

Polymer is very large molecule in which very large number of simple repeating structural units joined together by covalent bond. Here, simple repeating structural units are called monomer. Example, innumerable molecules of ethene monomer (C_2H_4) combined with each other in polythene $\{CH_2-CH_2\}_n$.

● Difference between macromolecule and polymer

Macro molecule and polymer are very large molecule. Repeating units are present in polymer. While in macromolecule, repeating units will be present or will not present. For example, there is one repeating unit $-CH_2-CH_2-$ in polythene. It is known as polymer and macromolecule. But there is no repeating unit in chlorophyll which has $C_{55}H_{72}O_5N_4Mg$ formula. So it is known as macromolecule.

● Classification of polymers

Classification based on source :

- (a) **Natural polymers** : Polymers present in nature are obtained from plants or animals e.g. protein, cellulose, starch, nucleic acids, natural rubber. Polymers which control the life style of plants or animals known as biopolymers. e.g. starch, protein, cellulose, nucleic acid.
- (b) **Synthetic polymers** : Polymer which is made in laboratories known as synthetic polymers. e.g., polythene, nylon, decron etc.
- (c) **Semisynthetic polymers** : Polymers which are formed by chemical reaction with the polymers present in nature are called semisynthetic polymers. e.g. cellulose diacetate is obtained by acetylation reaction of cellulose with acetic anhydride in presence of H_2SO_4 . Explosive cellulose nitrate are formed by nitration of cellulose. Vulcanised rubber obtained by vulcanisation of natural rubber which is used in manufacture of tyre.

● Classification based on reaction mode of polymerisation :

Polymerisation : When same or two or more than two different types of small molecules are joined together with each other in large amount by covalent bond and form a polymer. This process is called polymerisation. Some times small molecules like H_2O , HCl etc. are eliminated.

The unit which is repeated several times in a polymer is called repeating unit. Number of repeating unit 'n' in polymer molecule is called "degree of polymerisation."

Chain growth and step growth polymer :

Chain growth polymer : This type of polymer is formed by repeated addition of monomer molecules to the growing chain carrying a reactive intermediate such as a free radical, a carbocation or a carbanion.

Step growth polymer : In each step a distinct functionalised species are produced by condensation reaction and each step is independent of each other. Thus, the polymer is obtained is known as step growth polymer.

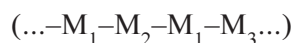
● **Some distinguishing points between chain growth polymerisation and step growth polymerisation.**

No.	Chain growth polymerisation	Step growth polymerisation
(i)	It is addition polymerisation	It is condensation polymerisation
(ii)	Monomer is added in growing chain.	Monomer form dimer, trimer etc. by addition in step by step.
(iii)	It takes place in presence of initiators.	No initiator is required.
(iv)	It is very fast reaction.	It is slow reaction.

● **Homopolymers and copolymers**

Homopolymers : When same type of innumerable monomers combine with each other and form polymer. It is known as homopolymers (...-M-M-M-M...). eg., polythene, polyvinyl chloride and neoprene.

Copolymer : Different types of chemical structure containing innumerable monomers combine with each other and form polymer is known as copolymer.



eg. Buna-S, Nitrile rubber, Nylon 66 Decron etc.

In polymerisation, two or more than two different types of monomers combined with each other and form polymer with high molecular mass is called copolymerisation.

● **Addition and Condensation Polymer :**

Addition Polymerisation :

In this method innumerable simple monomers are combined with each other. No simple molecules like (H_2O , NH_3 etc.) type is not released during this reaction. example : polythene

Condensation Polymerisation :

In this method innumerable simple monomers are combined with each other and released small molecules such as H_2O and NH_3 etc. Example : Nylon

● **Difference between addition and condensation polymer**

	Addition Polymer		Condensation Polymer
(1)	Formed by addition reaction.	(1)	Formed by condensation reaction.
(2)	Molecular mass is multiple of molar mass of monomer.	(2)	Molecular mass is not multiple of all molar mass of monomer.
(3)	Generally one type or two types of monomers participate in polymerisation.	(3)	More than one type of monomers participate in polymerisation.
(4)	Monomer is unsaturated molecule.	(4)	Monomer has two functional group.
(5)	It is chain growth polymer.	(5)	It is step growth polymer.

● **Classification based on structures**

Linear polymer :

In this type of polymers monomer units are present in long straight chain. Example : nylon and polyesters. Linear polymer have high boiling point and high density.

Branched Chain polymers :

This type of polymers contain branch in between the long straight chain in their constitution. e.g., Amylopectin, PVC polystyrene. Branched polymers have low boiling point and low density.

Cross linked polymers :

In this type of polymers long straight chain combined with each other at different places, so a net like structure is formed. example, phenol formaldehyde polystyrene-butadiene polymer and urea formaldehyde polymer .

● Classification based on molecular forces

Elastomers : Elastomers are polymer which contained 300 % more elastic property. Monomers are not combined in linear chain in elastomer but combined like net. So, it can be stretched like spring. The polymer comes into to its original position when force is removed. So, elastomers contained elastic property. eg., natural rubber, styrene butadiene rubber. They have limited cross bond. More cross linked bonds decreases the elastic property.

Fibers : If polymer chains are attracted by hydrogen bond or by dipole dipole forces are called Fibers. e.g., nylon, polyacrylonitrile.

Thermo setting polymers : The polymer does not become soft even at higher temperature is called thermosetting polymer. e.g. bakelite, phenol than normal temperature formaldehyde and melamine.

Thermoplastic polymer : The polymer becomes soft at higher temperature and again becomes inflexible on cooling is called thermoplastic. e.g. PVC, polythene, teflon and polystyrene. This polymer contains plasticity but does not contain elastic property. Hence, rubber contained elastic property but not contained plasticity.

