23 Polymers

QUICK LOOK

Polymers and Classification of Polymers

Polymers are substances of high molecular mass formed by the combination of large number of simple molecules called monomers. Polymers can be classify on the following basis:

(1) Classification Based on the Source: Polymers are two types:

(i) Natural Polymer: The polymers which are found in nature are called natural polymers *e.g.* proteins, polysaccharides, natural rubber are some examples.

(ii) Synthetic Polymers: The polymers which are synthetic or manmade. *e.g.* polyethene, nylon, dacron etc.

(2) Classification Based on Structure of Polymers: On the basis of structure polymers are three types:

(i) Linear Polymers: Generally have higher magnitude of inter particle forces and thus possess high density and high m.pt. such polymers have high tensile strength in the direction of polymer chain and very low tensile strength at right angle to it.

(ii) Branched Polymers: Generally have low density and low m.pt. such polymers have almost equal tensile strength in all direction which is less than that in linear chain polymers. *e.g.* amylopectin, glycogen etc.

(iii) Three Dimensional Net-work Polymers: In these polymers the initially formed linear polymers chains are joined together through two or more cross-links to form three-dimensional network structure. These are also called cross-linked polymers these are hard brittle and rigid *e.g.* Bakelite, urea, formaldehyde, melmac etc.

(3) Classification Based on Synthesis: The process by which the monomers are converted in to polymers is called polymerization. The number of times a monomer unit is repeated in a polymer is called degree of polymerization.

(i) Addition Polymerization: In this process the simple monomers are joined together without loss of molecules like H_2O, NH_3 etc. for *e.g.* Polythene, Polystyrene, PVC etc.

(ii) Condensation Polymerization: In this process the simple monomers are combined together with the loss of simple molecules like H_2O, NH_3 etc. *e.g.* Nylon, terylene etc.

Table 23.1: Addition and Condensation Polymers

Addition Polymers	Condensation Polymers
Formed by addition reaction.	Formed by condensation polymerization
Molecular mass is whole number multiple of monomer.	Molecular mass is not whole number multiple of the monomer.
Generally involve one monomer unit.	Generally involve more than one unit.
Monomers are unsaturated molecules.	Monomer units must have two active functional group.
They are generally chain growth polymers.	

(4) Classification Based on Molecular Forces: On the basis of intermolecular forces of attraction polymers can be classified in following types:

(i) Elastomers: In this type, the polymer chains are held together by weak intermolecular forces *e.g.* Natural rubber, vulcanized rubber, SBR (Styrene butadiene rubber) etc.

(ii) Fibres: In this type, the intermolecular forces between the chains are hydrogen bond or dipole-dipole interaction *e.g.* Nylon, polyester and orlon etc.

(iii) Thermoplastics: In this type, the intermolecular forces are intermediate between those of elastomers and fibers. *e.g.* polystyrene, PMMA etc.

(iv) Thermosetting: They are highly cross-linked hard, infusible and insoluble polymers .*e.g.* Bakelite, phenol formaldehyde etc.

Table: 23.2 Difference between Thermoplastic and Thermosetting Polymers

Thermoplastic polymers	Thermosetting polymers
(1) These soften and melt on heating.	These do not soften on heating but rather become hard in case prolonged heating is done these start burning.
(2) These can be remoulded recast and reshaped.	These cannot be remoulded or reshaped.
(3) These are less brittle and soluble in some organic solvents.	These are more brittle and insoluble in organic solvents.
(4) These are formed by addition polymerisation.	These are formed by condensation polymerisation.
(5) These have usually linear structures. Ex. Polyethylene, PVC, teflon.	These have three dimensional cross linked structures. Ex. Bakelite, urea, formaldehyde, resin.

Table 23.3: Rubber

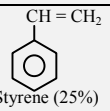
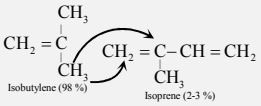
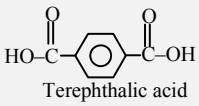
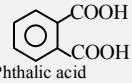
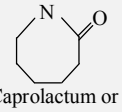
Rubber and Applications	Monomers	Formula
(i) Neoprene rubber Making automobile, refrigerator parts and electric wire.	$CH_2=\underset{\displaystyle Cl}{\underset{|}{C}}-CH=CH_2$ Chloroprene	$\left(-CH_2-\underset{\displaystyle Cl}{\underset{|}{C}}=CH-CH_2-\right)_n$
(ii) Styrene Butadiene Rubber (SBR) or Buna-*S* Making of tyre and other mechanical rubber goods.	$CH_2=CH-CH=CH_2$ Butadiene (75%) and  Styrene (25%)	$\left(-CH_2-CH=CH-CH_2-\underset{\displaystyle C_6H_5}{\underset{|}{CH}}-CH_2-\right)_n$
(iii) Butyl rubber Making of toys, tyre, tube etc.	 Isobutylene (98 %) Isoprene (2-3 %)	$\left(-CH_2-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH-CH_2-\underset{\displaystyle CH_3}{\underset{|}{C}}-CH_2-\right)_n$
(iv) Nitrile rubber or Buna *N* or GRA Used for make of fuel tank.	$CH_2=CH-CH=CH_2$ Butadiene (75%) and $CH_2=CH-CN$ Acrylonitrile (25%)	$\left(-CH_2-\underset{\displaystyle CN}{\underset{|}{CH}}-CH_2-CH=CH-CH_2-\right)_n$
(v) Polysulphide rubber (Thiokol)	$Cl-CH_2-CH_2-Cl$ Ethylene dichloride and Na_2S_4 Sodium tetrasulphide	$(-CH_2-CH_2-S-S-S-S-)_n$
(vi) Silicone rubber Used in the manufacture of hoses and tank lining, engine gasket and rocket fuel.	$Cl-\underset{\displaystyle Cl}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{Si}}}}-CH_3$ Chlorosilanes	$\left(-O-\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{Si}}}}-\right)_n$
(vii) Polyurethane rubber In the manufacture of fibre. Paints and heat insulator.	$HOCH_2-CH_2OH$ Ethylene glycol and $O=C=N-CH=CH-N=C=O$ Ethylene di-isocyanate	

