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CHAPTER NOTES

Polymers Class 12 Notes — CBSE Chemistry Chapter 15

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Polymers Class 12 Notes — CBSE Chemistry Chapter 15

Chapter 15 — **Polymers** — covers the science of macromolecules that form plastics, rubber, fibres, and many biological materials. From PVC pipes to nylon clothing to DNA in your cells, polymers are everywhere! This chapter carries **4-5 marks** in Board exams and is mostly factual — learn the monomers, types of polymerisation, and properties.

Key Concepts

Classification of Polymers

Based on Source

Type	Examples
Natural	Starch, cellulose, proteins, natural rubber, DNA
Semi-synthetic	Cellulose acetate (rayon), cellulose nitrate, vulcanised rubber
Synthetic	Polythene, nylon, PVC, Bakelite, Teflon

Based on Structure

Type	Structure	Properties	Examples
Linear	Long straight chains	High density, high m.p.	HDPE, nylon, polyester
Branched	Linear with side branches	Low density, low m.p.	LDPE, amylopectin, glycogen
Cross-linked (Network)	3D network	Hard, rigid, infusible	Bakelite, melamine, vulcanised rubber

Based on Polymerisation Type

Addition Polymerisation	Condensation Polymerisation
Monomers with C=C double bond	Monomers with two functional groups
No by-product	Small molecule lost (H_2O, HCl, NH_3)
Homopolymer: same monomer	Usually copolymer: 2 different monomers
Examples: PE, PP, PVC, PS, Teflon	Examples: Nylon, Polyester, Bakelite

Based on Molecular Forces (Mechanical Properties)

Type	Forces	Properties	Examples
Elastomers	Weak van der Waals	Elastic, can be stretched	Natural rubber, Buna-S, Neoprene
Fibres	Strong H-bonds	High tensile strength, crystalline	Nylon-66, Terylene, silk
Thermoplastics	Intermediate forces	Soften on heating, can be remoulded	Polythene, PVC, polystyrene
Thermosetting	Covalent cross-links	Hard, rigid, cannot be remoulded	Bakelite, melamine, urea-formaldehyde

Important Polymers — Monomers and Reactions

Addition Polymers

Polythene: $nCH_2=CH_2 \rightarrow (-CH_2-CH_2-)_n$

LDPE: high pressure (1000-2000 atm) + peroxide catalyst → branched, flexible

HDPE: low pressure + Ziegler-Natta catalyst ($TiCl_4 + Al(C_2H_5)_3$) → linear, tough

Polypropylene (PP): $nCH_2=CHCH_3 \rightarrow (-CH_2-CH(CH_3)-)_n$

PVC: $nCH_2=CHCl \rightarrow (-CH_2-CHCl-)_n$ (pipes, cable insulation)

Polystyrene (PS): $nCH_2=CHC_6H_5 \rightarrow (-CH_2-CHC_6H_5-)_n$ (thermocol, toys)

Teflon (PTFE): $nCF_2=CF_2 \rightarrow (-CF_2-CF_2-)_n$ (non-stick cookware)

Polyacrylonitrile (PAN/Orlon): $nCH_2=CHCN \rightarrow (-CH_2-CHCN-)_n$ (synthetic wool)

Rubber

Natural Rubber: Polymer of isoprene (2-methyl-1,3-butadiene)
cis-polyisoprene → elastic

Vulcanisation: Heating rubber with sulphur (3-5%) → cross-links form → harder, more elastic, less sticky. Charles Goodyear discovered this.

Buna-S (SBR): Copolymer of 1,3-butadiene + styrene (synthetic rubber for tyres)
Buna-N (NBR): Copolymer of 1,3-butadiene + acrylonitrile (oil-resistant rubber)
Neoprene: Polymer of chloroprene (2-chloro-1,3-butadiene) — oil/solvent resistant

Condensation Polymers

Nylon-66: Hexamethylenediamine + Adipic acid → $(-NH-(CH_2)_6-NH-CO-(CH_2)_4-CO-)_n + H_2O$
(66 = 6 C in diamine + 6 C in diacid) — used in ropes, fabrics, gears

Nylon-6: Caprolactam (ring-opening polymerisation) → same as polycaprolactam
(6 = 6 C in monomer) — used in tyre cords, textiles

Terylene (PET/Dacron): Ethylene glycol + Terephthalic acid → polyester + H_2O
Used in: PET bottles, polyester fabric, magnetic tapes

Bakelite: Phenol + Formaldehyde (→ Novolac → Bakelite with cross-links)
Thermosetting — used in electrical switches, handles

Melamine-formaldehyde: Melamine + formaldehyde → cross-linked polymer
Used in unbreakable crockery, laminates (Formica)

