# 15

# Polymer

## Multiple Choice Questions (MCQs)

**Q. 1** Which of the following polymers of glucose is stored by animals?

(a) Cellulose (b) Amylose
(c) Amylopectin (d) Glycogen

**Ans.** ***(d)*** Glycogen is a polymer of glucose found in liver, brain and muscles of animals. Cellulose is a polymer found in plant while amylose and amylopectin are structural units of starch.

**Q. 2** Which of the following is not a semisynthetic polymer?

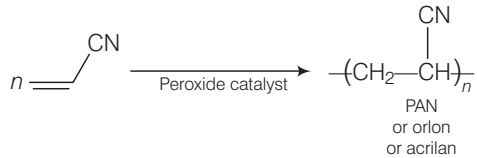
(a) *cis*-polyisoprene
(b) Cellulose nitrate
(c) Cellulose acetate
(d) Vulcanised rubber

**Ans.** ***(a)*** *cis*-polyisoprene is not a semisynthetic polymer while other three cellulose nitrate, cellulose acetate and vulcanised rubber are semisynthetic polymer made from cellulose, cellulose and natural rubber respectively.

**Q. 3** The commercial name of polyacrylonitrile is ..... .

(a) dacron (b) orlon (acrilan) (c) PVC (d) bakelite

**Ans.** ***(b)*** The commercial name of polyacrylonitrile is orlon (acrilan).

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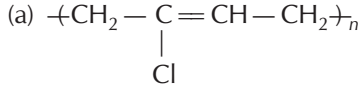
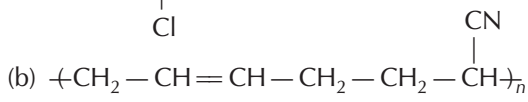
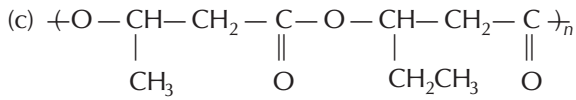
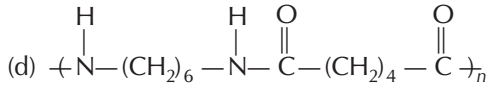
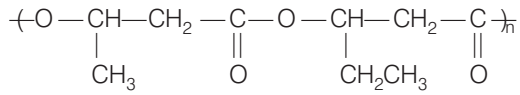
**Q. 4** Which of the following polymer is biodegradable?

(a) 

(b) 

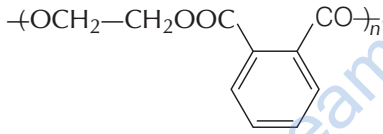
(c) 

(d) 

**Ans.** *(c)* 

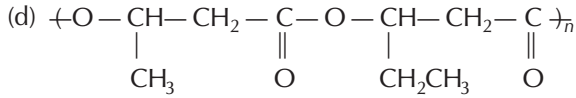
Poly β – hydroxybutyrate - co-β – hydroxy valerate is an example of biodegradable polymer.

**Q. 5** In which of the following polymers ethylene glycol is one of the monomer units?

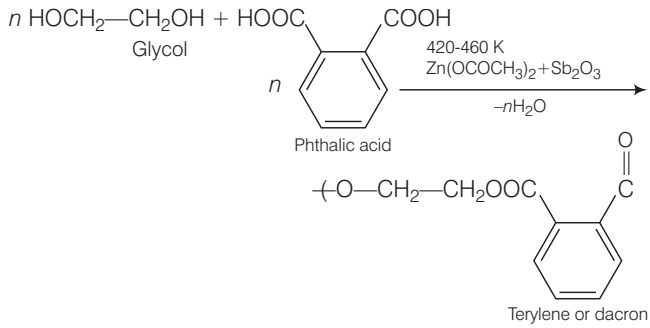
(a) 

(b) 

(c) 

(d) 

**Ans.** *(a)* Given polymer can be obtained condensation polymerisation of ethylene glycol and phthalic acid with the elimination of water molecule.

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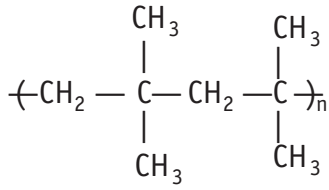
**Q. 6** Which of the following statements is not true about low density polyethene?

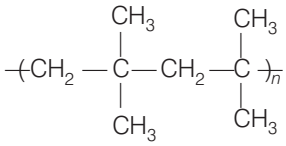
(a) Tough (b) Hard

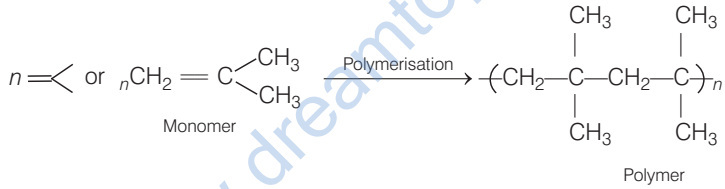
(c) Poor conductor of electricity (d) Highly branched structure

**Ans.** *(d)* Low density polythene has slightly branched but not highly branched structure.

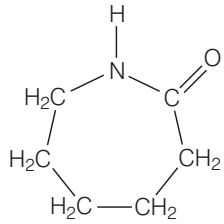
**Q. 7**  is a polymer having monomer units ..... .