Table 23.4: Plastics and Resin

Name of polymer and Applications	Abbreviat-ion	Starting materials (monomers)	Nature of polymer	Properties
(i) Polyolefines				
(a) Polyethylene or polyethene Packing material carry bags, insulation for electrical wires and cables.	LDPE (Low density polyethene)	$CH_2=CH_2$	*Low density* homo-polymer (branched) chain growth.	Transparent, moderate tensile strength, high toughness.
Manufacture of buckets, tubs, house ware, pipes, bottles and toys.	HDPE (high density polyethene)	$CH_2=CH_2$	*High density* homopolymer (linear) chain growth.	Transluscent, chemically inert, greater tensile strength, toughness.
(b) Polypropylene or polypropene Packing of textiles and foods, liners for bags, heat shrinkage wraps, carpet fibres, ropes, automobile mouldings, stronger pipes and bottles.	PP	$CH_3CH=CH_2$	Homopolymer, linear, chain growth.	Harder and stronger than polyethene.
(c) Polystyrene or Styron or styrofoam Plastic toys, house hold wares, radio and television bodies, refrigerator linings.		$C_6H_5CH=CH_2$	Homopolymer, linear, chain growth	Transparent
(ii) Polyhaloolefines				
(a) Polyvinyl chloride (i) Plasticised with high boiling esters PVC used in rain coats, hand bags, shower curtains, fabrics, shoe soles, vinyl flooring (ii) Good electrical insulator (iii) Hose pipes.	PVC	$CH_2=CH-Cl$ Vinyl chloride	Homopolymer chains growth	Thermoplastic
(b) Polytetrafluoroet-hylene or Teflon (i) For nonstick utensiles coating (ii) Making gaskets, pump packings valves, seals, non lubricated bearings	PTFE	$F_2C=CF_2$	Homopolymer, high melting point	Flexible and inert to solvents boiling acids even aqua regia. Stable upto 598 *K*.
(c) Polymonochlorotri-fluroroethylene Similar to those of teflon.	PCTFE	$ClFC=CF_2$	Homopolymer	Less resistant to heat and chemicals due to presence of chlorine atoms.
(iii) Formaldehyde Resins				
(a) Phenol formaldehyde resin or Bakelite (i) With low degree polymerisation as bindings glue for wood varnishes, lacquers.		Phenol and formaldehyde	Copolymer, step growth	Thermosetting polymer, hard and brittle

(ii) With high degree polymerisation for combs, for mica table tops, fountain pen barrels electrical goods (switches and plugs).				
(b) Melamine formaldehyde resin Non-breakable crockery.		Melamine and formaldehyde	Copolymer, step growth	Thermosetting polymer, hard but not so breakable.
(iv) Polyacrylates				
(a) Polymethacrylate (lucite, acrylite and plexiglass and perspex) Lenses light covers lights, shades signboards transparent domes skylight aircraft window, dentures and plastic jewellery.	PMMA	$CH_2=\underset{\displaystyle CH_3}{\underset{\vert}{C}}-COOCH_3$	Copolymer	Hard transparent, excellent light transmission, optical clarity better than glass takes up colours.
(b) Polyethylacrylate		$CH_2=CH-COOC_2H_5$	Copolymer	Tough, rubber like product

Table 23.5: Fibre

Name of Polymer and Applications	Abbreviation	Starting Materials	Nature of Polymer	Properties
(i) Polysters (a) Terylene or Dacron or mylar For wash and wear fabrics, tyre cords seat belts and sails.	PET (Polyethylene terephthalate)	$HO-CH_2-CH_2-OH$ and Ethylene glycol or Ethane -1, 2-diol  Terephthalic acid	Copolymer, step growth linear condensation polymer	Fibre crease resistant, low moisture absorption, not damaged by pests like moths etc.
(b) Glyptal or alkyd resin Paints and lacquers.		$HO-CH_2-CH_2-OH$ Ethylene glycol and  Phthalic acid	Copolymer, linear step growth condensation polymer	Thermoplastic dissolves in suitable solvents and solutions on evaporation leaves a tough but not flexible film.
(ii) Polyamides				
(a) Nylon-66 Textile fabrics, bristles for brushes etc.		$HO-\overset{\displaystyle O}{\overset{\Vert}{C}}[CH_2]_4-\overset{\displaystyle O}{\overset{\Vert}{C}}-OH$ Adipic acid and $H_2N-[CH_2]_6-NH_2$ Hexamethyllenediamine	Copolymer, linear, step growth condensation polymer	Thermoplastic high tensile strength abrasion resistant.
(b) Nylon-610 (i) Textile fabrics, carpets, bristles for brushes etc. (ii) Substitute of metals in bearings. (iii) Gears elastic hosiery.		$H_2N-[CH_2]_6-NH_2$ Hexamethyllene diamine and $HOOC[CH_2]_8COOH$ Sebacic acid	Copolymer, linear, step growth	Thermoplastic, high tensile strength, abrasion resistant
(c) Nylon-6 or Perlon Mountaineering ropes, tyre cords, fabrics.		 Caprolactum or $H_2N-[CH_2]_5-COOH$ ϵ-Aminocaproic acid	Homopolymer, linear	Thermoplastic high tensile strength abrasion resistant.
(iii) Polyacryloni-trile or orlon or acrilon Orlon, arcrilon used for making clothes, carpets blankets and preparation of other polymers.	PAN	$CH_2=CH-CN$	Copolymer	Hard, horney and high melting materials.