Biodegradable Polymers

Polymer	Composition	Use
PHBV	3-hydroxybutyrate + 3-hydroxyvalerate	Packaging, orthopaedic implants
Nylon-2-nylon-6	Glycine + aminocaproic acid	Biodegradable alternative

Important Definitions

Term	Definition
Polymer	High molecular mass substance formed by repetition of monomer units
Monomer	Simple molecule that combines to form a polymer
Homopolymer	Polymer made from one type of monomer
Copolymer	Polymer made from two or more different monomers
Vulcanisation	Cross-linking rubber with sulphur to improve properties
Thermoplastic	Polymer that softens on heating and can be remoulded
Thermosetting	Polymer that hardens permanently on heating (cannot be remoulded)

Solved Examples — NCERT Based

Example 1: Identifying Monomers

Q: Write the monomers of: (a) Nylon-66 (b) Terylene (c) Buna-S

Solution:

(a) Nylon-66: **Hexamethylenediamine** ($H_2N–(CH_2)_6–NH_2$) + **Adipic acid** ($HOOC–(CH_2)_4–COOH$)

(b) Terylene: **Ethylene glycol** ($HOCH_2CH_2OH$) + **Terephthalic acid** ($HOOC–C_6H_4–COOH$)

(c) Buna-S: **1,3-Butadiene** ($CH_2=CH–CH=CH_2$) + **Styrene** ($C_6H_5CH=CH_2$)

Example 2: Addition vs Condensation

Q: Classify the following as addition or condensation polymers: PVC, Bakelite, Polythene, Nylon-6.

Solution:

Addition: **PVC** (CH_2=CHCl), **Polythene** (CH_2=CH_2)

Condensation: **Bakelite** (phenol + formaldehyde, loses H_2O), **Nylon-6** (ring-opening of caprolactam — technically addition, but classified as condensation due to amide linkage)

Example 3: Thermoplastic vs Thermosetting

Q: Why can Bakelite not be remoulded but polythene can?

Solution: Bakelite has extensive **cross-links** (covalent bonds between chains) forming a rigid 3D network. Once set, these cross-links cannot be broken by heating → **thermosetting**. Polythene has only weak intermolecular forces between linear chains → softens on heating → can be remoulded → **thermoplastic**.

Example 4: LDPE vs HDPE

Q: How do LDPE and HDPE differ? What causes the difference?

Solution:

LDPE: Made at high pressure with peroxide catalyst → branched chains → low packing → low density (0.92 g/cm³) → flexible, used in packaging films.

HDPE: Made at low pressure with Ziegler-Natta catalyst → linear chains → tight packing → high density (0.97 g/cm³) → tough, rigid, used in pipes and bottles.

Important Questions for Board Exams

1 Mark Questions

1. What is the monomer of Teflon?
2. Name the polymer used in non-stick cookware.

3. What is vulcanisation?
4. What is the difference between a homopolymer and a copolymer?

2 Mark Questions

1. Distinguish between thermoplastic and thermosetting polymers with examples.
2. Write the monomers and one use each of Nylon-66 and Terylene.
3. What is LDPE and HDPE? How do they differ?
4. Name one natural and one synthetic biodegradable polymer.

3 Mark Questions

1. Classify polymers based on structure. Give one example of each type.
2. Explain the preparation and uses of: (a) Bakelite (b) Nylon-66 (c) Buna-S.
3. What is natural rubber? How is it vulcanised? What properties change after vulcanisation?

5 Mark Questions

1. What are polymers? How are they classified based on (a) source (b) polymerisation type (c) molecular forces? Give examples.
2. Write the monomers, polymerisation reactions, and uses of: PVC, Teflon, Nylon-66, Terylene, and Bakelite.

Quick Revision Points

- Addition: C=C monomers, no by-product (PE, PVC, PS, Teflon, PAN)
- Condensation: bifunctional monomers, loses H_2O (Nylon, Polyester, Bakelite)
- Thermoplastic: remould (PE, PVC, PS) | Thermosetting: cannot remould (Bakelite, melamine)
- Elastomers: rubber | Fibres: nylon, terylene (strong H-bonds)
- Natural rubber: cis-polyisoprene | Vulcanisation: + S → cross-linked
- Nylon-66: hexamethylenediamine + adipic acid | Nylon-6: caprolactam
- Terylene (PET): ethylene glycol + terephthalic acid
- LDPE: branched, flexible | HDPE: linear, rigid (Ziegler-Natta catalyst)
- Bakelite: phenol + formaldehyde → cross-linked thermosetting
- Teflon: PTFE → $(–CF_2–CF_2–)_n$ → non-stick, chemically inert