SAMPLE CONTENT

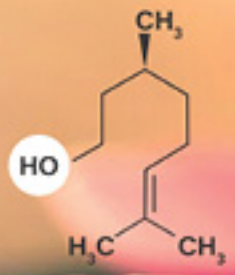
Precise

CHEMISTRY - II

STD. XII Sci.

Citronellol

Citronellol, present in rose oil, contains alcoholic (−OH) functional group and is widely used in perfume & fragrance industry.



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Precise
Chemistry – II
STD. XII Sci.

Salient Features

- Concise coverage of syllabus in Question Answer Format.
- Covers answers to all Textual Questions and Intext Questions.
- Includes solved Board Questions from 2013 to 2018.
- Includes Board Question Papers of 2017 and 2018.
- Quick Review for instant revision and summary of the chapter.
- Exercise, Multiple Choice Questions and Topic Test at the end of each chapter for effective preparation.

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Preface

In the case of good books, the point is not how many of them you can get through, but rather how many can get through to you.

"Std. XII Sci. : PRECISE CHEMISTRY - II" is a compact yet complete guide designed to boost students' confidence and prepare them to face the conspicuous Std. XII final exam.

This book is specifically aimed at Maharashtra Board students. The content of the book is framed in accordance with Maharashtra State board syllabus and collates each and every important concept in question and answer format. This book has been developed on certain key features as detailed below:

- Sub-topic wise classified **Question and Answer** format of the book provides students with appropriate answers for all textual and intext questions. We've also included few additional questions to ensure complete coverage of every concept.
- **Solutions to Board Questions** along with marking scheme (wherever relevant) have been included.
- **Notes** cover additional bits of relevant information on each topic.
- **Quick Review** facilitates instant revision at a glance.
- **Exercise** helps the students to gain insight on the various levels of theory and numerical-based questions.
- **Multiple Choice Questions** and **Topic Test** assess the students on their range of preparation and the amount of knowledge of each topic.

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

Please write to us at : mail@targetpublications.org

A book affects eternity; one can never tell where its influence stops.

Best of luck to all the aspirants!

Yours faithfully,
Publisher

Edition: Second

PAPER PATTERN

- There will be one single paper of 70 Marks in Chemistry.
- Duration of the paper will be 3 hours.

Section A: **(8 Marks)**

This section will contain Multiple Choice Questions and Very Short Answer (VSA) type of questions.

There will be 4 MCQs and 4 VSA type of questions, each carrying one mark.

Students will have to attempt all these questions.

Section B: **(14 Marks)**

This section will contain 7 Short Answer (SA-I) type of questions, each carrying 2 marks.

Internal choice is provided for only one question.

Section C: **(33 Marks)**

This section will contain 11 Short Answer (SA-II) type of questions, each carrying 3 marks.

Internal choice is provided for only one question.

Section D: **(15 Marks)**

This section will contain 3 Long Answer (LA) type of questions, each carrying 5 marks.

Internal choice is provided for each question.

Distribution of Marks According to Type of Questions

Type of Questions		
MCQ	1 Mark each	4 Marks
VSA	1 Mark each	4 Marks
SA I	2 Marks each	14 Marks
SA II	3 Marks each	33 Marks
LA	5 Marks each	15 Marks

Index

'Chapters 1 to 7 are a part of Std. XII: Precise Chemistry - I'

Note: All the Textual questions are represented by * mark.
All the Intext questions are represented by # mark.

15 Polymers

Subtopics

15.1 Introduction

Q.1. Explain the terms polymer and monomer. **(NCERT)**

Ans: i. ***Polymers*** *are high molecular mass substances consisting of large number of repeating structural units derived from simple molecules.* **OR**

Polymers *are macromolecules having high molecular weights and composed of smaller repeating units called monomers.*

(In Greek, 'poly' means 'many' and 'meros' means 'parts' or 'units').

eg. Polythene, nylon-6, carbohydrates, proteins, etc.

ii. *The simple molecules which combine to give polymers are called* ***monomers****.*

eg.

No.	Polymer	Monomer
a.	Polythene	Ethene
b.	Polystyrene	Styrene
c.	Polyvinyl chloride	Vinyl chloride

Q.2. Define the term polymerization. **(NCERT)**

Ans: *The process by which the simple molecules (i.e., monomers) are converted into polymers is called* ***polymerization****.* **OR**

Process of synthesizing polymers is called ***polymerization****.*

i.e., monomer $\xrightarrow{\text{Polymerization}}$ polymer

eg. Transformation of ethene to polythene.

15.2 Classification

***Q.3. What are the different ways of classification of polymers?**

Ans: Polymers are classified in a number of ways as mentioned below:

i. Classification based on source
ii. Classification based on structure of polymers
iii. Classification based on polymerization process
iv. Classification based on molecular forces
v. Classification based on growth polymerization

15.2.1 Classification based on source

Q.4. How are polymers classified on the basis of source?

Ans: On the basis of source, polymers are classified into the following categories:

i. Natural polymers: *The polymers obtained from nature (plants and animals) are called* ***natural polymers.*** *They are called plant polymers and animal polymers.*

eg. Natural rubber, wool, silk, starch, cellulose, jute, linen, etc.

ii. Semi-synthetic polymers: *The properties of natural polymers such as appearance, tensile strength, lustre, etc are modified by some chemical treatment, to obtain semi-synthetic polymer.*

eg. Acetate rayon, viscose rayon, cuprammonium silk, etc.

iii. Synthetic polymers: *The polymers which are synthesized in the laboratories or in the industries are called* ***synthetic polymers*** *or* ***man-made polymers****.*

eg. Plastic (polythene, PVC), synthetic fibres (polyester, nylon-6,6), synthetic rubber (neoprene, Buna-S), terylene, etc.

15.2.2 Classification based on structure of polymer

Q.5. How are polymers classified on the basis of structure? (NCERT)

Ans: On the basis of structure, polymers are divided into three types.

i. Linear polymers ii. Branched polymers iii. Network or cross linked polymers

***Q.6. What are branched and linear polymers? How are cross linked polymers formed?**

Ans: i. Linear polymers: *They are made up of long continuous chains without any excess attachments (branches). The repeating units are joined together to form a long chain.*

These are well packed and therefore, have high densities, high tensile strength and high melting points.

eg. Polythene, PVC.

a. $n\ CH_2 \parallel CH_2$ (Ethene, Monomer) $\xrightarrow{\text{Polymerization}} -CH_2-CH_2- \longrightarrow \left[CH_2-CH_2\right]_n$ (Repeating unit; Polythene)

b. $nCH_2=CH-Cl \xrightarrow{\text{Polymerization}} -CH_2-\underset{Cl}{CH}- \longrightarrow \left[CH_2-\underset{Cl}{CH}\right]_n$

(Vinyl chloride (Monomer); Repeating unit; PVC)

ii. Branched polymer: *These polymers consist of chain structure having one main chain of molecules with smaller chains as branches of main chain.*

These are irregularly packed and therefore have low density, low tensile strength and low melting points than those of linear polymers.

eg. Polypropylene having methyl groups as branches.

$$nCH_3-CH=CH_2 \xrightarrow{\text{Polymerization}} -\underset{CH_3}{CH}-CH_2- \longrightarrow \left[\underset{CH_3}{CH}-CH_2\right]_n$$

(Propylene; Repeating unit; Polypropylene)

iii. Network or cross linked polymers: *Linking of chain polymers by strong covalent bonds leads to network – like structure. They are also called cross-linked structure due to cross linking.*

They form a three dimensional network. These polymers are hard, rigid and brittle because of the network structure.

eg. Bakelite, melamine-formaldehyde resin, vulcanised rubber, etc.

Vulcanised rubber is formed by the vulcanisation of cis-1,4-polyisoprene chain.

***Q.7. Classify the following as linear, branched or cross linked polymers.**
i. Bakelite ii. Starch iii. Polythene iv. Nylon

Ans: i. Linear Polymer: Nylon, Polythene
ii. Branched Polymer: Starch
iii. Cross-linked polymer: Bakelite

15.2.3 Classification based on polymerization process

Q.8. How are polymers classified on the basis of polymerization process? [Oct 13]

Ans: On the basis of mode of polymerization, polymers are classified into the following groups:

i. Addition polymers: *The monomers, in case of the addition polymers, are alkenes or their derivatives and the polymers are formed by chain growth polymerization. The addition polymers contain all the atoms of monomers.*

eg. Orlon, Teflon, PVC, Polythene, etc. *[Definition + Any one example – **1 Mark**]*

a. $n\ CH_2 = \underset{\displaystyle CN}{\underset{|}{CH}} \xrightarrow{\text{Polymerization}} -CH_2-\underset{\displaystyle CN}{\underset{|}{CH}}- \longrightarrow \left[CH_2-\underset{\displaystyle CN}{\underset{|}{CH}}\right]_n$

Vinyl cyanide (Monomer) — Repeating unit — Orlon (Polyacrylonitrile)

b. $n\ CF_2 = CF_2 \xrightarrow{\text{Polymerization}} -CF_2-CF_2- \longrightarrow \left[CF_2-CF_2\right]_n$

Tetrafluoroethylene (Monomer) — Repeating unit — Teflon

ii. Condensation polymers: *These polymers are formed by combination of two monomers by elimination of a small molecule like water or methyl alcohol.* These polymers contains esters or amide linkages. The polymerization occurs in a stepwise manner and forms dimers, tetramers ..... and so on.
eg. polyesters, polyamides (nylons), polyurethanes, etc. *[Definition + Any one example – **1 Mark**]*

$$n\ HO-CH_2-CH_2-OH + n\ H_3C-O-\underset{\displaystyle O}{\underset{\|}{C}}-C_6H_4-\underset{\displaystyle O}{\underset{\|}{C}}-O-CH_3 \xrightarrow[-CH_3OH]{\text{Catalyst},\Delta}$$

Ethylene glycol — DMT (Dimethylterephthalate)

$$\left[O-CH_2-CH_2-O-\underset{\displaystyle O}{\underset{\|}{C}}-C_6H_4-\underset{\displaystyle O}{\underset{\|}{C}}\right] \xrightarrow[\Delta]{\text{Polymerisation}} \left[O-CH_2-CH_2-O-\underset{\displaystyle O}{\underset{\|}{C}}-C_6H_4-\underset{\displaystyle O}{\underset{\|}{C}}\right]_n$$

Repeating unit — Polyester

***Q.9. Explain the following terms:**
i. Condensation polymer. ii. Addition polymer.

Ans: i. *Refer Q.8.ii.* ii. *Refer Q.8.i.*

#Q.10. Classify the polymers given below as addition and condensation polymers:
PVC, polythene, polyester, polyacrylonitrile, polystyrene.

Ans: i. Addition polymers: PVC, polythene, polyacrylonitrile, polystyrene.
ii. Condensation polymers: polyester.

15.2.4 Classification based on molecular forces

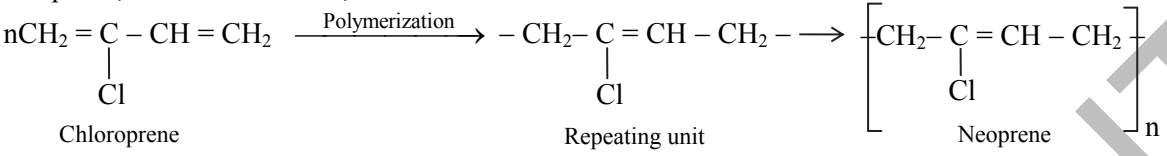
Q.11. How are the polymers classified on the basis of molecular forces? (NCERT)

Ans: On the basis of molecular forces, the polymers are classified into following classes.
i. Elastomers ii. Fibres iii. Thermoplastic polymers iv. Thermosetting polymers

Q.12. Write a note on elastomers. OR
What are elastomers? [July 18]

Ans: i. *The polymers that have elastic character like that of rubber are called **elastomers**.*
ii. When a small stress is applied the polymer chains get easily stretched. During stretching, polymers do not tear as cross linking is present.