	Thermosetting polymer		Thermoplastic polymer
(1)	It is formed by condensation polymerisation.	(1)	It is formed by addition or condensation polymerisation.
(2)	Once it get shape it will be not melt. It will be burn, on long heating.	(2)	It will become soft on heating and become hard by cooling.
(3)	It can not be recycled.	(3)	It can be recycled.
(4)	It possesses cross-linked structure.	(4)	It possess negligible cross linked.
(5)	It is hard and strong.	(5)	It is soft and less strong than thermosetting.
(5)	These polymers can not obtained again.	(6)	These polymers can obtained again.
(6)	They are insoluble in organic solvent.	(7)	Some of them are soluble in organic solvent.

Properties of polymer substances : Properties of polymers depends upon (i) structure of molecule in them. (ii) Average molecular mass of them. If number of molecules are more with higher molecular mass in any polymer then the boiling points, hardness of them is more. If number of molecules are more with less molecular mass in any polymer then the density, boiling point and hardness of them are less. In this type of polymers degree of polymerisation is high than it's called HDP and If degree of polymerisation is less than it is called LDP. Hard and durable instruments are made from HDP while soft and low weight instruments are made from LDP.

Linear polymers like polyamide and polyester are used as synthetic Fibers. Synthetic fibers can not combined with molecule of water by hydrogen bond in comparition of cotton. So, the cloth is eaisyly dry which is formed by polyaminde and polyester fiber.

Changing in properties of polymers : For changing properties of polymer for different uses, some substances are added in them.

- (i) Inorganic substances like TiO_2 , BaSO_4 , CaCO_3 , SiO_2 are added during polymerisation reaction to introduced heardness, density in some polymer. These substabce are called filler.
- (ii) In some polymers organic substance like Trycresyle phosphate, glycerine phthalate, tertiary butyl phthalate, olic acid are added to introduce property of softness. These substance are called plasticizer.
- (iii) In some substances, made from polymer crack observed in the prsence of sunlight. So that, the life of it decreases. If phenol, cresol, quinole, carbon-black are added in that polymers, the effect of sunlight is not observed. So, the degradation of this polymers can be stopped. This organic substance are called antioxidant.

• **Cheracteristics of Polymers :**

- (i) Different instruments are formed easily from polymer and their weight is less.
- (ii) Their is no effect of atmosphere and moisture on polymers. Whereas, their is harmful effect on metal, wood, leather, cotton cloth etc.
- (iii) Different instruments can be prepared from polymer because of some properties like heat resistant and non-conductor of electricity.
- (iv) There is no effect of chemicals and insects on polymers.
- (v) By adding proper useful substances in some polymer, we can change the properties.
- (vi) Raw material is easily available and cheap for manufacturing of polymer.

• **Common methods of polymerisation**

Mainly there are two types of polymerisation reaction : **Addition** and **Condensation polymerisation**.

(i) **Addition Polymerisation :**

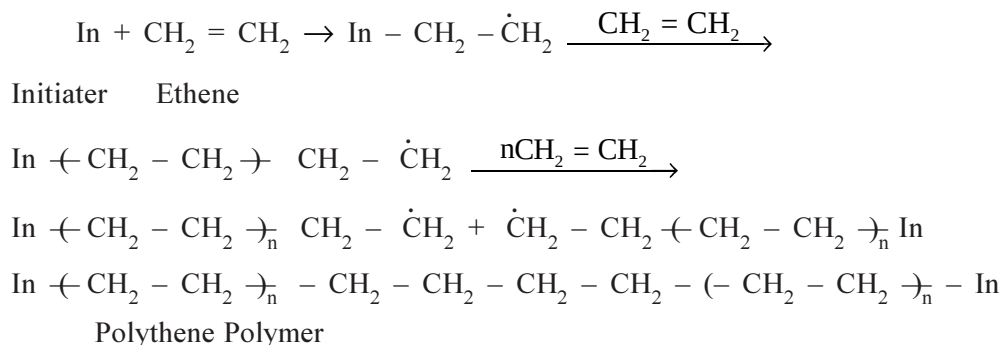
When same type of monomer containing one or more than one double bond are combined with each other by chemical bonding then **addition polymerisation** takes place. This reaction take place by free radical or carbocation or carbanion reactive intermediate which is produced from monomer. The addition polymerisation take place in ethene, propene, styrene, 1, 3 butadiene, isobutylene, vinyl

chloride, vinyl nitrile.

In polymerisation, if two different types of monomers containing double bond combine alternatively with each other by chemical bond then copolymer is formed. This polymerisation is called **addition copolymerisation**. eg. Buna-S is obtained from butadiene and styrene monomers.

