitrile is one because such molecules can react at one site that of adipic acid, 1,3-butadiene, hexamethylenediamine is two because they can bond at two positions with other-molecules.

Short Answer Type Questions (3 mark)

25. Define thermoplastics and thermosetting polymers.

Ans. ***Thermoplastic Polymers:*** These 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 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-formaldehyde resins, etc.

26. Write the names and structures of the monomers of the following polymers:
(i) Buna-S (ii) Buna-N (iii) Dacron (iv) Neoprene.

Ans.

S.No.	Polymers	Monomers Names	Monomers Structures
(i)	Buna-S	1, 3-Butadiene,	$CH_2 = CH - CH = CH_2$
		Styrene	$C_6H_5CH = CH_2$
(ii)	Buna-N	1, 3-Butadiene,	$CH_2 = CH - CH = CH_2$
		Acrylonitrile	$CH_2 = CH - CN$
(iii)	Dacron	Ethylene glycol	$OHCH_2 - CH_2OH$
		Terephathalic acid	HOOC–C$_6$H$_4$–COOH
(iv)	Neoprene	Chloroprene	$CH_2 = \underset{\displaystyle Cl}{\underset{\vert}{C}} - CH = CH_2$

27. What is 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.

For example: PHBV (Poly-β-hydroxybutyrate-co-β-hydroxyvalerate).

$$n\,HO-\underset{\displaystyle CH_3}{\underset{\vert}{CH}}-CH_2-COOH + n\,HO-\underset{\displaystyle CH_2CH_3}{\underset{\vert}{CH}}-CH_2-COOH \xrightarrow{\text{Polymerisation}}$$

3-Hydroxybutanoic acid 3-Hydroxypentanoic acid

$$\left[-O-\underset{\displaystyle CH_3}{\underset{\vert}{CH}}-CH_2-\overset{\displaystyle O}{\overset{\Vert}{C}}-O-\underset{\displaystyle CH_2Cl_3}{\underset{\vert}{CH}}-CH_2-\overset{\displaystyle O}{\overset{\Vert}{C}}-\right]_n + (2n-1)\,H_2O$$

28. How are polymers classified on the basis of forces operating between their molecules ? To which of these classes does nylon-6, 6 belong ?

Ans. On the basis of intermolecular forces, polymers are classified as follows:

(i) ***Elastomers:*** These have weaker intermolecular forces or van der Waals' forces. For example, Buna-S.

(ii) ***Fibres:*** These have strong intermolecualr forces. In nylon, the forces are hydrogen bonds while in polyesters, the forces are dipole-dipole interactions.

(iii) ***Thermoplastics:*** These polymers possess intermolecualr forces of attraction intermediate between elastomers and fibres. Examples are polythene and polyvinyl chloride.

(iv) ***Thermosetting polymers:*** These polymers are cross linked or heavily branched molecules, which on heating undergo extensive cross linking and again become infusible. For example, bakelite.

Nylon-6, 6 belongs to the fibre class.

29. Briefly describe the following terms giving one example of each:

(i) Polyolefins (ii) Polyamides (iii) Polyesters

Ans. (i) ***Polyolefins:*** These are polymers derived from unsaturated hydrocarbons, for example, polypropene.

(ii) ***Polyamides:*** The polymers having large number of amide linkage $\left(\begin{matrix}O\\ \|\\ -C-NH-\end{matrix}\right)$ in the chain are called polyamides, for example, nylon 6, 6 and nylon 6.

(iii) ***Polyesters:*** These are the polycondensation products of dicarboxylic acids and diols. Dacron or terylene is the best known example of polyesters.

30. Explain the following process with a suitable example in each case:

(i) Chain growth polymerisation.

(ii) Step growth polymerisation.

Ans. (i) ***Chain growth polymerisation:*** This type of polymerisation involves the initial formation of a free radical or an ion (from small amount of initiator such as organic peroxide) to which monomers get added up by a chain reaction. Here, the polymers are exact multiples of organic monomeric molecule and have only carbon atoms in their main chain. Various steps involved in chain growth polymerisation of ethene are:

(a) Initiator $\xrightarrow[\text{split up}]{\text{Heat, light, etc}}$ $\underset{\text{Free radical}}{\overset{\bullet}{A}}$

(b) $\overset{\bullet}{A} + \underset{\text{Monomer}}{CH_2 = CH_2} \rightarrow \underset{\text{(Intermediate species)}}{A - CH_2 - \overset{\bullet}{C}H_2}$

(c) $A - CH_2 - \overset{\bullet}{C}H_2 + \underset{\text{Monomer}}{CH_2 = CH_2} \rightarrow \underset{\text{(Bigger intermediate species)}}{A - CH_2 - CH_2 - CH_2 - \overset{\bullet}{C}H_2}$

Ex. Polyethylene, Teflon etc.

