

15.0 INTRODUCTION:

These are the compounds with high molecular weight and formed by association of number of simple molecules with the help of covalent bond.

These are also called as macromolecules because of their big size. Remember that all polymers are macromolecules but all macromolecules are not polymer.

e.g. Chlorophyll. It is macromolecule but not polymer.

15.1 CLASSIFICATION OF POLYMERS**15.1.1 Classification based up on source and availability :**

These are classified as,

1. Natural polymers:

These are obtained from natural source i.e. plants and animals.

i) **Vegetable polymers :** These are 90 % cellulose (polysaccharides) fibres obtained from plants. e.g. Cotton, jute, hemp, sisal, flex, linen, resin, rubber etc.

ii) **Animal polymers:** These are polyamide or simple protein fibres obtained from animals. e.g. Wool, silk etc.

2. Artificial polymers:

i) **Regenerated polymers (semi synthetic fibres or artificial silk) :** These are chemically treated cellulose fibres. Due to the chemical treatment strength of the cellulose fibre is modified and fibre becomes superior than original fibre. These fibres are burn difficulty. These are also used in the preparation of non-inflammable films and cinema films.

e.g. Viscose rayon, cupra ammonium silk, acetate rayon, cellulose nitrate, cellulose diacetate etc.

ii) **Synthetic polymers :** These are prepared from chemical compounds by polymerisation reaction. e.g. Nylon-6, Nylon-66, Terylene, polyethene, polypropene, buna-S, buna-N, polyneoprene, thiokol rubber, bakelite, melamine, PVC, teflon. etc.

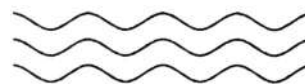
Nylon : Nylon was made in 1935 by W.C. Carothers an American chemist.

15.1.2 Classification based on structure of polymers:

These are classified as,

1. Linear polymers:

These polymer consist of linear and long chain. e.g. High density polyethene, polyvinyl chloride, nylon, polyester, cellulose, teflon etc.

**2. Branched polymers:**

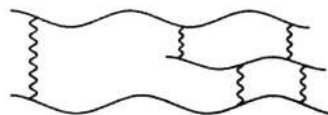
These polymer consist of linear chain and some branches.

e.g. Low density polyethylene, glycogen, starch, polypropene.

**3. Crossed linked or network polymers:**

These are formed from bifunctional and trifunctional monomers and consist of strong covalent bond between various linear polymeric chain. OR

These are polymer in which monomer units are cross linked together to form three dimensional network.



e.g. Bakelite, melamine, vulcanised rubber.

15.1.3 Classification on the basis of molecular forces

Application of polymer in different field depends upon their properties like tensile strength, elasticity, toughness, denier etc. These properties depends upon intermolecular forces like Vander Waals force, dipole – dipole attraction, hydrogen bonds present in polymer. On the basis of

magnitude of intermolecular forces, these are classified in to four types.

1. Elastomers:

The polymer that have, elastic character like rubber are called elastomers. In elastomers, polymer chains are held together by weak intermolecular forces. Because of presence of weak forces, they can stretched easily by applying small stress and return to its original shape when stress is removed.

e.g. Buna-N, buna-S, neoprene, butyl rubber etc

2. Fibres:

These are the polymer having strong intermolecular forces between the chains. Because of strong forces, the chains are closely packed giving high tensile strength and less elasticity. Therefore these polymer impart crystalline nature and having sharp m.p. These polymers are linear, long, thin, thread like and can be woven into fabrics. It should be noted that all polymer can not form fibres. The key requirement of a fibre forming polymer is that its molecule must be linear.

e.g. Nylon-66, Nylon-e. dacron, silk.

3) Thermoplastic polymers :

These are linear or slightly branched chain polymers. Which can be easily softening on heating and hard on cooling. These polymer possess intermolecular force between elastomers and fibres.

e.g. Polyethene, polystyrene, polyvinyl chloride, teflon.

4. Thermosetting polymers:

These are cross linked or highly branched polymer and undergoes permanent change on heating. They become hard and infusible on heating and can not be reused.

e.g. Bakelite, urea formaldehyde resin, melamine formaldehyde resin etc.

Decreasing order of molecular forces of polymer is,

Fibres > Thermosetting polymers > Thermoplastic polymers > Elastomers

15.1.4 Classification on the basis of mode of synthesis or polymerisation

These are divided in to three types.

- 1) Addition polymer 2) Condensation polymer

1. Addition polymer:

These polymers are formed by addition of repeated monomers units without the elimination of by-product is called as addition polymer. In this types, monomers are unsaturated compounds. e.g. Polyethene, buna-S orlon, teflon, PVC etc

2. Condensation polymer:

These polymers are formed by condensation reaction between two different bifunctional, trifunctional monomers. In these polymerisation reaction the elimination of small molecule such as water, alcohol, HX etc. takes place.

e.g. Terylene, nylon-66, nylon-6, poly urethane etc

3. Co-polymers

The polymers which are formed from two or more different monomers are called co-polymers.

e.g. Nylon-66, terylene, buna-S, buna-N, bakelite, melamine formaldehyde polymer etc.

15.2 GENERAL METHOD OF POLYMERISATION OR TYPES OF POLYMERISATION REACTIONS

Polymerisation reaction are two types.

- 1] Addition or chain growth polymerisation
- 2] Condensation or step growth polymerisation

1. Addition or chain growth polymerisation :

These polymers are formed by addition reaction without the elimination of smaller molecule.

Monomer used for such polymerisation reactions are alkenes, alkadienes and its derivatives.

This type of polymerisation leading to increase the length of carbon chain called as chain growth polymerisation. This type of polymerisation reactions also involves the initiator, which may be free radical, cations or anions.

The addition polymerisation reactions are very rapid and involves three steps.

- i) Chain initiation
- ii) Chain propagation
- iii) Chain termination

2. Condensation or step growth polymerisation :

This type of polymerisation involves the condensation reaction between two different bifunctional, trifunctional monomers. In the

polycondensation reaction smaller molecule like water, alcohols, HX are eliminated.

In this reaction no initiator is needed and polymer formed by step wise manner is called as step growth polymer and process is known as step growth polymerisation.

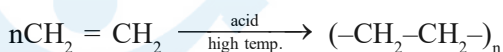
e.g. Nylon-6, nylon-66, terylene, bakelite, melamine-methanal polymer,

15.3 PREPARATION OF SOME ADDITION POLYMER

1. **Polyethylene:** Polyethylene are two types,

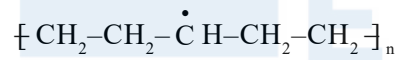
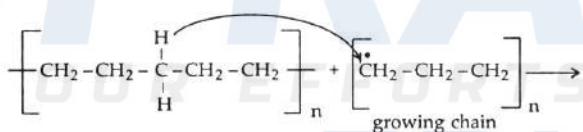
a) **Low density polymer (LOPE) :**

Ethene is polymerised in the presence of acid at high temperature i.e. 483 K and 1000 atm pressure and O_2 catalyst gives low density polyethylene or polyethene. It is branched polymer, as the growing chain takes H-atom from middle of the chain and the branch grows. This low density polymer is chemically inert but mechanically weak.

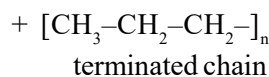


Branched polymer can be obtained by following ways.

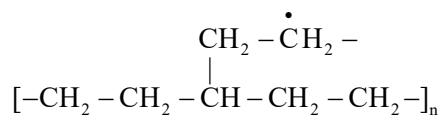
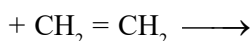
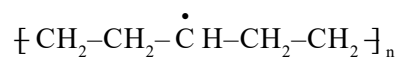
Step-i : Growing chain unit takes proton from another to form secondary free radical.



2° free radical



Step-ii : Secondary free radical combine with another molecule of ethylene to form branched polymer.



branched polymer of ethene

Uses: It is used as insulator for cable, packaging, bags, making toys etc

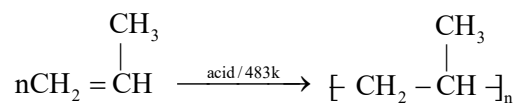
b) **High density polymer (HDPE) :**

It is linear addition polymer. It is prepared by polymerisation of ethene at 343 K under 6 to 7 atm pressure in the presence of Ziegler-Natta catalyst (trimethyl aluminium $(CH_3)_3Al$ and titanium tetrachloride $TiCl_4$). This polymer is chemically inert.

Uses : It is used to make bottles, jar, buckets, drums, pipes etc.