(a)  (b)  (c)  (d) 

**Ans.** *(a)*  can be obtained by addition polymerisation of  as shown below



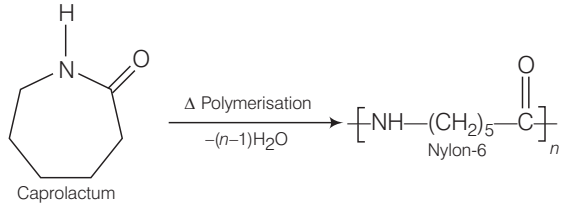

**Q. 8** Which of the following polymer can be formed by using the following monomer unit?



(a) Nylon-6, 6 (b) Nylon-2-nylon-6

(c) Melamine polymer (d) Nylon-6

**Ans.** *(d)* Given, monomer is the structure of caprolactum which on polymerisation produces Nylon-6.

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## Multiple Choice Questions (More Than One Options)

**Q. 9** Which of the following polymers, need atleast one diene monomer for their preparation?

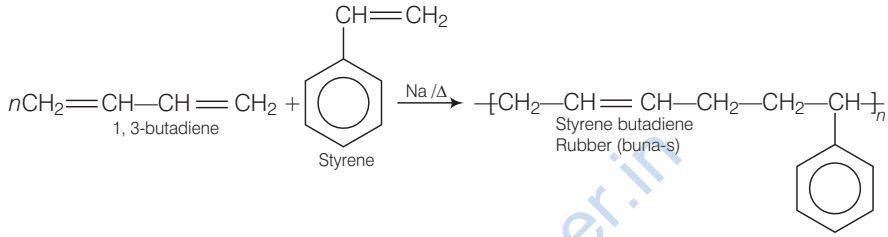
(a) Dacron (b) Buna-S

(c) Neoprene (d) Novolac

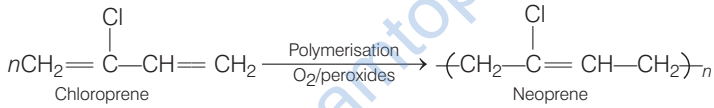
**Ans.** *(b,c)*

Buna-S and neoprene are two such polymers which needs atleast one diene monomer for their preparation.

(b) Buna-S is prepared by copolymerisation of 1, 3-butadiene and styrene.




(c) Neoprene is prepared by polymerisation of chloroprene




**Q. 10** Which of the following are characteristics of thermosetting polymers?

(a) Heavily branched cross linked polymers

(b) Linear slightly branched long chain molecules

(c) Become infusible on moulding so cannot be reused

(d) Soften on heating and harden on cooling, can be reused

**Ans.** *(a, c)*

**Thermosetting polymer**

(i) These are cross linked or heavily branched molecule.

(ii) These on heating undergo extensive cross linking in moulds and become infusible

(iii) These cannot be reused.

(iv) Examples are bakelite, urea-form aldehyderesin.

**Q. 11** Which of the following polymers are thermoplastic?

(a) Teflon (b) Natural rubber (c) Neoprene (d) Polystyrene

**Ans.** *(a, d)*

**Thermoplastic polymer**

(i) These are linear or slightly branched long chain molecules.

(ii) These polymers are hard at room temperature, become soft and viscous on heating and again rigid on cooling. This process of heat softening and hardening on cooling can be repeated as many times and as desired without any change in chemical composition.

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**Q. 12** Which of the following polymers are used as fibre?

(a) Polytetrafluoroethane (b) Polychloroprene

(c) Nylon (d) Terylene

**Ans.** ***(c, d)***

Nylon and terylene are used as fibre due to strong intermolecular forces like H-bonding which lead to close packing in chain and thus impart crystalline nature.

**Q. 13** Which of the following are addition polymers?

(a) Nylon (b) Melamine formaldehyde resin

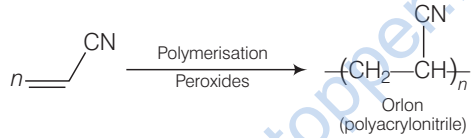
(c) Orlon (d) Polystyrene

**Ans.** ***(c, d)***

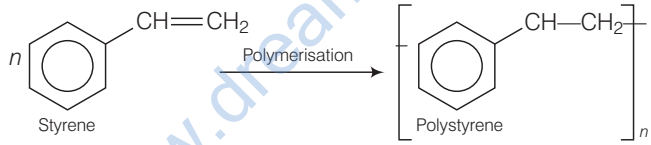
Addition polymers are formed by the repeated addition of a large number of same or different monomers possessing double and triple bonds.

*e.g.,*

(i) Orlon is obtained by addition polymerisation of acrylonitrile in presence of a perovide catalyst.




(ii) Polystyrene is obtained by addition polymeriration of styrene.




**Q. 14** Which of the following polymers are condensation polymers?

(a) Bakelite

(b) Teflon

(c) Butyl rubber

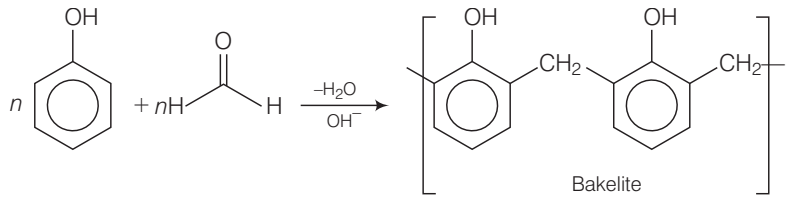
(d) Melamine formaldehyde resin

**Ans.** ***(a, d)***

Condensation polymers are formed by repeated condensation reaction between two bifunctional or trifunctional monomer units usually with the elimination of small molecules like water, alcohol, ammonia, $CO_2$, HCl.

*e.g.,*

(i) Bakelite is obtained by polymeristation of phenol and formaldehyde.

