

POLYMERS

SECTION A

Elastomers: Rubber like solids which can be stretched due to presence of weakest intermolecular forces between polymeric chain and which retract to their original position due to presence of few cross links between the chains.
Ex. Vulcanised rubber.

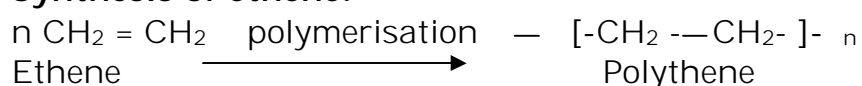
Fibre: Polymers which possess high tensile strength and high modulus due to strong intermolecular forces like H – bonding and which have crystalline nature, close packing of chains, sharp M.P. are called as fibres. These are used as fibres.

Ex. Nylon 6,6.

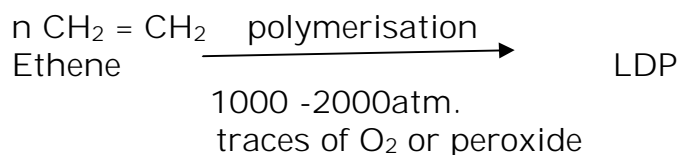
Difference between thermo plastics and thermosetting polymers.

	Thermo plastics		Thermosetting polymers
1	inter molecular force between polymeric chains are intermediate between weak van der Waal's force and H- bond and there is no cross linking due to extensive cross linking	1	Extensive cross linking between polymeric chains and therefore intermolecular force is stronger than thermoplastic
2	Easily moulded to a desired shape by heating	2	Become infusible and form an insoluble hard mass on heating
3	contains linear or slightly branched long chain molecules	3	contains cross linked or heavily branched long chain molecules

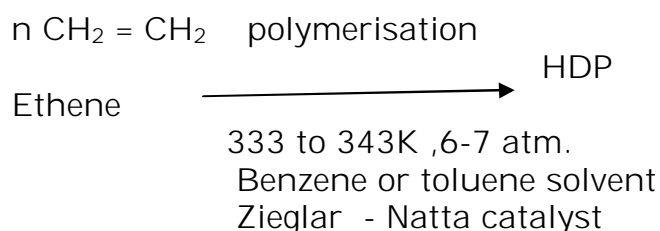
Synthesis of ethene:



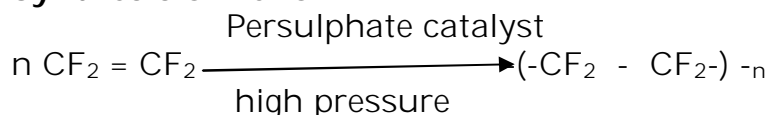
Synthesis of LDP:



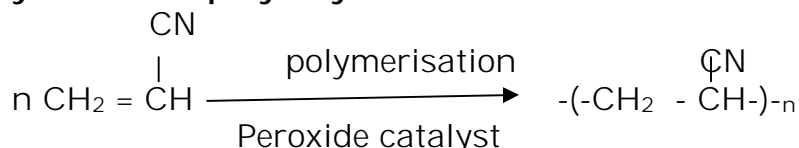
Synthesis of HDP:



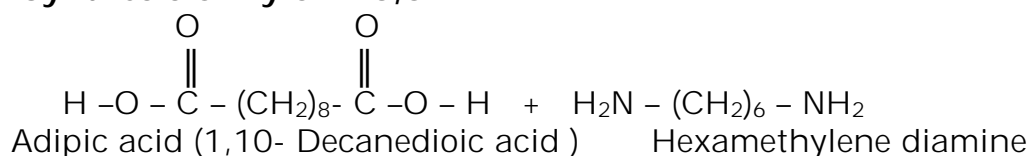
Synthesis of Teflon:



Synthesis of polyacrylonitrile:

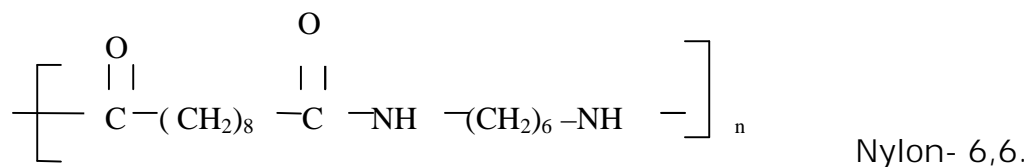


Synthesis of Nylon - 6,6:

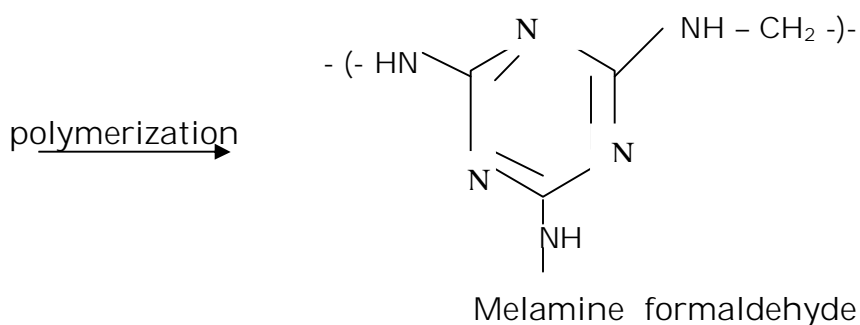
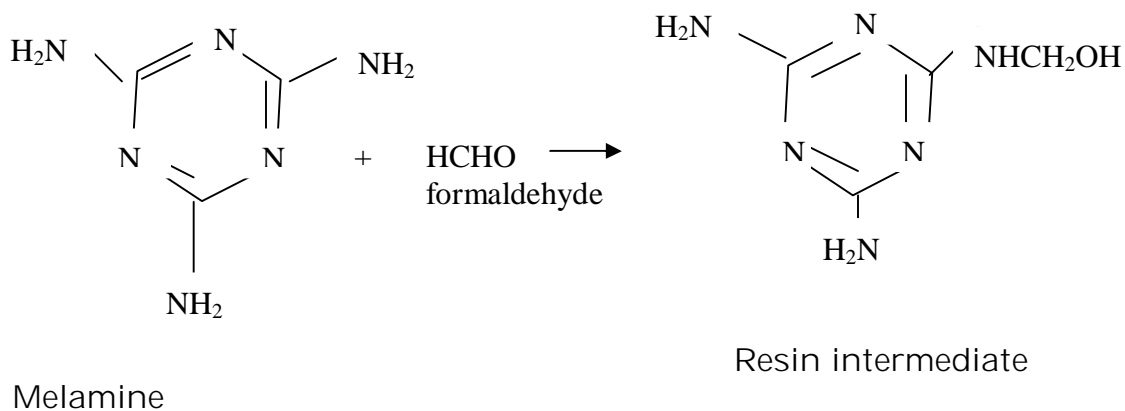
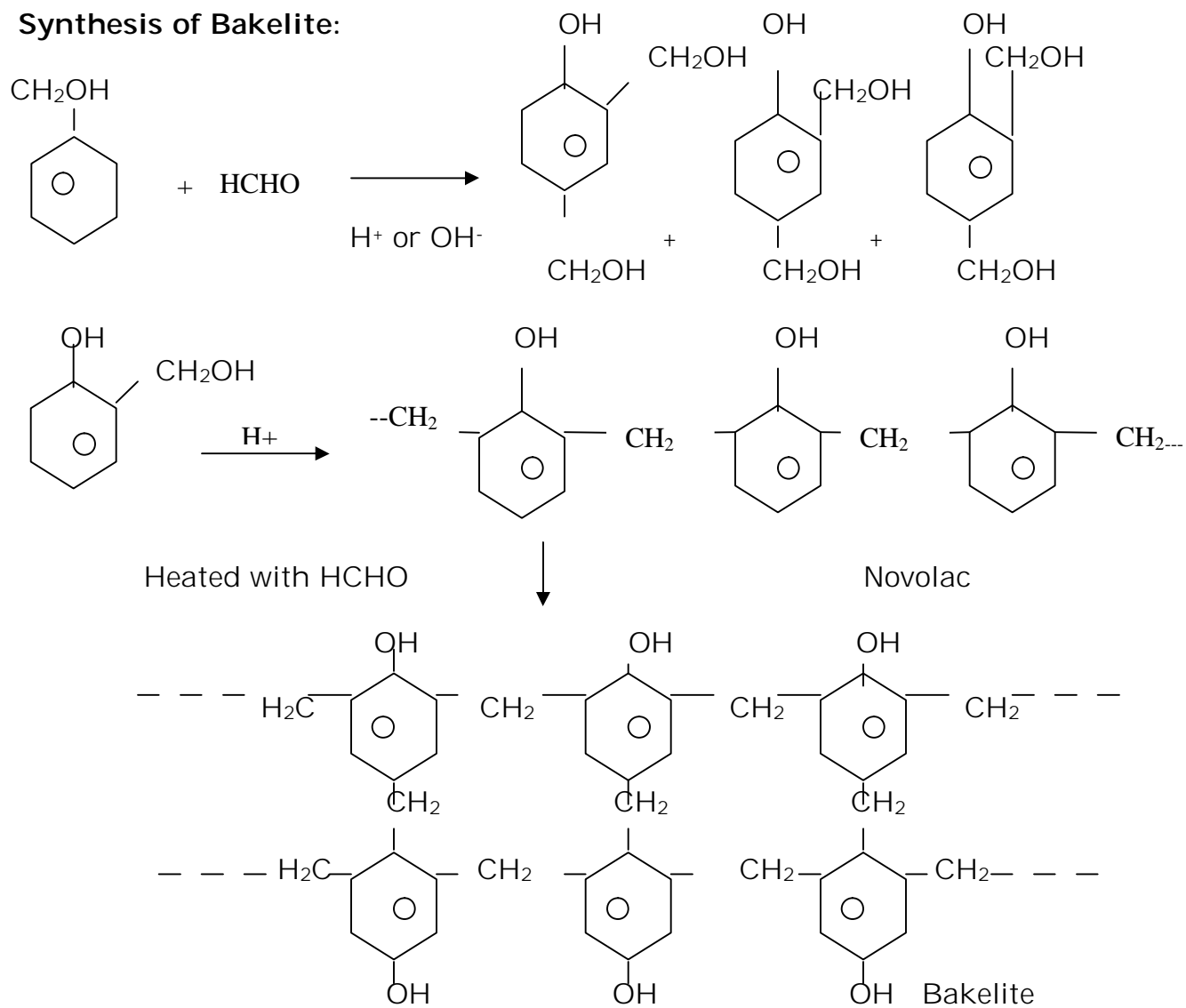