2. **Polypropene or polypropylene:**

Propene is polymerised in the presence of acid at 487 K and 1500 atm. pressure to give polypropene

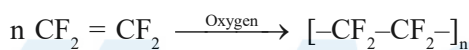


propene

polypropene

3. **Polytetrafluoro ethene (teflon or PTFE) :**

Tetrafluoro ethene is heated under high pressure in the presence of oxygen catalyst to give polytetrafluoro ethene.



tetrafluoroethene

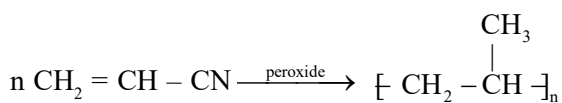
Teflon

Uses:

- Teflon is chemically inert and resistant to attack by corrosive reagents.
- It is used as insulator, making oil seal, gaskets, non sticky utensil, valves, seats etc.

4. **Polyacrylonitrile or orlon or acrilan (PAN) :**

Acrylonitrile is polymerised in the presence of peroxide catalyst to give polyacrylonitrile



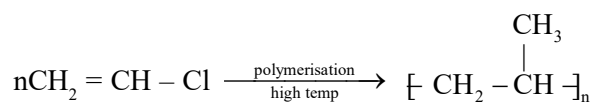
Acrylonitrile

polyacrylonitrile

Uses : It is used as formaking artificial wool, making commercial fabrics as orlon or acrolein, blankets etc.

5. **Polyvinyl chloride (PVC) :**

vinyl chloride on polymerisation to give polyvinyl chloride



vinyl chloride

polyvinyl chloride

15.4 PREPARATION OF CONDENSATION POLYMER

1. Nylon-6 (Perlon-L in Germany or Polycaprolactum) :

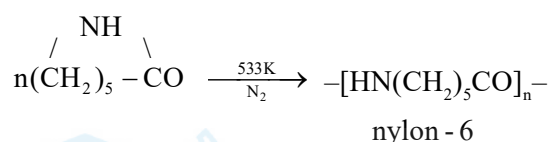
It is chemically named as polycaprolactum.

It is prepared by thermal polymerisation of ϵ -caprolactum. It is polyamide homopolymer of ϵ -caprolactum.

Raw material required for the preparation of nylon-6 is ϵ -caprolactum.

As monomer contains six carbon atoms, hence it named as Nylon-6.

Polymerisation of monomer (ϵ -caprolactum) to give nylon-6.



2. Nylon-66 :

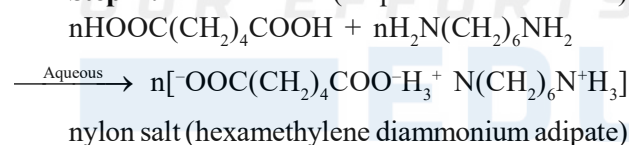
It is condensation polyamide heteropolymer or copolymer of adipic acid and hexamethylene diamine. Raw material required for the preparation of Nylon-66 is,

$\text{HOOC}-(\text{CH}_2)_4-\text{COOH}$ – Adipic acid

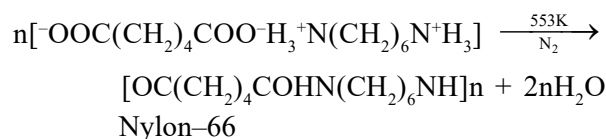
$\text{H}_2\text{N}-(\text{CH}_2)_6-\text{NH}_2$ – Hexamethylene diamine

As both monomer contains six carbon atoms, Hence, it is named as Nylon-66.

Step-i : Salt formation (Preparation of monomer)



Step-ii : Polymerisation of monomer (nylon salt)



Uses of Nylon-6 and Nylon-66 :

- It is used for preparation of bristles of tooth brushes.
- It is used for surgical sutures.
- It is used to prepare fishing nets, tyre records, conveyor belts, shirt, hosiery, hair brushes, strings, tennis racket, sarees, carpet, scrubber, fuel filter, artificial blood vessel etc.

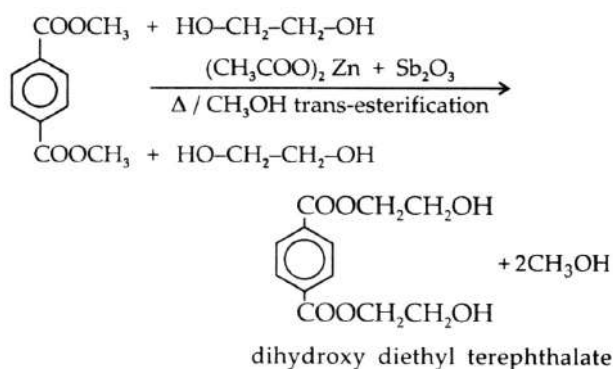
3. Terylene (Dacron in U.S.A. or polyester fibre) :

It is chemically named as polyethene terephthalate.

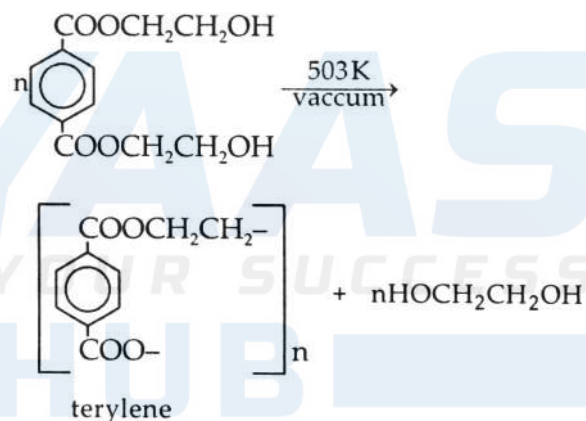
It is condensation heteropolymer or co-polymer polyester fibres.

Raw material required for preparation of terylene is i) Ethylene glycol and ii) Dimethyl terephthalate (DMT) or ester of terephthalic acid.

Step-i : Preparation of monomer:



Step-ii : Polymerisation of monomer (dihydroxy diethyl terephthalate) :



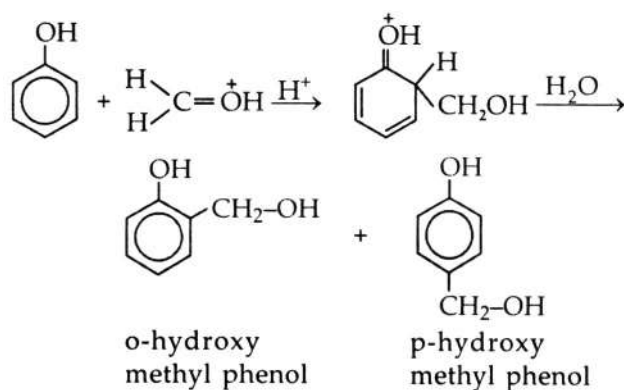
Uses :

- It is used in textile industry. When it is blended with cotton produce terycot. When it is blended with wool produce tery wool.
- It is used as, filter cloths.
- It is used to prepare fishing nets, tyre records, conveyor belts.
- It is used in magnetic recording tape, films, food wares.

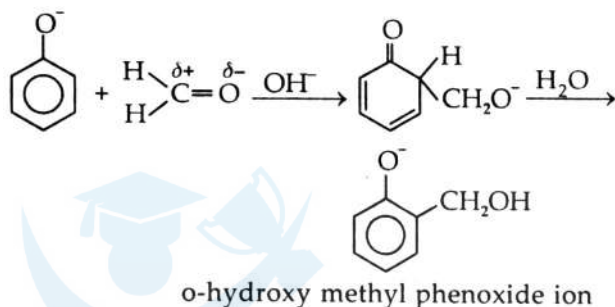
4. Bakelite (phenol-methanal polymer) :

Step-i : It is prepared from phenol and formaldehyde in the presence of acid or base catalyst. Phenol reacts with formaldehyde to form ortho or para hydroxy methyl phenol.