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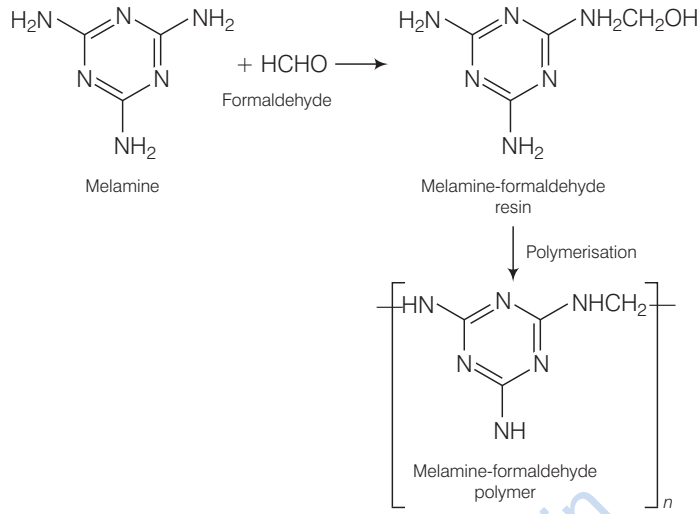
(ii) Melamine - Formaldehyde-resin




**Q. 15** Which of the following monomers form biodegradable polymers?

(a) 3-hydroxybutanoic acid + 3-hydroxypentanoic acid

(b) Glycine + amino caproic acid

(c) Ethylene glycol + phthalic acid

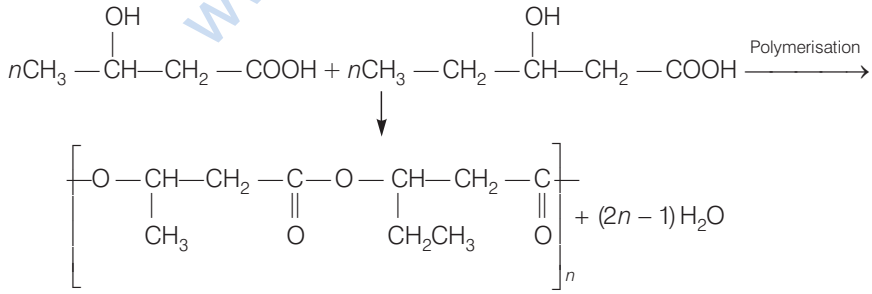
(d) Caprolactum

**Ans.** ***(a, b)***

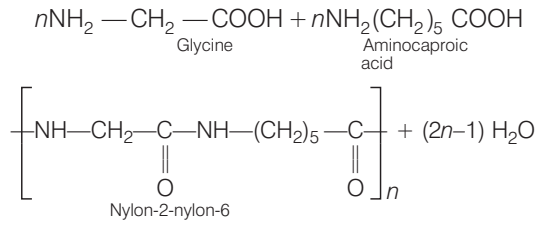
**Biodegradable Polymer** The polymers which are easily decomposed and not harmful for the environment are known as biodegradable polymer.

*e.g.,*

(i) PHBV is obtained by condensation polymerisation of 3 hydroxybutanoic acid and 3 hxydroypentanoic acid.




(ii) Glycine and aminocaproic acid produces nylon-2 nylon-6 polymer.

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**Q. 16** Which of the following are example of synthetic rubber?

(a) Polychloroprene (b) Polyacrylonitrile

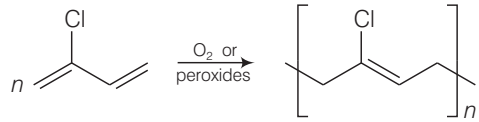
(c) Buna-N (d) *cis*-polyisoprene

**Ans.** ***(a, c)***

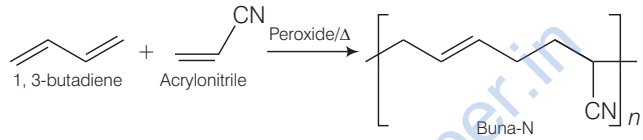
**Synthetic Polymer** Polymer which are not found in nature and can be synthesised in laboratory and industry are known as synthetic polymer.

*e.g.,*

(i) Polychloroprene also known as neoprene is a polymer of chloroprene [monomer].




(ii) Buna-N can be obtained by copolymerisation of 1, 3-Butadiene and acyrlonitrile as shown below




**Q. 17** Which of the following polymers can have strong intermolecular forces?

(a) Nylon (b) Polystyrene (c) Rubber (d) Polysters

**Ans.** ***(a, d)***

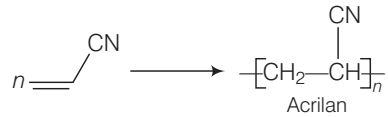
Nylon and polyesters have strong intermolecular forces of attractions due to presence of ether H-bonding or dipole-dipole interactions.

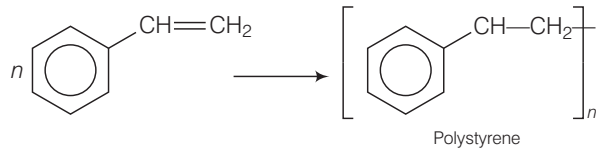
**Q. 18** Which of the following polymers have vinylic monomer units?

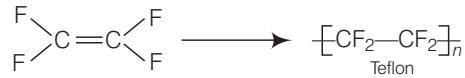
(a) Acrilan (b) Polystyrene (c) Nylon (d) Teflon

**Ans.** ***(a, b, d)***

Acrilan, polystyrene and teflon has vinylic monomer units as shown below.