553K | High pressure

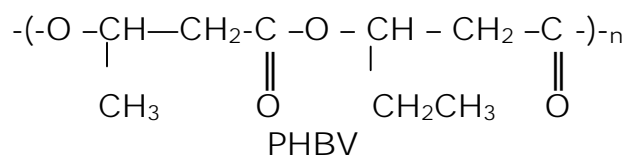
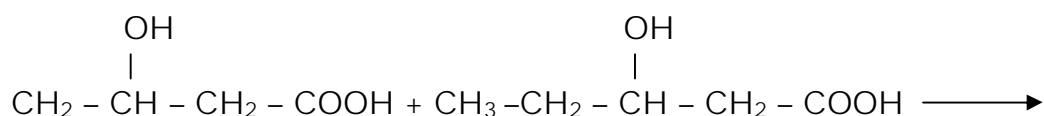
PREPARED BY MANISH TULI PRINCIPAL KV HIRNAGAR



Synthesis of Bakelite:

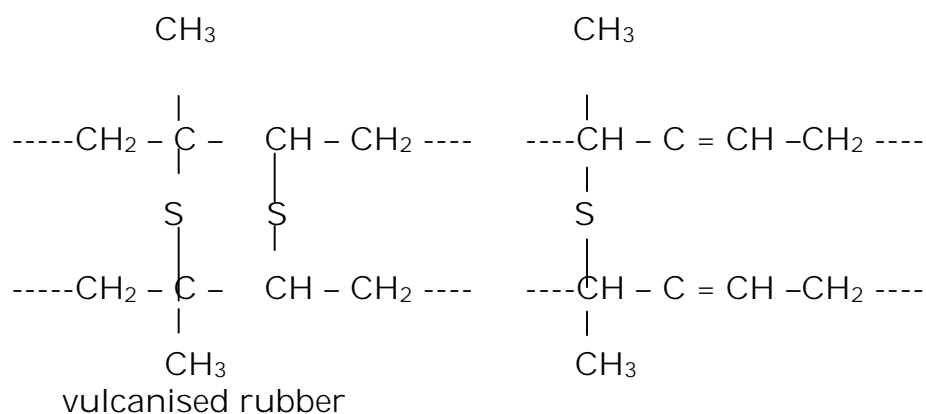
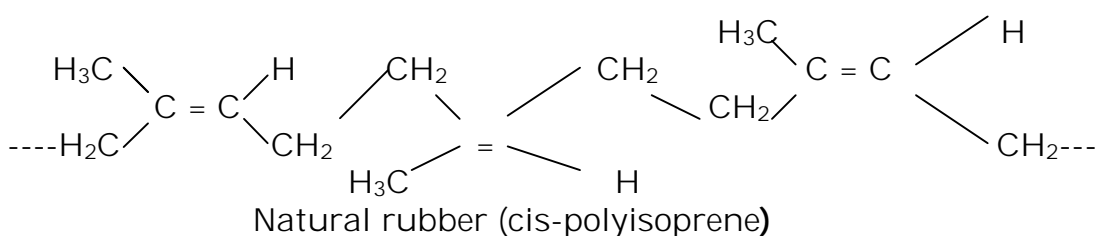


Synthesis of PHBV:



Uses of different polymers

1. Polypropene : manufacturing of ropes, toys, pipes fibres.
2. Polystyrene: as an insulator, as a wrapping material, manufacturing of toys, radio and television cabinets
3. PVC : to make rain coats, hand bags, in vinyl flooring , water pipes.
4. urea formaldehyde resin :to make unbreakable cupd and laminated sheets
5. Glyptal/Terylene/Dacron: to make paints and lacquers
6. Bakelite: to make combs, electrical switches, handles of utensils, computer discs
7. LDP: insulation of electricity carrying wires, manufacture of squeeze bottles, toys and flexible pipes.
8. HDP: to make buckets, dustbins, bottles, pipes .
8. Draw structures for natural rubber and vulcanized rubber.

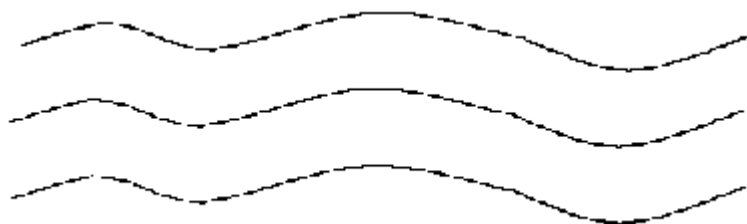


SECTION B

1. What are polymers?
2. How are polymers classified on the basis of structure?

On the basis of structure polymers are classified into three classes

- (i) Linear polymers: Polymers containing long straight polymer chains .
Ex. High density Polythene, PVC.



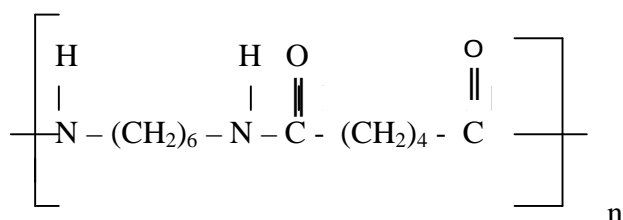
- (ii) Branched chain polymers: Linear polymer chains having some branches
Ex. Low density polythene



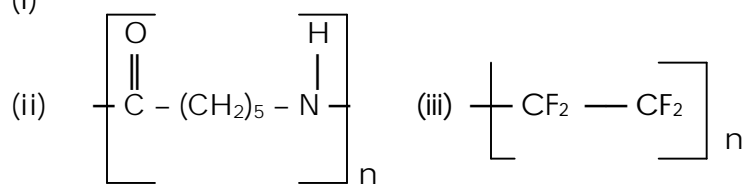
- (iii) Cross linked or network polymers: Polymers containing strong covalent bonds between various linear polymer chains and which are formed from bi-functional and tri-functional monomers.
Ex. Bakelite, melamine formaldehyde.