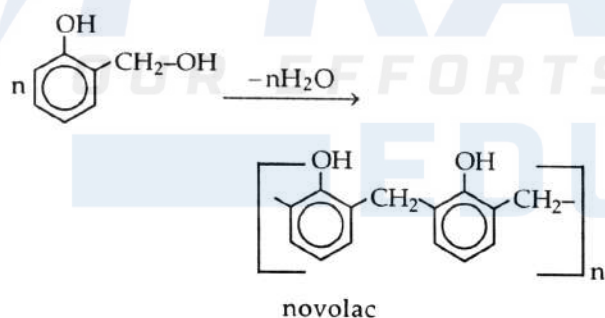
a) In the presence of acid catalyst:



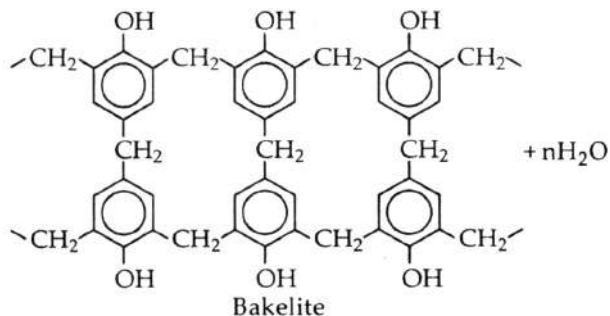
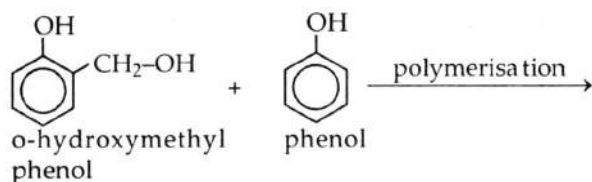
b) In the presence of base catalyst:



Step-ii : o-hydroxy methyl phenol or p-hydroxy methyl phenol reacts with phenol to give a linear polymer known as novolac which is used in paints. The overall reaction can be written as



Step-iii : o-hydroxy methyl phenol reacts with another molecular phenol to form compounds having two rings joined by $-\text{CH}_2-$ group. The process is continuous further to form high molecular weight three dimensional network solid known as bakel

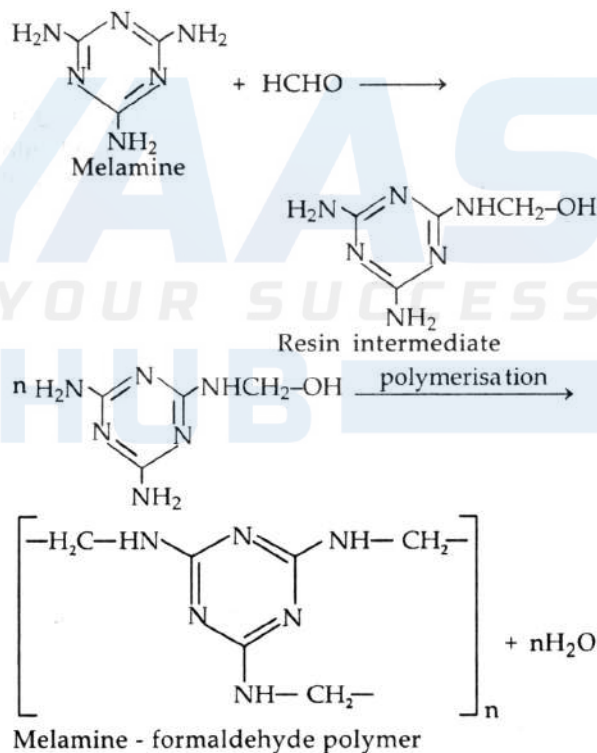


Uses:

- i) Novolac is liner polymer used in paints.
- ii) Bakelite is crossed linked polymer used for making combs, phonograph records, electrical switches, and handles of various utensil.

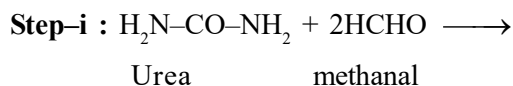
5. Melamine – formaldehyde polymer :

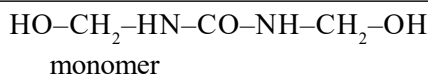
When melamine (heterocyclic triamine) is condensed with formaldehyde undergoes polymerisation to give high molecular weight melamine formaldehyde polymer. It is used for making crockeries.



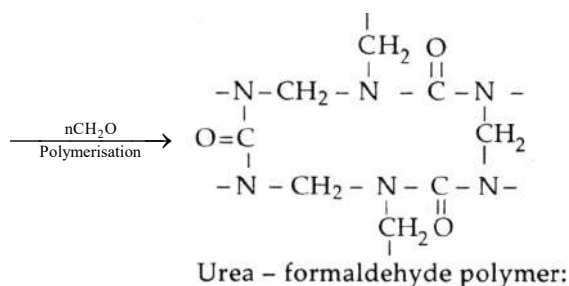
6. Urea – formaldehyde polymer:

When urea is condensed with formaldehyde undergoes polymerisation to give high molecular weight urea formaldehyde polymer. It is a moulded plastic.





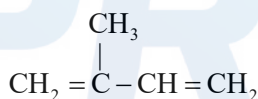
Step-ii: $n[\text{HO}-\text{CH}_2-\text{HN}-\text{CO}-\text{NH}-\text{CH}_2-\text{OH}]$



15.5 RUBBER

15.6 NATURAL RUBBER

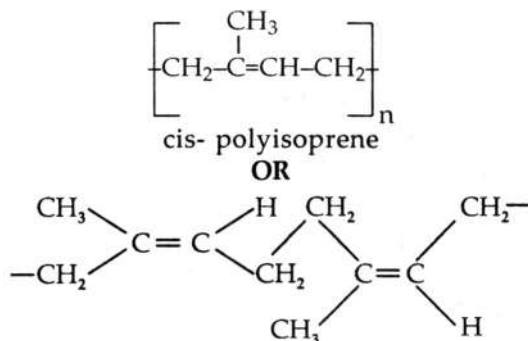
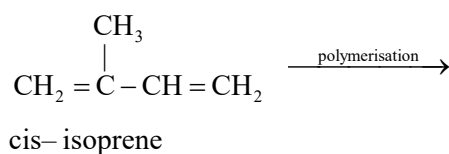
Rubber is natural polymer obtained from trees in the form of latex and have elastic properties. It is also called as elastomers. It is prepared from rubber latex which is a colloidal suspension of rubber in water. Natural rubber may be considered as a linear polymer of cis-isoprene (2-methyl 1, 3-butadiene) and called as cis-1, 4-polyisoprene. The trans 1, 4-poly isoprene occurs naturally as Gutta-percha which has zig-zig chain fitting in one another. It is a nonelastic and crystalline.



isoprene

In natural rubber, about 11,000 to 20,000 isoprene units are linked together in a linear chain.

When number of isoprene combine to form polyisoprene



Vulcanisation of rubber :

It was introduced by Charles Good year.

Natural rubber has following properties :

1. It become soft and sticky at high temperature and brittle at low temperature.
2. It has high water absorption capacity.
3. It is soluble in non polar solvent and easily attacked by oxidising agent.
4. It has long flexible chain having weak intermolecular forces and exhibits elastic property.

To improve above properties natural rubber can be vulcanised.

Definition : The process of heating of natural rubber with sulphur to improve its properties is known as vulcanisation.

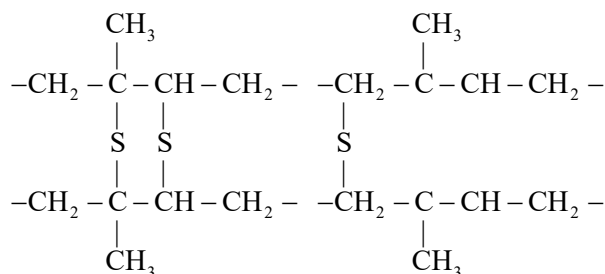
Process : In vulcanisation, natural rubber is heated with sulphur and additive like zinc oxide (ZnO) at 373 k to 415 k.

After vulcanisation, rubber makes hard, tough, high elastic property, less water absorption capacity, high tensile strength.

During vulcanisation, sulphur forms cross links at the reactive site of double bond and thus rubber gets stiffened.

The stiffness of rubber depends upon amount of sulphur added. For manufacture of tyre rubber 3% to 10% sulphur is added, and for manufacture of battery cases 20% to 30% sulphur is added. For making rubber band 1% to 3% sulphur is added.

The structure of vulcanised rubber is

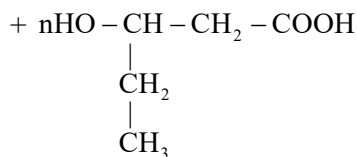


15.7 SYNTHETIC RUBBERS

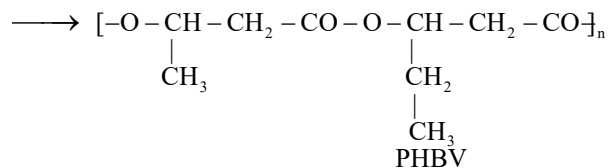
These are nothing but any vulcanisable rubber like polymer. These are either homopolymer or co-polymer. They are more flexible, tougher and more durable than natural rubber.

e.g. Neoprene, Buna-N, Buna-S, Thiokol or

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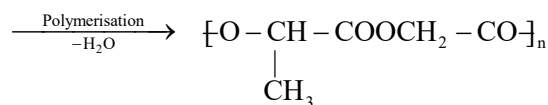
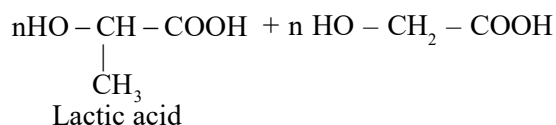
3-hydroxy pentanoic acid



2. Dextron or Polylactic acid (PLA) and Poly glycolic acid (PGA) :

This copolymers is commercially called dextron. It is polyester copolymer of polylactic acid (PLA) and poly glycolic acid (PGA). Raw material is lactic acid and glycolic acid. It is used for stitching

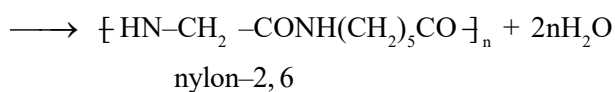
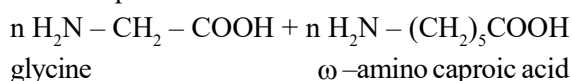
wounds surgery.