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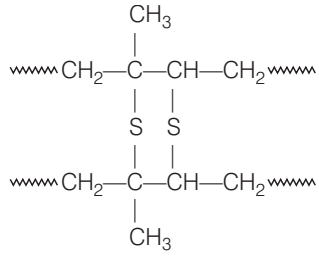
**Q. 19** Vulcanization makes rubber ..... .

(a) more elastic
(b) soluble in inorganic solvent
(c) crystalline
(d) more stiff

**Thinking Process**

*This problem includes the concept of vulcaniztion of rubber and characteristic of vulcanized rubber. Vulcanization of rubber produces more elastic and more stiff rubber due to presence of sulphide linkage.*



**Ans.** *(a, d)*

In vulcanized rubber, the polymer chains are held together by sulphur cross- linkages (—S—S—). These cross links make rubber more hard, elastic and stronger.

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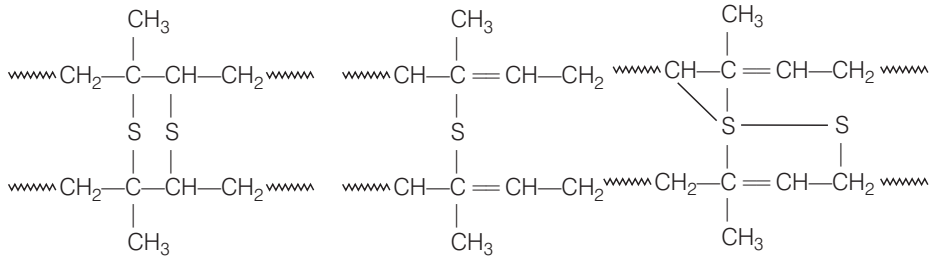
## Short Answer Type Questions

**Q. 20** A natural linear polymer of 2-methyl-1, 3-butadiene becomes hard on treatment with sulphur between 373 to 415 K and —S—S—bonds are formed between chains. Write the structure of the product of this treatment?

**Thinking Process**

*This problem is based on vulcanized rubber and its structure.*

**Ans.** The product is called vulcanised rubber. Its structure is



**Q. 21** Identify the type of polymer

— A — A — A — A — A — A —

**Ans.** Homopolymer as it contains only one type of monomer units. *i.e.,* only *A* monomer units.

**Q. 22** Identify the type of polymer

— A — B — B — A — A — A — B — A —

**Ans.** Copolymer, as it contains more than one type of monomer units. Here, *A* and *B* are two types of monomer units.

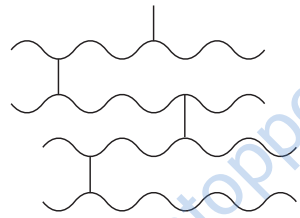
**Q. 23** Out of chain growth polymerisation and step growth polymerisation, in which type will you place the following.

$$\text{—(A)—}_m + \text{—(A)—}_n \longrightarrow \text{—(A)}_m\text{—(A)}_n \text{ or } \text{—(A—A)—}_{m+n}$$

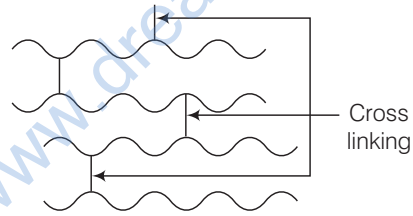
**Ans.** Chain growth polymerisation, as there is no loss of small molecules like water; methanol etc.

$$\text{—(A)—}_m + \text{—(A)—}_n \longrightarrow \text{—(A)}_m\text{—(A)}_n \text{ or } \text{—(A—A)—}_{m+n}$$

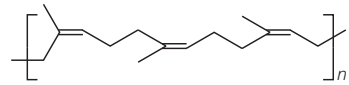
**Q. 24** Identify the type of polymer given in the following figure.



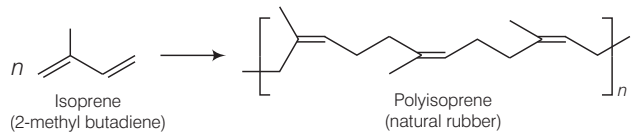
**Ans.** Cross-linked or network polymer.




**Q. 25** Identify the polymer given below.




**Ans.** The given polymer is formed by', 1, 4--addition of 2- methylbuta- 1,3- diene (isoprene) and stereochemistry is '*cis*' throughout. Therefore, the given polymer is '*cis*'- polyisoprene *i.e.,* natural rubber.




**Q. 26** Why are rubber called elastomers?

**Ans.** They change their shape on applying force and regain their original shape on removal of the applied force. Hence, rubbers are called elastomers.

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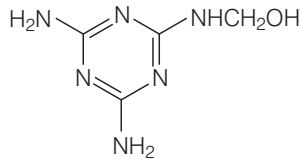
**Q. 27** Can enzyme be called a polymer?

**Ans.** *Yes*, these are made up of proteins which are polymers of amino acids.

**Q. 28** Can nucleic acid, protein and starch be considered as step growth polymers?

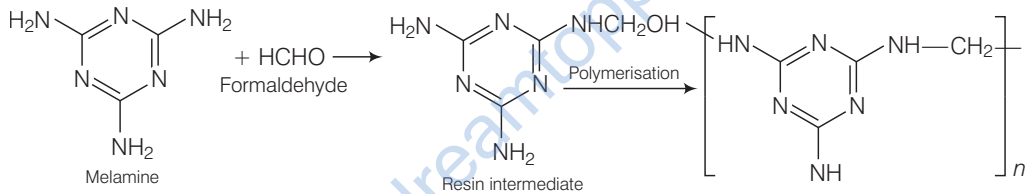
**Ans.** *Yes*, nucleic acid, protein and starch can be considered as step growth polymers as during their polymerisation reaction, they lead to removal of water molecule or any neutral molecule also. Thus, these are the examples of condensation polymers or step growth polymerisation.