Note

- **Homopolymers:** Polymers made of molecules of same substance are called homopolymers.
- **Co-polymers:** The polymers made and different types of molecules are copolymers.
- Polymers having ester linkage is called polyesters.
- Polymers of alkenes are generally called polyenes.
- Thermosetting polymers cannot be remoulded but thermoplastic polymers can be remoulded.
- Vulcanization is a process of treating natural rubber under heat and sulphur. Sulphur introduces cross–linkes. Vulcanization was introduced by Charles Goodyear.
- Natural silk on burning gives a smell of burning hair and shrinks in to a ball of cinder while artificials silk gives a thread of ash.
- Terylene is a British name of Dacron.
- Co-polymer of vinyl chloride 90% and vinyl acetate 10% is called Vinyon.

MULTIPLE CHOICE QUESTIONS

Polymers and Classification of Polymers

1. Which one of the following is a linear polymer?
a. Amylopectin **b.** Glycogen
c. Starch **d.** Amylose

2. Which of the following polymer is an example of fibre?
a. Silk **b.** Dacron
c. Nylon-66 **d.** All of these

3. Polyethylene is:
a. Random copolymer **b.** Homo polymer
c. Alternate copolymer **d.** Crosslinked copolymer

4. Which of the following is a biodegradable polymer?
a. Cellulose **b.** Polythene
c. Polyvinyl chloride **d.** Nylon-6

5. Polythene is:
a. Thermoplastic **b.** Thermosetting
c. Both (a) and (b) **d.** None of these

6. Bakelites are:
a. Rubber **b.** Rayon
c. Resins **d.** Plasticisers

7. Which of the following is a step-growth polymer?
a. Polyisoprene **b.** Polythene
c. Nylon **d.** Polyacrylonitrile

8. Which of the following is not a natural polymer?
a. Cellulose **b.** Protein
c. PVC **d.** Nucleic acid

9. Which of the following is not correct regarding terylene?
a. Step-growth polymer **b.** Synthetic fibre
c. Condensation polymer **d.** Thermosetting plastic

10. Which is not a polymer?
a. Sucrose **b.** Enzyme
c. Starch **d.** Teflon

11. '*Cis*-1, 4-polyisoprene' is:
a. Thermoplastic **b.** Thermosetting plastic
c. Elastic (rubber) **d.** Resin

12. Which is a naturally occuring polymer?
a. Polythene **b.** PVC
c. Acetic acid **d.** Protein

13. Which of the following is an example of condensation polymers?
a. Polythene **b.** PVC
c. Orlon **d.** Terylene

14. Nylon-66 is a:
a. Natural polymer
b. Condensation polymer
c. Addition polymer
d. Substitution polymer

15. Which of the following is a natural polymer?
a. Polyester **b.** Glyptal
c. Starch **d.** Nylon-6

16. Nylon is not a:
a. Condensation polymer **b.** Polyamide
c. Copolymer **d.** Homopolymer

17. Which of the following is synthetic rubber?
a. Buna-S **b.** Neoprene
c. Both a. and b. **d.** None of these

18. Which of the following is not an example of natural polymer?
a. Wool **b.** Silk
c. Leather **d.** Nylon

19. Which of the following is not a polymer?
a. Gun cotton **b.** Perspex
c. Shellac (*eg.* lac shellac) **d.** Wax (*eg.* bees wax)

20. Among the following a natural polymer is
a. Cellulose **b.** PVC
c. Teflon **d.** Polyethylene

General Methods of Preparation and Mechanism of Polymerisation

21. When condensation product of hexamethylenediamine and adipic acid is heated to 553K (80°C) in an atmosphere of nitrogen for about 4-5 hours, the product obtained is?
a. Solid polymer of nylon 66
b. Liquid polymer of nylon 66
c. Gaseous polymer of nylon 66
d. Liquid polymer of nylon 6

22. Which of the following can be polymerised to polythene?
a. Ethylene **b.** Ethylene chlorohydrin
c. Ethyl acetate **d.** Ethylmethyl ketone

23. Teflon is a polymer of the monomer or Teflon is obtained by the polymerisation of:
a. Monofluoroethene **b.** Difluoroethene
c. Trifluoroethene **d.** Tetrafluoroethene

24. Condensation product of caprolactum is:
a. Nylon-6 **b.** Nylon-66
c. Nylon-60 **d.** Nylon-6,10

25. In the natural rubber 'Caoutchouc', the isoprene units are joined by:
a. Head-to-head **b.** Tail-to-tail
c. Head-to-tail **d.** All of these

26. Polymerization of glycol with dicarboxylic acids is:
a. Addition polymerisation
b. Condensation polymerisation
c. Telomerisation
d. Any of these

27. Complete hydrolysis of cellulose gives:
a. D-fructose **b.** D-ribose
c. D-glucose **d.** L-glu cose

28. Polypropylene can be obtained by polymerisation of:
a. $CH \equiv CH$ **b.** $CH_2 = CH_2$
c. $CH_3 - CH = CH_2$ **d.** $CH_3 - C \equiv CH$

29. PVC is obtained by polymerization of:
a. $CH_2 = CH - CH_2 - Cl$ **b.** $CH_2 = CH - Cl$
c. $CH_3 - Cl$ **d.** $CH_3 - CHCl_2$

30. The degree of crystallinity of which of the following is highest?
a. Atactic polyvinylchloride
b. Isotactic polyvinylchloride
c. Syndiotactic polyvinylchloride
d. All of these

31. The compound required for the formation of a thermosetting polymer with methanol is:
a. Benzene **b.** Phenyl amine
c. Benzaldehyde **d.** Phenol

32. Which polymer is formed by chloroethene?
a. Teflon **b.** Polyethene
c. PVC **d.** Nylon

Composition, properties and uses of Polymers

33. Which of the following is resistant to boiling aqua-regia?
a. Polythene **b.** Perspex
c. Teflon **d.** Bakelite

34. 'Rayon' is:
a. Natural silk **b.** Artificial silk
c. Natural plastic or rubber **d.** Synthetic plastic

35. Orlon is a polymer of:
a. Styrene **b.** Tetrafluoro ethylene
c. Vinyl chloride **d.** Acrylonitrile

36. Molecular mass of a polymer is:
a. Small **b.** Very small
c. Negligible **d.** Large

37. Neoprene is a polymer of:
a. Propene **b.** Vinyl chloride
c. Chloroprene **d.** Butadiene

38. Natural rubber contains several thousand units of *X* linked together in the polymer chain. *X* is:
a. Neoprene **b.** Isoprene
c. Chloroprene **d.** Styrene