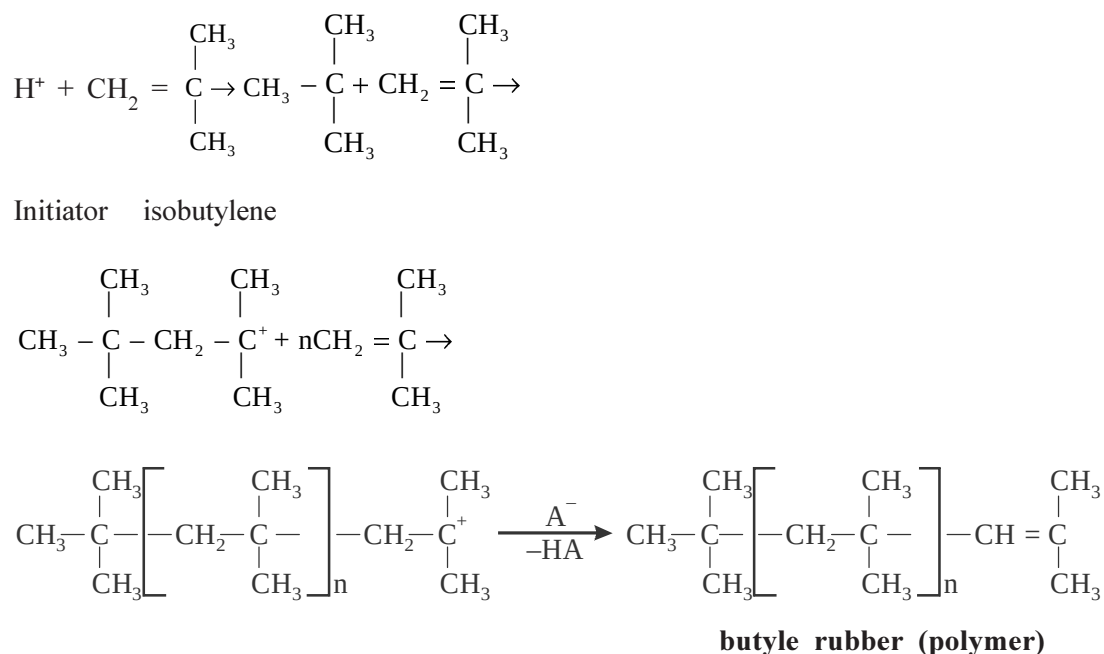
● Free radical addition polymerisation

Addition polymerisation reaction takes place by free radical reactive intermediate in unsaturated compounds like alkene or diene and its derivatives. Free radical reactive intermediate is produced by the use of initiators like 3° butyl peroxide in the first step of this reaction with the help of proper temperature and pressure. This new free radical combines alternatively with many ethene molecules and at every step longer chain of new free radical is formed. At the end on the basis of reaction condition, long chain of free radicals combine with each other to form polymer.



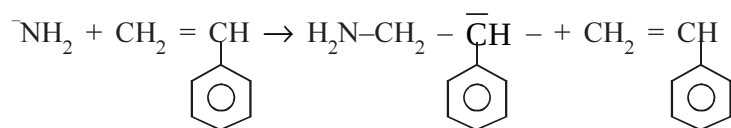
● Cationic addition polymerisation

Cationic reactive intermediate is produced by the use of initiators like acid in the first step of this reaction at proper temperature and pressure. This reactive intermediate combined with many other monomers containing electron releasing group and double bond step by step. At the end polymer is obtained in the presence of base.

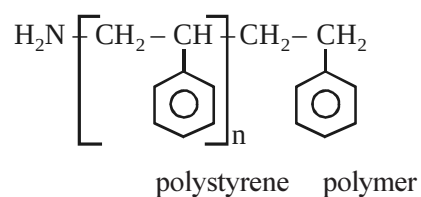
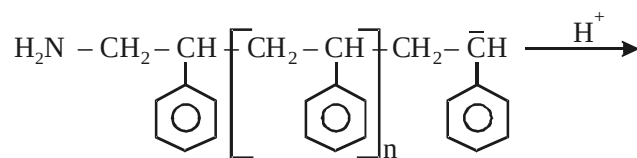
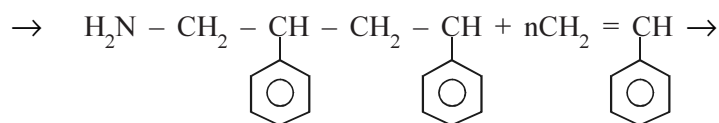


● Anionic addition polymerisation

Anionic reactive intermediate is produced by the uses of initiators like potassium amide in the first step of this reaction at proper temperature and pressure. This reactive intermediate combined step by step with many other monomers containing electron-withdrawing group and double bond. At the end polymer is obtained in the presence of acid.



Initiater styrene

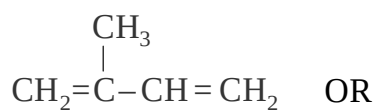


● Condensation polymerisation

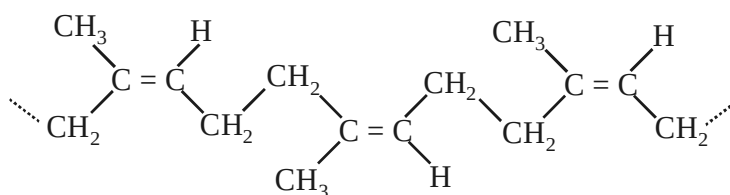
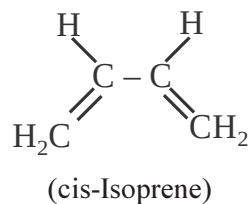
In this type of polymerisation condensation reaction repeatedly takes place between two different type of monomers possessing two similar functional groups. As a result of this condensation polymerisation reaction, simple molecules such as water, ammonia or alcohol are removed. Nylon 66 is obtained from hexamethylenediamine and adipic acid and terylene is obtained from dimethyl terphthalate and ethyleneglycol monomers.

● Natural rubber

Natural rubber is polymer of isoprene. In natural rubber all the double bonds have cis stereochemistry. So, natural rubber is cis poly-isoprene. By making incision in the trunk of rubber trees, the colloidal suspension of milky rubber in water, called latex is obtained.



2-methylbuta -1, 3 diene
(Isoprene)



Natural rubber [cis 1, 4-polyisoprene]

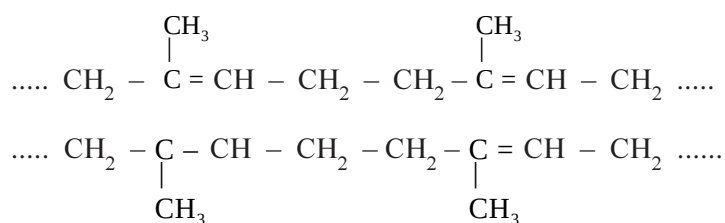
● Limitation of Natural rubber

- Their efficiency is not like plastic or they do not possess elastic properties.
- They become dry at low temperature and become soft at high temperature. They can be used at 10° C to 60° C temperature.
- Its tensile strength is less. (Only 200 kg cm²)
- Its water adsorption capacity is very high.
- They are oxidised by air easily.
- Its resistance against tear and wear is less and less durable.
- When force is applied it changes shape.

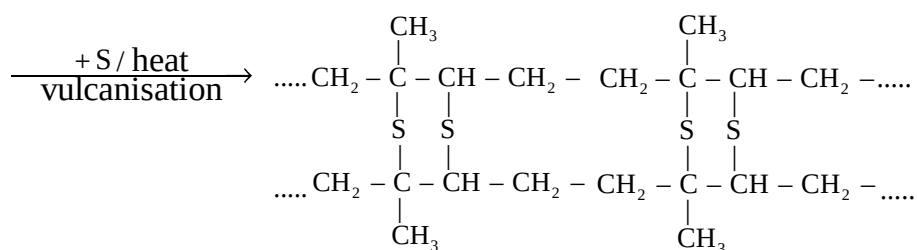
● Vulcanisation

In 1893, **Charles Goodyear** discovered that mixture of natural rubber and sulphur when heated at temperature 373 to 415 K its physical properties can be necessarily improved to a spectacular manner.