Dextron

3. Nylon - 2 - nylon - 6 (Nylon-2,6)

It is a polyamide copolymer of glycine and ω -amino caproic acid.



Examples of some other polymer

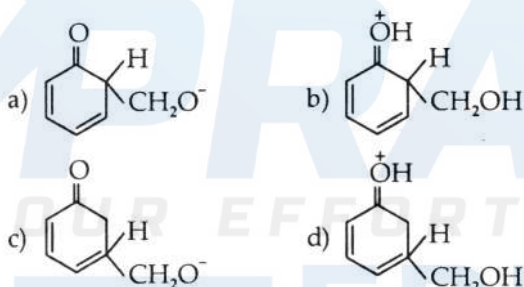
S.N.	Name of the polymer	Name/s of monomer	Class	Uses
1.	Dynel	Vinyl chloride and acrylonitrile	Copolymer	Human hair wigs
2.	Glyptal	Ethylene glycol and phthalic acid	Copolymer	In paints
3.	Thiokol	Ethylene chloride and sodium tetrasulphide	Condensation poly sulphide	Rubber
4.	Superglue	Methyl α -cyanoacrylate	Homopolymer	Glue
5.	Kevlar	Terephthalic acid chloride and p-phenylene diamine	Polyamide condensation	Bullet proof vats and helmets
6.	Nomex	m-phthalic acid and m-dinitro benzene	Polyamide condensation	Protective cloths for race car driver and fire fighter
7.	Lexan	Diethyl carbonate and Bisphenol A	Polyester condensation	Bullet proof windows and helmets
8.	Polyurethane or thermocole	Toulene diisocyanate and Ethylene glycol	Copolymer	For padding and building insulation as light in weight
9.	Saran	Vinyl chloride and vinylidene chloride	Copolymer	Bumper



MULTIPLE CHOICE QUESTIONS

1. Which of the following is linear polymer?
a) Starch b) Bakelite
c) PVC d) Polypropene
2. Low density polyethylene is
a) cross linked polymer
b) branched polymer
c) linear polymer
d) condensation polymer
3. High of density polyethylene is
a) linear polymer
b) branched polymer
c) cross linked polymer
d) rubber
4. Which of the following is branched polymer?
a) PVC b) Nylon
c) Polypropene d) Melamine
5. Which of the following is not linear polymer
a) Bakelite
b) Polyester
c) cellulose
d) high density polyethene
6. Which of the following is natural polymer?
a) Buna-S b) Buria-N
c) Bakelite d) Polyisoprene
7. Which of the following has rubber like properties?
a) Fibres
b) Thermosetting polymers
c) Thermoplastic polymers
d) elastomers
8. Buna-N is
a) fibres
b) elastomer
c) Thermosetting polymer
d) Thermoplastic polymer
9. Which of the following is not fibres?
a) Nylon-6 b) Nylon-66
c) Nylon-2, 6 d) dacron
10. Teflon is
a) elastomer b) fibres
c) Thermoplastic d) Thermosetting
11. Which of the following is crossed linked thermosetting polymer
a) Neoprene b) Bakelite
c) Teflon d) Polyethene
12. Which of the following polymer undergoes permanent change on heating?
a) Urea-methanal b) Buna-S
c) Dacron d) Polyethene
13. The polymer which can be easily softening on heating and hard on cooling is
a) Neoprene b) Melamine-methanal
c) PVC d) Buna-N
14. Which of the following is not thermoplastic polymer
a) Polyethene b) Neoprene
c) Polyvinyl chloride d) polytetrafluoroethene
15. Natural silk is a
a) polyester b) polyamide
c) polyacid d) polysaccharide
16. Artificial silk is a
a) polypeptide b) polysaccharides
c) polyethylene d) polyvinyl chloride.
17. Protein fibres are
a) animal fibres b) vega table fibres
c) regenerated fibres d) synthetic fibres
18. Which of the following polymer is an example of fibre?
a) silk b) dacron
c) nylon-66 d) all of these
19. Generally, molecular mass of a polymer is over
a) 100 b) 500
c) 1,000 d) 10,000
20. Which is naturally occurring polymer?
a) Terylene b) Nylon-6
c) Cellulose d) Nylon-66
21. Which is not a natural polymer?
a) Silk b) Wool
c) Leather d) Nylon
22. Which of the following is not a polymer?
a) Starch b) Cellulose
c) Fructose d) Protein
23. Which of the following is a semisynthetic polymer?
a) Silk b) Wool
c) Rayon d) Cotton
24. The natural polymer among the following is
a) pectin b) teflon
c) polyethylene d) terylene

25. The main constituent of most natural fibres is
 a) glycogen b) starch
 c) cellulose d) all of these
26. Which one of the following is a true synthetic fibre?
 a) Nylon-6 b) Terene
 c) Nylon-66 d) All of these
27. Cotton is
 a) cellulose fibre b) polyamide fibre
 c) polyester fibre d) none of these
28. Plant fibres are
 a) protein fibres b) cellulose fibres
 c) polyester fibres d) none of these
29. Which of the following is artificial silk?
 a) Viscose rayon b) Nylon-6
 c) Terylene d) Nylon-66
30. Jute is
 a) natural fibre b) polyamide fibre
 c) synthetic fibre d) regenerated fibre
31. In the preparation of bakelite polymer by using base catalyst, the intermediate species formed from phenol and formaldehyde is

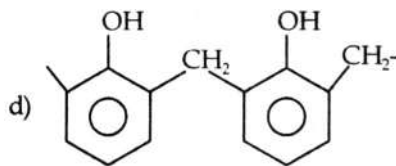
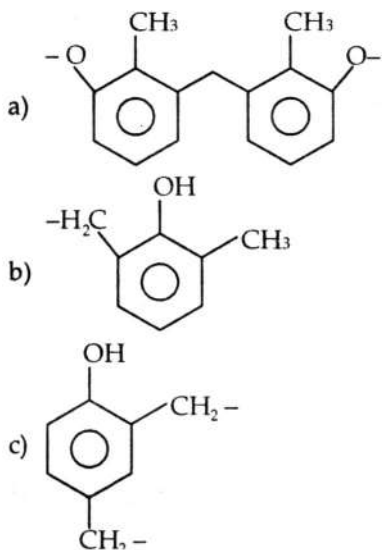


32. The polymer which can stretched easily by applying small stress and return to its original shape when stress is removed
 a) Buna-S b) Dacron
 c) teflon d) Bakelite
33. Thermosetting polymers are
 a) Addition linear polymer
 b) cross linked linear polymer
 c) Addition cross linked polymer
 d) cross linked copolymer
34. Which of the following is chain growth polymer
 a) teflon b) Nylon-66
 c) Nylon-6 d) terylene
35. In chain growth polymerization initiator is
 a) free radicals b) cations
 c) anions d) one of these
36. In which of the following polymer preparation,

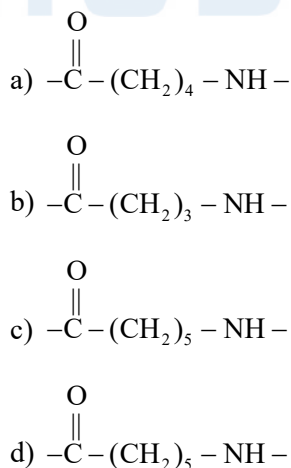
no initiator is required?