3. Write the names of monomers of the following polymers.



(i)



- (i) Hexamethylene diamine or Hexane -1,6- diamine. and Hexane -1,6 -dioic acid.
(ii) 6 - aminohexanoic acid
(iii) Tetrafluoroethene

4. Classify the following as addition and condensation polymers.

Terylene, Bakelite,

Polyvinyl chloride, Polythene.

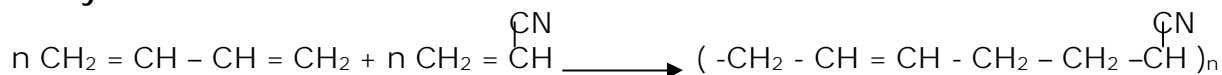
Addition polymers: Polyvinyl chloride, Polythene

Condensation polymers: Terylene, Bakelite

5. Explain the difference between Buna - N and Buna - S

Buna - N is a co-polymer of 1,3 - Butadiene and Acrylonitrile

Synthesis of Buna -N:



1,3 -Butadiene.

Buna - N (Butadiene acrylonitrile co-polymer)

Buna - S is a co-polymer of 1,3 - Butadiene and styrene.

For Buna - N (Refer below)

6. Arrange the following polymers in an increasing order of their intermolecular forces.

(i) Nylon- 6,6, Buna - S , Polythene

(ii) Nylon- 6 , Neoprene, Polyvinyl chloride.

(i) Buna - S, Polythene, Nylon- 6,6

PREPARED BY MANISH TULI PRINCIPAL KV HIRNAGAR

(ii) Neoprene, Polyvinyl chloride, Nylon-6

7. Is $[-CH_2 - CH(C_6H_5) -]_n$ a homopolymer or a co-polymer?

It is a homopolymer and the monomer form which it is obtained is



8. What are polyesters? Give an example. Give an example for a biodegradable poly ester.

9. Polymers synthesized by the condensation of dicarboxylic acids and diols.

Ex. Terylene

Ex. For a biodegradable poly ester is PHBV

i.e. Poly β -hydroxyl butyrate-co- β -hydroxyl valerate

SECTION C

CBSE 2008

1. Define the term polymerization. (1)

The process of formation of macrosized molecules of high molecular mass in which very large number of repeating structural units are joined together by covalent bonds.

2. Distinguish between homopolymers and co-polymers (2)

Homopolymers	co-polymers
1. Polymers made by polymerization of a single type of monomer	1. Polymers made by addition polymerization or condensation polymerization of two or more different types of monomers
2. contains multiple units of the same single monomer Ex. Polythene, Nylon-6.	2. contains multiple units of two different monomers. Ex. Buna - S, Nylon-6,6

CBSE 2007

1. Write formulae of monomers of polythene and Teflon. (2)

Monomer of polythene $CH_2 = CH_2$

Monomer of Teflon $CF_2 = CF_2$

2. Write the structures of monomers used and one use of each of the following polymers. (a) Teflon (b) Buna - N (2)

OR

What are biodegradable polymers? Give two examples. (2)

Teflon is used to make non-stick surface coated utensils.

Monomers of Buna - N (i) $CH_2 = CH - CH = CH_2$ 1,3-Butadiene.

(ii) $CH_2 = \overset{\text{CN}}{\underset{|}{\text{CH}}}$ Acrylonitrile.

Buna - N is used to make oil seals and tank linings.

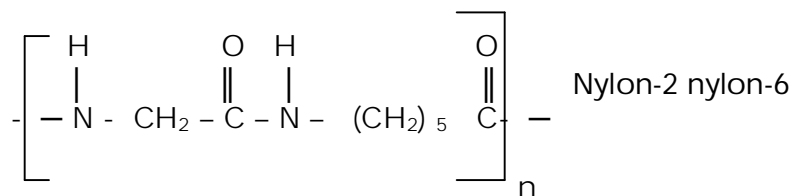
OR

Biodegradable synthetic polymers containing functional group similar to the functional groups present in biopolymers and which are made to avoid environmental problems made by polymeric solid wastes.

Ex. 1. Poly β -hydroxybutyrate-co- β -hydroxy valerate (PHBV)(2) Nylon-2-nylon-6.

CBSE 2005

What are biodegradable polymers. Write the structural formula of a biodegradable polymer. (2)

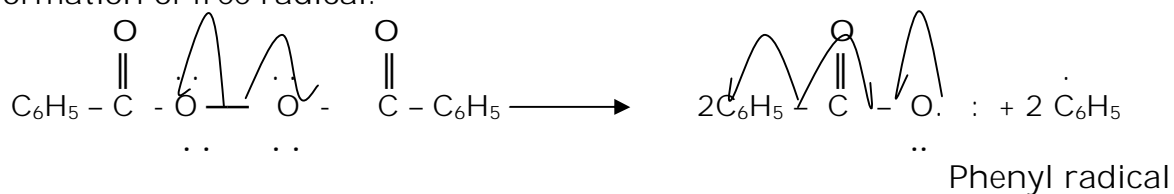


CBSE 2004

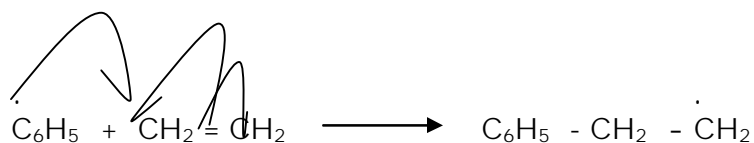
Write the mode of free radical addition polymerization of an alkene. Clearly indicate the role of an initiator in it. (2)

Mixture of ethene and benzoyl peroxide is exposed to sun light or heated.