39. The synthetic polymer which resembles natural rubber is?
a. Neoprene **b.** Chloroprene
c. Glyptal **d.** Nylon

40. The polymer used for making contact lenses for eyes is:
a. Polymethylmethacrylate **b.** Polyethelene
c. Polyethylacrylate **d.** Nylon-6

41. Characteristic property of Teflon is:
a. 2000 poise viscosity
b. High surface tension
c. Non-inflammable and resistant to heat
d. Highly reactive

42. Which of the following is not a polymer?
a. Silk **b.** DNA
c. DDT **d.** Starch

43. Isoprene is a valuable substance for making:
a. Propene **b.** Liquid fuel
c. Synthetic rubber **d.** Petrol

44. Which of the following is used in vulcanization of rubber?
a. SF_6 **b.** CF_4
c. Cl_2F_2 **d.** C_2F_2

45. In elastomer, intermolecular forces are:
a. Nil **b.** Weak
c. Strong **d.** Very strong

46. Which of the following is a polyamide?
a. Teflon **b.** Nylon –66
c. Terylene **d.** Bakelite

47. Three dimensional molecules with cross links are formed in the case of a:
a. Thermoplastic **b.** Thermosetting plastic
c. Both **d.** None

48. Discovery of 'nylon' is associated with:
a. Newyork and London **b.** Newyork and Longuet
c. Nyholm and London **d.** None of these

49. Nylon yarns are usually:
a. Highly inflammable
b. Non-inflammable
c. Both a. and b. types are known
d. Uncertain inflammability

50. Which of the following is a synthetic polymer?
a. Rubber **b.** Perspex
c. Protein **d.** Cellulose

51. Triethyl aluminium titanium chloride used in plastic industry is a:
a. Vulcaniser **b.** Plasticiser
c. Ziegler-Natta catalyst **d.** Telomer

52. Neoprene, a synthetic rubber contains which of the following element besides C and H:
a. N **b.** O **c.** Cl **d.** F

53. Which is not a polymer?
a. Ice **b.** Starch
c. Protein **d.** Cellulose

54. 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 linear molecules consisting of very long chains
d. They have linear molecules interlinked with forces like hydrogen bonding

55. Natural rubber is basically a polymer of or The monomer of natural polymer rubber is:
a. Neoprene **b.** Isoprene
c. Chloroprene **d.** Butadiene

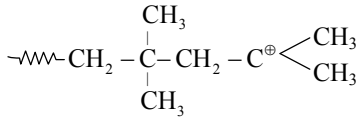
56. What is not true about polymers?
a. Polymers do not carry any charge
b. Polymers have high viscosity
c. Polymers scatter light
d. Polymers have low molecular weight

57. Which one of the following in used to make 'non-stick' cookware?
a. PVC
b. Polystyrene
c. Polyethylene terephthalate
d. Polytetrafluoroethylene

58. Nylone 66 is:
a. Polyamide **b.** Polyester
c. Polystyrene **d.** Polyvinyl

59. Which of the following polymer has ester linkage?
a. Nylon-66 **b.** PVC
c. Terylene **d.** SBR

60. The monomer of the polymer



is:

a. $H_2C = C\begin{matrix}CH_3\\CH_3\end{matrix}$ **b.** $(CH_3)_2C = C(CH_3)_2$
c. $CH_3CH = CHCH_3$ **d.** $CH_3CH = CH_2$

NCERT EXEMPLAR PROBLEMS

More than One Answer

61. Which of the following is synthetic rubber?
a. Buna-S **b.** Neoprene
c. Teflon **d.** Terylene

62. The catalyst used in the manufacture of polyethene by Ziegler method:
a. Triphenyl aluminium
b. Titanium tetrachloride
c. Trimethyl aluminium
d. Titanium isopropoxide

63. Terylene is the polymer of:
a. Ethylene glycol **b.** Terephthalic acid
c. Vinyl chloride **d.** Hexamethylene diamine

64. Ethylene-propylene rubber (EPR) are:
a. Stereoregular **b.** Saturated
c. Unsaturated **d.** Syndiotactic

65. Acrylic resins are:
a. Colourless **b.** Dark brown
c. Thermoplastic **d.** Transparent

66. Which one is classified as a condensation polymer?
a. Teflon **b.** Acrylonitrile
c. Dacron **d.** Neoprene

67. Which of the following polymers can be made by free radical addition polymerisation mechanism?
a. PE **b.** HDPE
c. LDPE **d.** Telflon

68. Which of the following polymers can be made by condensation polymerisation reaction?
a. Dacron **b.** Nylon-6,6
c. Bakelite **d.** PE

69. Nylon-5,10 can be prepared by:

a. $H_2N(CH_2)_5NH_2$ + Decanoic acid (Sebacle acid)

b. $HOOC(CH_2)COOH + H_2N(CH_2)_{10}NH_2$

c. $H_2N(CH_2)_6NH_2 + HOOC(CH_2)_8COOH$

d. $H_2N(CH_2)_{10}NH_2 + HOOC(CH_2)_4COOH$

70. Which of the following polymers contain 1,3-butadiene as one of the monomers?

a. Butyl rubber **b.** Nitrile rubber

c. ABS plastic **d.** SBR

71. The method of choice for determining the molecular weight of a polymer is:

a. Osmotic pressure

b. Gas density

c. Lowering of freezing point

d. Direct weighing of a single molecule

72. Which one among the following is a thermosetting plastic?

a. PVC **b.** PVA

c. Bakelite **d.** Perspex

73. A condensation polymer among the following polymers is:

a. PVC **b.** Teflon

c. Decron **d.** Polystyrene

74. Acetate rayon is prepared from:

a. Acetic acid **b.** Glycerol

c. Starch **d.** Cellulose

75. The monomers used in the production of nylon-66 are:

a. Hexamethylene diamine and ethylene glycol

b. Adipic acid and ethylene glycol

c. Adipic acid and hexamethylene diamine

d. Dimethyl terephthalate and ethylene glycol

76. The mass average molecular mass and number average molecular mass of a polymer are respectively 40,000 and 30,000. The polydispersity index of polymer will be:

a. < 1 **b.** > 1

c. 1 **d.** 0

77. The value of *n* in the formula $(C_5H_{10}O_5)$ $(C_5H_{10}O_5)_n$ for inulin is about:

a. 30 **b.** 300

c. 3000 **d.** 300000

78. Teflon is a polymer of:

a. Tetrafluoro ethane **b.** Tetrafluro propene

c. Difluorodichloro ethane **d.** Difluoro ethene

79. In the process of forming 'mercerised cellulose' the swelling of cellulose is caused by:

a. Water **b.** Na_2CO_3

c. Aq. NaOH **d.** Aq. HCl

80. The catalyst used for the polymerisation of olefins is:

a. Ziegler Natta catalyst

b. Wilkinson's catalyst

c. Pd-catalyst

d. Zeise's salt catalyst

81. The plastics if are hard, become soft and readily workable by addition of certain compounds called:

a. Catalysts **b.** Telomers

c. Plasticisers **d.** Vulcaniser

Assertion and Reason

Note: Read the Assertion (A) and Reason (R) carefully to mark the correct option out of the options given below:

a. If both assertion and reason are true and the reason is the correct explanation of the assertion.

b. If both assertion and reason are true but reason is not the correct explanation of the assertion.

c. If assertion is true but reason is false.

d. If the assertion and reason both are false.

e. If assertion is false but reason is true.

82. **Assertion:** Hydrogenation is the process of converting an oil into a fat, called vegetable ghee.
Reason: Hydrogenation as carried out in presence of a catalyst usually finely divided nickel.

83. **Assertion:** The time of vulcanisation and temperature is increased by adding accelerators.
Reason: By vulcanising, a material of high tensile strength can be obtained.

84. **Assertion:** Bakelite is a thermosetting polymer.
Reason: Bakelite can be melted again and again without any change.

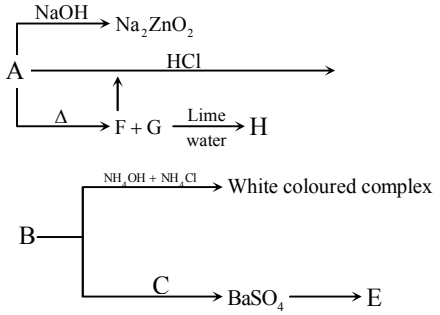
85. **Assertion:** Teflon has high thermal stability and chemical inertness.
Reason: Teflon is a thermoplastic.

86. **Assertion:** In vulcanisation of rubber, sulphur cross links are introduced.
Reason: Vulcanisation is a free radical initiated chain reaction.

Comprehension Based

Paragraph –I

Read the paragraph and answer the given questions



A. C is an rotten smell gas.

B. E is called lithophone used as white paint.

C. G is a colourless gas having acidic nature.

D. D is in soluble in HCl.

87. When G reacts with aqueous NaOH, product formed is;

a. Na_2CO_3 **b.** Na_2SO_3

c. Na_2SO_4 **d.** $NaNO_3$

88. When compound F heated with cobalt nitrate, it gives

a. $CoCuO_2$ **b.** $CoO \cdot CuO$

c. $CoZnO_2$ **d.** $CoFeO_2$

89. Compound A is:

a. $HgSO_4 \cdot 2H_2O$ **b.** $ZnSO_4 \cdot 7H_2O$

c. $ZnSO_4$ **d.** $FeSO_4 \cdot 7H_2O$

Paragraph -II

The process by which the monomers are converted into polymers is called polymerisation. Homopolymers and copolymers can exist in three different types of chain configurations i.e. linear, branched or cross–linked. When two different repeater units in a copolymer are distributed at random throughout the chain, the polymer is called a 'random polymer'.

90. The repeating units of PTFE are:

a. Cl_2CH-CH_3 **b.** $F_2C=CF_2$

c. F_3C-CF_3 **d.** $FClC=CF_2$

91. Which of the following represents the example of homopolymer?

a. PMMA **b.** Bakelite

c. Glyptal **d.** Nylon–66

92. $n(CF_2=CF_2) \xrightarrow{(NH_4)_2SO_4} X$. Here X is:

a. PVC **b.** PMMA

c. PAN **d.** None of these

Match the Column

93. Match the statement of Column with those in Column II:

Column I (Polymer)	**Column II** (Type)
(A) Poly (methyl methacrylate) PMMA	**1.** Thermosetting polymer
(B) Orlon	**2.** Thermoplastic polymer
(C) Bakelite	**3.** Addition polymer
(D) Decron	**4.** Condensation polymer

a. A→2, 3; B→3; C→1, 4; D→4

b. A→1, 3; B→3; C→2, 4; D→4

c. A→2, 4; B→1; C→2, 4; D→4

d. A→2, 3; B→1; C→3, 4; D→1

94. Match the statement of Column with those in Column II:

Column I	**Column II**
(A) Pepsin	**1.** Genetic material
(B) Nucleic acid	**2.** Digestive enzyme
(C) Ascorbic acid	**3.** Antibiotic
(D) Testosterone	**4.** Sex hormone
	5. Vitamin

a. A→3, B→1, C→4, D→2 **b.** A→1, B→2, C→5, D→3

c. A→1, B→3, C→2, D→4 **d.** A→4, B→1, C→3, D→2

95. Match the polymers in column-I with their main uses in column II and choose the correct answer:

Column I	**Column II**
(A) Polystyrene	**1.** Paints and lacquers
(B) Glyptal	**2.** Rain coats
(C) Polyvinyl chloride	**3.** Manufacture of toys
(D) Bakelite	**4.** Computer discs

a. A→2, B→1, C→3, D→4 **b.** A→3, B→1, C→2, D→4

c. A→2, B→4, C→3, D→1 **d.** A→3, B→4, C→2, D→1

Integer

96. The mass average molecular mass and number average molecular mass of a polymer are respectively 40,000 and 30,000. The polydispersity index of polymer will be:

97. The value of n in the formula $(C_5H_{10}O_5)_n$ for inulin is about Specific rotations of α-anomer of given mono saccharide is +112° and for β-anomer is +19° Specific rotation of equilibrium mixture is 52.7°. Calculate % composition of α and β anomers in the equilibrium mixture:

98. Calculate % composition of α anomers in the equilibrium mixture:

99. Calculate % composition of β anomers in the equilibrium mixture:

100. The total number of lone pairs of electrons in melamine is:

ANSWER

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
d	d	b	a	a	c	c	c	d	a
11.	**12.**	**13.**	**14.**	**15.**	**16.**	**17.**	**18.**	**19.**	**20.**
c	d	d	b	c	d	c	d	d	a
21.	**22.**	**23.**	**24.**	**25.**	**26.**	**27.**	**28.**	**29.**	**30.**
b	a	d	d	c	b	c	c	b	c
31.	**32.**	**33.**	**34.**	**35.**	**36.**	**37.**	**38.**	**39.**	**40.**
d	c	c	b	d	d	c	b	a	a
41.	**42.**	**43.**	**44.**	**45.**	**46.**	**47.**	**48.**	**49.**	**50.**
c	c	c	a	b	b	b	a	c	b
51.	**52.**	**53.**	**54.**	**55.**	**56.**	**57.**	**58.**	**59.**	**60.**
c	c	a	d	b	d	d	a	c	a
61.	**62.**	**63.**	**64.**	**65.**	**66.**	**67.**	**68.**	**69.**	**70.**
a,b	b,c	a,b	a,b	a,d	c	a,b,c	a,b,c	a	all
71.	**72.**	**73.**	**74.**	**75.**	**76.**	**77.**	**78.**	**79.**	**80.**
a	c	c	d	c	b	a	a	c	a
81.	**82.**	**83.**	**84.**	**85.**	**86.**	**87.**	**88.**	**89.**	**90.**
c	b	e	c	b	b	b	c	b	b
91.	**92.**	**93.**	**94.**	**95.**	**96.**	**97.**	**98.**	**99.**	**100.**
a	d	a	b	b	1	30	36	64	6

SOLUTION

Multiple Choice Questions

1. **(d)** Amylose is a linear polymer of $\alpha-D-Glucose$

$$(-Glucose-Glucose-Glucose-)_n$$
$$(C_1-C_4\ \alpha-linkage)$$

2. **(d)** Silk is protein fibre. Dacron is polyester fibre and Nylon-66 is polyamide fibre.

3. **(b)** Polyethylene is a homopolymer

$$n\,CH_2=CH_2\longrightarrow(-CH_2-CH_2-)_n$$

4. **(a)** Cellulose is the natural fibre which are biodegradable polymer rest are synthetic polymer which are not biodegradable.

5. **(a)** Thermoplastic are those which becomes soft on heating and can be remoulded again.

6. **(c)** Resins is amorphous organic solids or semisolids which usually have a typical lustre and are often transparent or translucent.

7. **(c)** Step growth polymerization involves condensation reaction between two difunctional monomer to produce dimer which in turn, produce, tetramer and so on with the loss of simple molecules like $H_2O,\ NH_3, HCl$ etc.

8. **(c)** PVC is a synthetic polymer made by vinylchloride.

9. **(d)** Terylene is fibre not a thermosetting plastic because on heating they melt and do not show plastic property while rest option are true regarding to Terylen

10. **(a)** Sucrose is a disaccharides which upon acid or enzymatic hydrolysis gives only two molecules of monosaccharides.

$$Sucrose\xrightarrow{H^+\text{ or invertaase}}D(+)\text{-glucose}+(D)(-)\text{-fructose}$$

11. **(c)** Natural rubber is the only addition polymer of nature and is known as $Cis-1,4-$ polyisoprene.

12. **(d)** Protein is a natural polymer of $\alpha-$ amino acids.

13. **(d)** Nylon is the copolymer of Hexamethylene diamine and adipic acid. It is not a homo-polymer because homopolymer formed by two same monomer unit.

14. **(b)** Nylon-66 is manufactured by the condensation polymerization of adipic acid and hexamethylenediamine with the lose of H_2O as steam.

15. **(c)** Starch is a natural polymer and other are synthetic.

16. **(d)** Nylon is the copolymer of Hexamethylene diamine and adipic acid. It is not a homo-polymer because homopolymer formed by two same monomer unit.

17. **(c)** Buna-*S* and Neoprene both are synthetic rubber.

18. **(d)** Nylon is a synthetic polymer.

19. **(d)** Wax is a molecular solid.

20. **(a)** It is present in the cell wall of plant.

21. **(b)** The condensation polymerisation of hexamethylene diamine and adipic acid is done in solution form by interface technique. In this liquid nylon polymer is obtained.

$$n.H_2N-(CH_2)_6-NH_2$$

$$nHOOC-(CH_2)_4-COOH\xrightarrow[-nH_2O]{\text{Polymerisation}}$$

$$\underset{\text{Nylon}}{[-HN-(CH_2)_6-NHCO-(CH_2)_4-CO-]_n}$$

22. **(a)** $\underset{\text{Ethylene}}{n\,CH_2=CH_2}\longrightarrow\underset{\text{Polythene}}{(-CH_2-CH_2-)_n}$

23. **(d)** Tetrafluoroethene $(CF_2=CF_2)$.