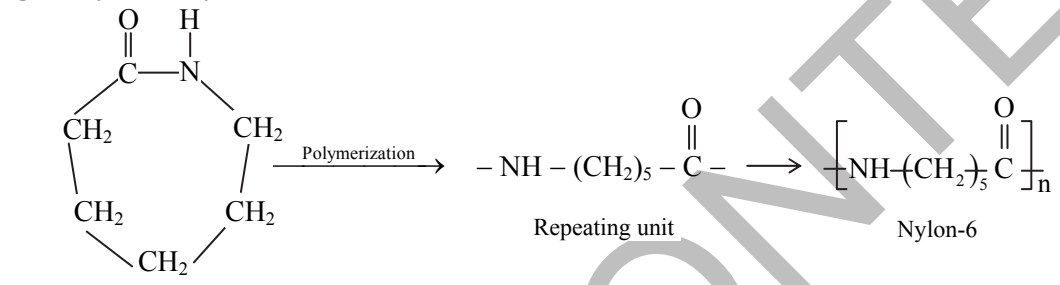
iii. When the stress is removed, the polymer chains regain the original shape. This property is known as elasticity.
iv. Elastomers are soft and stretchy. They are used for making rubber bands.
eg. Neoprene, vulcanized rubber, etc.



Chloroprene — Repeating unit — Neoprene

Q.13. Write a note on fibres.

Ans: i. ***Fibres*** *are the thread-forming solids which possess high tensile strength and are used in textile industries.*
ii. The strong intermolecular forces between the chains (which lead to close packing of chains) are hydrogen bonds.
eg. Nylon, Terylene, etc.



∈-Caprolactum (monomer) — Repeating unit — Nylon-6

iii. Nylon fibres contain hydrogen bond between –NH group of one chain and $-\overset{|}{C}=O$ group of another chain. Thus, amide linkages are involved in hydrogen bonding.

Q.14. What are thermoplastic polymers? **[Mar 14]**

Ans: i. ***Thermoplastic polymers*** *are the linear or slightly branched long chain molecules capable of softening on heating and hardening on cooling.*
ii. These polymers are intermediate between elastomers and fibres. They can be remoulded and recycled.
eg. Polythene, polystyrene, PVC, etc. *[Definition + Any one example – **1 Mark**]*

Q.15. What are thermosetting polymers?

Ans: i. ***Thermosetting polymers*** *are cross linked or heavily branched molecules, which on heating undergo extensive cross linking in moulds and again become infusible.*
ii. On repeated heating under pressure, these polymers do not become soft, hence cannot be remoulded, recycled or reused.
eg. Bakelite, urea-formaldehyde resins, etc.

***Q.16. How do thermosetting polymers differ from thermoplastic polymers? Explain with examples.**

OR

Distinguish between thermoplastic polymers and thermosetting polymers. **[July 18]**

Ans:

	Thermosetting Polymers	Thermoplastic Polymers
i.	They do not soften on heating under pressure.	They soften on heating and harden on cooling.
ii.	They cannot be remoulded, recycled or reused	These can be remoulded or reshaped.
iii.	These have crosslinked structures.	These have linear structures.
iv.	They are formed by condensation polymerization.	They are formed by addition polymerization.
eg.	Bakelite, urea-formaldehyde resins, etc.	PVC, polythene and polystyrene, etc.

15.2.5 Classification based on growth polymerization

Q.17. What are the methods of polymerization?

Ans: There are two methods of polymerization by which polymers can be prepared.

i. Chain growth polymerization:

a. *In this type of polymerization, the molecules of the same monomer or different monomers add together on a large scale to form polymers.*

b. The monomers used are unsaturated compounds like alkenes, alkadienes and their derivatives.
c. The polymer obtained by this method is known as addition polymer.
d. This mode of polymerization leads to an increase in chain length. Hence, it is known as chain growth polymerization.
e. Chain growth can take place through initiator such as free radical or ionic species.
eg. Polythene, polyacrylonitrile, teflon.

ii. Step growth polymerization:

a. *This type of polymerization generally involves a repetitive condensation reaction between two bi-functional monomers*.
b. These poly condensation reactions may result in the loss of some simple molecules as water, alcohol, etc., and lead to the formation of condensation polymers with high molecular mass.
c. The polymer obtained by this method is known as condensation polymer.
d. In these reactions, the product of each step is again a bi-functional species and the sequence of condensation goes on.
e. Since each step produces a distinct functionalized species and is independent of each other, this process is also called as step growth polymerization.
eg. Polyamides (Nylons), polyesters (Terylene), Phenol-formaldehyde polymer (Bakelite), Melamine-formaldehyde polymer.

Q.18. *Differentiate between condensation and addition polymerization. OR
How can you differentiate between addition and condensation polymerization? (NCERT)

Ans:

	Addition Polymerization	Condensation Polymerization
i.	Molecules of the same or different monomers add together on a large scale to form a polymer.	It involves repetitive condensation reaction between two bi-functional monomers.
ii.	Monomers used are unsaturated compounds such as alkenes, alkadienes and their derivatives.	Monomers used are bi-functional compounds.
iii.	There is no elimination in this reaction.	There is loss of some molecules as water, alcohol, etc. in this reaction.
iv.	It gives addition polymers.	It gives condensation polymers.
v.	This is also known as chain growth polymerization.	This is also known as step growth polymerization.
eg.	Polythene, teflon, polyacrylonitrile.	Polyamides, polyesters, bakelite.

***Q.19. Classify the following polymers as step growth or chain growth polymers:**
Terylene, Polyvinyl chloride, Polythene, Nylon-6,6.

Ans: Chain growth polymers: Polyvinyl chloride, Polythene
Step growth polymers: Terylene, Nylon-6,6

15.3 Co-polymerization

Q.20. *Write a note on co-polymerization. OR
Explain the term co-polymerization and give two examples. (NCERT)

Ans: i. ***Co-polymerization*** *is a polymerization reaction in which a mixture of more than one monomeric species is allowed to polymerize and form a copolymer.*
ii. Copolymers are the heteropolymers containing multiple units of each monomer in a chain.
iii. The copolymer can be made not only by chain growth polymerization but also by step growth polymerization. It contains multiple units of each monomer used in the same polymeric chain.
iv. The polymers of required and desired properties can be obtained by the combination of three or more monomers.

eg. a. ABS plastic is obtained by the combination of three or more monomers, acrylonitrile (A), butadiene (B) and styrene (S). It is tough and strong. Articles which withstand heavy impact are prepared from ABS plastic.
b. The polymer saran is obtained from combination of two monomers, vinylidene chloride and vinyl chloride. It is used as a film for wrapping food.

Q.21. Explain the term heteropolymer.

Ans: *The polymers made from two or more monomeric species (of different kind) are known as* ***heteropolymers.***

eg. Buna-S, Buna-N, terylene, nylon-6,6, etc.

***Q.22. Explain the following terms:**

i. Copolymer **ii. Homopolymer [Mar 13, 17]**

Ans: i. Copolymer: *The polymers made by addition polymerization from two different monomers are termed as* ***co-polymers****.*

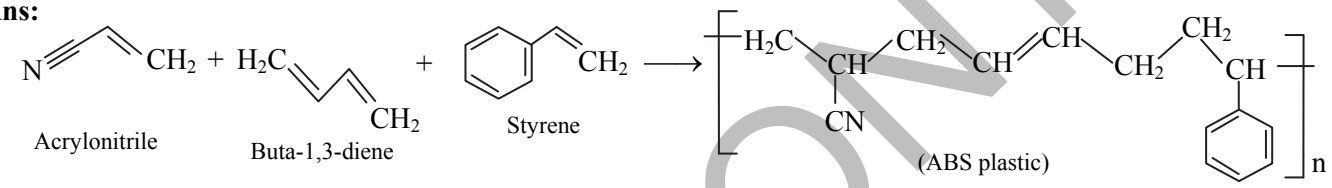
eg. Buna-S, Buna-N, etc.

ii. Homopolymer: *Polymers whose repeating structural units are derived from only one type of monomer units are called* ***homopolymers****.*

eg. Polythene (prepared by using only one type of monomer, i.e., ethene), PVC (monomer: vinyl chloride), Polystyrene (monomer: styrene), etc. *[Definition + Any one example – **1 Mark**]*

***Q.23. A polymer contains three monomers: acrylonitrile, butadiene and styrene. Predict the structure of this ABS plastic.**

Ans:



Acrylonitrile — Buta-1,3-diene — Styrene — (ABS plastic)

15.4 Chain growth polymerization or addition polymerization

Q.24. Write a note on chain growth polymerization or addition polymerization.

Ans: i. For chain growth polymerization, alkenes are treated with small quantity of initiators.

ii. The reactive end of growing chain adds to the double bond of monomer.

iii. Free radicals, carbocations or carbanions are formed as intermediates and are reactive.

iv. The nature of intermediate formed depends on the type of monomer and initiator.

Q.25. Define initiators. Give two examples of initiators used in free radical polymerization.

Ans: ***Initiators*** *are molecules which undergo decomposition easily to form free radicals which initiate the reaction.*

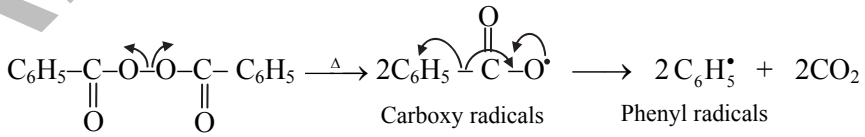
eg. Initiators such as benzoyl peroxide, tert-butyl peroxide, or acetyl peroxide are used in free radical polymerization.

Q.26. *Write the steps involved in the free radical mechanism in polymerization of ethylene. OR Write the free radical mechanism for the polymerization of ethene. (NCERT)

Ans: Addition polymerization proceeds by chain reaction which follows free radical mechanism.

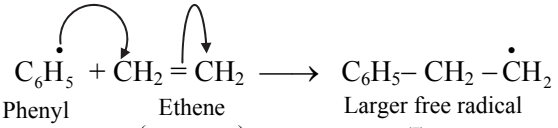
Free radical mechanism involves following steps:

i. Formation of free radicals: Ethene is polymerized by heating it alongwith benzoyl peroxide. Benzoyl peroxide breaks to form two carboxy radicals. This is followed by the decarboxylation of carboxy radicals to obtain phenyl radicals.



Benzoyl peroxide (catalyst) — Carboxy radicals — Phenyl radicals

ii. Chain initiating step: The addition of ethene to phenyl radicals results in the formation of larger free radical.



Phenyl radical — Ethene (monomer) — Larger free radical (I)

iii. Chain propagating step: The radical (I) produced in 2nd step reacts with another molecule of ethene to form an even bigger sized radical. The repetition of this sequence with new and bigger radicals carries the reaction forward and the step is termed as chain propagating step. During this step, thousands and thousands of ethylene molecules are added.

$$C_6H_5 - CH_2 - \dot{C}H_2 + CH_2 = CH_2 \longrightarrow C_6H_5 - CH_2 - CH_2 - CH_2 - \dot{C}H_2$$

Ethene — Bigger free radical (II)

iv. Chain terminating step: The chain propagating step can be stopped by any of the following methods:

a. The supply of ethene is stopped
b. Impurity such as oxygen is added
c. Two polymer chains are coupled.

This step is called chain terminating step.

$$2C_6H_5\text{-}(CH_2 - CH_2)_n\text{-}CH_2 - \dot{C}H_2 \longrightarrow C_6H_5\text{-}(CH_2-CH_2)_n\text{-}CH_2-CH_2-CH_2-CH_2\text{-}(CH_2-CH_2)_n\text{-}C_6H_5$$

Polythene polymer

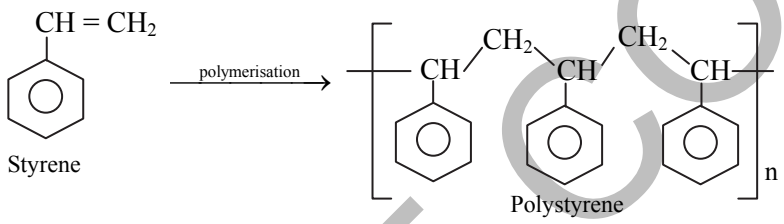
#Q.27. What are the different possibilities in the chain terminating step?