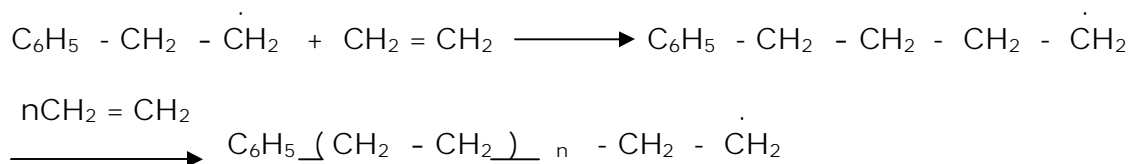
Formation of free radical:



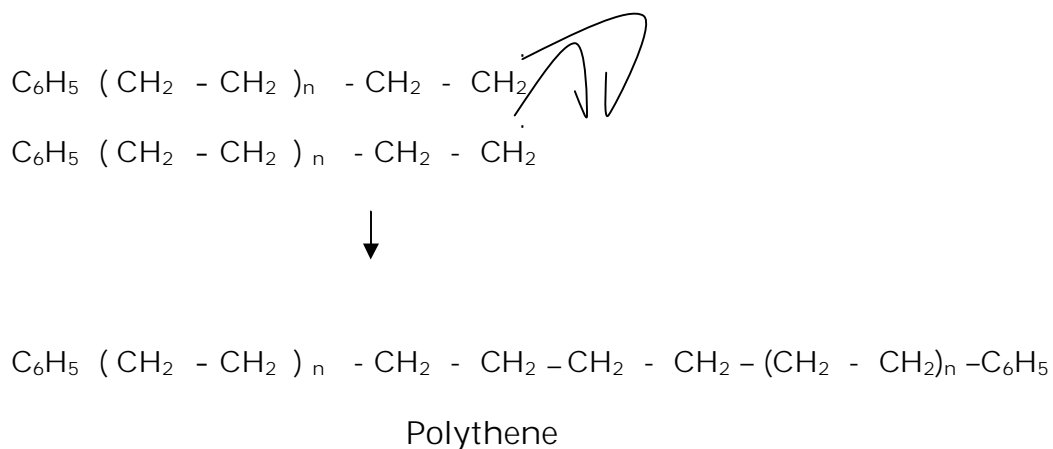
Chain initiation step:



Chain propagation step:



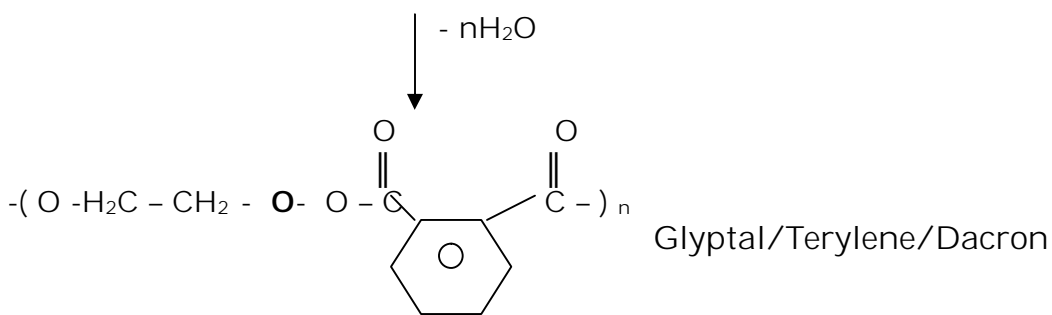
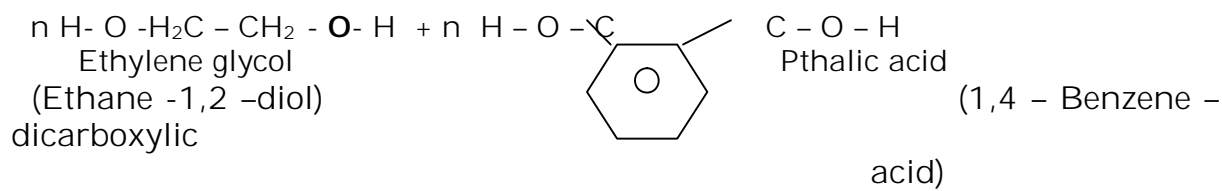
Chain terminating step :