(ii) ***Step growth polymerisation:*** This type of polymerization involves a series of condensation reactions between simple monomers containing polar group, with or without the elimination of small molecules like water, HCl, NH_3, etc. In addition to carbon atoms, these polymers contain other atoms also in their main chain. Steps may be illustrated as follows:

(a) $\underset{\text{monomer}}{A} + \underset{\text{monomer}}{B} \xrightarrow{\text{condensation}} A - B$

(b) $A - B + A \xrightarrow{\text{condensation}} A - B - A$

(c) $A - B + A - B \xrightarrow{\text{condensation}} A - B - A - B$

(d) $A - B - A - B + A - B \xrightarrow{\text{condensation}} \underset{\text{Polymer}}{A - B - A - B - A - B....(A - B)_n}$

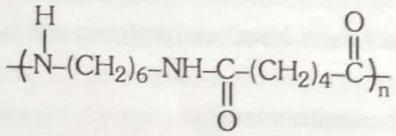
Examples: Terylene, Nylon, etc.

EXERCISE-1

PREVIOUS YEARS BOARD PROBLEMS

CBSE 2016

1. (i) What is the role of benzoyl peroxide in the polymerization of ethene ?
   (ii) Identify the monomers in the following polymer:



   (iii) Arrange the following polymers in the increasing order of their intermolecular forces:
   Nylon-6, 6 Polythene, Buna-S

2. Write the mechanism of free radical polymerization of ethene.

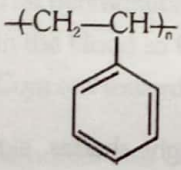
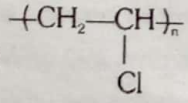
CBSE 2015

1. Write the names and structures of the monomers of the following polymers :
   (i) Nylon-6, 6
   (ii) Bakelite
   (iii) Polystyrene

CBSE 2014

1. Write the name of monomers used for getting the following polymers:
   (i) Bakelite (ii) Neoprene
2. Based on molecular forces what type of polymer is neoprene ?
3. Write the name of monomers used for getting the following polymers:
   (i) Terylene (ii) Nylon-6, 6
4. Which of the following is a fibre ?
   Nylon, Neoprene, PVC.
5. Write the name of monomers used for getting the following polymers:
   (i) Teflon (ii) Buna-N

CBSE 2013

1. Is  a homopolymer or a copolymer ?
2. Give one example of a condensation polymer.
3. Is  a homopolymer or a copolymer ?
4. Define thermoplastic and thermosetting polymers. Give one example of each.

   OR

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

CBSE 2012

1. Explain the following terms giving a suitable examples for each
(i) Elastomers (ii) Condensation polymers (iii) Addition polymers.

CBSE 2011

1. Write the name of monomers of neoprene.
2. In nylon-6-6 what does the designation '66' mean?
3. What is the repeating structural unit in polythene polymer ?
4. Distinguish between addition polymers and condensation polymers. Classify the following into addition and condensation polymers.
(i) Polyethene (ii) PTFE (iii) Polybutadiene (iv) Bakelite
5. Write the name and structures of monomers and of the following polymes.
(i) Buna-S (ii) Dacron (iii) Glyptal

CBSE 2010

1. Write the sturcture and one use of each of the following polymers
(i) PVC (ii) Urea-formaldehyde resin (iii) Bakelite
2. Write the structure and one use of urea formaldehyde resin.
3. What is meant by copolymerisation ?
4. Mention two important uses of each of the following.
(i) Bakelite (ii) Nylon-6
5. Write the structure of repeating monomeric units of
(i) Dacron (ii) Neoprene (iii) Polyvinyl chloride (iv) Teflon
6. Differentiate between thermoplastic and thermosetting polymers. Give one example of each.

CBSE 2009

1. Name the subgroups into which polymers are classified on the basis of magnitude of intermolecular forces.
2. Write chemical equation for the synthesis of
(i) Nylon-6 (ii) Nylon-66 (iii) Polythene
3. What is the primary structure feature necessary for a molecule to make it useful in a condensation polymeristaion reactions?