**Q. 29** How is the following resin intermediate prepared and which polymers is formed by this monomer unit?




Resin intermediate

**Ans.** Reaction between melamine and formaldehyde can be shown as




Melamine

Resin intermediate

Melamine form aldehyde product

Melamine-formaldehyde polymer is formed by this monomer unit.

**Q. 30** To have practical applications why are cross links quetioined in rubber?

**Ans.** Cross links in rubber required for increasing the elasticity of rubber.

**Q. 31** Why does cis-polyisoprene posses elastic property?

**Ans.** *cis*-polyisoprene is also known as natural rubber. Its elastic property is due to the existence of weak van der Waals' interactions between their various polymer chains.

**Q. 32** What is the structural difference between HDP and LDP? How does the structure account for different behaviour and nature, hence use of a polymer?

**Ans.** HDP (high density polymer) consists of linear molecule and has a high density due to close packing. It is a translucent polymer. While LDP (low density polymer) has highly branched structure and hence, does not pack well resulting in low density. It is a transparent material.

**Q. 33** What is the role of benzoyl peroxide in addition polymerisation of alkenes? Explain its mode of action with the help of an example.

**Ans.** Role of benzoyl peroxide is to initiate the free radical polymerization reaction which can be easily understood by taking an example of polymerization of ethene to polyethene.

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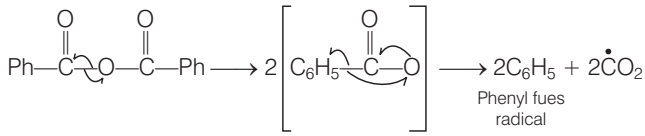
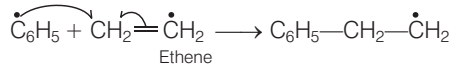
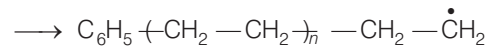
(i) Chain initiation

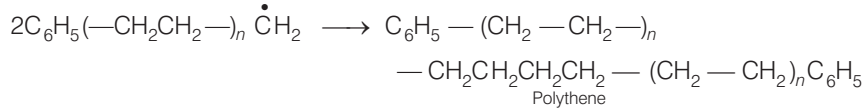



(ii) Chain propagation




(iii) Chain terminator step

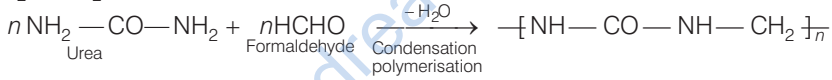



**Q. 34** Which factor imparts crystalline nature to a polymer like nylon?

**Ans.** Strong intermolecular forces like hydrogen bonding and linear structure that lead to close packing of chains and hence, imparts crystalline character. *e.g.,* nylon

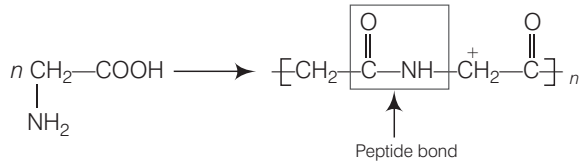
**Q. 35** Name the polymer used in laminating sheets and give the name of monomeric units involved in its formation.

**Ans.** Urea formaldehyde resin is used for laminated sheets. The monomer of this resin is urea ($NH_2CoNH_2$) and formaldehyde (HCHO).




**Q. 36** Which type of biomolecules have some structural similarity with synthetic polyamides? What is similarity?

**Ans.** Polyamides have structural repeatation of amide linkages which is similar to peptide bond as present in polypeptide chains of proteins.




**Q. 37** Why should the monomer used in addition polymerisation through free radical pathway be very pure?

**Ans.** During free radical polymerisation, monomers should be very pure because even very trace amounts of impurities may act as inhibitors which leads to the formation of polymers with shorter length.

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## Matching The Columns

**Q. 38** Match the polymer of Column I with correct monomer of Column II.

| Column I | | Column II | |
|---|---|---|---|
| A. | High density polyethene | 1. | Isoprene |
| B. | Neoprene | 2. | Tetrafluoro ethene |
| C. | Natural rubber | 3. | Chloroprene |
| D. | Teflon | 4. | Acrylonitrile |
| E. | Acrilan | 5. | Ethene |

**Ans.** **A.** → (5) **B.** → (3) **C.** → (1) **D.** → (2) **E.** → (4)

Column I represents various kind of polymer and Column II represents their monomer units. Correct matching can be done as

| Column I | | Column II |
|---|---|---|
| A. | High density polymer | Ethene |
| B. | Neoprene | Chloroprene |
| C. | Natural rubber | Isoprene |
| D. | Teflon | Tetrafluoroethene |
| E. | Acrilan | Acrylonitrile |

**Q. 39** Match the polymers given in Column I with their chemical names given in Column II.

| Column I | | Column II | |
|---|---|---|---|
| A. | Nylon-6 | 1. | Polyvinyl chloride |
| B. | PVC | 2. | Polyacrylonitrile |
| C. | Acrilan | 3. | Polycaprolactum |
| D. | Natural rubber | 4. | Low density polythene |
| E. | LDP | 5. | *cis*-polyisoprene |

**Ans.** **A.** → (3) **B.** → (1) **C.** → (2) **D.** → (5) **E.** → (4)

Column I represents various polymers and Column II represents their chemical names.

| Column I | | Column II |
|---|---|---|
| A. | Nylon-6 | Polycaprolactum |
| B. | PVC | Polyvinyl chloride |
| C. | Acrilan | Polyacrylonitrile |
| D. | Natural rubber | *cis*-polyisoprene |
| E. | LDP | Low density polythene |