- a) polypropene
 b) teflon
 c) polyacrylonitrile
 d) melamine-formaldehyde polymer
37. Correct decreasing order of molecular forces of polymer is
 1) Thermosetting polymers
 2) fibres
 3) Thermoplastic polymers
 4) Elastomers
 a) $1 > 2 > 3 > 4$ b) $2 > 1 > 3 > 4$
 c) $4 > 3 > 2 > 1$ d) $2 > 3 > 1 > 4$
38. In addition polymer monomer used is
 a) unsaturated compounds
 b) saturated compounds
 c) bifunctional saturated compounds
 d) trifunctional saturated compounds
39. Which of the following has strong intermolecular force between the chain?
 a) Dacron b) Bakelite
 c) Buna-N d) Buna-S
40. Decreasing order of intermolecular forces of polymer is
 1) neoprene 2) silk
 3) teflon
 4) melamine formaldehyde resin
 a) $2 > 1 > 4 > 3$ b) $2 > 3 > 4 > 1$
 c) $2 > 4 > 3 > 1$ d) $2 > 1 > 3 > 4$
41. Which of the following has weak molecular forces?
 a) Nylon-6 b) Nylon-66
 c) Silk d) Buna-S
42. In free radical mechanism of polymerization of addition polymer the chain propagation step is
 a) $I^\cdot + M \longrightarrow IM^\cdot$
 b) $\text{Initiator} \longrightarrow I^\cdot$
 c) $1 M^\cdot + M \longrightarrow 1 M M^\cdot$
 d) $I(M)_n M^\cdot + I(M)_n M^\cdot \longrightarrow I(M)_n M-M(M)_n$
43. Low density polyethene is
 a) branched polymer b) Linear polymer
 c) Copolymer d) step growth polymer
44. The catalyst used in the preparation of high density polyethylene is
 a) N_2

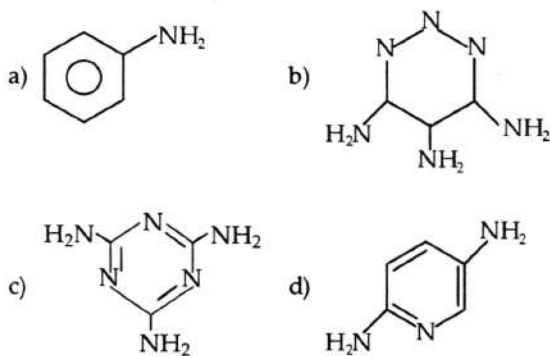
- b) $(\text{CH}_3)_3\text{Al} + \text{SnCl}_4$
 c) $\text{PdBaSO}_4 + \text{quinoline}$
 d) $\text{H}_2 + \text{Ni}$
45. Which of the following Ziegler – Natta catalyst?
 a) $\text{Pd.BaSO}_4 + \text{quinoline}$
 b) $(\text{CH}_3)_3\text{Al} + \text{SnCl}_3$
 c) Pyridinium chlorochromate
 d) $\text{Zn .Hg} + \text{conc.HCl}$
46. Orion is prepared from polymerization of
 a) $\text{CH}_3\text{--CH} = \text{CH}_2$ b) $\text{CF}_2 = \text{CF}_2$
 c) $\text{CH}_2 = \text{CH} - \text{CN}$ d) $\text{CH}_2 = \text{CH--Cl}$
47. Teflon is polymer of
 a) $\text{FCH} = \text{CH}_2$ b) $\text{CFH} = \text{CHF}$
 c) $\text{CF}_3 = \text{CF}_3$ d) $\text{CF}_2 = \text{CF}_2$
48. Polyacrylonitrile contain a linkage of
 a) amide b) ester
 c) alcohol d) carbon and carbon
49. PVC is obtained by polymerization of
 a) $\text{CH}_2 = \text{CH}_2$ b) $\text{CH}_3\text{--CH} = \text{CH}_2$
 c) $\text{CH}_2 = \text{CH--Cl}$ d) $\text{C}_6\text{H}_5 - \text{CH} = \text{CH}_2$
50. Monomer of acrilan is
 a) vinyl chloride b) vinyl alcohol
 c) ethylene glycol d) acrylonitrile
51. Repeating unit of teflon is
 a) $-\text{CF}_3 - \text{CF}_3 -$ b) $-\text{CHF}_2 - \text{CHF}_2 -$
 c) $-\text{CF}_2 - \text{CF}_2 -$ d) $-\text{CH}_2 - \text{CF}_2 -$
52. Bakelite is a
 a) formaldehyde resin
 b) artificial rubber
 c) phenol formaldehyde resin
 d) phenol–urea resin
53. Which of the following is novo lac



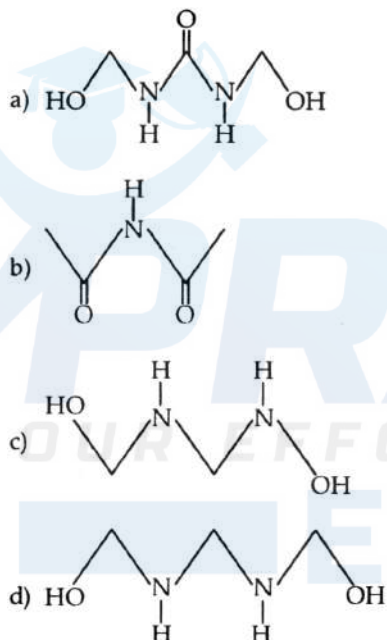
54. Novolac is
 a) cross-linked polymer
 b) linear polymer
 c) addition polymer
 d) synthetic rubber
55. Teflon polymer has monomer of
 a) difluoroethene b) fluoroethene
 c) tetrafluoroethane d) tetrafluoroethene
56. The product of addition polymerization reaction is
 a) Nylon b) PVC
 c) terylene d) Bakelite
57. The polymer acrilan has the repeating unit.
- a) $-\text{CH}_2 - \overset{\text{CN}}{\underset{|}{\text{CH}}} -$ b) $-\text{CH}_2 - \overset{\text{C}_6\text{H}_5}{\underset{|}{\text{CH}}} -$
- c) $-\text{CH}_2 - \overset{\text{CH}_3}{\underset{|}{\text{CH}}} -$ d) $-\text{CH}_2 - \overset{\text{Cl}}{\underset{|}{\text{CH}}} -$
58. Which of the following polymer is used for coating as a thin layer on the inner side of nonsticky utensil ?
 a) Bakelite b) PVC
 c) Buna-S d) Teflon
59. The repeating unit of nylon-6 is



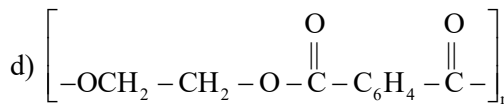
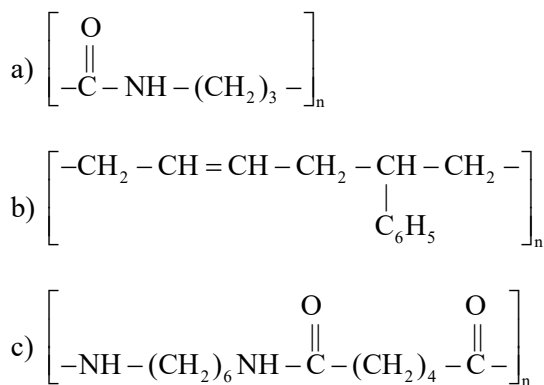
60. Which of the following compound is used for preparation of melamine formaldehyde polymer



61. The polymer used for making crockeries
- teflon
 - melamine-methanal polymer
 - urea-formaldehyde polymer
 - Bakelite
62. Monomer unit in urea-formaldehyde polymer is



63. Which of the following structure represent terylene?



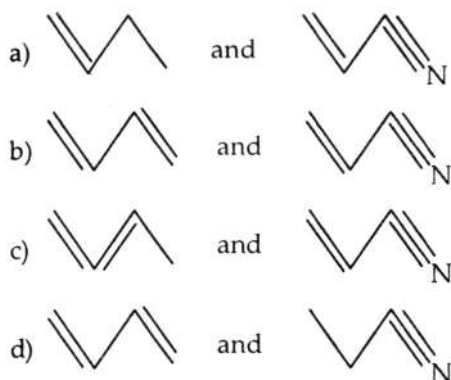
64. What type of polymer is represented by the following segment?
- Polyamide
 - Polyester
 - Polyolefin
 - Polyethylene
65. An example of a condensation polymer is
- PVC
 - terylene
 - polypropylene
 - teflon
66. Nylon-66 is a copolymer of
- urea and formaldehyde
 - hexamethylene diamine and adipic acid
 - phenol and formaldehyde
 - vinyl chloride and vinyl alcohol.
67. Which of the following, glycol is an important constituent?
- Dacron
 - Nylon 6
 - Teflon
 - Viscose rayon
68. Perlon is
- rubber
 - nylon-6
 - terylene
 - oxlon
69. The polymer, which has amide linkage, is
- nylon-66
 - terylene
 - teflon
 - bakelite
70. Which one of the following pair is not correctly matched?
- Terylene – condensation polymer
 - Polysaccharides – artificial silk
 - Nylon-S – homopolymer of s-caprolactum
 - Silk – synthetic fibre
71. Caprolactum is used for manufacturing
- bakelite
 - nylon-6
 - rubber
 - dacron.
72. Which of the following is not a polyamide?
- Wool
 - Leather
 - Nylon
 - Natural rubber.
73. The two monomers required in the preparation of terylene are
- vinyl chloride
 - phthalic acid and ethylene glycol
 - terephthalic acid and ethylene glycol
 - adipic acid and hexamethylene diamine