Charge

EXERCISE-1

PREVIOUS YEARS BOARD PROBLEMS

POLYMERS

CBSE 2016

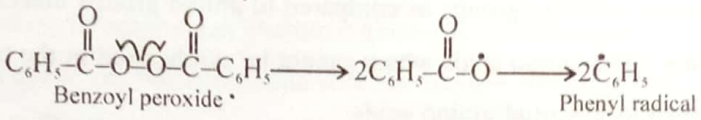
Sol.1 (i) Catalyst / initiator of free radical

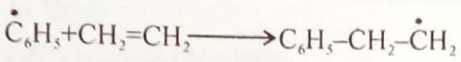
(ii) Hexamethylene diamine and adipic acid / structure / IUPAC name

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

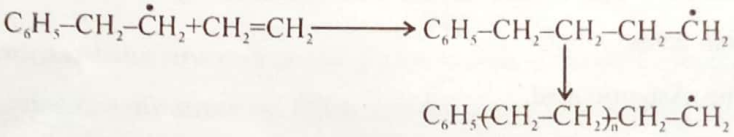
Sol.2

Chain initiation steps



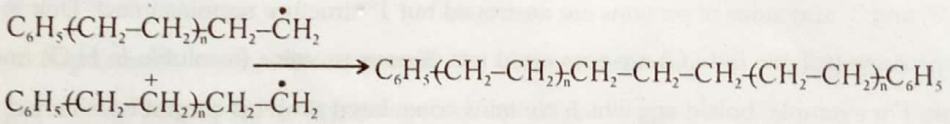


Chain propagating steps

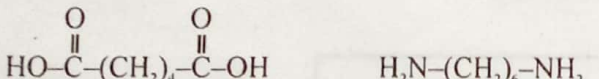


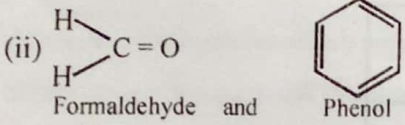
Chain terminating steps

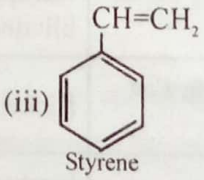
For termination of the long chain, these free radicals can combine in different ways to form polythene. One mode of termination of chain is shown as under :



CBSE 2015

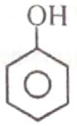
Sol.1 (i) 

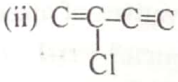
(ii) 

(iii) 

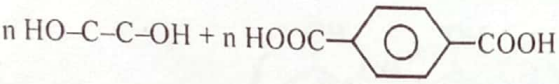
(Note: half mark for structure/s and half mark for name/s in each case)

CBSE 2014

Sol.1 (i)  + HCHO

(ii) 

Sol.2 Vender wall force of atteraction.

Sol.3 (i) 

(ii) $n\ NH_2 - (CH_2)_6 - NH_2 + n\ HOOC-(CH_2)_4-COOH$

Sol.4 Nylon

Sol.5 (i) $n[CF_2 = CF_2]$

(ii) $nCH_2=CH-CH=CH_2$

$nCH_2=CH-CN$

CBSE 2013

Sol.1 It is a homopolymer.

Sol.2 Backalite

Sol.3 Homopolymer

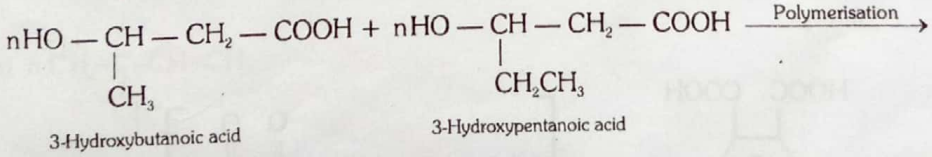
Sol.4 ***Thermoplastic Polymers:*** These are the linear or slightly branched long chain molecules capable of repeatedly softening on heating and hardening on cooling. These polymers possess intermolecular forces of attraction intermediate between elastomers and fibres. Some common thermoplastics are polythene, polystyrene, polyvinyls, etc.

Thermosetting 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-formaldehyde resins, etc.

OR

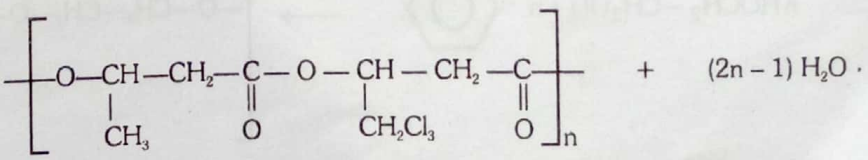
Polymers which disintegrate by themselves over a period of time due to environmental degradation by bacteria etc are called biodegradable polymers.

For example: PHBV (Poly-β-hydroxybutyrate-co-β-hydroxyvalerate).



3-Hydroxybutanoic acid

3-Hydroxypentanoic acid



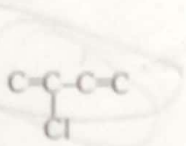
CBSE 2012

Sol.1 (i) These are rubber like solids with elastic properties. These polymers have the weakest intermolecular forces.

(ii) These polymers are formed by repeated condensation or series of condensation reactions between two different bi–functional or frifanctional monomeric units.