This process is called vulcanisation. Thus added sulphur combined nearly to double-bond of chain in natural rubber.



two chain of cis-polyisoprene



(Vulcanised rubber)

Thus, vulcanisation makes a substance strong due to cross linkage. Strength of vulcanised rubber depends upon proportion of sulphur which is added during the reaction. eg. 5 % sulphur is present in rubber which is used in tyres but 30 % sulphur is present in rubber which is used to making battery-cases. Stretching speed of vulcanised rubber and its property of regains to its original shape depend on cross linkage of sulphur.



● **Molecular mass of polymers**

(i) Number average molecular mass ($\bar{M}_n$)

$$\bar{M}_n = \frac{\sum_{i=1}^{\infty} N_i M_i}{\sum_{i=1}^{\infty} N_i}$$

$$= \frac{N_1 M_1 + N_2 M_2 + N_3 M_3}{N_1 + N_2 + N_3}$$

(ii) Weight average molecular mass ($\bar{M}_w$)

$$\bar{M}_w = \frac{\sum_{i=1}^{\infty} N_i M_i^2}{\sum_{i=1}^{\infty} N_i M_i}$$

$$= \frac{N_1 M_1^2 + N_2 M_2^2 + N_3 M_3^2}{N_1 M_1 + N_2 M_2 + N_3 M_3}$$

Here, N_1 , N_2 , N_3 is number of molecules having molecular mass of M_1 , M_2 , M_3 respectively.

Example : In a sample of polymer substance 30% molecules have 20,000 molecular mass, 40% molecules have 30,000 molecular mass and remaining molecule have 60,000 molecular mass. Find out $\bar{M}_w$ and $\bar{M}_n$.

• **Solution :**

$$\bar{M}_n = \frac{(30 \times 20000) + (40 \times 30000) + (30 \times 60000)}{(30 + 40 + 30)}$$

$$= \frac{600000 + 1200000 + 1800000}{100}$$

$$= \frac{3600000}{100} = 36000$$

$$\bar{M}_w = \frac{30(20000)^2 + 40(30000)^2 + 30(60000)^2}{(30 \times 20000) + (40 \times 30000) + (30 \times 60000)}$$

$$= \frac{(12 + 36 + 108)(1.0 \times 10^9)}{(6 + 12 + 18)(1.0 \times 10^5)}$$

$$= \frac{(156)(1.0 \times 10^4)}{36} = 43333$$

● **Poly Dispersity Index (PDI)**

“The ratio of mass and number average molecular mass ($\bar{M}_w / \bar{M}_n$) is called polydispersity index (PDI). Natural polymers are generally monodispersed, therefore $PDI = 1$. It means that $\bar{M}_w = \bar{M}_n$. Synthetic polymers are always polydispersed, so $PDI > 1$. It means that $\bar{M}_w > \bar{M}_n$. Calculation of number average molecular mass ($\bar{M}_n$) in any polymer is depends upon the number of molecules present in the polymer sample.

Molar mass of single molecule present in polymer substance can be calculated by light scattering, chromatographic and ultracentrifuge methods.

● Biopolymers

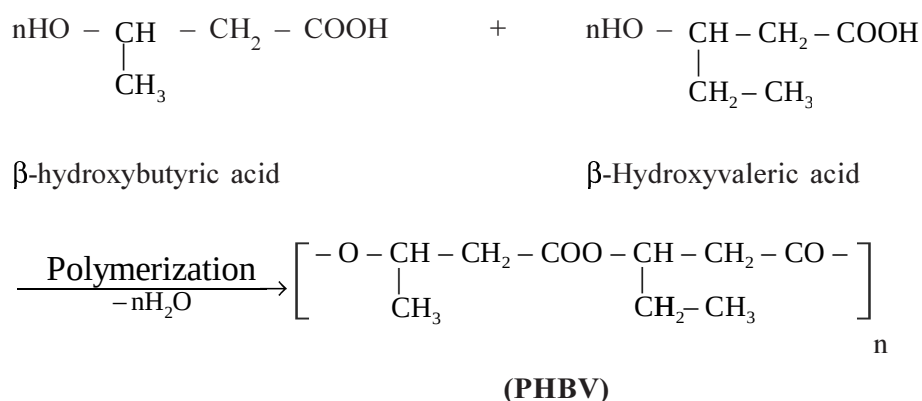
The polymer substances present in nature such as polysaccharide, protein and nucleic acid which are very useful for human life are called biopolymers.

Synthetic polymer substances show inertness towards the environmental process. In everyday use synthetic polymer substances can not be easily degraded. So it is not converted into life essential products. These type of non-biodegradable polymer waste is an acute problem. As a result environmental problems have been created.

The degradation of biopolymers which takes place mainly by enzymes, hydrolysis. There is no issue of its disposal. So synthetic biodegradable polymers can be synthesised, which are convenient to living systems. Using some aliphatic substances as monomers, many polymers are industrially prepared and some polymers of them possess biodegradable properties.

● Poly-Hydroxy Butyrate-Co-β- Hydroxyvalerate (PHBV)

PHBV is the co-polymer of polyester class polymer. It is prepared from β-hydroxy butyric acid monomer and β-hydroxy valeric acid monomer by copolymerisation condensation reaction. It possesses biodegradable character. There is stiffness property of β-hydroxy butyric acid and has flexibility property of β-hydroxy valeric acid.



PHBV is used in special types of packaging and in orthopaedic devices and in capsules for filling controlled release of drugs. When a drug is enclosed in a capsule of PHBV, it is released only when the polymer is degraded in the body. PHBV also undergoes bacterial degradation in environmental condition.

● PGA (Polyglycolic acid) and PLA (Polylactic acid)

PGA and PLA are prepared industrially. Dextran is the first biodegradable polyester polymer used for post operative stitches.