74. The raw material for nylon-66 is
a) adipic acid
b) tetrafluoroethylene
c) hexamethylene diamine
d) both 'a' and 'c'
75. Dimethyl terephthalate and ethylene glycol react to form
a) nylon-66 b) nylon-6
c) neoprene d) dacron
76. Butadiene and acrylonitrile polymer is known as
a) nylon-66 b) nylon-Ze
c) buna-S d) buna-N
77. Cupra-ammonium silk is
a) natural fibre b) semi synthetic fibre
c) protein fibre d) true synthetic fibre
78. Which of the following is nylon salt ?
a) $-\text{OOC}(\text{CH}_2)_4\text{COO}^- \text{H}_3^+ \text{N}(\text{CH}_2)_4\text{N}^+\text{H}_3$
b) $-\text{OOC}(\text{CH}_2)_6\text{COO}^- \text{H}_3\text{N}(\text{CH}_2)_6\text{NH}_3$
c) $-\text{OOC}(\text{CH}_2)_6\text{COO}^- \text{H}_3^+ \text{N}(\text{CH}_2)_4\text{N}^+\text{H}_3$
d) $-\text{OOC}(\text{CH}_2)_4\text{COO}^- \text{H}_3^+ \text{N}(\text{CH}_2)_6\text{N}^+\text{H}_3$
79. Dimethyl terephthalate is a ester of
a) phthalic acid b) terephthalic acid
c) oxalic acid d) caproic acid
80. Which of the following fibres are made of polyamide?
a) Dacron b) Orlon
c) Nylon d) Rayon
81. A polymer is formed when simple chemical units
a) combine to form long chains
b) combine to form helical chains
c) break up
d) become round
82. A raw material used in making nylon-66 is
a) ethylene b) butadiene
c) adipic acid d) methanol
83. In which of the following polymerisation new bonds are formed by the elimination of small molecules?
a) Condensation b) Addition
c) Simple d) Coordination
84. Which of the following is co-polymer?
a) Orlon b) Teflon
c) PHBV d) Polyisoprene
85. Dihydroxy diethyl terephthalate is obtained by ethylene glycol and what?
a) PHBV b) DMT
c) HDPE d) PVC
86. Monomers used to prepare superglue are
a) vinyl chloride
b) methyl α -cyanoacrylate
c) isoprene
d) chloroprene
87. A polymer made from a polymerization reaction that produces small molecules (such as water) as well as the polymer is classified as a/an polymer.
a) addition b) natural
c) condensation d) elimination
88. Dacron, a synthetic polyester fibre is made from
a) ester of terephthalic acid and ethylene glycol
b) phthalic acid and cellulose
c) caprolactum and alcohol
d) alcohol and ethene
89. Which of the following is commonly called polyamide?
a) Nylon b) Rayon
c) Orion d) Terylene
90. Nylon-66 is made from hexamethylene diamine and
a) phthalic acid b) sulphurous acid
c) adipic acid d) glycol
91. Raw material used for preparation nylon 6 is
a) ϵ -caprolactum b) ω -amino caproic acid
c) adipic acid d) phthalic acid
92. Terylene, a polymer is produced by condensing ethylene glycol with
a) succinic acid b) oxalic acid
c) D.M.T. d) phthalic acid
93. Which of the following contains nitrogen?
a) Teflon b) Nylon
c) Terylene d) Starch
94. IUPAC name of hexamethylene diamine is
a) hexamethylene 1,6-diamine
b) 1, 6 - diamino hexamethylene
c) 1, 6 - diamno hexane
d) 1, 6 - hexane - diamine
95. Nylon polymers are
a) acidic b) basic
c) amphoteric d) neutral
96. Trans-esterification means
a) preparation of ester from ester
b) preparation of ester from acid
c) preparation of ester from alcohol
d) reverse of esterification

97. Side product during the preparation of Dacron fibre is
a) glycerol b) ethylene glycol
c) ethyl alcohol d) propylene glycol
98. Nylon-6 is also called as
a) orlon b) polycaprolactum
c) acrilan d) dacron
99. Terylene is also known as
a) Dacron b) Mylor
c) Cronar d) Polyester
100. Nylon is classified as a
a) polyolefin b) polyamide
c) polyester d) polyethylene
101. Polycaprolactum is
a) nylon-6 b) nylon-66
c) terylene d) mylor
102. In the preparation of nylon-6 polymerisation carried out in the presence of
a) nitrogen b) oxygen
c) chlorine d) fluorine
103. The fibre obtained by the condensation of hexamethylene diamine and adipic acid is
a) Dacron b) Nylon '66'
c) Rayon d) Teflon
104. Nylon is generic name for all synthetic fibre forming
a) Polysters b) Polymeric amides
c) Polystyrene d) Polyethylene
105. Nylon-26 is
a) biodegradable polymer
b) nonbiodegradable polymer
c) rubber
d) elastomer
106. Terylene is a
a) Polyamide b) Polyester
c) Polyethylene d) Polypropylene
107. Terylene is a condensation polymer of ethylene glycol and
a) Benzoic acid
b) Phthalic acid
c) Salicylic acid
d) Ester of terephthalic acid
108. Dextron is
a) Polyester b) Polyamide
c) Polycellulose d) Polypropylene
109. The compound used in the manufacture of butyl rubber is
a) Ethylene b) Vinyl chloride
c) Isobutylene d) Adipic acid
110. Which of the following is nylon 6 ?
a) $[\text{HN}(\text{CH}_2)_4\text{CO}]_n$ b) $[\text{HN}(\text{CH}_2)_3\text{CO}]_n$
c) $[\text{HN}(\text{CH}_2)_2\text{CO}]_n$ d) $[\text{HN}(\text{CH}_2)_5\text{CO}]_n$
111. Nylon salt is known as
a) tetramethylene diammonium adipate
b) dimethylene hexammonium adipate
c) hexamethylene diammonium adipate
d) trimethylene diammonium adipate
112. Which of the following is nylon 66?
a) $[\text{OC}(\text{CH}_2)_6\text{CONH}(\text{CH}_2)_4\text{NH}]_n$
b) $[\text{OC}(\text{CH}_2)_4\text{CONH}(\text{CH}_2)_6\text{NH}]_n$
c) $[\text{OC}(\text{CH}_2)_4\text{CONH}(\text{CH}_2)_4\text{NH}]_n$
d) $[\text{OC}(\text{CH}_2)_6\text{CONH}(\text{CH}_2)_6\text{NH}]_n$
113. Which of the following is a synthetic condensation polymer?
a) Terylene b) Nylon - 66
c) Both 'a' and 'b' d) Nylon - 6
114. Nylon 66 belongs to the class of
a) Addition polymer
b) Condensation polymer
c) Addition homopolymer
d) Condensation heteropolymer
115. Which of the following is used in manufacture of paints?
a) Glyptal b) Dynel
c) Thiokol d) Kevlar
116. Terylene is used for making
a) sails b) fabrics
c) seat belts d) all of these
117. Wash and wear clothes are manufactured using
a) terylene fibres
b) nylon fibres
c) wool fibres
d) cotton mixed with nylon
118. Which of the following is used to make tooth brush bristles ?
a) Viscose rayon b) Acetate rayon
c) Nylon-6 d) Terylene
119. Synthetic fibres like nylon-66 are very strong because
a) They have high molecular weights and high melting points
b) They have a high degree of cross-linking by strong C-C bond

