CHAPTER 26 — POLYMERS

Notes · Chemistry-10 (Full Chapter Compilation)

DESCRIPTIVE QUESTIONS

Q.1 Define polymerization. How are polymers useful for us? *[10226001]*

Ans. Key points: Polymers | Polymerization | Importance of Polymers

Polymers

Polymers or macromolecules are ***extremely*** *large molecules which are formed by linking together a very large number of simple molecular units called monomers.*

Polymerization

The process of formation of a polymer from a **monomer** is called polymerization. This reaction usually occurs under high pressure and in the presence of a **catalyst**.

$nCH_2=CH_2 \rightarrow -[CH_2-CH_2]_n-$ (Ethene → Polyethene)

Examples

- **(i) Natural polymers:** Carbohydrates, proteins and nucleic acids are the everyday examples of polymers which exist naturally.
- **(ii) Man-made polymers:** Plastics, synthetic fibers, and natural rubber are the examples of man-made polymers.

Importance of polymers

- One of the most significant changes which has occurred throughout the world has been the gradual replacement of metals, wood and cotton with man-made synthetic polymers.
- Polymers are important in our daily life due to their high strength, flexibility and resistance to heat and chemicals. These properties make them useful for a wide range of applications.

TYPES OF POLYMERS

Q.2 What are the types of polymers? Explain addition polymers with examples. *[10226002]*

Ans. Key points: Types of Polymers | Addition Polymers

Types of polymers

There are two main types of polymers:

- (a) Addition Polymers
- (b) Condensation Polymers

Addition Polymers

Addition polymers are a type of polymers which are formed when **monomer** *molecules containing a double bond combine together through a* **covalent bond** *to give a very large molecule without producing any by-product.*

Example: A large number of ethene molecules add together to give one very big molecule which is called **polyethene** or polythene. During this reaction, the C=C double bond in ethene breaks down to allow ethene molecules to join together.

Conditions: Polymerization reactions usually take place at **high pressure** and in the presence of a catalyst.

By-product: In addition polymerization, **no molecule** is eliminated and no by-product is formed.

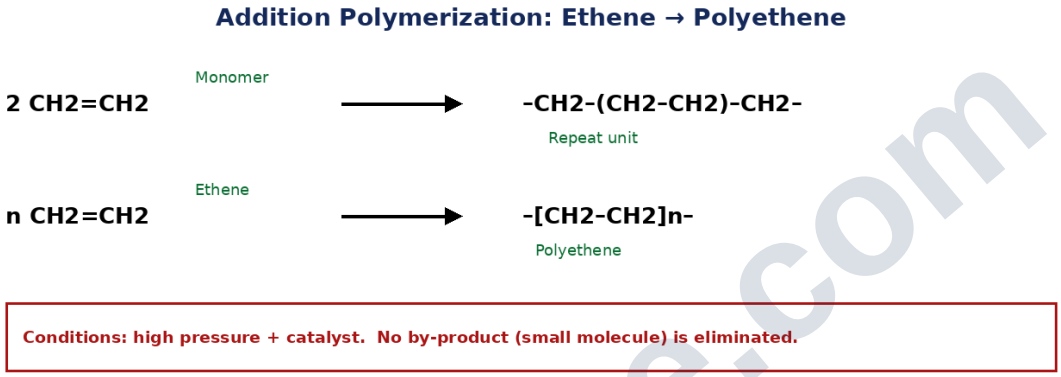


Fig. 26.1 — Addition polymerization: ethene monomers joining to form the repeat unit and polyethene

26.1 Quick Check

1. Give an example of a commercial product which is formed using polyethene. *[10226003]*

Ans. A common commercial product made from polyethylene is plastic shopping bags. These are usually made from low-density polyethylene (LDPE) which makes them light, flexible and waterproof. Other examples include food packaging films, buckets and containers etc.

2. Write three properties of synthetic polymers. *[10226004]*

Ans. The three important properties of synthetic polymers are:

- **(i) Durability:** Synthetic polymers are strong and long lasting.
- **(ii) Light weight:** Most synthetic polymers are very light in weight, making them easy to handle.
- **(iii) Resistance to chemicals and corrosion:** They are resistant to many chemicals, acids and water.

Q.3 Explain condensation polymers with examples. How are polyethylene terephthalate (PET) and polyamides formed? How can you recycle PET? *[10226005]*

Ans. Key points: Condensation Polymers | Polyethylene Terephthalate | Polyamides

Condensation polymers

A condensation polymer is formed when two **different** *molecules containing two different* **functional groups** *react together with the elimination of a small molecule like H2O, HCl and NH3 etc.*

Condition: The reaction takes place in the presence of an **acid** or a **base**.