Nylon-2 nylon-6 is of polyamide class co-polymer and obtained by condensation polymerisation reaction of two different types of monomers, glycine and aminocaproic acid. It is a biodegradable polymer.

On the basis of source	On the basis of structure	On the basis of polymerisation reaction	On the basis of molecular forces	On the basis of growth of polymerisation reaction
1. Natural polymers e.g. protein, starch	1. Linear eg. cotton, wool, nylon	1. Addition polymer. e.g. polystyrene	1. Elastomer eg. natural rubber	1. Addition polymerisation reaction e.g. PVC, PTFE
2. Semi synthetic polymer e.g. rayon	2. Branched e.g. PVC, Teflon	2. Homopolymer e.g. neoprene	2. Fibers e.g. terylene	2. Condensation polymerisation reaction e.g. nylon - 66
3. Synthetic polymers e.g. synthetic rubbers, synthetic fibers	3. Cross linked e.g. bakelite	3. Copolymer eg. nylon-6 PHBV	3. Thermoplastic e.g. polythene, PVC	
		4. Condensation polymer e.g. teflon	4. Thermosetting polymers e.g. bakelite	

- Which polymer is obtain by condensation polymerisation ?
(A) Polythene (B) Teflon
(C) Phenol formaldehyde resin (D) Nitrile rubber
- Natural rubber is polymer of which monomer ?
(A) ethelene (B) vinyl (C) phenol (D) isoprene
- Which synthetic polymer is obtained from caprolectum ?
(A) Nylon-6 (B) Teflon (C) Terylene (D) Nylon-6
- Synthetic polymer (Neoprene) is
(A) polyester (B) polyamide (C) polysacarine (D) polychloroprene
- Which of the following type is polyamide ?
(A) Nylon (B) Orlon (C) Teflon (D) Terylene
- How impurity of polymer solution is measure ?
(A) adsorption of light by solution (B) emmision of light by solution
(C) scattering of light by solution (D) none of these
- In which of the following peptie bond is present ?
(A) Polysaccharide (B) Protein (C) Nucleotide (D) Vitamine
- Synthetic hair wig of humane is copolymer, which is prepared from vinylchloride and acrilonitrile. What is it ?
(A) PVC (B) PAN (C) Cellulose (D) Dynel

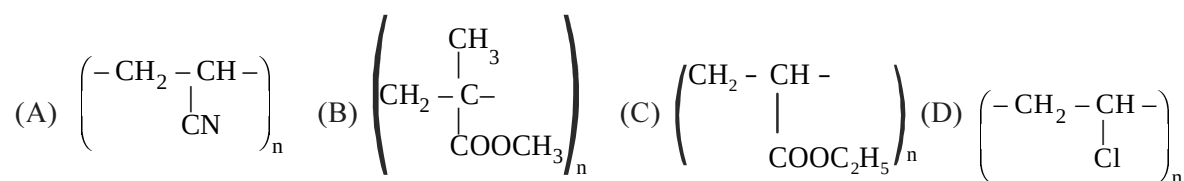
9. Which synthetic polymer is like natural rubber ?
 (A) Neoprene (B) Chloroprene (C) Glyptal (D) Nylon (E) None of these
10. Natural rubber is polymer of which monomer ?
 (A) trans isoprene (B) cis isoprene
 (C) none of these (D) S.N trans-isoprene
11. Orlon is polymer of which monomer ?
 (A) Tetrafluoro ethylene (B) Acrylonitrile
 (C) Ethanoic acid (D) Benzen
12. Which fibers are of polyamide type ?
 (A) Decron (B) Orlon (C) Nylon (D) Rayon
13. Bakelite is obtained by reaction between which substances ?
 (A) Formaldehyde and Quinol. (B) Aniline and Urea
 (C) Phenol and Methanal (D) Phenol and Chloroform
14. Which one is the raw material of Nylon ?
 (A) adipic acid (B) butadiene rubber (C) isoprene (D) ethylene
15. Polyethene polymer is made from monomer.
 (A) $\text{CH}_2 = \text{CH}_2$ (B) $\text{CH}_2 = \text{CCl}_2$ (C) $\text{CHCl} = \text{CHCl}$ (D) $\text{CH}_2 = \text{CHCl}$
16. Which of the following is an example of thermosetting polymer ?
 (A) Polythene (B) Neoprene (C) PVC (D) Bakelite
17. With whom phenol is reactaed Backelite obtained ?
 (A) Polythene (B) Acetylc (C) Formaldihyde (D) Chlaro Benzene
18. Which catalyst is used in preparation of polythene by ziegler-Natta method ?
 (A) Lithium tetrachloride and tryphenyl Aluminium
 (B) Titanium tetrachloride and triethyl aluminium
 (C) Titanium
 (D) Titanium isoperoxide
19. Which of the following pair is not true ?
 (A) Terylene : Condensation polymer of terphthalic acid and ethylene glycol
 (B) Teflon : Cross linking stable polymer prepared from phenol and formaldehyde.
 (C) Glyptal : It is homopolymer of methyl metha crylate
 (D) Synthetic rubber : It is condensation polymer of butadiene and styrene.
20. Which is the product of Addition polymerisation ?
 (A) PVC (B) Nylon (C) Terylene (D) Polyamide
21. Which is the natural Bio-polymer ?
 (A) Teflon (B) Nylon-66 (C) Rubber (D) DNA