- c) They have a linear molecules consisting of very long chains
 d) They have linear molecules interlinked with forces like hydrogen bonding.
120. Glycol is
 a) monohydric alcohol
 b) dihydric alcohol
 c) trihydric alcohol
 d) polyhydric alcohol
121. Four methylene groups are present in
 a) m-amino caproic acid
 b) s-caprolactum
 c) adipic acid
 d) nylon-6
122. Natural rubber is polymer of
 a) $\text{CH}_2 = \text{CH}-\text{Cl}$
 b) $\text{cis CH}_2 = \overset{\text{CH}_3}{\underset{|}{\text{C}}} - \text{CH} = \text{CH}_2$
 c) $\text{trans CH}_2 = \overset{\text{CH}_3}{\underset{|}{\text{C}}} - \text{CH} = \text{CH}_2$
 d) $\text{cis CH}_2 = \overset{\text{CH}_3\text{CH}_3}{\underset{|}{\text{C}}} - \text{CH} = \text{CH}_2$
123. Which of the following is Gutta-percha?
 a) $\text{cis CH}_2 = \overset{\text{CH}_3}{\underset{|}{\text{C}}} - \text{CH} = \text{CH}_2$
 b) $\text{trans CH}_2 = \overset{\text{CH}_3}{\underset{|}{\text{C}}} - \text{CH} = \text{CH}_2$
 c) $\text{cis CH}_2 = \overset{\text{CH}_3}{\underset{|}{\text{C}}} - \text{CH}_2 - \overset{\text{CH}_3}{\underset{|}{\text{C}}} = \text{CH}_2$
 d) $\text{trans CH}_2 = \overset{\text{CH}_3}{\underset{|}{\text{C}}} - \text{CH}_2 - \overset{\text{CH}_3}{\underset{|}{\text{C}}} = \text{CH}_2$
124. Vulcanization of rubber was introduced by
 a) Cahn-Ingold b) Fisher
 c) Charles Good year d) Newman
125. Which of the following is not the property of natural rubber
 a) Low tensile strength
 b) high water absorption capacity
 c) soft and sticky
 d) high elasticity
126. Helmets are made from
 a) Glyptal b) Kevlar
 c) Thiokol d) Dynel
127. Neoprene is prepared from
 a) isoprene b) vinyl cyanide
 c) chloroprene d) isobutylene
128. The monomer used in the preparation of neoprene is
 a) neopentyl chloride
 b) neopentane
 c) 2-chlorobuta-1,3-diene
 d) chloropicrin
129. In the preparation of dextran one of the raw Which of the following is Buna-N material is lactic acid another is
 a) glycolic acid b) valeric acid
 c) phthalic acid d) oxalic acid
130. Butyl rubber is addition polymer of
 a) iso-butylene and isoprene
 b) iso-butylene and chloroethane
 c) iso-butylene and chloroprene
 d) iso-butylene and chloromethane
131. Which of the following is neoprene rubber
 a) $\left[\text{CH}_2 - \overset{\text{CN}}{\underset{|}{\text{C}}} = \text{CH} - \right]_n$
 b) $\left[\text{CH}_2 - \overset{\text{OH}}{\underset{|}{\text{C}}} = \text{CH} - \right]_n$
 c) $\left[\text{CH}_2 - \overset{\text{Cl}}{\underset{|}{\text{C}}} = \text{CH}_2 - \text{CH}_2 - \right]_n$
 d) $\left[\text{CH}_2 - \overset{\text{Cl}}{\underset{|}{\text{C}}} = \text{CH} - \text{CH}_2 - \right]_n$
132. Polymerization of chloroprene is catalyzed by
 a) N_2 catalyst
 b) peroxide catalyst
 c) $\text{H}_2 + \text{Ni}$ catalyst
 d) Lindlar catalyst
133. The monomer required for the preparation of

Buna-N is



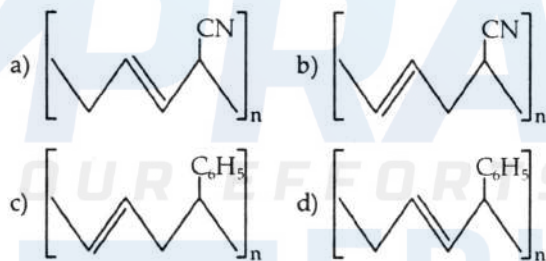
134. Which of the following is not synthetic rubber?

- poly 1,3-butadiene acrylonitrile
- poly 1,3-butadiene styrene
- Butyl rubber
- Polyisoprene

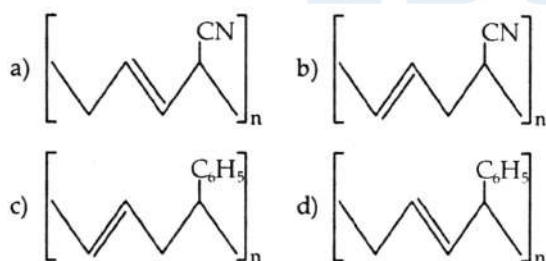
135. Buna-S is prepared from

- 1, 3-butadiene and vinyl cyanide
- 1, 3-butadiene and styrene
- 1,2-butadiene and vinyl cyanide
- 1,2-butadiene and styrene

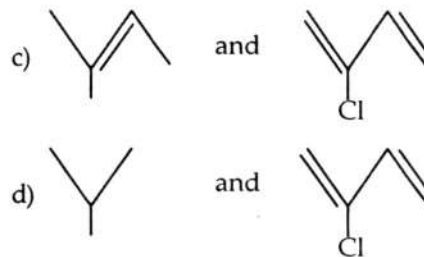
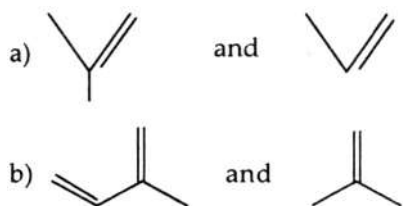
136. Which of the following is Buna-N



137. Which of the following is SBR rubber



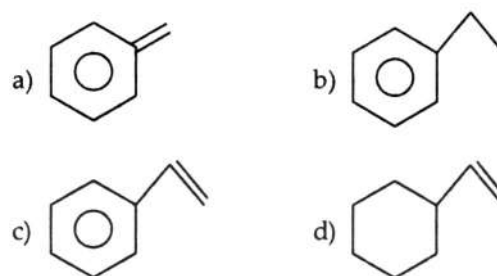
138. Monomer used for preparation of butyl rubber is



139. Butyl rubber is copolymer of

- iso-butylene and vinyl chloride
- iso-butylene and chloroprene
- iso-butane and chloroprene
- iso-butylene and isoprene

140. Which of the following is styrene?



141. Substance used in paints is

- teflon
- dynel
- PVC
- novolac

142. Which of the following is not true?

- In vulcanization, the formation of sulphur bridge between different chains make rubber hard and strong
- Natural rubber has trans configuration at every double bond
- Buna-N is a copolymer of 1, 3-butadiene and vinyl cyanide
- Natural rubber is a 1, 4-polymer of isoprene

143. Which is not true polymer

- polymer does not carry any charge
- polymer have high viscosity
- polymer scatter light
- polymer have low molecular weight

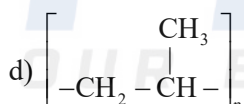
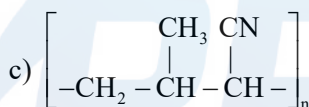
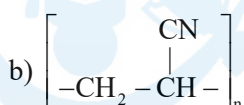
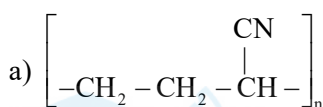
144. Teflon, neoprene, Nylon-6 are all

- co-polymer
- condensation polymer
- Homopolymer
- monomers

145. Interparticle forces present in Nylon-66 are

- Vander Waal's
- hydrogen bonding
- dipole-dipole attraction
- none of the above

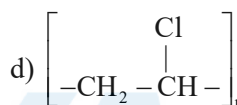
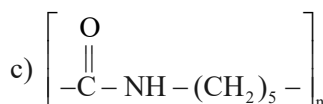
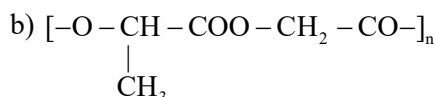
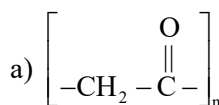
146. Natural rubber is
 a) All trans polyisoprene
 b) All cis-polyisoprene
 c) chloroprene
 d) Buna-N
147. Which of the following is branched polymer?
 a) Nylon
 b) low density polyethylene
 c) high density polyethylene
 d) polyester
148. Chloroprene is repeating unit in
 a) Polystyrene b) Buna-S
 c) Buna-N d) neoprene
149. Acrilan is hard, and high melting material, which of the following represent it's structure



150. Which of the following is chain growth polymer?
 a) Nylon-26 b) PVC
 c) Nylon-66 d) Nylon-6
151. The polymer which undergoes environment degradation by microorganism is known as
 a) chain-growth polymer
 b) chain step polymer
 c) biodegradable polymer
 d) non-biodegradable polymer
152. Which of the following is biodegradable polymer?
 a) Dextron b) Polyethylene
 c) PVC d) Nylon-6
153. Which of the following is not biodegradable polymer?
 a) polyhydroxy butyrate-co-d-hydroxy valerate
 b) polyglycolic acid