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**Q. 40** Match the polymers given in Column I with their commercial names given in Column II.

| | Column I | | Column II |
|---|---|---|---|
| A. | Polyester of glycol and phthalic acid | 1. | Novolac |
| B. | Copolymer of 1, 3-butadiene and styrene | 2. | Glyptal |
| C. | Phenol and formaldehyde resin | 3. | Buna-S |
| D. | Polyester of glycol and terephthalic acid | 4. | Buna-N |
| E. | Copolymer of 1,3- butadiene and acrylonitrile | 5. | Dacron |

**Ans.** **A.** → (2) **B.** → (3) **C.** → (1) **D.** → (5) **E.** → (4)

Column I represents monomers of polymer and Column II represents their commercial name.

| | Column I | Column II |
|---|---|---|
| A. | Polyester of glycol and phthalic acid | Glyptal |
| B. | Copolymer of 1, 3-butadiene and styrene | Buna-S |
| C. | Phenol and formaldehyde resin | Novolac |
| D. | Polyester of glycol and terephthalic acid | Dacron |
| E. | Copolymer of 1, 3-butadiene and acrylonitrile | Buna-N |

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**Q. 41** Match the polymers given in Column I with their main applications given in Column II.

| | Column I | | Column II |
|---|---|---|---|
| A. | Bakelite | 1. | Unbreakable crockery |
| B. | Low density polyethene | 2. | Non-stick cookwares |
| C. | Melamine-formaldehyde resin | 3. | Packaging material for shock absorbance |
| D. | Nylon-6 | 4. | Electrical switches |
| E. | Polytetrafluoroethane | 5. | Squeeze bottles |
| F. | Polystyrene | 6. | Tyre, cords |

**Ans.** **A.** → (4) **B.** → (5) **C.** → (1) **D.** → (6) **E.** → (4) **F.** → (3)

| | Column I | Column II |
|---|---|---|
| A. | Bakelite | Electrical switches |
| B. | Low density polyethene | Squeeze bottles |
| C. | Melamine-formaldehyde resin | Unbreakable crockery |
| D. | Nylon-6 | Tyre, cords |
| E. | Polytetrafluoroethane | Non-stick cookwares |
| F. | Polystyrene | Packaging material for shock absorbance |

**Q. 42** Match the polymers given in Column I with the preferred mode of polymerisation followed by their monomers Column II.

| | Column I | | Column II |
|---|---|---|---|
| A. | Nylon-6,6 | 1. | Free radical polymerisation |
| B. | PVC | 2. | Ziegler-Natta polymerisation or coordination polymerisation |
| C. | HDP | 3. | Anionic polymerisation |
| | | 4. | Condensation polymerisation |

**Ans.** **A.** → (4) **B.** → (1) **C.** → (2)

Column I represents name of various polymer and Column II represents mechanism of polymerisation. Correct matching can be done as

| | Column I (Polymer) | Column II (Mechanism of polymerisation) |
|---|---|---|
| A. | Nylon- 6, 6 | Condensation polymerisation |
| B. | PVC | Free radical polymerisation |
| C. | HDP | Ziegler-Natta polymerisation or coordination polymerisation |

**Q. 43** Match the polymers given in Column I with the type of linkage present in them given in Column II.

| | Column I | | Column II |
|---|---|---|---|
| A. | Terylene | 1. | Glycosidic linkage |
| B. | Nylon | 2. | Ester linkage |
| C. | Cellulose | 3. | Phosphodiester linkage |
| D. | Protein | 4. | Amide linkage |
| E. | RNA | | |

**Ans.** **A.** → (2) **B.** → (4) **C.** → (1) **D.** → (4) **E.** → (3)

Column I represents name of polymer and Column II represents types of linkage. Hence, correct matching can be done as

| | Column I | Column II |
|---|---|---|
| A. | Terylene | Ester linkage |
| B. | Nylon | Amide linkage |
| C. | Cellulose | Glycosidic linkage |
| D. | Protein | Amide linkage |
| E. | RNA | Phosphodiester linkage |

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**Q. 44** Match materials given in Column I with the polymers given in Column II.

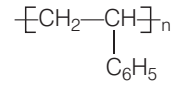
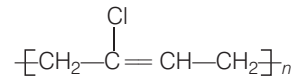
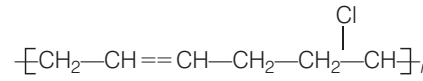
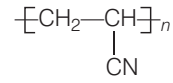
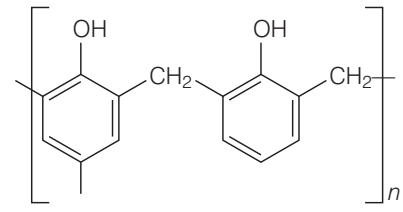
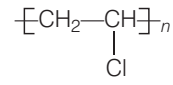
| Column I | | Column II | |
|---|---|---|---|
| A. | Natural rubber latex | 1. | Nylon |
| B. | Wood laminates | 2. | Neoprene |
| C. | Ropes and fibres | 3. | Dacron |
| D. | Polyester fabric | 4. | Melamine formaldehyde resins |
| E. | Synthetic rubber | 5. | Urea-formaldehyde resins |
| F. | Unbreakable crockery | 6. | *cis*-polyisoprene |