22. Tetrafluoro ethene is monomer of which polymer ?
 (A) Ethelene (B) PVC (C) Teflon (D) Nylon-66
23. Which of the following is chain polymer ?
 (A) Bakelite (B) Ethelene (C) Teflon (D) PVC
24. What is an ebonixe ?
 (A) Natural rubber (B) Synthetic rubber
 (C) Hard valcanized rubber (D) Poly-propene
25. Bakelite is obtained by reaction between which substances ?
 (A) Urea and formaldehyde
 (B) Phenol and formaldehyde
 (C) Tetra methylene glycol and hexamethylisocynate
 (D) Ethylene glycol and dimethylterphatalate.
26. High molecular mass present in polymer.
 (A) elastomer (B) fiber
 (C) thermoplastic (D) thermosetting plastic
27. PMMA is polymer of which monomer ?
 (A) methyl methacrylate (B) methacrylate (C) methylacrylate (D) ethylacrylate
28. Bekelite is obtained by reaction between phenol and formaldehyde, then in first step the reaction between two substances show example of ?
 (A) aromatic electrophilic substitution reaction
 (B) aromatic nucleophilic substitution reaction
 (C) free dradical reaction
 (D) aldol reaction
29. Glyptal polymer is obtained by reaction between glycerol and which substance ?
 (A) melonic acid (B) phthalic acid (C) maleic acid (D) acetic acid
30. is monomer of Teflon polymer.
 (A) Difluoro ethene (B) Mono fluoro ethene (C) Tetra fluoro ethene (D) Tetra chloro ethene
31. Which polymer is not addition polymer ?
 (A) Polythene (B) Polystyrene (C) Neoprene (D) Terylene
32. Which polymer is used in manufacturing of non-stick kitchen vessels ?
 (A) PVC (B) Polystyren
 (C) Polyethene (D) Polytetrafluoroethene
33. Which is the example of addition polymer ?
 (A) Buna-S (B) Bakelite (C) Nylon-6 (D) Melamine
34. Which of the following is copolymer ?
 (A) Nylon-6 (B) Nylon-6 6 (C) PMMA (D) Polyethene
35. Which polymer possesses isoprene monomer ?
 (A) Natural rubber (B) Nylon-6, 6 (C) Polyethene (D) Deoron

36. Which polymer is not synthetic ?
 (A) Polyethene (B) PVC (C) Nylon (D) Cellofen
37. Which of the following is not true for polymer ?
 (A) Polymer does not possess any type of electric charge.
 (B) Polymer have high density.
 (C) They can scatter light
 (D) They have low molecular mass
38. In which class, polymer can be classified on the basis of preparation method ?
 (A) Only Addition polymer (B) Only condensation polymer
 (C) Co-polymer (D) (A) and (B) Both
39. Natural rubber is polymer of which monomer ?
 (A) butadiene (B) ethyne (C) styrene (D) isoprene
40. Terylene is condensation polymer of ethylene glycol and ?
 (A) benzoic acid (B) acetic acid (C) terephthalic acid (D) salicylic acid
41. Ziegler-Natta catalyst is
 (A) $K[pyCl_3]$ (C244) (B) $(ph_3p)_3 RhCl$ (C) $Al_2 (C_2H_5)_6 + TiCl_4$ (D) $Fe(C_2H_5)_2$
42. Preparation of Nylon-66 is possible by condensation of HMDA with,
 (A) phenol (B) benzaldehyde (C) adipic acid (D) succinic acid
43. The reaction of heating of natural rubber with sulphur is known as
 (A) galvanization (B) vulcanisation (C) nitration (D) sulphonation
44. Terylene is obtained by polymerisation of terephthalic acid and
 (A) ethylene glycol (B) phenol (C) ethanol (D) catacol
45. Teflon, styrene and neoprene all are
 (A) co-polymer (B) condensation polymer (C) homopolymer (D) monomer
46. Which type of intermolecular attraction force are present in Nylon-66 ?
 (A) Van der Waals (B) hydrogen bond
 (C) dipole-dipole attraction (D) none of these
47. $CF_2 = CF_2$ is monomer of which of the following polymer ?
 (A) Teflon (B) Glyptal (C) Nylon-6 (D) Buna-S
48. Generally soft-drink bottle and baby feeding bottle is made from which of the following polymer ?
 (A) polyester (B) polyurethane (C) polyamide (D) polystyrene
49. Which polymer is used in preparation of bulletproof glass ?
 (A) PMMA (B) Lexan (C) Nomex (D) Kevlar

50. Which of the following substance is used for making Nylon ?
 (A) adipic acid (B) styrene (C) teflon (D) phenol
51. What is obtained by polymerisation of Caproelctum ?
 (A) Terylene (B) Teflon (C) Gypstal (D) Nylon-6
52. How polyvinyl alcohol is obtained ?
 (A) By polymerisation of vinyl alcohol
 (B) By hydrolysis of polyvinyl acetate in basic medium
 (C) By polymerisation of acetelene
 (D) Reaction of acetelene with H_2SO_4 in presence of HgSO_4
53. Which pair is not true ?
 (A) Nylon : $\left[\text{CH}_2 - \underset{\text{Cl}}{\text{C}} = \text{CH} - \text{CH}_2 \right]_n$
 (B) Nylon-66 : $\left[\text{NH} (\text{CH}_2)_6 \text{NHCO} - (\text{CH}_2)_4 \overset{\text{O}}{\parallel} \text{C} - \text{O} \right]_n$
 (C) Terylene : $\left[\text{OCH}_2 - \text{CH}_2\text{O} - \underset{\text{O}}{\parallel} \text{C} - \text{C}_6\text{H}_4 - \underset{\text{O}}{\parallel} \text{C} \right]_n$
 (D) PMMA $\left[\text{CH}_2 - \underset{\text{COOCH}_3}{\overset{\text{CH}_3}{\text{C}}} \right]_n$
54. Which of the following is polyamide type polymer ?
 (A) Terylene (B) Rayon (C) Nylon-6 (D) Polystyrene
55. $\left[\underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}} - \text{CH}_2 \right]_n$ is obtained from which monomer ?
 (A) 2-methylpropene (B) styrene (C) propylene (D) ethene
56. Which is the condensation polymer ?
 (A) Decron (B) PVC (C) Polystyrene (D) Teflon
57. Which catalyst is used for polymerisation of polythene ?
 (A) Ziglar Nata catalyst (B) Vilfinshan catalyst
 (C) Palladium catalyst (D) Zeiesh solt complex
58. Which compound is used in pigment ?
 (A) Terylene (B) Nylon (C) Glyptal (D) Chloroprene