Examples of condensation polymers: Polyethylene terephthalate (PET) and polyamide etc.

Polyethylene terephthalate (PET) or (Polyester)

Ethane diol reacts with a **dicarboxylic acid** *(terephthalic acid) to give a polymer called Polyethylene Terephthalate (PET) or (polyester).*

The **carboxyl group** present in terephthalic acid reacts with the **hydroxyl group** of the diol to give an **ester linkage**.

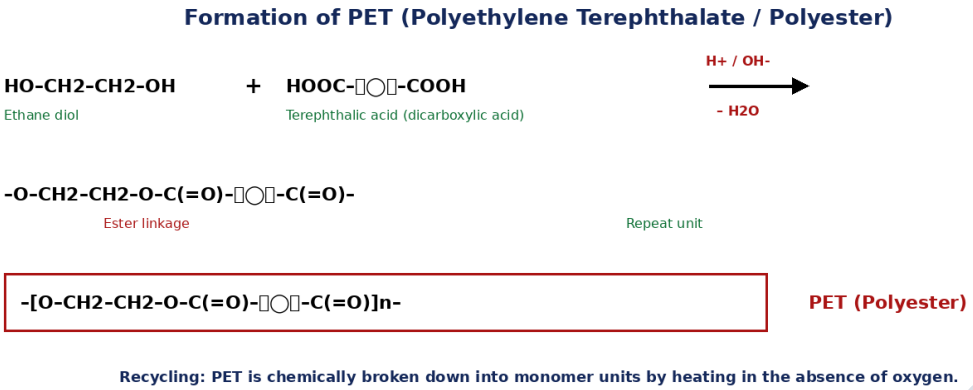


Fig. 26.2 — Formation of PET from ethane diol and terephthalic acid via an ester linkage

Repeating unit

This product is called a repeat unit. Since the functional groups are present at both ends of the resulting molecule, the polymerization process continues at both ends to give a very big molecule.

Recycling of PET

PET can be **recycled** by chemically breaking it down to the monomer units. Chemical recycling can be done through heating the polymer in the **absence** of oxygen.

Polyamide

Another condensation polymer, a **polyamide**, is formed when **butanedioic acid** reacts with a diamine. Each –COOH group of the dicarboxylic acid reacts with each –NH2 group present in diamine to form an **amide linkage**. A **water** molecule is lost during the condensation reaction. The repeat unit thus formed is then converted into a polymer. Polyamides are strong and widely used in synthetic fibers such as nylon.

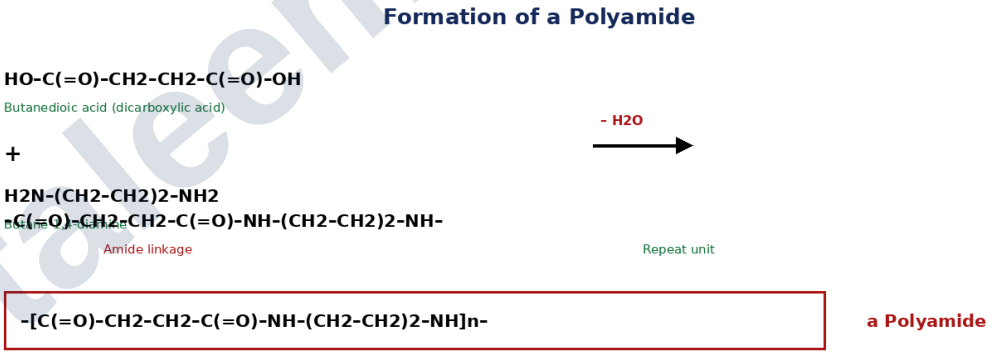


Fig. 26.3 — Formation of a polyamide from butanedioic acid and butane-1,4-diamine via an amide linkage

26.2 Quick Check

1. How is an ester linkage between two monomers formed? *[10226006]*

Ans. An ester linkage is formed by a condensation reaction between two monomers:

- Carboxylic acids
- Alcohols

R–C(=O)–OH + R'–OH → R–C(=O)–O–R' + H2O (Carboxylic acid + Alcohol → Ester)

2. How does condensation polymerization occur? *[10226007]*

Ans. Condensation polymerization occurs when small monomers join together by forming covalent bonds while eliminating small molecules like water or NH3.

Examples: Formation of polyester and polyamides.

Interesting Information!

S.Q. How can the properties of polymers be changed according to a specific application? Give an example. *[10226008]*

Ans. Properties of polymers can be changed through careful control of their chemical structure and composition, enabling their use in highly specific applications like non-stick coating (Teflon).