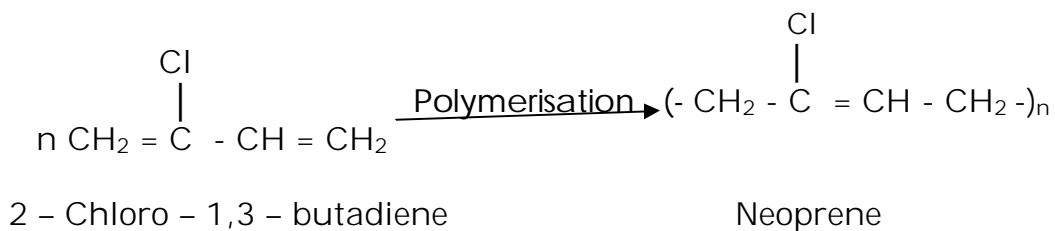
Write equations for synthesis of following (i) Glyptal (ii) Neoprene (2)

(i) Glyptal:





(ii) Neoprene

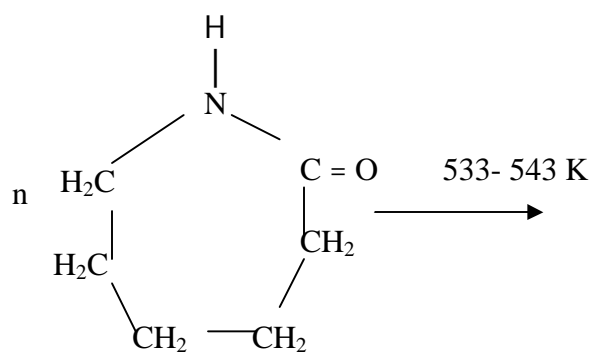


CBSE 2003

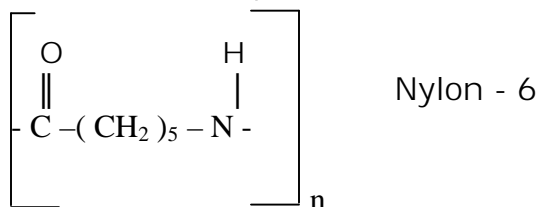
Write equations used for synthesis of (i) Terylene (ii) Neoprene (2)

Write equations for synthesis of (i) Nylon-6 (ii) Buna-S (2)

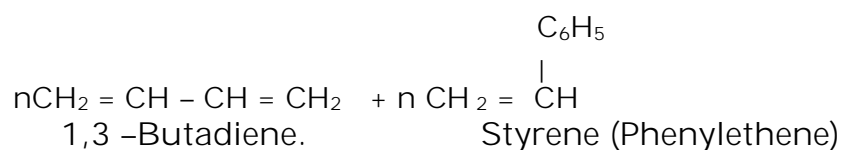
(i) Nylon-6 :

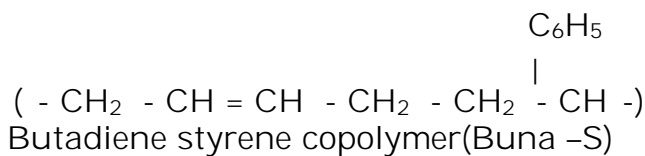


Caprolactum



(ii) Buna-S:

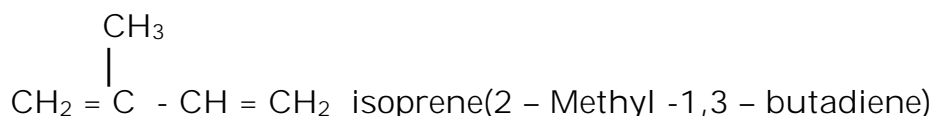




CBSE 2002

Write names and structures of monomers of following polymers. (i) natural rubber (ii) Terylene (2 marks)

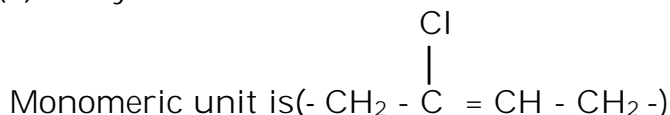
(i) Natural rubber:



Write the information asked for the following polymers

- (i) Bakelite: materials used for its preparation
 (ii) Synthetic rubber - monomer unit. (iii) PVC ; monomer unit. (iv) Nylon -66 materials required for preparation. (2)

- (i) Bakelite: Phenol and formaldehyde
 (ii) Synthetic rubber: monomer is Chloroprene .,



- (iii) PVC : monomer Vinyl chloride, Monomeric unit is $\left(-\text{CH}_2 - \overset{\text{Cl}}{\underset{|}{\text{CH}}} - \right)$
 (iv) Nylon - 6,6: (1) Hexamethylenediamine (2) Adipic acid

Explain the following terms with suitable examples in each case (i) chain growth polymerization (ii) step growth polymerization. (2)

(i) chain growth polymerization :

The process of formation of polymer by simple addition of molecules of the same or different unsaturated monomers is called as chain growth polymerization or addition polymerization.

Ex. Synthesis of polythene (Refer above)

(ii) Step growth polymerization: The process of formation of polymer by repeated condensation reaction between two bi -functional monomers is called step growth polymerization or condensation polymerization

Ex. Synthesis of Terylene (Refer above) .

CBSE 2001

Write names and structures of the monomers of each of the following polymers. (i) Natural rubber (ii) Buna -S (2)

CBSE 1999

How are Buna - S and Terylene synthesized? Give chemical equations . (2)

CBSE 1996

Mention which of the following are addition polymers ? (i) Terylene (ii) Nylon - 66 (iii) Neoprene (iv) Teflon (2)

SECTION - D (Higher order questions for high achievers)

1. What do you mean by chain transfer agent?

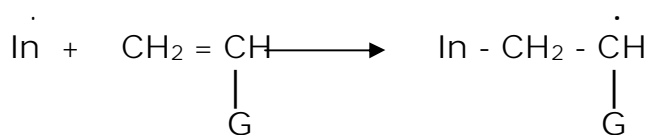
The reagent that react with the growing chain in addition polymerization to interrupt the further growth of original chain and in which product of such a reaction will initiate its own chain growth to form a new polymer with lower molecular mass.