Ans: The different possibilities in the chain terminating steps are:

i. The supply of ethene is stopped
ii. Impurity such as oxygen is added
iii. Two polymer chains are coupled.

#Q.28. In polystyrene, there are phenyl groups on every other carbon atom instead at random, explain.

Ans:



Styrene — Polystyrene

As polystyrene is a linear polymer obtained from addition polymerization of styrene, phenyl groups are present at regular intervals.

***Q.29. Write the structure of monomers used in the preparation of following:**

#i. $$\left[O - CH_2 - CH_2 - CH_2 - \underset{\displaystyle H}{\overset{|}{N}} - \underset{\displaystyle O}{\overset{\|}{C}}\right]_n$$

Note: The structure given in textbook exercise is modified as methanol is formed by the combination of methoxy group of ester and hydrogen from alcohol.

ii. $$\left[O - CH_2 - CH_2 - CH_2 - CH_2 - O - \underset{\displaystyle O}{\overset{\|}{C}} - C_6H_4 - \underset{\displaystyle O}{\overset{\|}{C}}\right]_n$$

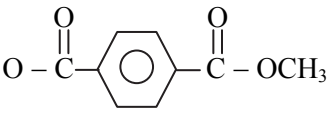
Note: The structure given in textbook exercise is modified as methanol is formed by the combination of –H group from alcohol and $-OCH_3$ from ester.

#iii. $$\left[(CH_2)_9 - \underset{\displaystyle H}{\overset{|}{N}} - \underset{\displaystyle O}{\overset{\|}{C}} - \underset{\displaystyle H}{\overset{|}{N}}\right]_n$$

#iv. $$\left[CH_2 - \underset{\displaystyle Cl}{\overset{|}{C}} = CH - CH_2\right]_n$$

Ans: i. $HO - CH_2 - CH_2 - CH_2 - OH$ and $H_2N - \overset{\displaystyle O}{\overset{\|}{C}} - OCH_3$

Propane-1,3-diol — Methyl carbamate

ii. $HO - CH_2 - CH_2 - CH_2 - CH_2 - OH$ and 

Butane-1,4-diol

Dimethyl terephthalate

iii. $HO - (CH_2)_9 - OH$ and $H_2N - \overset{\overset{O}{\|}}{C} - NH_2$

Nonane-1,9-diol Diamino methanal (urea)

iv. $CH_2 = CH - CCl = CH_2$

Chloroprene

15.5 Preparation of some addition polymers

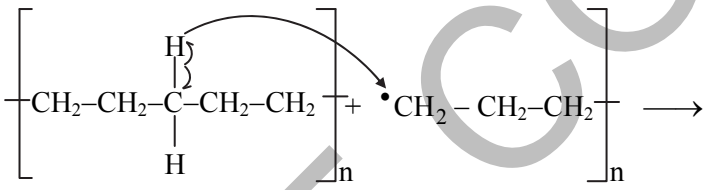
Q.30. How is low density polymer (LDPE) prepared?

Ans: The low density polymer (LDPE) is the addition polymer made from the monomer ethene.

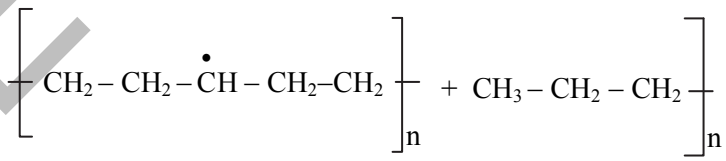
Preparation:

i. Ethene is heated at 200 °C to 300 °C at a pressure of 1000 atm. A small amount of oxygen is used as catalyst. A peroxide is formed from oxygen. This initiates the reaction.

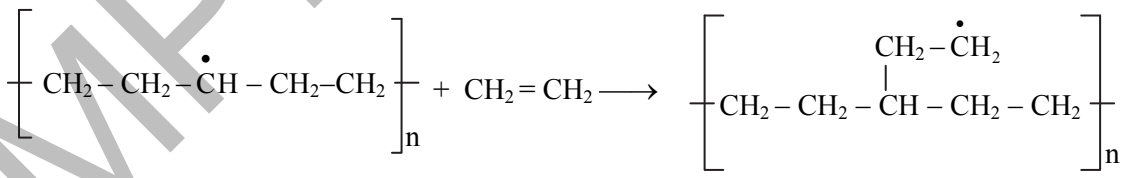
ii. LDPE is a branched polymer. Branching occurs when the growing chain abstracts hydrogen atom from the middle of the chain. This results in the formation of 2° free radical from 1° free radical. The newly formed 2° free radical adds ethene. In this way the branch grows.



Growing end of chain



2° free radical chain Terminated chain



Q.31. Mention the properties and uses of low density polymer (LDPE).

Ans: i. Properties of LDPE:

a. LDPE is a low melting polymer.

b. It is chemically inert and tough but mechanically weak and is a poor conductor of electricity.

ii. Uses of LDPE:

a. It is widely used as a packaging material in the form of thin plastic films, bags etc.

b. It is used as insulation for electrical wires and cables.

c. It is used in manufacturing of toys and flexible pipes.

Q.32. How is high density polymer (HDPE) prepared?

Ans: The high density polymer (HDPE) is the addition polymer made from the monomer ethene. HDPE is the abbreviation for high density polyethylene.

Preparation:

i. Ethene is heated at 100 °C at a pressure of 6 to 7 atm. Zieglar-Natta catalyst is used during the process.
ii. Zieglar-Natta catalyst is titanium chloride and triethyl aluminium [$TiCl_4 + (C_2H_5)_3Al$].
iii. Initially a titanium complex is formed from ethylene and titanium chloride. Hence, HDPE is known as co-ordination polymer.

Q.33. Mention the properties and uses of high density polymer (HDPE).

Ans: Properties of HDPE:

i. HDPE is a high melting polymer having high density.
ii. It is a translucent polymer.
iii. It is chemically inert but has greater toughness, hardness and tensile strength than low density polythene.

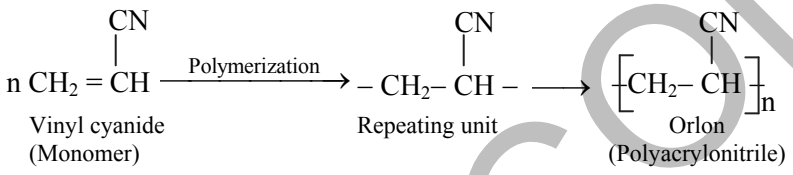
Uses of HDPE:

It is used in the manufacture of containers (buckets, bottles, drums etc), housewares, pipes, toys, etc.

Q.34. How is polyacrylonitrile (PAN) prepared? Mention its application/uses.

Ans: Preparation:

i. Polyacrylonitrile (PAN) is the addition polymer made from the monomer acrylonitrile.
ii. The commercial name of PAN is orlon or acrilan.
iii. It is prepared by the addition polymerization of acrylonitrile. A peroxide catalyst is used during the process.

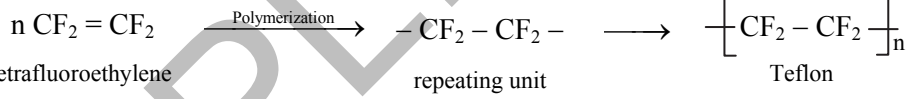


Uses: PAN is used,

i. as an artificial wool in making blankets, sweaters, bathing suits, etc.
ii. for making synthetic carpets.

Q.35. How is polytetrafluoroethylene (Teflon) prepared? Mention its uses.

Ans: Preparation: Teflon is the addition polymer made from the monomer tetrafluoroethylene. Tetrafluoroethylene is heated under high pressure in presence of oxygen (which acts as a catalyst) to form Teflon.



Teflon is chemically inert. It has excellent toughness. It is not attacked by corrosive reagents.

Uses:

i. Oil seals of gaskets and valves are made from teflon.
ii. The non-stick coating on cooking utensils is made from teflon.

#Q.36. Saran is crystalline but PVC is amorphous, even though both are formed by free radical mechanism. Explain.

Ans: i. In Saran [Poly (vinylidene chloride)], the molecules arrange in regular pattern due to steric effect of two chlorine atoms above and below the plane. Hence, it exists as crystalline form.
ii. While in PVC, due to one chlorine atom, polymer molecules become entangled, lose their regular pattern to give amorphous form.

15.6 Step growth polymerization or condensation polymerization

Q.37. Write a note on step growth polymerization or condensation polymerization.

Ans: i. The combination of two or more monomers with elimination of simple molecules (such as water or methyl alcohol) gives step growth polymers or condensation polymers.
ii. Monomers used in the polymerization process have bifunctional groups.

iii. The product of first step also has two functional groups so that it can continue the growth of chain. Thus, the condensation sequence goes on.

iv. The polymerization process is step growth polymerization

eg. Nylons (polyamide fibers), terylene (polyester fibers), etc.

15.7 Preparation of some step growth polymers

***Q.38. How is Nylon-6,6 prepared? [Mar 13 old course; Oct 14, Mar 17]**

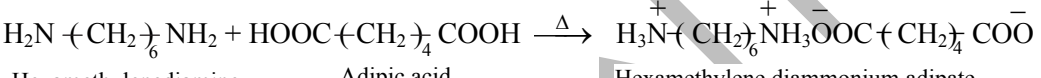
Ans: i. Nylon-6,6 is a linear polyamide, condensation polymer.

ii. It is prepared by the condensation polymerization of hexamethylenediamine with adipic acid under high pressure and at high temperature.

iii. Equimolar aqueous solutions of both monomers are mixed. Nylon salt is formed by neutralization.

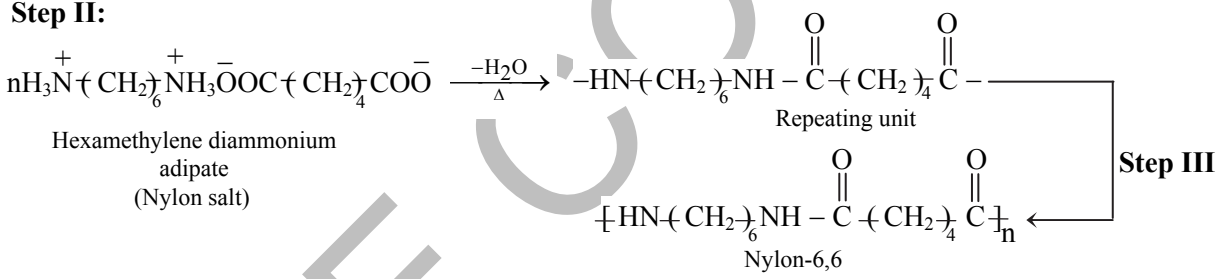
iv. The step growth condensation of the nylon salt with elimination of water molecule gives nylon-6,6 polymer.

Step I:



*[Formation of nylon salt – **1 Mark**]*

Step II:



*[Formation of polymer – **1 Mark**]*

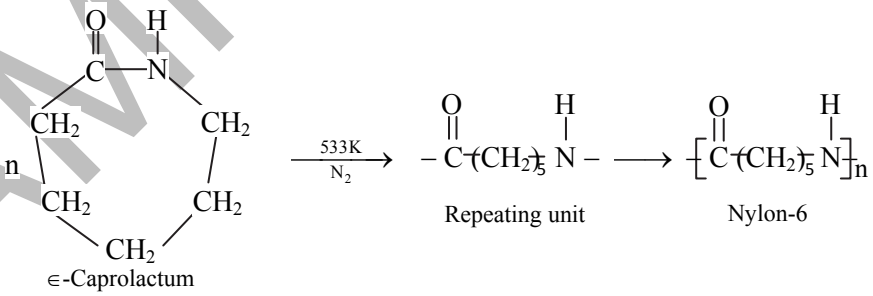
Q.39. How is Nylon-6 prepared?

Ans: Preparation of Nylon-6:

i. It is a polyamide, condensation polymer.

ii. It is obtained by heating ∈-Caprolactum at a high temperature (533 K) in an inert atmosphere.

iii. Nylon-6 is also known by a name perlon.



Q.40. What are the properties of Nylon-6?

Ans: Properties of Nylon-6:

i. Nylons are crystalline polymers, beautiful and take up bright colours.