59. Cellulose acetate is
 (A) Natural polymer (B) Semisynthetic (C) Synthetic (D) Plasticizer
60. Cellulose diacetate is
 (A) natural polymer (B) semisynthetic polymer (C) synthetic polymer (D) plasticizer
61. Teflon is polymer of
 (A) tetrafluoro ethylene (B) tetraiodo ethylene
 (C) tetrabromo ethylene (D) tetrachloro ethylene
62. Bakelite is prepared by
 (A) reaction between phenol and formaldehyde.
 (B) reaction between phenol and polyethene.
 (C) reaction of polypropene with acid.
 (D) reaction between phenol and ethylene glycol.
63. Which are monomer units of Nylon 66 ?
 (A) Hexamethylenediamine and adipic acid.
 (B) Hexamethylenediamine and phthalic acid.
 (C) Only hexamethylene.
 (D) Only phthalic acid.
64. Natural rubber is which type of polymer ?
 (A) Condensation polymer (B) Addition polymer
 (C) Complet polymer (D) None of these
65. Which of the following is protein ?
 (A) Nylon (B) Rayon (C) Natural silk (D) Terydene
66. In which of the following substance ester group is present ?
 (A) Nylon (B) Polyethene (C) Terylene (D) PVC
67. Natural rubber is polymer of
 (A) isoprene (B) styrene (C) ethelene (D) butadiene
68. Which polymer is used as fiber in tyres of vehicle ?
 (A) Terylene (B) polythene (C) Nylon-6 (D) Bakelite
69. Acrilan has very high melting point then what is the structure of it ?



70. From which, Nylon fibers are prepared ?
 (A) Polyamide polymer (B) Poly ethelen polymer
 (C) Polyvinyl polymer (D) Polyester polymer
71. Bakelite is polymer of
 (A) HCHO and acetic acid (B) HCHO and phenol
 (C) C_2H_5OH and phenol (D) CH_3COOH and Benzene
72. Which polymer is biodegradable ?
 (A) Cellulose (B) polythene (C) Polyvinyl chloride (D) Nylon-6
73. Nylon-66 is not
 (A) condensation polymer (B) co-polymer (C) polyamide (D) homopolymer
74. Which polymer is chain growth polymer ?
 (A) Starch (B) Nucleic acid (C) Polystyrene (D) protein
75. Which of the following is monomer of orlon ?
 (A) Vinyl cynde (B) Acrolein (C) Glycole (D) Isoprene
76. Which polymer is obtained from $CF_2 = CF_2$?
 (A) Neoprene (B) Teflon (C) Pinacole (D) PVC
77. Which substance is used for making a strong rubber for tyres ?
 (A) Wax (B) 1, 3 butadiene (C) CaC_2 (D) Carbon black
78. Which are the monomers of Nylon-66 ?
 (A) Butadiene and Acrylonitrile (B) Ethelen glycol and Terephthelic acid
 (C) Hexa methylene diamine and Adipic acid (D) Melamine and Formaldehyde
79. The value of number average number molecular mass and weight average molecular mass is 30,000 and 40,000 respectively then, what is the value of PDI ?
 (A) ≤ 1 (B) ≥ 1 (C) 1 (D) 0
80. Which initiator is used in cationic polymerisation reaction ?
 (A) BuLi (B) $LiAlH_4$ (C) HNO_3 (D) $AlCl_3$
81. Thermosetting polymer bakelite is obtained by the reaction of phenol with
 (A) CH_3CHO (B) HCHO (C) HCOOH (D) CH_3CH_2CHO
82. Which polymer have very weak intermolecular attraction force ?
 (A) Nylon (B) Polyvinylchloride (C) Cellulose (D) Natural rubber

83. Co-polymer Buna-N is prepared from which monomer ?
 (A) $\text{CH}_2 = \text{CH-CN}$ and $\text{CH}_2 = \underset{\text{CH}_3}{\text{C}} = \text{CH}_2$
- (B) $\text{CH}_2 = \text{CH} - \overset{\text{Cl}}{\text{C}} = \text{CH}_2$ and $\text{H}_2\text{C} = \text{CH} - \text{CH} = \text{CH}_2$
- (C) $\text{H}_2\text{C} = \text{CH} - \text{CH} = \text{CH}_2$ and $\text{H}_6\text{C}_6 - \text{CH} = \text{CH}_2$
- (D) $\text{H}_2\text{C} = \text{CH} - \text{CN}$ and $\text{H}_2\text{C} = \text{CH} - \text{CH} = \text{CH}_2$
84. Bakelite is obtained by the reaction between phenol and
 (A) HCHO (B) $(\text{CH}_2\text{OH})_2$ (C) CH_3CHO (D) CH_3COCH_3
85. The value of PDI for natural polymer is
 (A) 0 (B) 1 (C) very high value (D) 100
86. What is the formula of number average molecular mass ?
 (A) $\overline{M}_n = \frac{\sum N_i M_i^2}{\sum N_i}$ (B) $\overline{M}_n = \frac{\sum N_i M_i}{\sum N_i}$ (C) $\overline{M}_n = \frac{\sum N_i M_i^2}{\sum N_i M_i}$ (D) $\overline{M}_n = \frac{\sum M_i N_i}{\sum N_i}$
87. In one sample 30% molecules have 20,000 molecular mass and 40% molecules have 30,000 molecular mass and other have 60,000 molecular mass then what is the value of $\overline{M}_n$ is?
 (A) 3,60,000 (B) 36,000 (C) 46,000 (D) 50,000
88. In one polymer 30% molecules have 20,000 molecular mass, 40% molecules have 30,000 molecular mass and other have 60,000 molecular mass than what is the value of $\overline{M}_w$?
 (A) 43,000 (B) 43,333 (C) 50,000 (D) 46,000
89. Which polymer is not example of chain polymer ?
 (A) Nylon (B) Buna-S (C) PMMA (D) Glyptal
90. Which polymer is example of Fibers ?
 (A) Silk (B) Decron (C) Nylon-66 (D) all of these
91. Natural rubber is which type of polymer ?
 (A) Condensation polymer (B) Addition polymer (C) Polyamide (D) None.
92. $[\text{NH}(\text{CH}_2)\text{NHCO}(\text{CH}_2)_4\text{CO}]_n$ is
 (A) thermosetting (B) homopolymer (C) copolymer (D) addition polymer
93. Which is not example of condensation polymer ?
 (A) Melamine (B) Gliptal (C) Decron (D) Neoprene
94. Which polymer possess strong inter-molecular force like Hydrogn bond ?
 (A) Natural rubber (B) Teflon (C) Nylon-66 (D) Polystyrene
95. is not a polymer from the following.
 (A) Ice (B) Starch (C) Protein (D) Cellulose
96. Which polymer is flourine base ?
 (A) Neoprene (B) Teflon (C) Pinakol (D) PVC