2. What is an inhibitor in polymerization ? Give an example. The highly unreactive radical formed by chain transfer agent if it inhibit further

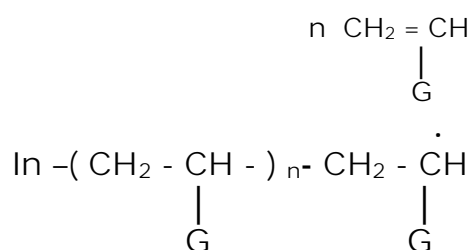
polymerization and leads to chain termination is called as inhibitor. Ex. Benzoquinone.

3. What is addition polymerization? Explain the mechanism of addition polymerization. (Vinyl polymerization)

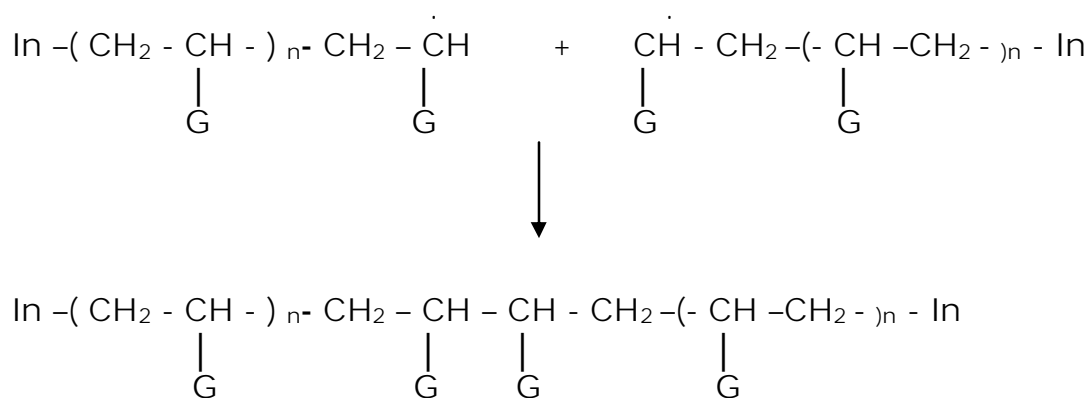
Chain initiating step: $\text{In} - \text{In} \longrightarrow 2 \text{In}$ (initiator)



Chain propagating step:



Chain terminating step:



Poly vinyl Polymer.

4. What are poly amide fibres ? Give an example each for a synthetic and natural poly amide fibres.
Polymers possessing amide linkages . Ex. Nylo-6,6, is a synthetic polyamide fibre.
Wool is an example for a natural polyamide fibre.
5. Give reason. Molecular mass of polymers is always expressed in average.
A polymer contains chains of repeated monomeric units varying lengths.
6. On what factor does the growth of polymeric chain depend upon?
Availability of monomers in the reaction mixture.
7. On what factors does the properties of polymers depend upon?
Molecular mass, size and structure.
8. Thermosetting polymers are infusible . Why ?
Due to presence of intensive cross linking.
9. Give formula for a catalyst used in synthesis of HDP
(C₂H₅)₃Al and TiCl₄
10. Compare and contrast between LDP and HDP

LDP	HDP
1. has highly branched structure	1. has linear molecules.
2. chemically inert and tough	2. chemically inert and tough

PREPARED BY MANISH TULI PRINCIPAL KV HIRNAGAR

- flexible
- poor conductor of electricity

3.hard

SECTION E (EXERCISE QUESTIONS)

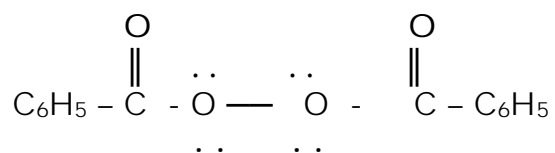
- Explain the term polymer and monomer.
Polymer: Macromolecules of high molecular mass formed by polymerization reaction and in which very large number of repeating structural units are joined together by covalent bonds.
Monomer: The small molecules that combine with each other to form a macromolecule called polymer.
- What are natural and synthetic polymers? Give two examples of each type.
The polymers which are naturally found in plants and animals are called natural polymers. Ex. Proteins, Cellulose.
The man made polymers or the polymers which are synthesized by polymerizing simple compounds.
Ex. Nylon - 6,6., Buna - S
- Distinguish between the terms homopolymers and copolymers and give an example of each.
- How do you explain the functionality of a monomer? Define the term polymerization.
Unsaturated compounds i.e. compounds containing double or triple bonds act as monomers because of their high reactivity towards addition reaction. In presence of a catalyst they undergo repeated addition.
Monomers containing bi-functional or tri-functional groups undergo condensation reaction to form polymers with the elimination of some simple molecules.
- Define the term polymerization.
(Refer above)
- Is $(\text{NH}-\text{CHR}-\text{CO})_n$ a homopolymer or a copolymer? If so why?
A homopolymer because repeating monomeric unit is from a single monomer.
i.e. $\text{H}_2\text{N}-\text{CHR}-\text{COOH}$
- In which classes, the polymers are classified on the basis of molecular forces?
Classes of polymers are
(i) Elastomers (ii) Fibres (iii) Thermoplastic polymers (iv) Thermosetting polymers.
- How can you differentiate between addition and condensation polymerization?
- Explain the term co-polymerisation and give two examples.
The process of formation of a polymer either by chain growth polymerization or step growth polymerization of two or more different kinds of monomers is called co-polymerisation.
Ex. Buna - S, Nylon - 6,6.
- Write the free radical mechanism for the polymerisation of ethene.
(Refer above)
- Define thermoplastics and thermosetting polymers with two examples of each.
Thermoplastics: Linear or slightly branched long chain molecules capable of repeatedly softening on heating and hardening on cooling.
Ex. Polythene, polystyrene
Thermosetting polymers: Cross linked or heavily branched molecules which on heating undergo extensive cross linking in moulds and again become infusible.
Ex. Bakelite, urea - formaldehyde.
- Write the monomers used for getting the following polymers (i) polyvinyl chloride
(ii) Teflon (iii) Bakelite