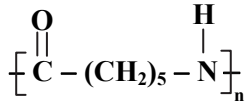
ii. They do not dissolve in hydrocarbon solvent.

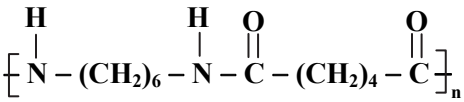
iii. They show resistance to dilute acids and bases.

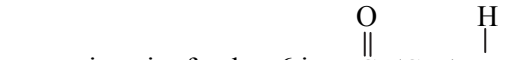
iv. They have good tensile strength.

Q.41. What are the monomeric repeating units of nylon-6 and nylon-6,6? (NCERT) OR

Write the name of monomers of the following polymers: (NCERT)

i. 

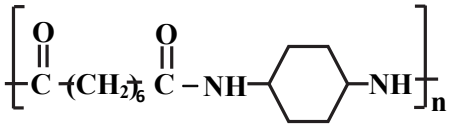
ii. 

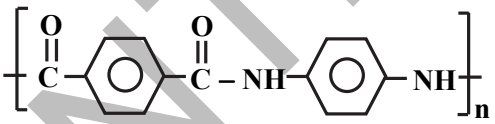
Ans: i. The monomeric unit of nylon-6 is  which is derived from ∈ – caprolactum.

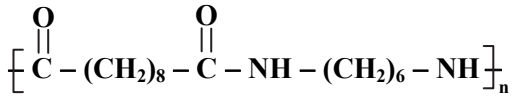
ii. The monomeric unit of nylon-6,6 is derived from two monomers, hexamethylenediamine and adipic acid having the following structure:

Hexamethylenediamine Adipic acid

Q.42. What are the monomers used to prepare nylons given below?

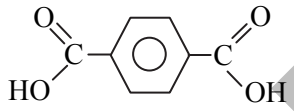
#i. 

#ii. 

iii.  **(NCERT)**

Ans: i.  and 

1,8-Octanedioic acid Cyclohexane-1,4-diamine

ii.  and 

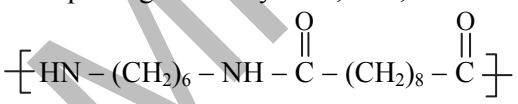
Benzene-1,4-dicarboxylic acid Benzene-1,4-diamine

iii. 

1,10-Decanedioic acid Hexamethylenediamine

#Q.43. Draw the structure of repeating unit in nylon-6,10.

Ans: The repeating unit in nylon-6,10 is,



Q.44. State the significance of numbers 6 and 6,6 in the polymer nylon-6 and nylon-6,6.

Ans: i. Nylon-6 means that it is a condensation polymer of only one type of monomer molecules containing six carbon atoms, i.e., caprolactum.

ii. Nylon-6,6 on the other hand, implies that it is a condensation polymer of two types of monomer molecules each containing six carbon atoms, i.e., adipic acid [$HOOC\text{-}(CH_2)_4\text{-}COOH$] and hexamethylenediamine [$H_2N\text{-}(CH_2)_6\text{-}NH_2$].

Q.45. Mention the uses of nylon.

Ans: Nylons are:

i. used in making bristles for brushes, fishing nets, bed covers, toys, and in textile industry.
ii. blended with wool to make socks and sweaters.
iii. used in the manufacture of cords and climbing ropes.
iv. also used in making scrubbers, sarees, shirts, paints and coating in industry.

Q.46. Define polyesters.

Ans: *Polymers which have ester linkages are called* ***polyesters****.*

They are prepared by the condensation polymerization of diacids with diols.

eg. Dacron or terylene

Q.47. *How is terylene prepared? [July 17] OR

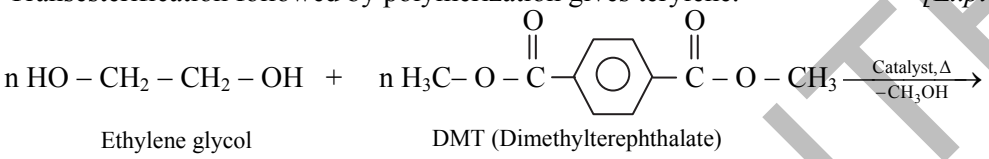
How is dacron obtained from ethylene glycol and terephthalic acid? (NCERT)

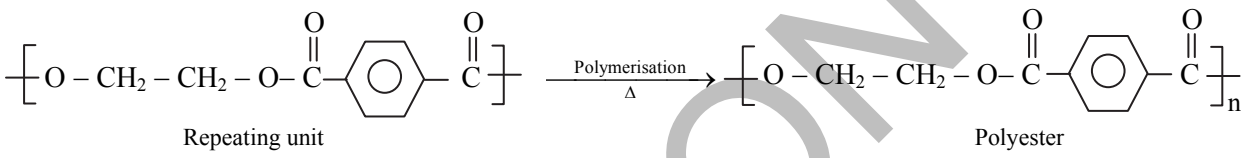
Ans: i. Dacron (Terylene) is a polyester, condensation polymer.

ii. This polymer is obtained by the condensation polymerization of ethylene glycol (1,2-Ethanediol) and dimethylterephthalate.

iii. Monomers are heated at 503 K. The catalyst used is a mixture of zinc acetate and antimony trioxide.

iv. Transesterification followed by polymerization gives terylene. *[Explanation – **1 Mark**]*





*[Formation of terylene – **1 Mark**]*

Note: Dimethylterephthalate is the ester of terephthalic acid with methanol.

Q.48. State the properties of terylene.

Ans: Properties of terylene:

i. Terylene is resistant to heat, crease, chemicals, light, moths, bacteria, etc.

ii. It dry quickly because it absorb very little water. Hence it is durable.

Q.49. State the uses of i. terylene ii. PVC

Ans: i. Uses of terylene:

a. It is used in the manufacture of wash and wear fabrics.

b. It is blended with cotton to form terrycot and with wool to form terrywool. This increases their resistance to wear and tear.

c. It is used in preparation of fishing nets, ropes, trousers, magnetic tape recorders, tyres, etc.

ii. Uses of PVC:

a. It is used for making pipes.

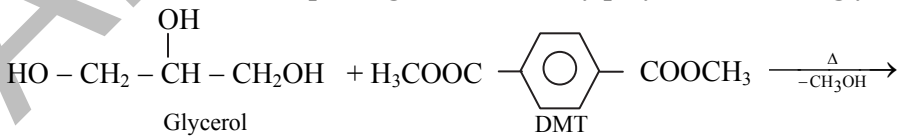
b. It is used as a synthetic leather.

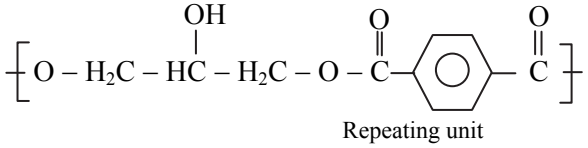
***Q.50.Write the uses of polythene.**

Ans: *Refer Q.31. and Q.33.(Only uses).*

#Q.51. Write the structure of repeating unit formed by polymerization of glycerol and DMT.

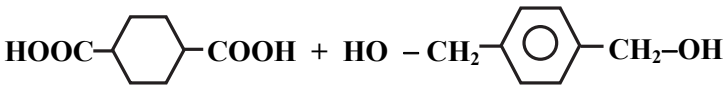
Ans:

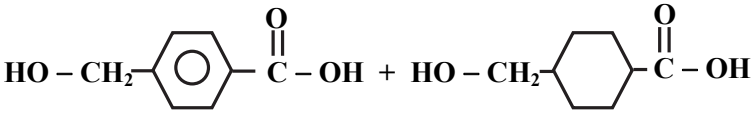


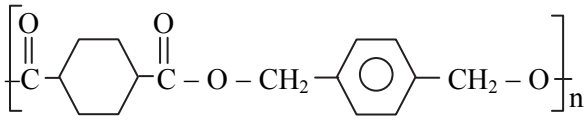
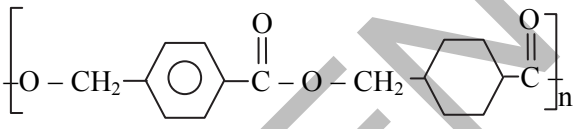


(Structure of only repeating unit is expected in the answer).

#Q.52. Draw the structure of polymers formed using the following monomers:

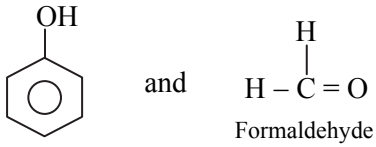
i. 

ii. 

Ans: i.  ii. 

***Q.53. Write name of monomers used in preparing bakelite polymer.** **(NCERT)**

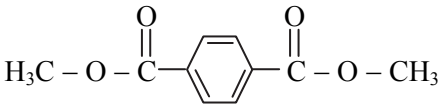
Ans: Bakelite polymer:



Phenol and Formaldehyde

Q.54. Draw the structure of dimethyl terephthalate. **[Mar 13 old course]**

Ans:

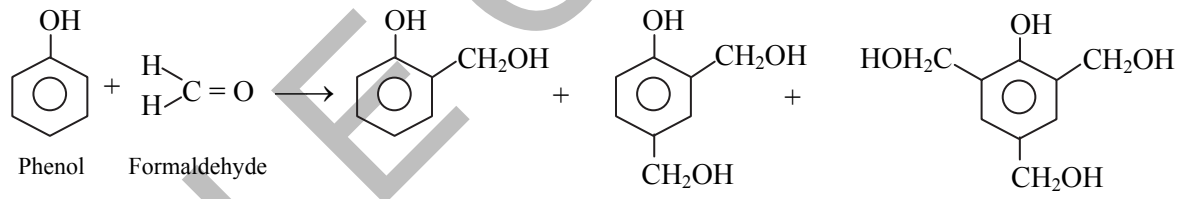


Dimethyl terephthalate (DMT)

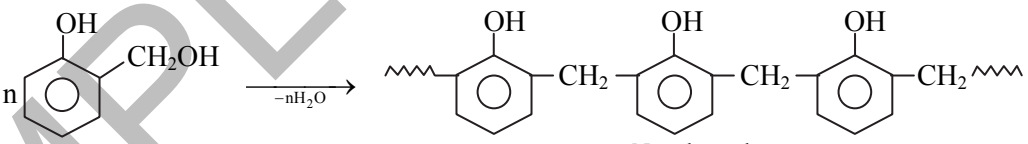
*[Structure – **1 Mark**]*

***Q.55. Write the reaction to prepare Novolac Polymer.** **[Mar 13]**

Ans: Overall reaction for the formation of Novolac can be written as,

Step I: 

Phenol Formaldehyde

Step II: 

Novolac polymer

*[Step I – **1 Mark**, Step II – **1 Mark**]*

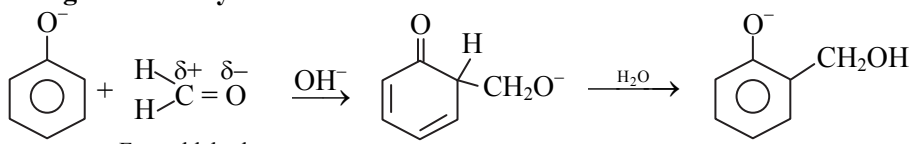
***Q.56. Write the mechanism of polymerization of phenol and formaldehyde using basic and acidic catalyst to prepare bakelite.**

Ans: Bakelite (Phenol-formaldehyde polymer):

i. Bakelite is prepared from the monomers, phenol and formaldehyde.
ii. It is obtained by condensation of phenol with formaldehyde in the presence of either an acid or a base catalyst.
iii. The reaction begins with the formation of o- or p-hydroxymethylphenol derivatives.