24. **(d)** PVC is polyvinyl chloride, a polymer of vinyl chloride.

$$\underset{\text{1-chloroethene}}{n.CH_2=CH.Cl}\xrightarrow{\text{Polymerisation}}\underset{\text{PVC}}{\left[\begin{array}{c}Cl\\|\\-CH_2-CH-\end{array}\right]_n}$$

25. **(c)** $\overset{\text{Head}}{CH_2}=\underset{CH_3}{\overset{|}{C}}-\overset{\text{Tail}}{CH}=CH_2+\overset{\text{Head}}{CH_2}=\underset{CH_3}{\overset{|}{C}}-\overset{\text{Tail}}{CH}=CH_2$

$$\longrightarrow(-CH_2-\underset{CH_2}{\overset{|}{C}}=CH-CH_2-CH_2-\underset{CH_3}{\overset{|}{C}}=CH-CH_2-)_n$$

From steric effects, the polymer formed has head to tail configuration.

26. **(b)** Condensation Polymerization because loss of water molecule takes place.

27. **(c)** *D*-glucose is the monomer of cellulose.

28. **(c)** $\underset{\text{Propene}}{n CH_3-CH=CH_2} \longrightarrow (-CH_2-\underset{\underset{CH_3}{|}}{CH}-)_n$

Polypropylene

29. **(b)** $\underset{\text{Vinyl chloride}}{n(CH_2=CH-Cl)} \longrightarrow (-CH_2-\underset{\underset{Cl}{|}}{CH}-)_n$

(PVC)

30. **(c)** Syndiotactic polyvinylchloride

$$\left(-CH_2-\underset{\underset{Cl}{|}}{CH}-CH_2-\underset{\underset{Cl}{|}}{CH}-CH_2-\underset{\underset{Cl}{|}}{CH}-CH_2-\underset{\underset{Cl}{|}}{CH}-CH_2-\underset{\underset{Cl}{|}}{CH}-\right)_n$$

In this arrangement the chlorine atoms are alternately arranged. The polymer is stereoregular and has high crystallinity.

31. **(d)** When phenol react with HCHO form bakelite which is a thermosetting polymer.

32. **(c)** Generally chloroethene (vinyl chloride) formed PVC polyvinyle chloride.

33. **(c)** Teflon is flexible, inert to solvents and to boiling with acids even to aqua - regia and is stable upto 598K.

34. **(b)** 'Rayon' is man-made fibre which consists of purified cellulose in the form of long threads. Rayon resembles silk in appearance. Hence, called as artificial silk.

$$\underset{\text{(from woodpulp)}}{\text{Cellulose}} \xrightarrow[CS_2]{NaOH} \underset{\text{(Syrup like liquid)}}{\text{Viscose}} \xrightarrow[\text{into dil. } H_2SO_4]{\text{Pass through}} \underset{\text{(Fine silken thread)}}{\text{Rayon}}$$

35. **(d)** Acrylonitrile is a hard, horny and high melting material. It is used in the manufacture of oron and Acrilan fibres which are used for making clothes, carpets and blankets.

36. **(d)** Polymer always consists of hundreds to thousands of repeating structural units. Hence they have very high molecular mass.

37. **(c)** $\underset{\text{Chloroprene}}{n(CH_2=\underset{\underset{Cl}{|}}{C}-CH=CH_2)} \longrightarrow (-CH_2-\underset{\underset{Cl}{|}}{C}=CH-CH_2-)_n$

Neoprene

38. **(b)** Isoprene $(CH_2=\underset{\underset{CH_3}{|}}{C}-CH=CH_2)$

39. **(a)** In Neoprene monomer unit is

$CH_2=\underset{\underset{Cl}{|}}{C}-CH=CH_2$ (chloroprene)

While Isoprene $(CH_2=\underset{\underset{CH_3}{|}}{C}-CH=CH_2)$ is the monomer of natural rubber.

40. **(a)** Also known as PMMA. It is a transparent, excellent light transmitter and its optical clarity better than glass so it is used in the preparation of lenses for eyes.

41. **(c)** Teflon is non-inflammable and resistant to heat so it is used in coating, particularly in non-sticking frying pans.

42. **(c)** DDT is an organic compound used as insectiside not is a polymer.

43. **(c)** Rubber is a polymer of isoprene. Its chemical formula is $(C_5H_8)_n$. .

44. **(a)** SF_6 is used in the vulcanisation of rubber. Sulphur is heated with polymer to introduce cross-linking and thus, form tough polymer.

45. **(b)** Polymer chain in elastomer are held together by weak intermolecular forces eg. Vulacanised rubber.

46. **(b)** Nylons are polyamide fibres.

47. **(b)** Thermosetting plastics have three dimensional cross-linked structure. Such polymers are prepared in two steps. The first step is the foramtion of long chain molecules which are capable of further reaction with each other. The second step is the application of heat which cause a reaction to occur between the chains, thus producing a complex cross-linked polymer.

48. **(a)** Nylon was simultaneously discovered in New york and London.

49. **(c)** Both highly inflammable and Non-inflammable

50. **(b)** Perspex is a synthesized polymer.

51. **(c)** Ziegler-Natta catalyst $(C_2H_5)_3Al + TiCl_4$

52. **(c)** $\underset{\text{Chloroprene}}{n(CH_2=\underset{\underset{Cl}{|}}{C}-CH=CH_2)} \longrightarrow \underset{\text{Neoprene}}{\left(CH_2-\underset{\underset{Cl}{|}}{C}=CH-CH_2\right)_n}$

53. **(a)** Ice is a molecular solid.

54. **(d)** They have linear molecules interlinked with forces like hydrogen bonding.

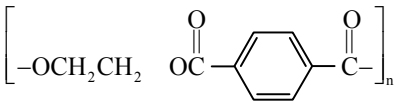
55. **(b)** $n\,CH_2=\underset{CH_3}{\overset{|}{C}}-CH=CH_2 \longrightarrow \underset{\text{Natural rubber}}{\left(-CH_2-\underset{CH_3}{\overset{|}{C}}=CH-CH_2-\right)_n}$

56. **(d)** Polymers have high molecular weight.

57. **(d)** Teflon has great chemical inertness and high thermal stability, hence used for making non-stick utensils. For this purpose, a thin layer of teflon is coated on the inner side of the vessel.

58. **(a)** All the nylons are polyamides.