97. In elastomer intermolecular attraction force is
 (A) zero (B) weak (C) strong (D) very strong
98. Cellulose is polymer of
 (A) fructose (B) ribose (C) glucose (D) sucrose
99. PVC is used
 (A) in making of cosmetic (B) in making of tyres
 (C) in making of non-stick pan (D) in making of plastic pipe
100. polymer is used in manufacturing of contact lens for eyes.
 (A) Polymethyle methephilite (B) Polythene
 (C) polyethyle acrylyte (D) Nylon-6
101. Which polymer is used in preparation of magnetic recording tap ?
 (A) Decron (B) Acrelin (C) Terylene (D) Bakelite
102. Which of the following is not a polymer of following ?
 (A) Silk (B) DNA (C) DDT (D) Starch
103. Perlone is
 (A) rubber (B) nylon-6 (C) terylene (D) orlon
104. Ebonyte is
 (A) polypropene (B) natural rubber (C) synthetic rubber (D) valcanised rubber
105. polymer is used in bulletproof glass.
 (A) Lenan (B) PMMA (C) Nomex (D) Kevaler
106. Which of the following statement is false ?
 (A) Synthetic silk is made from cellulose.
 (B) Nylon-66 is a example of an elastomer.
 (C) Isoprene is a repeating unit in Natural rubber.
 (D) Starch and cellulose both are polymer of glucose.
107. Arrange the given polymer in descending order according to their intermolecular attraction force. (i) Nylon-66 (ii) Buna-S (iii) Polyethen
 (A) (i) > (ii) > (iii) (B) (ii) > (iii) > (i) (C) (ii) < (iii) < (i) (D) (iii) < (i) < (ii)
108. Which is the used in valcanized rubber ?
 (A) SF_6 (B) CF_4 (C) Cl_2F_2 (D) C_2F_2
109. Aarlon is polymer of
 (A) styrene (B) tetrachloro ethelene
 (C) vinyl chloride (D) acrylonitrile
110. Which polymer has very weak intermolecular attration forces ?
 (A) Nylon (B) Polyvinyl chloride (C) Cellulose (D) Natural rubber

111. Rayon fibers are made from
- (A) polymethelene (B) polyester (C) cellulose (D) styrene
112. Natural rubber is
- (A) polymer of buta-1,3-diene (B) polymer of ethylene
(C) polymer of 2-methyl-1, 3-butadiene (D) polymer of styrene
113. is the product of addition polymerisation reaction.
- (A) PVC (B) Nylon (C) Terylene (D) Polyamide
114. Which of the following is not a polymer ?
- (A) sucrose (B) catalyst (C) starch (D) teflon
115. In present time, which one is used in coating of tyres ?
- (A) Terylene (B) Polythene (C) Polypropen (D) Nylon-6
116. Protein is
- (A) polyester (B) polyamide (C) polythene (D) polyanhydride
117. Which of the following polymer is used in valve packing ?
- (A) Teflon (B) Terylene (C) Polystyrene (D) Polythene
118. What percentage of sulphur present valcanised rubber used in manufacturing of tyre ?
- (A) 5 % (B) 3 % (C) 30 % (D) 55.0 %
119. is used in preparation of plastic crokery of household.
- (A) Melamine and tetrachloroethan (B) Melenoied acid and hexamethelenamine
(C) Melamine and vinyl acetate (D) Melamine and formaldehyde
120. The repeating unit in PTFE is
- (A) $-\text{CF}_2-\text{CF}_2-$ (B) $-\text{CH}_2-\text{CH}_2-$ (C) $-\text{CF}_3-\text{CF}_3-$ (D) $-\text{CH}_2-\text{CH}(\text{CN})-$

Answers : 1. (C), 2. (D), 3. (D), 4. (D), 5. (A), 6. (C), 7. (B), 8. (D), 9. (A), 10. (B), 11. (B), 12. (C), 13. (C), 14. (A), 15. (A), 16. (D), 17. (C), 18. (B), 19. (B), 20. (A), 21. (D), 22. (C), 23. (D), 24. (C), 25. (C), 26. (D), 27. (A), 28. (A), 29. (B), 30. (C), 31. (D), 32. (D), 33. (A), 34. (B), 35. (A), 36. (D), 37. (D), 38. (D), 39. (D), 40. (C), 41. (C), 42. (C), 43. (B), 44. (A), 45. (C), 46. (B), 47. (A), 48. (D), 49. (B), 50. (A), 51. (D), 52. (B), 53. (B), 54. (C), 55. (A), 56. (A), 57. (A), 58. (C), 59. (A), 60. (B), 61. (A), 62. (A), 63. (A), 64. (B), 65. (C), 66. (C), 67. (A), 68. (C), 69. (A), 70. (A), 71. (B), 72. (A), 73. (D), 74. (C), 75. (A), 76. (B), 77. (D), 78. (C), 79. (B), 80. (B), 81. (B), 82. (D), 83. (D), 84. (A), 85. (B), 86. (B), 87. (B), 88. (B), 89. (D), 90. (D), 91. (B), 92. (C), 93. (D), 94. (C), 95. (A), 96. (B), 97. (B), 98. (C), 99. (D), 100. (A), 101. (D), 102. (C), 103. (B), 104. (D), 105. (A), 106. (B), 107. (A), 108. (A), 109. (D), 110. (D), 111. (C), 112. (C), 113. (A), 114. (A), 115. (D), 116. (B), 117. (A), 118. (A), 119. (D), 120. (A).