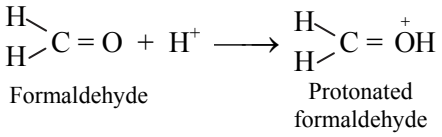
Reaction:

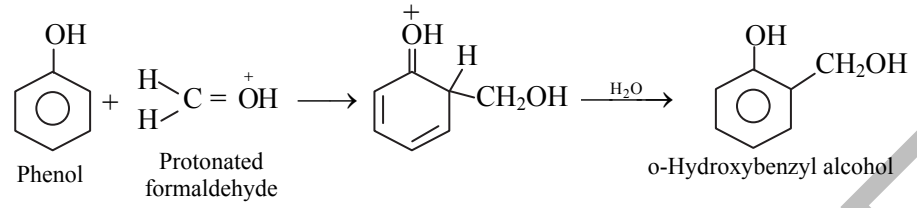
a. Using basic catalyst:



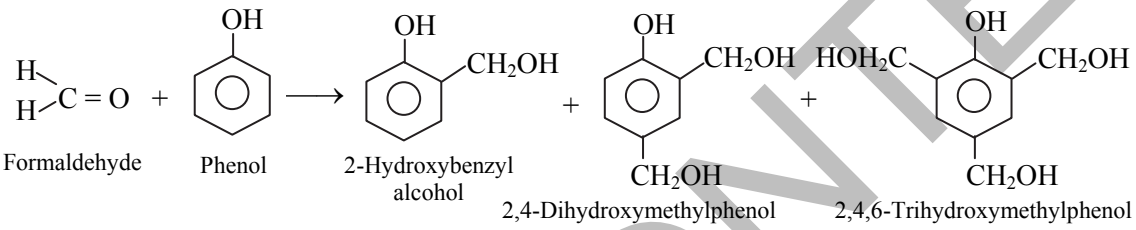
Phenoxide or phenate ion Formaldehyde

b. Using acidic catalyst:

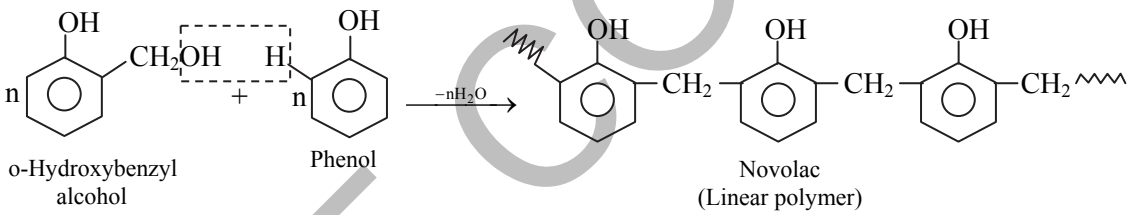




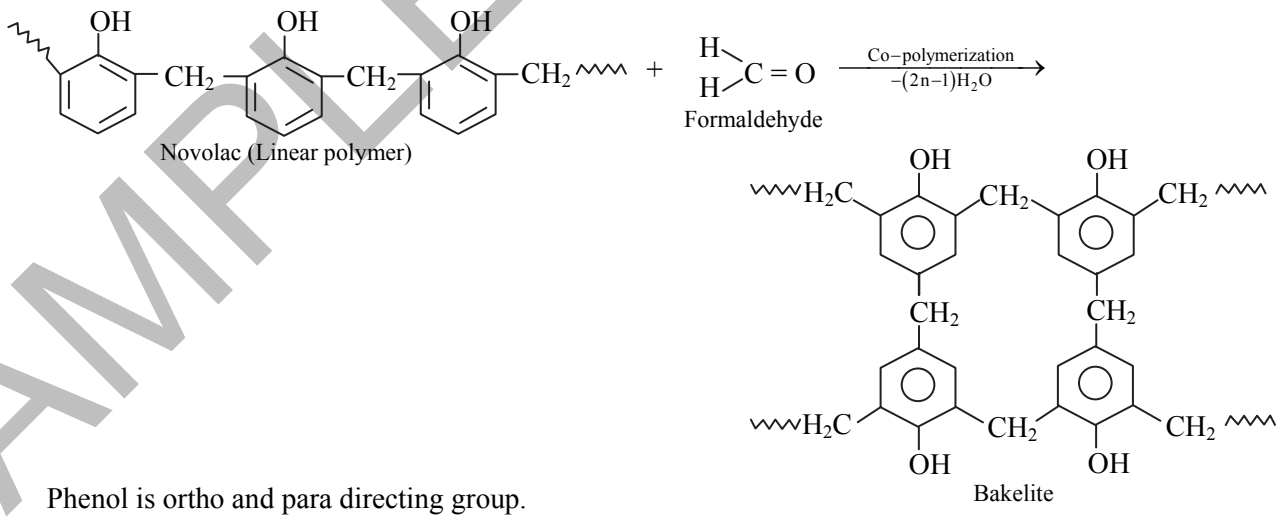
iv. A mixture of derivatives of phenols is obtained as shown below.



v. o-Hydroxybenzyl alcohol or 2-Hydroxy benzyl alcohol reacts with another molecule of phenol to form a linear polymer **novolac** (having two rings joined by – CH_2 – linkage).



vi. Novolac on further heating with the formaldehyde undergoes cross linkage by linking at two ortho and one para positions, to form three dimensional, infusible solid called **bakelite**.



Note: i. Phenol is ortho and para directing group.
ii. Linear polymer novolac is used in paints.

Q.57. What are the uses of bakelite?

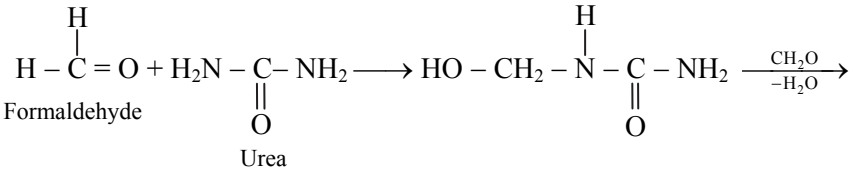
Ans: Uses of bakelite:

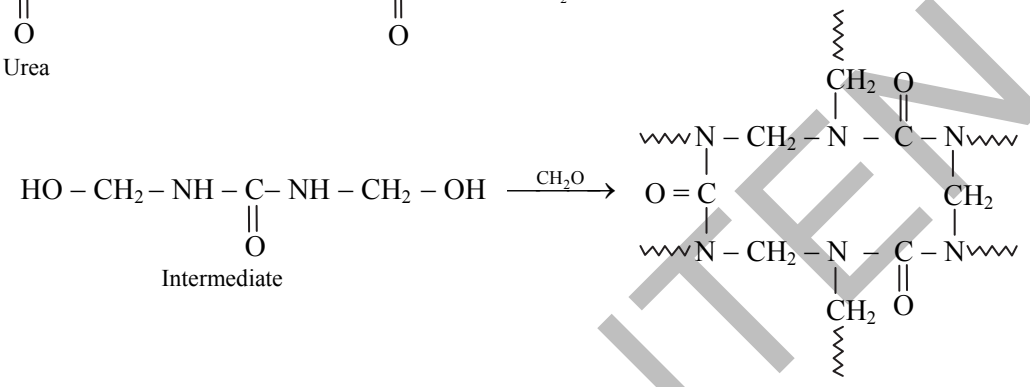
i. Low degree polymerization gives soft bakelites which are used for making glue for binding laminated wooden planks and in varnishes.

ii. High degree polymerization gives hard bakelites which are used in the making of electrical switches, plugs, fountain pens, phonograph records, handles of cooker, frying pans, combs, etc.

Q.58. How is urea formaldehyde polymer prepared from formaldehyde and urea?

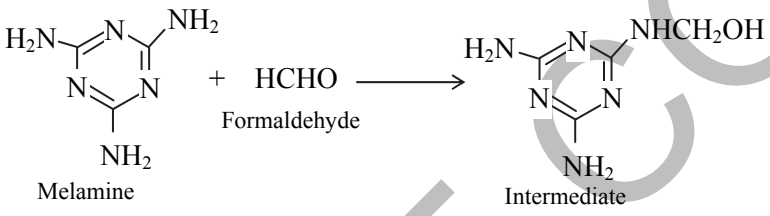
Ans: **Urea formaldehyde polymer:** Urea and formaldehyde undergo condensation polymerization to form urea formaldehyde polymer.

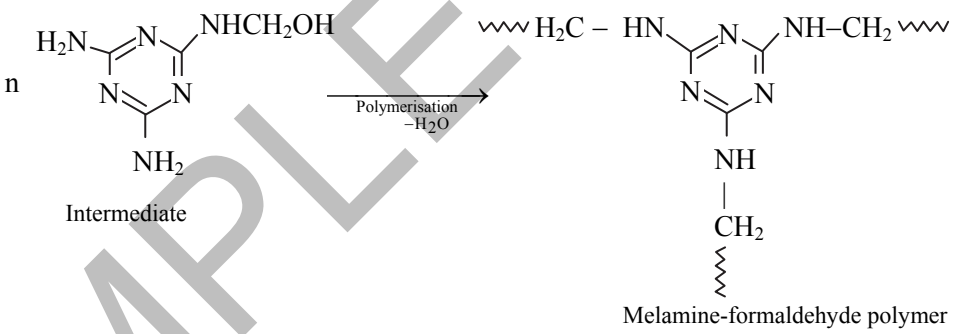




Q.59. How is melamine-formaldehyde polymer prepared?

Ans: Melamine-formaldehyde polymer is a condensation polymer and is prepared by the condensation polymerization of melamine and formaldehyde.





Q.60. Mention the uses of urea-formaldehyde polymer and melamine-formaldehyde polymer.

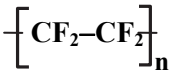
Ans: i. Urea formaldehyde polymer is used as a moulded plastic.

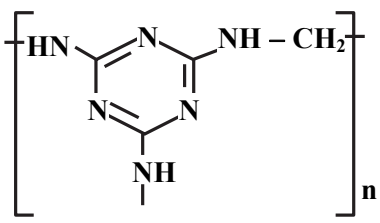
ii. Melamine-formaldehyde polymer is used in the manufacture of crockeries.

***Q.61. Write the uses of melamine.**

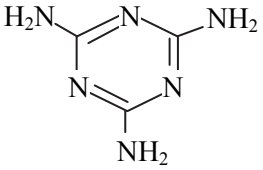
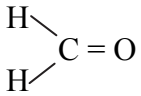
Ans: **Melamine:** It is one of the monomers used for the preparation of melamine-formaldehyde polymer.

Q.62. Write the names of monomers of the following polymers: **(NCERT)**

i. 

ii. 

Ans: i. Tetrafluoroethylene, $CF_2=CF_2$

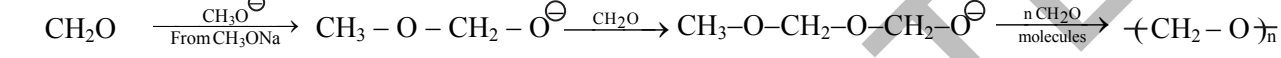
ii.  and 

Melamine
(2,4,6-Triamino-1,3,5-triazine)

Formaldehyde

***Q.63. Formaldehyde polymerises by the action of a strong base sodium methoxide. Suggest the mechanism of its polymerization.**

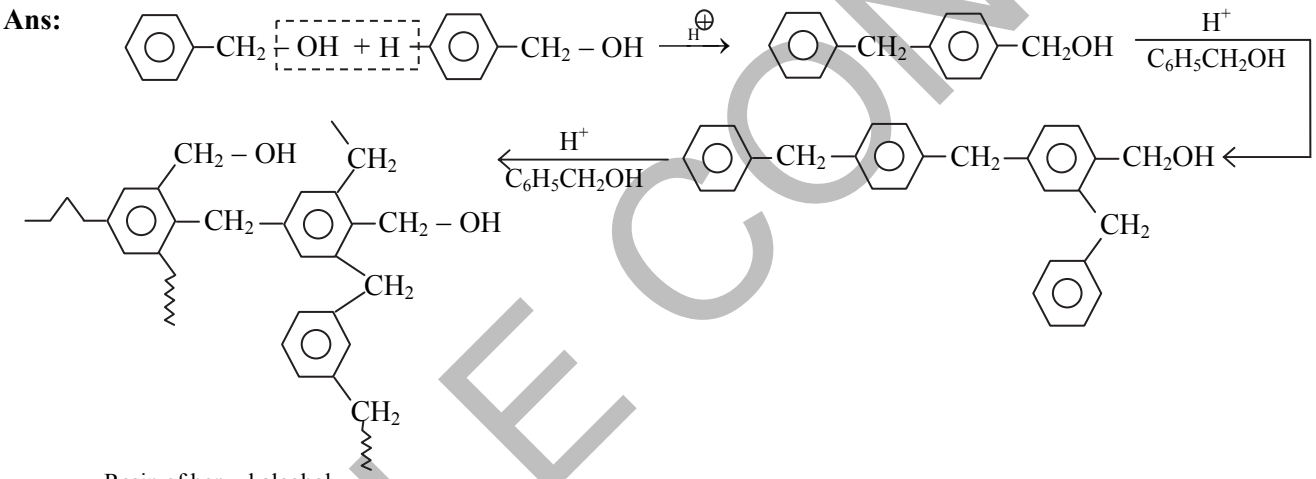
Ans: Methoxide ion from sodium methoxide acts as a nucleophile and attacks C = O double bond of formaldehyde to form an anion. This anion adds to another formaldehyde molecule. In this way several formaldehyde molecules are added.