Q.4 Differentiate between addition and condensation polymerization. *[10226009]*

Ans. Key point: Difference between Addition and Condensation Polymerization

Addition Polymerization	Condensation Polymerization
(i) Single type of monomer: A single monomer is used which should have a double or a triple bond.	**(i) Different types of monomers:** This polymerization takes place between two monomers. The monomer molecules have two functional groups present, one on each end of the molecule.
(ii) Nature of reaction: It involves an addition reaction and only a single product is formed.	**(ii) Nature of reaction:** It involves the condensation between two monomers with the elimination of a small molecule like H2O, HCl or NH3.
(iii) Molecular mass: The molecular mass of the product polymer can be found by adding the molecular masses of all the monomers used.	**(iii) Molecular mass:** The molecular mass of the polymer cannot be found by adding the molecular masses of all the monomers.
(iv) Nature of bond (monomer contains double or triple bond): The polymer formed contains only single bonds along the polymer backbone chain.	**(iv) Nature of bonds (monomer contains two functional groups):** The polymer formed contains a specific linkage, e.g. ester linkage or amide linkage.
Examples: Polyethene, polystyrene, polyvinylchloride (PVC), etc.	**Examples:** Polyester, nylon, bakelite, etc.

STRUCTURE OF MONOMER FROM POLYMER

Q.5 Explain how the structure of a monomer is obtained from addition and condensation polymer. *[10226010]*

Ans. Key point: Structure of Monomer from Polymer

(a) Addition Polymer

- (i) Write down the structure of the addition polymer.

$$-[CH_2-CH_2]_n-$$

- (ii) Identify the repeating unit in the polymer. Remove the brackets, the extended bonds from each side and the subscript n. Change the single bond to a double bond.

$$-[CH_2-CH_2]_n- \rightarrow -CH_2-CH_2- \rightarrow CH_2=CH_2$$

(b) Condensation polymer

To obtain the monomers from a condensation polymer, the repeat unit of the polymer is identified and the brackets and subscript are removed.

26.1 Example

(i) Write down the structure of a condensation polymer, e.g. polyester. *[10226011]*

$$-[CO-CH_2-CH_2-CO-O-CH_2-CH_2-O]_n-$$

(ii) Identify the repeating unit in the polymer. Remove the brackets, the extended bonds at both ends and the subscript n. Break the bond between CO and O of the ester linkage. Add OH to each end of the dicarboxylic acid monomer. Add H to each end of the diol monomer.

$$-[CO-CH_2-CH_2-CO-O-CH_2-CH_2-O]_n-$$

$$n\ -[CO-CH_2-CH_2-CO-O-CH_2-CH_2-O]- \rightarrow$$

$$n\ HO-CO-CH_2-CH_2-CO-OH + n\ H-O-CH_2-CH_2-O-H$$

26.2 Example

(i) Write down the structure of a condensation polymer, a polyamide. *[10226012]*

$$-[CO-CH_2-CH_2-CO-NH-(CH_2-CH_2)_2-NH]_n-$$

(ii) Identify the repeating unit in the polymer. Remove the brackets, the extended linkage at both ends and the subscript n. Break the bond between CO and NH of the amide linkage. Add OH to each end of the dicarboxylic acid monomer. Add H to each end of the diamine monomer.

$$n\ -[CO-CH_2-CH_2-CO-NH-(CH_2-CH_2)_2-NH]- \rightarrow$$

$$n\ HO-CO-CH_2-CH_2-CO-OH + n\ H-NH-(CH_2-CH_2)_2-NH-H$$

26.3 Quick Check

1. What do you understand by the term repeating unit? *[10226013]*

Ans. A repeating unit is the smallest structural part of a polymer that repeats again and again to form the long polymer chain. It is also known as a monomer.

Example: In polyethene (polymer), Monomer = ethene ($CH_2=CH_2$), Repeating unit = $-[CH_2-CH_2]-$

2. Draw the structure of a polyamide linkage. *[10226014]*

Ans. The polyamide linkage (amide bond) is formed between a $-COOH$ (carboxyl group) and a $-NH_2$ (amino group). It is formed by condensation reaction with loss of a water molecule.

$$-[CO-CH_2-CH_2-CO-NH-(CH_2-CH_2)_2-NH]_n- \quad \text{(Amide linkage in polyamide)}$$

Interesting Information!

S.Q. How do chemists make polymers of desired properties? *[10226015]*

Ans. By varying the type and proportion of monomers, chemists can make polymers which show specific properties, such as flexibility, strength and thermal stability, to meet specific application requirements.

PLASTICS

Q.6 What are plastics? Describe their uses and properties. *[10226016]*

Ans. Key points: Plastics | Uses of Plastics | Properties of Plastics

Plastics

Polymerization of monomers like ethylene, propylene and styrene gives **polyethylene (PE)**, **polypropylene (PP)** and **polystyrene (PS)** respectively. All these polymers are a few examples of compounds called Plastics.