(i) Poly vinyl chloride: Vinyl chloride (chloroethene)

(ii) Teflon: Tetrafluoroethene

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

Benzoyl peroxide



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

Due to presence of double bond it may have either cis or trans orientation. But in natural rubber all double bonds have cis stereochemistry. Natural rubber is cis- poly isoprene.

Cis -poly isoprene chains held together by van der waal's forces and has a coiled structure. Chain can be stretched like a spring and exhibits elastic properties. It becomes soft at high temperature and becomes brittle at lower temperature and show high water absorption capacity and also non-resistant to oxidizing agents.

15. Discuss the main purpose of vulcanization of rubber.

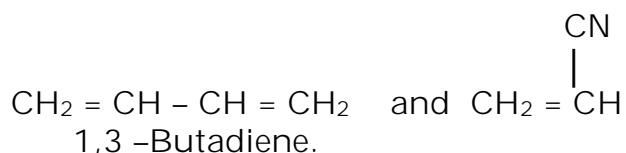
Natural rubber because of its structure becomes soft at a temperature above 335K and becomes brittle below 283K, show high water absorption capacity, soluble in non- polar solvents and non - resistant to oxidizing agents. Hence it is not so usefull. To overcome these properties vulcanization is done.

When vulcanization is done rubber gets stiffened due to formation of S cross links.

16. What are the monomeric repeating units of Nylon - 6 and Nylon - 6,6? (refer above)

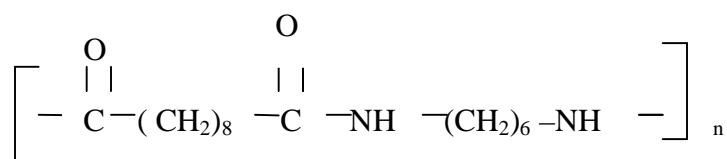
17. Write the names and structures of the monomers of the following polymers:

a. Buns -S (ii) Buna - N (iii) Dacron (iv) Neoprene
(iii) Buna - N monomers : 1,3 - Butadiene and acrylonitrile (ethene nitrile)



18. Identify the monomer in the following polymeric structures.

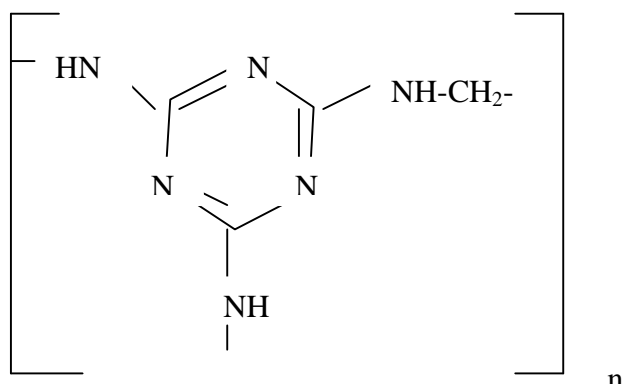
(i)



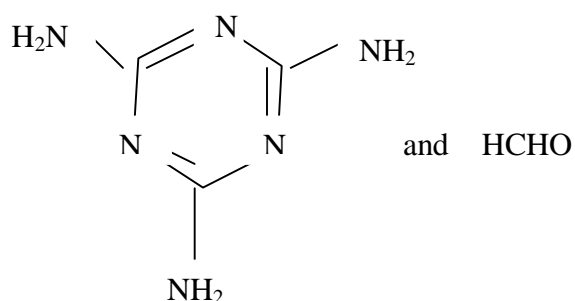
Monomers are $\text{H} - \text{O} - \text{C}(=\text{O}) - (\text{CH}_2)_8 - \text{C}(=\text{O}) - \text{O} - \text{H}$ and $\text{H}_2\text{N} - (\text{CH}_2)_6 - \text{NH}_2$
Adipic acid (1,10- Decane dioic acid) Hexamethylene diamine.

(Hexane -1,6-diamine)

(ii)



Monomers are



19. How is decron obtained from ethylene glycol and terephthalic acid?
(Refer above)

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

A biodegradable aliphatic poly ester is Poly β -hydroxybutyrate -co- β - hydroxy valerate (PHBV)

PREPARED BY :

NAYAK UDAY D.

P.G.T. IN CHEMISTRY, J.N.V. CHIKMAGALURE, MOB. NO; 9449620408