Formaldehyde

***Q.64. Benzyl alcohol with concentrated H_2SO_4 gives resinous material which has high boiling point. Predict the structure of this resinous material.**

Ans:

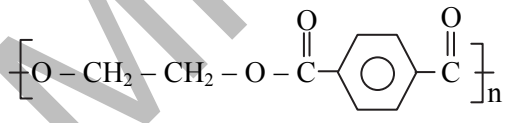


Resin of benzyl alcohol

***Q.65. Following monomers are used to prepare polymers. Predict the structure of polymers:**

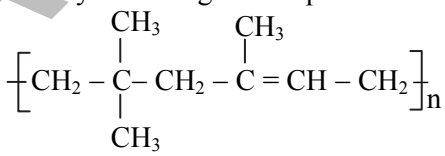
i. Ethylene glycol ii. Isobutylene iii. ∈-Caprolactum
iv. Ethene v. Formaldehyde.

Ans: i. Ethylene glycol alongwith DMT is used to prepare terylene.



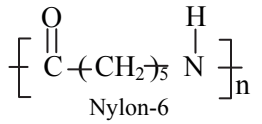
Polyester (Terylene)

ii. Isobutylene alongwith isoprene is used to prepare butyl rubber.



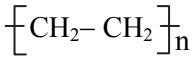
Butyl rubber

iii. ∈-Caprolactum is used for the preparation of nylon-6.



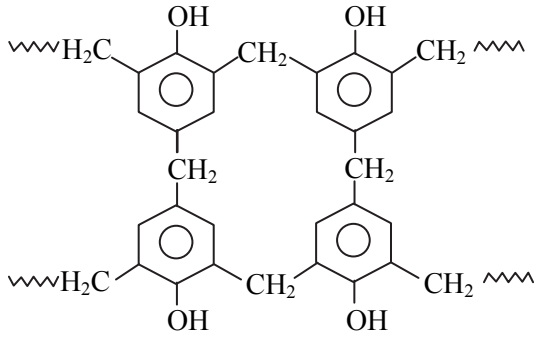
Nylon-6

iv. Ethene is used for the preparation of polythene.



Polythene

v. Formaldehyde alongwith phenol is used for the preparation of bakelite.



Bakelite

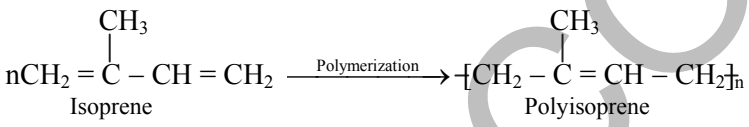
15.8 Natural rubber

Q.66. Write a note on natural rubber.

Ans: Natural rubber:

i. It is a natural polymer. It is obtained from latex which is a colloidal solution of rubber particle in water.

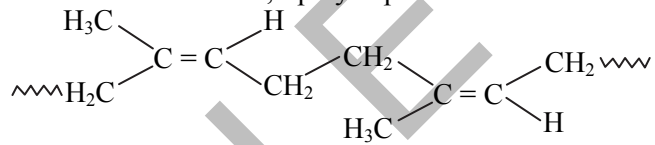
ii. Polyisoprene is a linear polymer of isoprene (2-Methylbuta-1,3-diene).



Isoprene — Polyisoprene

iii. Since each repeating unit in polyisoprene contains a double bond, it may have either a cis-or a trans-orientation.

iv. Natural rubber is cis-1,4-polyisoprene.



cis-1,4-polyisoprene
(Natural rubber)

v. The cis-polyisoprene molecule consists of various chains held together by weak van der Waals interactions. It can be stretched like spring and exhibits elastic properties.

vi. Gutta-Percha is trans-1,4-polyisoprene. It has zigzag chains which fit in one another. Gutta-Percha is crystalline and non-elastic.

15.9 Vulcanization of rubber

Q.67. *Write a note on vulcanization of rubber. OR
Discuss the main purpose of vulcanization of sulphur. (NCERT)

Ans: Vulcanization of rubber:

i. ***Vulcanization*** *is a process which consists of heating raw rubber with sulphur and an appropriate additive at a temperature ranging between* 100 °C to 150 °C.

ii. Natural rubber is very soft and sticky. It has less tensile strength. It becomes hard when heated with sulphur. The process of vulcanization was discovered by Charles Goodyear.

iii. Natural rubber when mixed with 3 to 5% sulphur and heated at 100-150 °C, forms cross linking of cis-1,4-polypropene chains through disulphide bonds, (–S–S–). Crosslinking prevents the polymer from being torn when it is stretched.

iv. By controlling the amount of sulphur used in vulcanization, the physical properties of rubber can be altered to suit the requirements.

v. When 20-30% sulphur is used, hard rubber is obtained. The rubber made with 3 to 10% sulphur is a little harder. It is used in tyres.

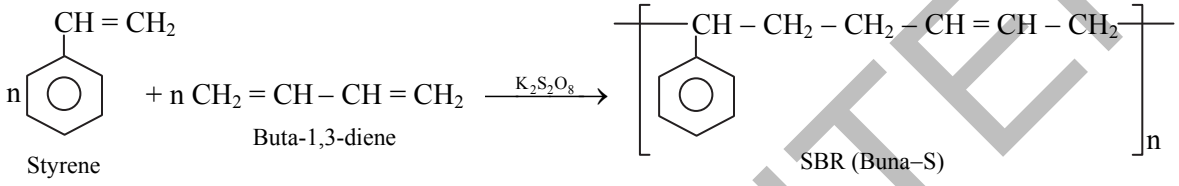
vi. 1 to 3% sulphur is used for low sulphur rubber. It is used in rubber bands.

15.10 Preparation of synthetic rubbers

Q.68. Write a note on:

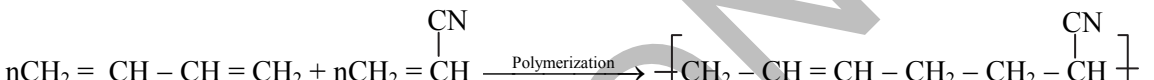
i. Buna-S ii. Buna-N iii. Neoprene rubber iv. Butyl rubber

Ans: i. Buna-S: Buna-S or styrene butadiene rubber (SBR) is obtained by copolymerization of styrene and Buta-1,3-diene. Inner tubes for tyres, motors, bubble gums, etc., are made from buna-S.



Styrene — Buta-1,3-diene — SBR (Buna–S)

ii. Buna-N: It is a copolymer, synthetic rubber. Buna-N is obtained by the co-polymerization of Buta-1,3-diene and acrylonitrile in the presence of a peroxide catalyst.

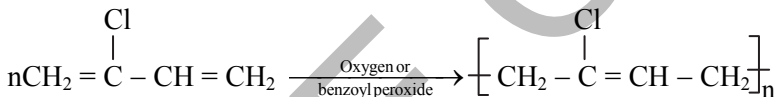


Buta-1,3-diene — Acrylonitrile — Buna-N

It is used in making oil seals, tank lining, soles of the shoes and adhesives.

iii. Neoprene rubber: It is a homopolymer, synthetic rubber.

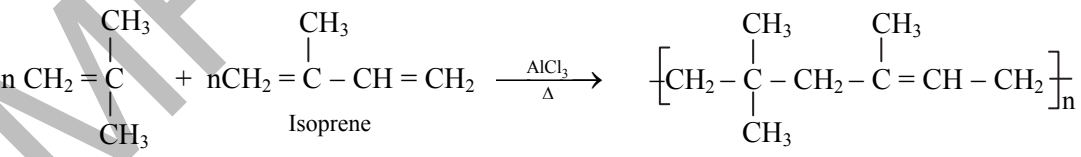
Neoprene or polychloroprene is formed by the free radical polymerization of chloroprene (2-chlorobuta-1,3-diene).



2-Chlorobuta-1,3-diene — Neoprene

It is superior to natural rubber. It shows resistant towards chemical action. It is used for manufacturing conveyor belts, gaskets, tyres, and chemical containers.

iv. Butyl rubber: It is obtained by copolymerization of isobutylene and isoprene. The mixture of monomers is heated at 100 °C. The catalyst used is anhydrous aluminium chloride. The solvent is methyl chloride.



Isobutylene — Isoprene — Butyl rubber

The inner-tubes of tyres and motors are made from butyl rubber.

Q.69. Arrange the following polymers in increasing order of their intermolecular forces:

i. Nylon-6,6, Buna-S, Polythene ii. Nylon-6, Neoprene, Polyvinyl chloride (NCERT)

Ans: The increasing order of intermolecular forces is:

i. Buna-S < Polyethene < Nylon-6,6 ii. Neoprene < Polyvinyl chloride < Nylon-6.

***Q.70. Write the names of monomers used in preparing Nylon-6,8.**

Ans: Nylon-6,8:

$H_2N – (CH_2)_6 – NH_2$ and $HOOC – (CH_2)_6 – COOH$

Hexamethylene diamine — Octane-1,8-dioic acid

15.11 Non-biodegradable and biodegradable polymers

Q.71. *What are biodegradable polymers? Give examples. OR
What is a biodegradable polymer? Give an example of biodegradable aliphatic polyester. (NCERT)

Ans: *The polymers which are degraded by micro-organisms within a suitable period so that the polymers and their degraded products do not cause any serious effects on the environment are called* ***biodegradable polymers****.*
eg. Polyhydroxy butyrate-co-β-hydroxy valerate (PHBV), Nylon-2-nylon-6, Dextron, etc.

Q.72. Write a short note on non-biodegradable polymer.

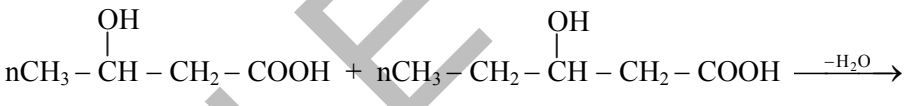
Ans: i. ***Non-biodegradable*** *polymers are those polymers which are not degraded by micro-organisms.*
eg. Plastic (Polyethylene), Nylon, Rayon, Polyester, PVC, Dacron.
ii. Major portion of synthetic polymers are being used as throw away containers and packing materials.
iii. These do not disintegrate by themselves (are non-biodegradable) over a period of time which has presented mankind with a serious waste disposal problem.

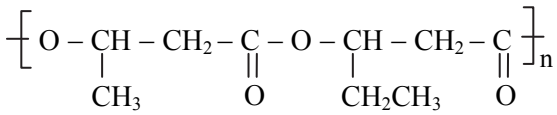
Q.73. Explain the need of biodegradable polymers.

Ans: i. A large number of polymers are quite resistant to the environmental degradation process and are thus responsible for the accumulation of polymeric solid waste materials.
ii. These solid wastes cause acute environmental problems and remain undegraded for quite a long time.
iii. In a view of the general awareness and concern for the problems created by the polymeric solid wastes, certain new biodegradable synthetic polymers have been designed and developed.
iv. These polymers contain functional groups similar to the functional groups present in biopolymers.
v. Aliphatic polyesters are one of the important classes of biodegradable polymers.

Q.74. Write the reaction involved in preparation of following biodegradable polymers:
i. Polyhydroxy butyrate-co-β-hydroxy valerate (PHBV)
ii. Dextron
iii. Nylon-2-nylon-6

Ans: i. Polyhydroxy butyrate-co-β-hydroxy valerate (PHBV): It is obtained by the co-polymerization of 3-hydroxy butanoic acid and 3-hydroxy pentanoic acid.