**Ans.** **A.** → (6) **B.** → (5) **C.** → (1) **D.** → (3) **E.** → (2) **F.** → (4)

Column I represents various uses or precursurs of polymers and Column II represents name of related polymer. The correct matching can be done as

| Column I | | Column II |
|---|---|---|
| A. | Natural rubber latex | *cis*-polyisoprene |
| B. | Wood laminates | Urea-formaldehyde resins |
| C. | Ropes and fibres | Nylon |
| D. | Polyester fabric | Dacron |
| E. | Synthetic rubber | Neoprene |
| F. | Unbreakable crockery | Melamine formaldehyde resins |

**Q. 45** Match the polymers given in Column I with their repeating units given in Column II.

| Column I | | Column II | |
|---|---|---|---|
| A. | Acrilan | 1. |  |
| B. | Polystyrene | 2. |  |
| C. | Neoprene | 3. |  |
| D. | Novolac | 4. |  |
| E. | Buna–N | 5. |  |
| | | 6. |  |

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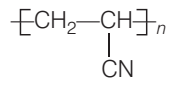
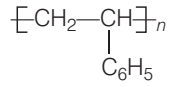
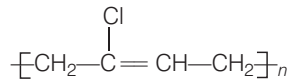
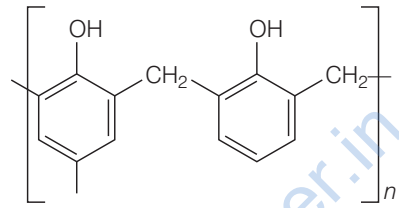
**Ans.** **A.** → (4) **B.** → (1) **C.** → (2) **D.** → (4) **E.** → (3)

Column I represents name of polymer and Column II represents their molecular formula. The correct matching can be done as

| | Column I | Column II |
|---|---|---|
| A. | Acrilan |  |
| B. | Polystyrene |  |
| C. | Neoprene |  |
| D. | Novolac |  |
| E. | Buna–N |  |

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## Assertion and Reason

*In the following questions a statement of assertion* (A) *followed by a statement of reason* (R) *is given. Choose the correct answer out of the following choices.*

(a) Assertion and Reason both are correct statement But reason does not explain Assertion.

(b) Assertion and Reason both are correct statements and Reason explains the Assertion.

(c) Both assertion and reason are wrong statements.

(d) Assertion is correct statement and Reason is wrong statement.

(e) Assertion is wrong statement and reason is correct statement.

**Q. 46** **Assertion** (A) Rayon is a semisynthetic polymer and is taken as a better choice than cotton fabric.

**Reason** (R) Mechanical and aesthetic properties of cellulose can be improved by Acetylation.

**Ans.** ***(b)*** Assertion and reason both are correct and reason explains the assertion.

Rayon is a semisynthetic polymer and is taken as a better choice than cotton fabric because mechanical and aesthetic properties of cellulose can be improved by acetylation.

**Q. 47** **Assertion** (A) Most of the synthetic polymers are not biodegradable.

**Reason** (R) Polymerisation process induces toxic character in organic molecules.

**Ans.** *(d)* Assertion is correct statement but reason is not correct statement. Most of synthetic polymers are not biodegradable because they are not easily broken by soil organisms and hazardous to the environment.

**Q. 48** **Assertion** (A) Olefinic monomers undergo addition polymerisation.

**Reason** (R) Polymerisation of vinyl chloride is initiated by peroxides/persulphates.

**Ans.** *(a)* Assertion and reason both are correct but reason does not explain assertion.

Olefin monomers undergo addition polymerisation because it add on to other monomers of olefin through free radical mechanism due to the presence of peroxide initiator and double bond and produces high molecular mass polymers.

**Q. 49** **Assertion** (A) Polyamides are best used as fibres because of high tensile strength.

**Reason** (R) Strong intermolecular forces (like hydrogen bonding within polyamides) lead to close packing of chains and increase the crystalline character, hence, provide high tensile strength to polymers.

**Ans.** *(b)* Assertion and reason both are correct and reason explains assertion. Polyamides are best used as fibres because of high tensile strength. This is due to strong intermolecular forces (like hydrogen bonding within polyamides) lead to close packing of chains and increase the crystalline character, hence, provide high tensile strength to polymers.

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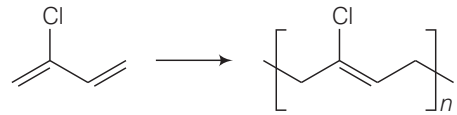
**Q. 50** **Assertion** (A) For making rubber synthetically, isoprene molecules are polymerised.

**Reason** (R) Neoprene (a polymer of chloroprene) is a synthetic rubber.

**Ans.** *(e)* Assertion is wrong and reason is correct statement. Correct assertion is, neoprene is a naturally occurring polymer of chloroprene prepared by polymerisation of 2-chloro butadiene.




Chloroprene Neoprene

**Q. 51** **Assertion** (A) Network polymers are thermosetting.

**Reason** (R) Network polymers have high molecular mass.

**Ans.** *(a)* Assertion and reason both are correct and reason does not explain assertion.

Network polymers are thermosetting because they can't be reused after heating once. Because after heating it undergo extensive cross linking in moulds and again become infusible.

**Q. 52** **Assertion** (A) Polytetrafluoroethene is used in making non-stick cookwares.

**Reason** (R) Fluorine has highest electronegativity.

**Ans.** *(a)* Assertion and reason both are correct but reason does not explain assertion.

Polytetrafluoroethene (teflon) is used in making non-stick cookwares because it is chemically inert, thermally stable and resistant to attack by corrosive reagents.