(iii) These plymers are formed by the repeated addition of monomer molecules possessing double or triple bonds. In other words, monomers are unsaturate compounds and common derivatives of alkenes.

CBSE 2011

Sol.1 

Sol.2 no. of carbon in monomer

Sol.3 n. $CH_2 = CH_2$

Sol.4 (i) These are rubber like solids with elastic properties. These polymers have the weakest intermolecular forces.

(ii) These polymers are formed by repeated condensation or series of condensation reactions between two different bi–functional or frifanctional monomeric units.

(iii) These plymers are formed by the repeated addition of monomer molecules possessing double or triple bonds. In other words, monomers are unsaturate compounds and common derivatives of alkenes.

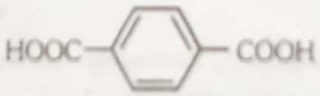
→ Addition : 1, 2, 3

→ Condensation : 4

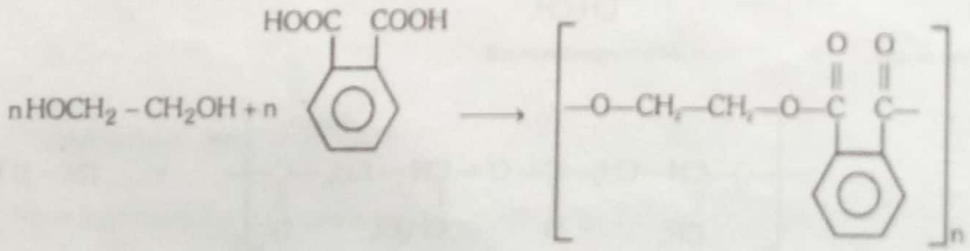
Sol.5 (i) Buna-S — 1, 3-Butadiene, $CH_2 = CH - CH = CH_2$

Styrene $C_6H_5CH = CH_2$

(ii) Dacron — Ethylene glycol $OHCH_2 - CH_2OH$

Terephathalic acid 

(iii) Glyptal



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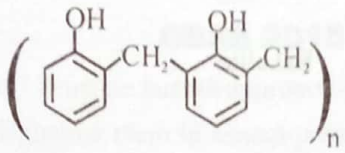
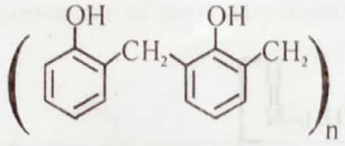
Sol.1 (i) **PVC :-** $\left(CH_2-\underset{Cl}{CH}\right)_n$ Manufacture of rain coats, hand bogs water pipes.

(ii) **Urea-formddehyde :-** $\left(NH-CO-NH-CH_2\right)$ For making unbreakably cups and Laminated sheets

(iii) **Bakelite :-**  For making combs, electrical switches,] computer discs.

Sol.2 **Urea-formddehyde :-** $\left(NH-CO-NH-CH_2\right)$ For making unbreakably cups and Laminated sheets

Sol.3 The polymers made by addition polymerisation of two different kinds of monomers are known as copolymers. The process by which copolymers are formed, is called copolymerisation.

Sol.4 (i) **Bakelite :-**  For making combs, electrical switches,] computer discs.

(ii) **Nylon–6 :-** Tyre cords, fabrics and ropes.

Sol.5 (i) $n\ HOH_2C-CH_2-OH + n\ HOOC-C_6H_4-COOH$

(ii) $n\ CH_2=\underset{Cl}{C}-CH=CH_2$

(iii) $n\ CH_2=\underset{Cl}{CH}$

(iv) $n\ CF_2 = CF_2$

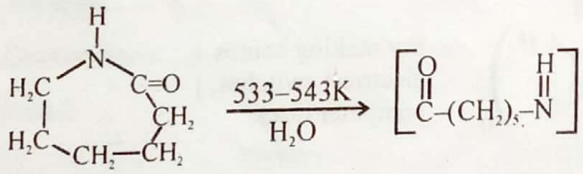
Sol.6

	Thermoplastic	Thermosetting
-	Force of attraction ie intermediate b/w fibre and elastiomer (ionic bond)	Cross linkage (hard)
-	Can be remouled	not
-	Ex. polyethene	Bakelite

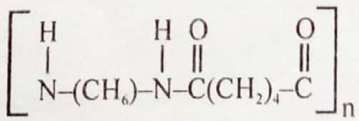
CBSE 2009

Sol.1 elastomers, fibre, thermoplatic, thermocetting

Sol.2 (i)



(ii) $n\ HOOC(CH_2)_4COOH + n\ H_2N(CH_2)_6NH_2 \xrightarrow[\text{High pressure}]{553\ K}$



(iii) $n\ CH_2{=}CH_2 \longrightarrow [CH_2 - CH_2]_n$

Sol.3 It should have bi functional and tri functional group.