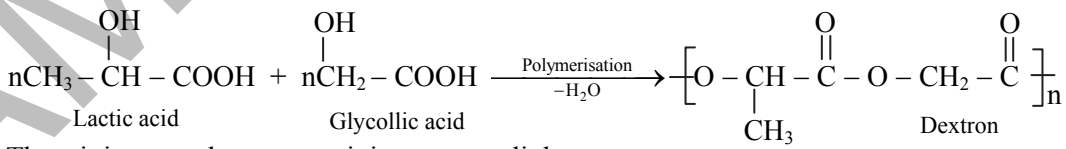




PHBV

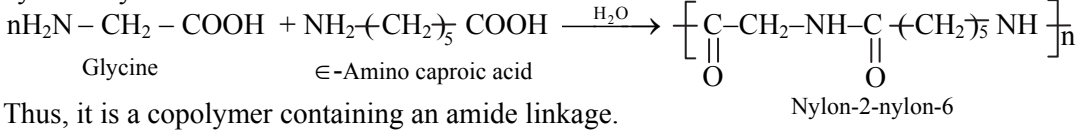
Thus, it is a copolymer containing an ester linkage.

ii. Dextron: It is obtained by the co-polymerization of glycollic acid and lactic acid.



Thus, it is a copolymer containing an ester linkage.

iii. Nylon-2-nylon-6: The condensation polymerization of glycine and ∈-amino caproic acid gives nylon-2-nylon-6.



Thus, it is a copolymer containing an amide linkage.

Q.75. What are the uses of biodegradable polymers?

Ans: Orthopaedic devices, implants, surgical sutures, drug release matrices, etc., contain biodegradable polymers.

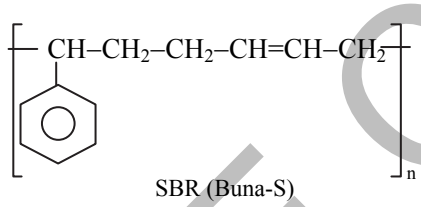
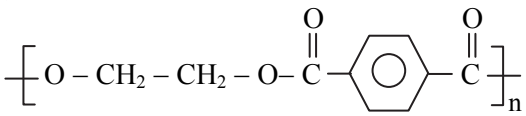
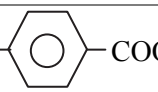
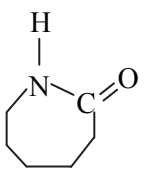
Quick Review

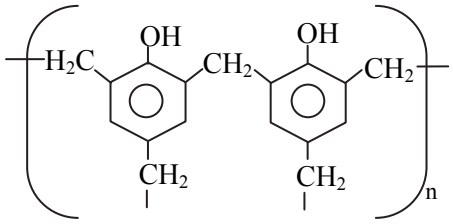
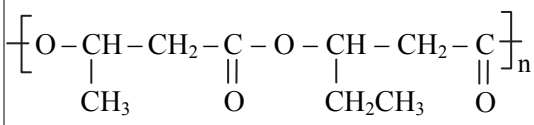
➢ **Classification of polymers:**

Classification of polymers

- **Based on sources**
  - **Natural polymers**
    Obtained from nature i.e., plants as well as animal sources.
    eg. Jute, Linen, Silk, Wool, etc.
  - **Semi-synthetic polymers**
    Derived from naturally occurring polymers by chemical modifications.
    eg. Acetate rayon, viscose rayon, cuprammonium silk, etc.
  - **Synthetic polymers**
    Derived by synthesizing in laboratory or in industries.
    eg. Nylon, Teflon, etc.
- **Based on the structure**
  - **Linear polymers**
    Have long and linear chains without any excess attachments or branches.
    eg. PVC, HDPE, etc.
  - **Branched chain polymers**
    Have long chains with the side chains or branches of different lengths.
    eg. LDPE, Polypropylene, etc.
  - **Network or Cross-linked polymers**
    Have chain polymers which are cross-linked by covalent bonds leading to 3D network like structure. **eg.** Melamine, Bakelite, etc.
- **Based on the polymerization process**
  - **Addition polymers**
    Formed by direct addition of repeated monomers without the elimination of byproduct molecules. **eg.** PAN, Teflon, etc.
  - **Condensation polymers**
    Formed by the condensation of two or more than two bifunctional monomers with the elimination of simple molecules like H_2O, CH_3OH, HCl, NH_3.
    eg. Polyster,Nylon-6, etc.
- **Based on the molecular forces**
  - **Elastomers**
    Have elastic character like rubber. **eg.** Vulcanized rubber, Neoprene, etc.
  - **Fibres**
    Have strong intermolecular forces (hydrogen bonds or dipole-dipole interactions) between the chains. **eg.** Silk, Nylon-6, etc.
  - **Thermoplastic polymers**
    Softened easily on repeated heating and hardened when cooled with little change in their properties. **eg.** Polystyrene, PVC, etc.
  - **Thermosetting polymers**
    Have cross-linked or heavily branched structure and undergo permanent change on heating. **eg.** Melamine, Bakelite, etc.

➢ **Examples of some of the polymers:**

No.	Name of Polymer	Polymer Structure	Monomer	Uses
1.	Polythene	$\left(CH_2 - CH_2\right)_n$	$CH_2 = CH_2$	As insulator, anti corrosive, packing material, in making household and laboratory wares
2.	Polytetrafluoro ethylene (Teflon)	$\left(CF_2 - CF_2\right)_n$	$CF_2 = CF_2$	As lubricant, insulator and making cooking wares
3.	Polyacrylonitrile (Orlon)	$\left(CH_2 - \underset{\displaystyle CN}{\underset{\vert}{CH}}\right)_n$	$CH_2 = CHCN$	In making synthetic fibres and synthetic wool
4.	Styrene butadiene rubber (SBR or Buna-S)	 SBR (Buna-S)	(i) $CH_2 = CH - CH = CH_2$ (ii) $CH = CH_2$ $\vert$ C_6H_5	In making automobile tyres and footwear
5.	Nitrile rubber (Buna-N)	$\left(CH_2{-}CH{=}CH{-}CH_2{=}CH_2{-}\underset{\displaystyle CN}{\underset{\vert}{CH}}\right)_n$	(i) $CH_2 = CH - CH = CH_2$ (ii) $CH = \underset{\displaystyle CN}{\underset{\vert}{CH_2}}$	In making oil seals, manufacture of hoses and tank linings
6.	Neoprene	$\left(CH_2 - \underset{\displaystyle Cl}{\underset{\vert}{C}} = CH - CH_2\right)_n$	$CH_2 = \underset{\displaystyle Cl}{\underset{\vert}{C}} = CH = CH_2$	As insulator, making conveyor belts and printing rollers
7.	Terylene (Dacron)	 Terylene	(i) H_3COOC–  –$COOCH_3$ (ii) $HO{-}CH_2{-}CH_2{-}OH$	For making fibres, safety belts, tyre cords, tents, etc.
8.	Nylon-6	$\left(NH - (CH_2)_5 - \overset{\displaystyle O}{\overset{\Vert}{C}}\right)_n$		In making fibres plastics, tyre, cords and ropes.

9.	Nylon-6,6		(i) $HOOC–(CH_2)_4–COOH$ (ii) $H_2N–(CH_2)_6–NH_2$	In making brushes, synthetic fibres, parachutes, ropes and carpets.
10.	Bakelite		(i) HCHO (ii) C_6H_5OH	For making combs, gears, protective coating and electrical fittings.
11.	Poly hydroxy butyrate-co-β-hydroxy valerate (PHBV)	 PHBV	(i) $CH_3CH(OH)CH_2COOH$ (ii) $CH_3CH_2CH(OH)CH_2COOH$	As a speciality packaging material, orthopaedic devices and in controlled release of drugs.

➢ **Examples of some other polymers:**

No.	Name of polymer	Class of polymer	Name/s of monomer/s	Uses
1.	Dynel	Copolymer	Vinyl chloride and acrylonitrile	Human hair wigs
2.	Glyptal	Copolymer	Ethylene glycol and phthalic acid	In paints
3.	Thiokol	Condensation (polysulphide rubber)	Ethylene chloride and sodium tetra sulphide	Rubber
4.	Superglue	Homopolymer	Methyl α-cyanoacrylate	Glue
5.	Kevlar	Polyamide	Terephthalic acid chloride and p-phenylenediamine	Bullet proof vests and helmets
6.	Nomex	Polyamide condensation	m-phthalic acid and m-dinitrobenzene	Protective clothes for race car drivers and fire fighters.
7.	Lexan	Polycarbonate, polyester condensation	Diethylcarbonate and bisphenol A	Bullet proof windows and helmets.
8.	Polyurethane	Copolymer	Toluene diisocyanate and ethylene glycol	For padding and building insulation as light in weight.
9.	Thermocole or polystyrene	Homopolymer	Styrene	For padding and building insulation as light in weight.
10.	Saran	Copolymer	Vinyl chloride and vinylidene chloride	As a film for wrapping food.

Exercise

One Mark Questions

1. Name the monomers involved in the preparation of nylon-6,6.
Ans: *Refer Q.41.ii.*

2. What is a semi-synthetic polymer? Give an example.
Ans: *Refer Q.4.ii.*

*3. Explain the term: Monomer
Ans: *Refer Q.1.ii.*

4. Give two examples of cross-linked polymers.
Ans: *Refer Q.6.iii.example.*

*5. Explain the term Elastomers. *(Reaction is not expected in the answer).* **[Mar 13, 17]**
Ans: *Refer Q.12.i. and example.*
*[Definition and Any one example – **1 Mark**]*

6. State two examples of biodegradable polymers.
Ans: *Refer Q.71.example.*

7. Define: Condensation polymer with an example.
Ans: *Refer Q.8.ii.*

8. Write the reaction for the preparation of nylon-6. **[Mar 16]**
Ans: *Refer Q.39.iii.*
*[Chemical reaction with names of reactants and products – ½ **Mark**, reagents/reaction conditions – ½ **Mark**]*

9. Write any 'two' uses of terylene. **[Oct 14]**
Ans: *Refer Q.49.i. [Any two uses – ½ **Mark each**]*

10. Give reason: Condensation polymerization is also called as step growth polymerzation.
Ans: *Refer Q.17.ii.e.*

11. Write the structure of melamine. **[Oct 13]**
Ans: *Refer Q.59.(Structure of melamine).*
*[Structure – **1 Mark**]*

12. Mention two examples of thermosetting polymers.
Ans: *Refer Q.15.example.*

Two Marks Questions

1. Write names and chemical formulae of monomers used in preparing Buna-S. **[Mar 14]**
Ans: *Refer Q.68.i.*(*Reactants*).
*[Structure + Name of monomers – **1 Mark each**]*

2. What is HDPE? Explain its preparation?
Ans: *Refer Q.32.*

3. How are polythene and neoprene prepared? **[Mar 16]**
Ans: *Refer Q.6.i.example.a. and Q.68.iii. (Reaction).*
*[Chemical reactions with names of reactants, products and reagents/reaction conditions – **1 Mark each**]*

4. Explain with examples, branched and linear polymers. **[Mar 15]**
Ans: *Refer Q.6.ii. and Q.6.i.*
*[Branched Polymer: Explanation – ½ **Mark**, Any one example – ½ **Mark**, Linear Polymer: Explanation – ½ **Mark**, Any one example – ½ **Mark**]*

5. How are the following polymers prepared?
i. Orlon. ii. Teflon. **[July 16]**
Ans: i. *Refer Q.8.i.example.a.*
ii. *Refer Q.8.i.example.b.*
*[Chemical reactions with names of reactants, products and reagent/reaction conditions – **1 Mark each**]*

6. Write the formulae of the raw materials used for preparation of: **[July 16]**
i. Buna-S ii. Dextron
Ans: i. *Refer Q.68.i.*
*[Structure of monomers – ½ **Mark each**]*
ii. *Refer Q.74.ii.*
*[Structure of monomers – ½ **Mark each**]*

7. Write the names and chemical formulae of monomers used in preparing Buna-N. **[July 17]**
Ans: *Refer Q.68.ii.*(*Reactants*).
*[Names of monomers + Chemical formulae – **1 Mark each**]*

8. What are biodegradable polymers and non-biodegradable polymers? Write 'one example' of each. **[Mar 15]**
Ans: *Refer Q.71. and Q.72.i.*
*[Biodegradable polymer: Definition – ½**Mark**, Any one example – ½ **Mark**, Non-biodegradable polymer: Definition – ½ **Mark**, Any one example – ½ **Mark**]*

Three Marks Questions

*1. Write the uses of:
i. Teflon ii. Orlon
iii. PVC
Ans: i. *Refer Q.35.(Uses).*
ii. *Refer Q.34.(Uses).*
iii. Refer Q.49.ii.