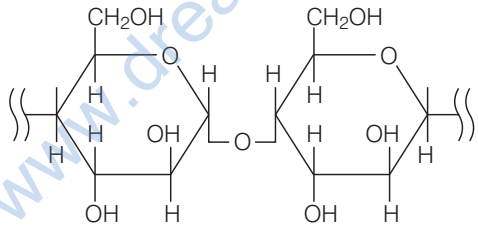
## Long Answer Type Questions

**Q. 53** Synthetic polymers do not degrade in the environment for a long time. How can biodegradable synthetic polymers be made. Differentiate between biopolymers and biodegradable polymers and give examples of each type.

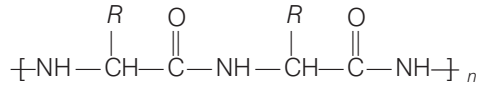
**Ans.** Synthetic polymers are quite resistant to environmental degradation process and are responsible for accumulation of polymer solid waste material. New biodegradable synthetic polymers have been designed and developed. These polymers contain similar functional groups as present in biopolymers.

*e.g.,* aliphatic polyesters

Biopolymer, are polymers of amino acid or carbohydrates which are linked to each other by peptide or glycosidic linkages as shown below



Starch (polymer of glucose)



Polymer of amino acid

Biopolymer can or can't be biodegradable.

*e.g.*, protein, starch etc, are biodegradable but keratin are non-biodegradable.

Biodegradable polymer are polymers which can be degradable always.

*e.g.,* DHBV nylon-2, Nylon-6

**Q. 54** Differentiate between rubbers and plastics on the basis of intermolecular forces.

**Ans.** Rubber is a natural polymer which possess elastic properties. Natural polymer is a linear polymer of isoprene (2-methyl-1, 3-butadiene).

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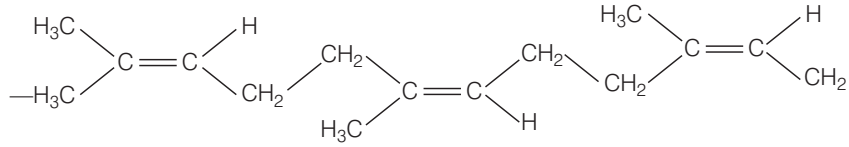
In natural rubber *cis*-polyisoprene molecules consists of various chains held together by weak van der Waals' interaction and has coiling structure. So, it can be stretched like a spring.



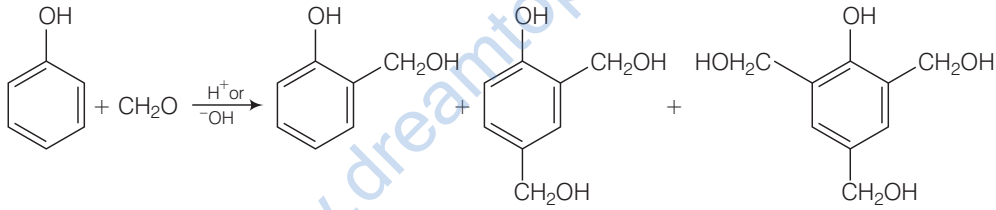
Natural rubber

Plastics are generally polymer of ethene known as polythene. Polythene is thermoplastic polymer which may be linear (HDP) or branched (LDP) these type of polymers. Possesses intermediate intermolecular forces of attraction. It has linear, structure that can be moulded but can't be regained on its original shape after stretching.

**Q. 55** Phenol and formaldehyde undergo condensation to give a polymar (A) which on heating with formaldehyde gives a thermosetting polymer (B). Name the polymers. Write the reactions involved in the formation of (A). What is the structural difference between two polymers?

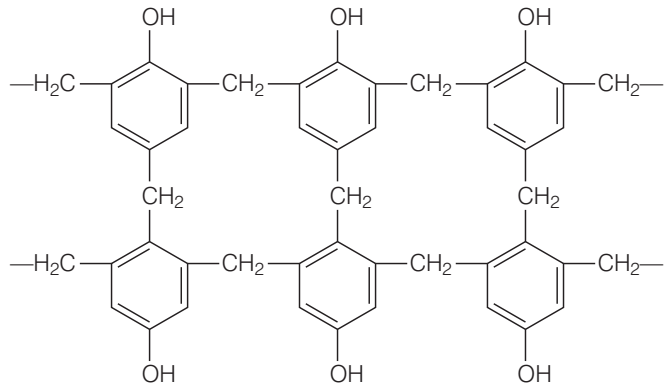
**Ans.** Phenol and formaldehyde undergo condensation to give a polymer novolac (*A*) which on heating with formaldehyde gives bakelite (*B*) as a thermosetting polymer.

Sequence of the reaction can be written as



Novolac (*A*)

Structural difference in between these two is that novolac is a linear polymer while bakelite is a cross linked polymer.



Bakelite (*B*)

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**Q. 56** Low density polythene and high density polythene, both are polymers of ethene but there is marked difference in their properties. Explain.

**Ans.** Low density and high density polythenes are obtained under different conditions. These differ in their structural features. Low density polythenes are highly branched structures while high density polythene consists of closely packed linear molecules. Close packing increases the density.

**Q. 57** Which of the following polymers soften on heating and harden on cooling? What are the polymers with this property collectively called? What are the structural similarities between such polymers? Bakelite, urea-formaldehyde resin, polythene, polyvinyls, polystyrene.

**Ans.** Polythene, polyvinyls and polystyrene soften on heating and harden on cooling. Such polymers are called thermoplastic polymers. These polymers are linear array of slightly branched long chain molecules.

These possess intermolecular forces whose strength lies between strength of intermolecular forces of elastomers and fibres while bakelite, urea formaldehyde resin are thermosetting polymers which on heating undergo extensive cross linking in moulds and again become infusible.

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