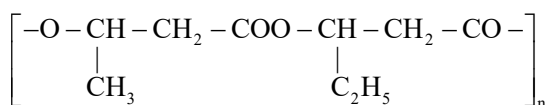
- c) Nylon-2, 6
 d) Nylon-6, 6

154. PHBV is prepared from
 a) glycolic acid
 b) 3-hydroxy butanoic acid and 3-hydroxy pentanoic acid
 c) glycine and w-amino caproic acid
 d) glycine and 3-hydroxy butanoic acid
155. Which of the following is dextran,



156. Nylon 2,6 is prepared from
 a) glycine and ϵ -caprolactum
 b) glycine and hexamethylene diamine
 c) glycine and 3-hydroxybutanoic acid
 d) glycine and ω -amino caproic acid
157. Two monomers used in the preparation of of dextran are
 a) 3-hydroxy butanoic acid and 3-hydroxy pentanoic acid
 b) ϵ -amino caproic acid and glycine
 c) lactic acid and glycolic acid
 d) isobutyric acid and isoprene
158. Dextran is
 a) polyamide b) polyamine
 c) polyester d) natural rubber
159. Polymer given below is .
 $[-\text{HN} - \text{CH}_2 - \text{CONH}(\text{CH}_2)_5\text{CO}]_n$
 a) Nylon-6 b) Nylon-2,6
 c) Nylon -6, 6 d) Nylon-3, 6
160. Glycolic acid and lactic acid on polymerisation gives
 a) orlon b) dextron
 c) dacron d) PHBV

161. The monomer of following polymer is



- a) $\text{HO} - \text{CH}_2 - \text{CH}_2 - \text{COOH}$
 b) $\text{HO} - \text{CH}_2 - \text{CH}_2 - \text{COOH}$
 $\qquad |$
 $\qquad \text{CH}_3$
 c) $\text{HO} - \text{CH}_2 - \text{CH}_2 - \text{COOH}$
 $\qquad |$
 $\qquad \text{C}_2\text{H}_5$
 d) both b and c
162. PHBV is
 a) polyester fibre
 b) polyamide fibre
 c) cyclic dimer of glycolic acid
 d) cyclic dimer of lactic acid
163. Isoprene substances are used for making
 a) propane b) propene
 c) natural rubber d) petrol
164. Which of the following statement is wrong
 a) PVC stands for polyvinyl chloride
 b) PTFE stands for teflon
 c) Buna-N stand for natural rubber
 d) PAN stands for polyacrylonitrile
165. Teflon is not used in
 a) clothes b) making oil seal
 c) non stick pan d) valves
166. Nylon-6 is not a
 a) condensation polymer
 b) polyamide
 c) copolymer
 d) homopolymer
167. Polymer containing nitrogen is
 a) Dacron b) Buna-S
 c) PAN d) Dextron
168. Buna-N is polymer of
 a) 1, 3-butadiene only
 b) styrene only
 c) acrylonitrile only
 d) 1,3-butadiene and acrylonitrile
169. Condensation product of caprolactum is
 a) Nylon-6 b) Nylon-66
 c) Buna-S d) Nylon-2,6
170. Thiokol is used as
 a) rubber
 b) for making human hair wigs

- c) helmets
 d) bullet proof windows

171. Human hair wigs are prepared from
 a) Glyptal b) Nomex
 c) Lexon d) Dynel
172. Which of the following is polysulphide rubber
 a) Glyptal b) thiokol
 c) Buna-N d) Neo-prene
173. Which of the following is used to make bullet proof windows?
 a) Nomex b) Lexan
 c) Glyptal d) PAN
174. Fire fighter uses cloths of
 a) Lexan b) Nylon
 c) Terylene d) Nomex
175. Chain growth polymerisation is important reaction of
 a) PTFE b) polyamide
 c) polyester d) Bakelite
176. Which of the following has rubber like properties?
 a) Fibres
 b) Thermosetting polymers
 c) Thermoplastic polymers
 d) elastomers
177. Which of the following is not synthetic rubber?
 a) poly 1,3-butadiene acrylonitrile
 b) poly 1,3-butadiene styrene
 c) Butyl rubber
 d) Polyisoprene
178. Which of the following is not true?
 a) In vulcanization, the formation of sulphur bridge between different chains make rubber hard and strong
 b) Natural rubber has trans configuration at every double bond
 c) Buna-N is a copolymer of 1, 3-butadiene and vinyl cyanide
 d) Natural rubber is a 1, 4-polymer of isoprene
179. For manufacture of tyre rubber the percentage is sulphur is
 a) 20 - 30 % b) 30 - 40 %
 c) 1 - 3 % d) 3 - 10 %
180. Neoprene rubber is
 a) addition co-polymer
 b) condensation co-polymer
 c) homopolymer
 d) condensation heteropolymer

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HINT & SOLUTIONS - MCQ'S

15. b) Natural is protein fibrous which contains polyamide linkage.
16. b) Chemically-treated cellulose (a polysaccharide) is called artificial silk.
64. b) The given segment has the ester linkage, $-\text{COO}-$ therefore, the polymer is a polyester.
65. b) In condensation polymerization, a series of condensation reactions between the (generally two) monomers containing at least two functional groups each occur with the loss of a small molecule such as H_2O , CH_3OH or HX ($\text{X} = \text{halogen}$). Terylene is a condensation polymer of ethylene glycol and dimethylterephthalate.
66. b) It is polymer of two monomers $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$ and $\text{HOOC}(\text{CH}_2)_4\text{COOH}$. It is a polyamide, because it has amide linkage i.e. $(-\text{CONH}-)$ linkages.
67. a) Dacron is a polymer of ethylene glycol and dimethyl terephthalate
68. b) We know that, perlon is Nylon-6.
69. a) We know that nylon-66 is a synthetic polymer belonging to polyamide group. It is made from 6 carbon atoms of dicarboxylic acid and 6 carbon atoms of diamine.
71. b) Nylon-s is obtained by the polymerization of caprolactum.
72. d) Wool and leather are proteins and hence are natural polyamides. Nylon is also synthetic polyamide.
73. c) We know that, terylene is prepared by the condensation polymerization of ethylene glycol and terephthalic acid with the elimination of water molecule.
74. d) We know that, nylon-66 is formed by the reaction between adipic acid and hexamethylene diamine. Both monomer units consist of 6-carbon atoms. Therefore it is called nylon-66 and is the raw material of nylon-66.
75. d) We know that, dacron (terylene) is obtained
116. d) We know that, terylene is very strong fibre. It by dimethyl terephthalate with ethylene is used for making sails, fabrics and seat belts. glycol. Dacron is slightly hygroscopic and has elastic recovery. It is non-inflammable and melts at 533 K.

QUESTIONS ASKED IN MHT - CET

1. In USA terylene is known as
a) terene b) nylon
c) dacron d) cronar
2. Starting materials for nylon-66 are
a) hexamethylene diamine and ethylene glycol
b) hexamethylene diamine and adipic acid
c) hexamethylene diamine and DMT
d) hexamethylene diamine and glycerol
3. Formula of nylon-66 is
a) $[\text{OC}(\text{CH}_2)_6\text{CONH}(\text{CH}_2)_4\text{NH}]_n$
b) $[\text{OC}(\text{CH}_2)_4\text{CONH}(\text{CH}_2)_6\text{NH}]_n$
c) $[\text{OC}(\text{CH}_2)_4\text{CONH}(\text{CH}_2)_4\text{NH}]_n$
d) $[\text{OC}(\text{CH}_2)_6\text{CONH}(\text{CH}_2)_6\text{NH}]_n$
4. Nylon-6 is
a) hydrocarbon polymer
b) polyamide
c) polyester
d) polyether
5. Nylon thread are made of
a) polyvinyl polymer
b) polyester polymer
c) polyamide polymer
d) polyethylene polymer
6. When condensation of hexamethylene diamine and adipic acid in a inert atmosphere the product obtained is
a) a solid polymer of nylon-66
b) a semi solid polymer of nylon-66
c) a solid polymer of nylon-6
d) a semi solid polymer of nylon-6
7. Nylon-66 is
a) homopolymer
b) condensation homopolymer
c) condensation heteropolymer
d) condensation polyamide heteropolymer
8. Monomer of terylene is

- a) dihydroxy dimethyl terephthalate
 - b) dihydroxy diethyl terephthalate
 - c) dimethyl terephthalate
 - d) dimethyl terephthalate and glycol
9. Hemp is
- a) synthetic fibre b) vegetable fibre
 - c) animal fibre d) not a fibre
10. Terylene is
- a) polyamide b) polyester
 - c) polypeptide d) polyamine
11. Biodegradable polymer which can be produced from glycine and aminocaproic acid is :
- a) Nylon 2 – nylon 6 b) PHBV
 - c) Buna – N d) Nylon 6,6

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