59. **(c)** Terylene has ester linkage. It is the polymer of ethylene glycol with terephthalic acid. It is used in textile industry.



Dacron or terylene

60. **(a)** $H_2C=C<\begin{matrix}CH_3\\CH_3\end{matrix}$

NCERT Exemplar Problems

More than One Answer

61. **(a, b)** Buna-S, Neoprene

62. **(b, c)** Titanium tetrachloride, Trimethyl aluminium

63. **(a, b)** Ethylene glycol, Terephthalic acid

64. **(a, b)** Stereoregular, Saturated

65. **(a, d)** Colourless , Transparent

66. **(c)** Teflon, Acrylonitrile and Neoprene and addition polymers while Dacron is a condensation polymer.

67. **(a,b,c)** These do not contain EDG or EWG, so they can be prepared by free radical addition polymerisation.

68. **(a,b,c)** Polyester and polyamide undergo condensation polymerisation.

69. **(a)** Nylon-5,10 refers to 5-C-atom diamine and 10-C-atom dibasic acid (first numeral refers to diamine and second numeral refers to dicaboxylic acid).

70. **(a,b,c,d)** (c) ABS (refers to acrylonitrile butadiene styrene).
(d) SBR (refers to styrene butadiene rubber)
(a) Butyl rubber also refers to butadiene.
(b) Nitrile rubber refers to Buna-N.

71. **(a)** Osmotic pressure method is best for the determination of molecular weight of polymers and proteins since O.P., though very small, is measurable. On the other hand, in other colligative properties (*e.g.,* ΔT_b, ΔT_t, $\Delta p/p^o$ methods, the difference is very small and cannot be measured, while in other methods, heating is required which changes the properties of polymer and proteins.)

72. **(c)** Bakelite is thermosetting polymer. It becomes infusible on heating and cannot be remoulded

73. **(c)** The polymer formed by the condensation polymerisation is known as condensation polymer. Decron (Terylene) is a condensation polymer. It is formed by the condensation polymerisation of terephthalic acid and ethylene glycol.

74. **(d)** Rayon fibre is chemically identical to cotton but has a shine like silk, rayon is also called a regenerated fibre because during its preparation. Cellulose is regenerated by dissolving it in NaOH and CS_2.

75. **(c)** Adipic acid $(HOOC-(CH_2)_4-COOH)$ and Hexamethylene diamine $(NH_2-(CH_2)_6-NH_2)$

76. **(b)** Average number molecular weight $\overline{M_n}=30,000$

Average mass molecular weight $\overline{M_w}=40,000$

Polydispersity index (PDI) $=\dfrac{\overline{M_w}}{\overline{M_n}}=\dfrac{40,000}{30,000}=1.33$

77. **(a)** 30-Inulin $(C_5H_{10}O_5)_{30}$ is found in the "Roots of Dahaliya".

78. **(a)** $\underset{\text{Tetrafluoro ethane}}{nCF_2=CF_2} \longrightarrow \underset{\text{Teflon}}{[-CF_2-CF_2-]_n}$

79. **(c)** Cellulose forms a transluscent mass on treatment with conc. NaOH which imparts a silky lustre to cotton. This process is mercerisation and the cotton so produced is known as mercerised cotton

80. **(a)** $Al(C_2H_5)_3+TiCl_4$ is Ziegler Natta catalyst.

81. **(c)** *e.g.*- PVC is extremely stiff and hard but the addition of *di-n* butyl phthalate Plasticizers makes it soft and rubber like.

Assertion and Reason

82. **(b)** Hydrogenation or hardening of oil is a process in which various unsaturated radicals of fatty glycerides are converted into more highly or completely saturated glycerides by the addition of hydrogen in the presence of a catalyst, usually finely divided nickel.

83. **(e)** The time of vulcanisation is reduced by adding accelerators and activators.

84. **(c)** Bakelite can be heated only once.

85. **(b)** Due to the presence of strong C–F bonds, teflon has high thermal stability and chemical inertness.

86. **(b)** Vulcanisation is a process of treating natural rubber with sulphur or some compounds of sulphur under heat so as to modify its properties. This cross-linking gives mechanical strength to the rubber.

Comprehension Based

87. **(b)** Na_2SO_3

88. **(c)** $CoZnO_2$

89. **(b)** $ZnSO_4 \cdot 7H_2O$

90. **(b)** $F_2C=CF_3$

91. **(a)** PMMA

92. **(d)**

Match the Column

93. **(a)** A→2, 3; B→3; C→1, 4; D→4

94. **(b)** A→1, B→2, C→5, D→C
Pepsin is a diagestic enzyme, nucleic acid is genetic material, ascorbic acid is vitamin C and testosterone is sex hormone.

95. **(b)** A→3, B→1, C→2, D→4

Integer

96. **(1)** Average number molecular weight $\overline{M}_n = 30,000$

Average mass molecular weight $\overline{M}_w = 40,000$

Polydispersity index (PDI) $= \frac{\overline{M}_w}{\overline{M}_n} = \frac{40,000}{30,000}$

= 1.33 (Approximately 1)

97. **(30)** 30-Inulin () $(C_5H_{10}O_5)_{30}$ is found in the "Roots of Dahaliya".

For 98–99

Let a and b the mole fraction of α- and β-glucose respectively at equilibrium.

Then a + b = 1 . . .(*i*)

However, we know that the specific rations of α-and β-glucose are +112° and + 19° respectively. Thus if the specific rotation of the equilibrium mixture is + 52.7°.

Then at equilibrium 112° a + 19° b = 52.7° . . .(*ii*)

From equation (*i*), b = 1–a

Putting the value of b in equation (*ii*)

112a + 19(1–a) = 52.7

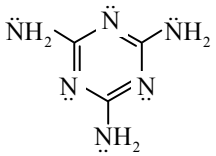
On solving a = 0 a = 0.362 or 36.2% (Approx. 36),

∴ b = 0.638 or 63.8% (Approx. 64)

98. **(36)**

99. **(64)**

100. **(6)** lone pairs



Melamine

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