2. i. Explain the preparation of LDPE.
   ii. Draw structure of SBR.

Ans: i. *Refer Q.30.*
ii. *Refer Q.68.1.(Product)*

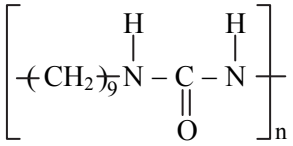
3. Write the reactions involved in the preparation of:
   i. Teflon ii. Orlon
   iii. PVC **[Oct 15]**

Ans: i. *Refer Q.8.i.example.b.*
ii. *Refer Q.8.i.example.a.*
iii. *Refer Q.6.i.example.b.*
*[Chemical reactions with names of reactants, products and reagents/reaction conditions – **1 Mark each**]*

*4. Write the uses of:
   i. Nylon. ii. Bakelite.

Ans: i. *Refer Q.45.* ii. *Refer Q.57.*

5. i. Write the reactions involved in the preparation of nylon-6,6.
   ii. Draw the structure of the monomer used to prepare the following polymer.



Ans: i. *Refer Q.38.iv.Steps I, II and III.*
ii. *Refer Q.29.iii.*

6. Explain the preparation and uses of nylon-2-nylon-6**.** **[Mar 18]**

Ans: *Refer Q.74.iii. and Q.75.*

Five Marks Questions

1. i. Write a note on neoprene rubber.
   ii. State the uses of PHBV.
   iii. Write a note on chain growth polymerization.

Ans: i. *Refer Q.68.iii.*
ii. *Refer Q.75.*
iii. *Refer Q.24.*

*2. Write the names of monomers used in preparing following polymers:
   i. Dacron ii. Melamine
   iii. Buna-S iv. Buna-N
   v. Butyl rubber

Ans: i. *Refer Q.47.iv.(Reactants).*
ii. *Refer Q.62.ii.*
iii. *Refer Q.68.i.*
iv. *Refer Q.68.ii.*
v. *Refer Q.68.iv.*

Multiple Choice Questions

1. Which of the following is NOT a synthetic polymer ?
   (A) Polyethylene (B) PVC
   (C) Nylon (D) Cellulose

2. Select the natural polymer from among the following
   (A) rubber (B) polythene
   (C) bakelite (D) polyvinyl chloride

3. Neoprene, a synthetic rubber contains which of the following elements besides C and H?
   (A) N (B) O (C) Cl (D) F

4. Which of the following is an inert polymer used in coating, particularly in non-sticking frying pans?
   (A) Teflon (B) Dacron
   (C) Bakelite (D) Orlon

5. Amongst the following, identify a copolymer. **[Mar 16]**
   (A) Orlon (B) PVC
   (C) PHBV (D) Teflon

6. Saran is a copolymer of _____.
   (A) styrene and buta-1,3-diene
   (B) styrene and acrylonitrile
   (C) vinylidene chloride and vinyl chloride
   (D) vinyl chloride and styrene

7. An example of chain growth polymer is _____.
   (A) Nylon-6,6 (B) Bakelite
   (C) Terylene (D) Teflon

8. HDPE is a polymer obtained by polymerization of _____.
   (A) acetylene (B) ethylene
   (C) vinyl chloride (D) propylene

9. The Zieglar-Natta catalyst is used in the preparation of _____. **[Oct 13]**
   (A) LDPE (B) PHBV
   (C) PAN (D) HDPE

10. Dacron is obtained by the condensation polymerization of _____.
   (A) terephthalic acid and formaldehyde
   (B) dimethylterephthalate and ethylene glycol
   (C) phenol and formaldehyde
   (D) phenol and phthalic acid

11. The catalyst used to prepare monomer of terylene is _____.
   (A) copper acetate and zinc chloride
   (B) zinc acetate and antimony trioxide
   (C) sodium sulphate and lead oxide
   (D) zinc chloride and sodium sulphate

12. Bakelite is a copolymer of _____.
(A) HCHO and ethylene
(B) HCHO and phenol
(C) phenol and ethylene
(D) phenol and methylene

13. Bakelite is the polymer of _____. **[Mar 14]**
(A) benzaldehyde and phenol
(B) acetaldehyde and phenol
(C) formaldehyde and phenol
(D) formaldehyde and benzyl alcohol

14. Perlon-L and Nylon-6,6 are used in making_____.
(A) crockeries (B) ropes
(C) cooking pans (D) tyre tubes

15. Novolac on heating with methanal undergoes cross linkage to form _____.
(A) teflon (B) bakelite
(C) terylene (D) perlon

16. Wash and wear clothes are manufactured using _____.
(A) nylon fibres
(B) cotton mixed with nylon
(C) terylene fibre
(D) wool fibres

17. Which of the following is polyamide? **[Oct 14]**
(A) Teflon (B) Nylon-6,6
(C) Terylene (D) Bakelite

18. Tooth brush bristles are made of _____.
(A) Terylene (B) Nylon-6,6
(C) Teflon (D) Orlon

19. A similarity between Nylon-6 and Nylon-6,6 is _____.
(A) they are isomers
(B) starting material for their manufacture are isomers
(C) their monomers contain 12 carbon atoms
(D) they are polymers

20. A polymer which contains ester linkage is_____. **[July 18]**
(A) teflon (B) buna-N
(C) dextron (D) neoprene

21. Natural rubber is basically a polymer of _____.
(A) Neoprene (B) Isoprene
(C) Chloroprene (D) Butadiene

22. What is natural rubber? **[Oct 15]**
(A) Cis-1,4-polyisoprene
(B) Neoprene
(C) Trans-1,4-polyisoprene
(D) Butyl rubber

23. Monomer of natural rubber is _____.
(A) $CH_3 - \underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}} = CH - CH_3$
(B) $CH_3 - CH = CH - CH - CH_3$
(C) $CH_2 = \underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}} - CH = CH_2$
(D) $CH_2 = \underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}} - \underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}} = CH_2$

24. Which of the following is INCORRECT?
(A) Nylon-6 is obtained by polymerization of amino caproic acid.
(B) Rayon is a semi-synthetic fibre.
(C) Terylene has low moisture absorption property.
(D) Buna-N is a copolymer-synthetic rubber.

25. Which of the following is biodegradable polymer?
(A) Nylon-6,6 (B) PHBV
(C) Rayon (D) Dacron

26. Nylon-2-nylon-6 is obtained by the condensation polymerization of the monomers _____.
(A) glycine and lactic acid
(B) alanine and ∈-aminocaproic acid
(C) glycine and ∈-aminocaproic acid
(D) alanine and lactic acid

27. Which of the following is non-biodegradable polymer?
(A) PHBV
(B) PVC
(C) Nylon-2-nylon-6
(D) Dextron

28. A polymer used in paints is _____. **[Mar 18]**
(A) nomex (B) thiokol
(C) saran (D) glyptal

Answers to Multiple Choice Questions

1.	(D)	2.	(A)	3.	(C)	4.	(A)
5.	(C)	6.	(C)	7.	(D)	8.	(B)
9.	(D)	10.	(B)	11.	(B)	12.	(B)
13.	(C)	14.	(B)	15.	(B)	16.	(C)
17.	(B)	18.	(B)	19.	(D)	20.	(C)
21.	(B)	22.	(A)	23.	(C)	24.	(A)
25.	(B)	26.	(C)	27.	(B)	28.	(D)

TOPIC TEST

Total : 25 Marks

Section A (1 × 5 = 5 Marks)

Choose the correct alternative:

1. Polystyrene is a/an _____ polymer.
   (A) fibrous (B) thermoplastic (C) thermosetting (D) elastomeric
2. For making rubber bands, _____ is added to natural rubber during vulcanization.
   (A) 1 – 3 % sulphur (B) 3 – 10 % sulphur (C) 20 – 30 % sulphur (D) 40 – 50 % sulphur
3. Amongst the following, identify an addition polymer.
   (A) Dacron (B) Nylon-6,6 (C) Bakelite (D) Orlon

Answer the following:

4. Define co-polymerization.
5. State any two properties of nylon-6.

Section B (2 × 3 = 6 Marks)

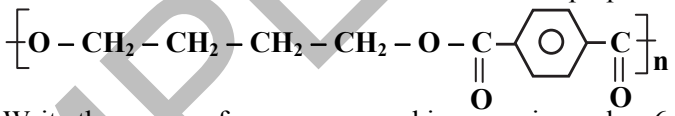
6. Distinguish between thermosetting and thermoplastic polymers.
7. Write the formulae of the raw materials used for the preparation of: i. Butyl rubber ii. Dextron
8. Write the reactions involved in the preparation of: i. Nylon-6 ii. PHBV

   OR

   Write a note on fibres.

Section C (3 × 3 = 9 Marks)

9. Explain the process of vulcanization of rubber.
10. i. Define: Biodegradable polymer.
    ii. Write the uses of teflon.
    iii. Classify the following as addition and condensation polymers:
    Bakelite, Polystyrene, Teflon, Dacron.
11. i. Give reason: Formaldehyde polymerises by the action of sodium methoxide, a strong base. Write its mechanism.
    ii. Draw the structure of the monomers used in the preparation of the following polymer,



    iii. Write the names of monomers used in preparing nylon-6,8.

    OR

    i. Explain the preparation of nylon-6,6?
    ii. State the different possibilities involved in the chain terminating step of a polymerization reaction.

Section D (5 × 1= 5 Marks)

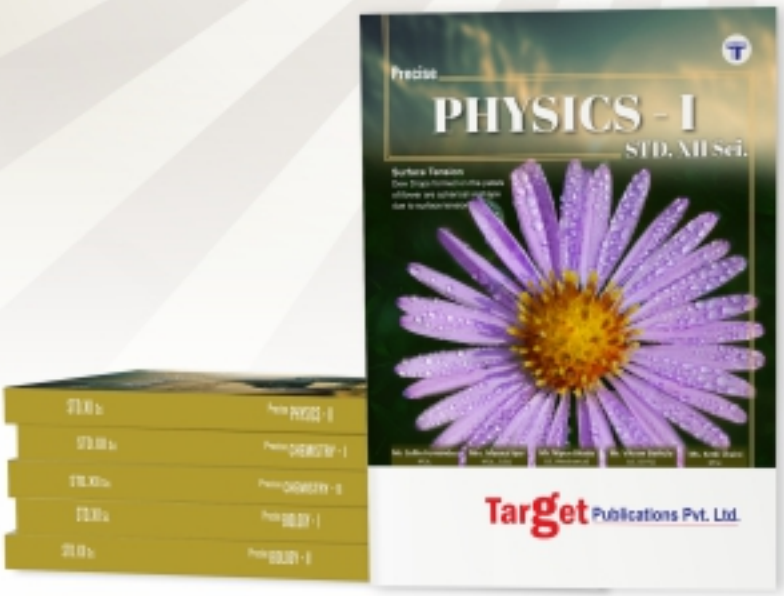
12. i. Draw the structure of bakelite polymer.
    ii. Write the reaction involved in the preparation of terylene.
    iii. Draw the structures of the monomers used for the preparation of:
    a. Nylon-2-nylon-6 b. Buna-S
    iv. Define a condensation polymer with any one example.

    OR

    i. Draw the structure of natural rubber.
    ii. Write the reaction involved in the preparation of novolac polymer.
    iii. Draw the structure of repeating unit formed by the polymerization of glycerol and DMT.+
    iv. Mention any two uses of dacron.

Std. XII

Precise Science



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- Precise Chemistry - II
- Precise Biology - I
- Precise Biology - II

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