Uses of plastics

- These plastics are used to make all types of carry-home food containers, e.g. soft drink bottles, water bottles, juice bottles etc.
- They are also used to manufacture shopping bags, kitchen-wares, buckets, tables, chairs, food wrappers, cups and plates etc.

Properties of plastics

- Plastics are light weight, flexible and durable.
- They can be easily moulded into solid objects of almost any desired shape.
- All these properties have led to their widespread use in almost every sphere of our daily life. Starting from the early 20th century, millions of tons of plastics are made every year (Fig. 26.1: everyday plastic products such as chairs, buckets, containers, cups and storage boxes).

IMPORTANCE OF POLYMERS IN TEXTILE INDUSTRY

Q.7 Describe the role of synthetic polymers in the textile industry. *[10226017]*

Ans. Key points: Importance of Polymers in Textile Industry | Properties of Synthetic Fibers | Uses of Synthetic Fibers

Importance of polymers in textile industry

Polymers which are used in the textile industry are called **synthetic fibers**.

Examples: The examples of synthetic fibers are nylon, polyester, rayon, acrylic etc.

Properties of synthetic fibers

The properties of synthetic fibers which enable them to be used in the textile industry are as follows:

- (i) They are cheaper in cost than natural fibers like cotton and silk.
- (ii) They are stronger and more durable than natural fiber.
- (iii) They do not shrink.
- (iv) They resist wrinkling.
- (v) They are light weight and quick drying.
- (vi) They are moth and insect resistant.

Uses of synthetic fibers

- The polyesters and nylon are the two common polymers which account for **69%** of all the material used in the clothing industry worldwide.
- Polyester is an important fiber for its strength and resistance to shrinking. It is commonly used in sportswear and hosiery.
- Acrylic is light weight, soft and provides warmth (Fig. 26.2: rolls of synthetic fabric used in the textile industry).

ADVERSE EFFECTS OF PLASTICS

Q.8 Describe the adverse effects of synthetic polymers on the environment. *[10226018]*

Ans. Key points: Adverse Effects of Plastics | Plastics Pollution | Attempts to Reduce Plastic Pollution

Adverse effects of plastics

Unlike other materials, plastics do not undergo **biodegradation**. When articles made of plastics are discarded, they can take **upto 1000 years** to break down. This fact has led to a build-up of huge amounts of plastics in the environment.

Plastic pollution

- Accumulation of such a huge amount of different articles made of plastics has caused widespread environmental problems.
- Plastic pollution is found almost everywhere — on lands, in air and in all the water bodies: rivers, ponds, lakes, seas and oceans. This pollution has reached an extremely alarming level and has led to serious health problems (Fig. 26.3: plastic waste accumulating on beaches and posing a hazard to marine life such as sea turtles).

Attempts to reduce plastic pollution

Discarded plastic articles we put in the bins are disposed of through burning, dumping in the landfill, or thrown in the drains from where they make their way to rivers and oceans. Burning of discarded plastic articles in town creates a hazardous environmental condition because this releases dangerous gases in the air.

Interesting Information!

S.Q. How can polymers be 3D printed? *[10226019]*

Ans. Polymers can be 3D printed using a variety of techniques. These techniques involve layer-by-layer deposition of the polymer material to create three-dimensional objects.

MULTIPLE CHOICE QUESTIONS (EXERCISE)

A. *Choose and tick the correct answer from the given choices.*

1. Which of the following polymer is a synthetic polymer? *[10226020]*
(a) Starch (b) Cellulose (c) Animal fat (d) Polyester

2. Which polymer has an amide linkage? *[10226021]*
(a) Polyester (b) Polyamide (c) Polyethene (d) Polystyrene

3. Identify an ester linkage: *[10226022]*
(a) R–C(=O)–O–R (b) R–C(=O)–R (c) R–C(=O)–O–NH–R (d) R–C(=O)–NH–R

4. The structure of the monomer of –[CH2–CH]n– / OCOCH3 is: *[10226023]*
(a) CH2=CH2 (b) CH2=CH–CH3 (c) CH2=CH–OCOCH3 (d) CH2=CH–CO–O–CH3

5. Which of the following polymers can be recycled? *[10226024]*
(a) PET (b) Polystyrene (c) PVC (d) Epoxy

6. Which of the following polymers is biodegradable? *[10226025]*
(a) Polyamide (b) Polyester (c) Starch (d) PET

7. Which of the following polymers is obtained by condensation polymerization? *[10226026]*
(a) Polyvinyl chloride (b) Polystyrene (c) Polyamide (d) Polyethene

SLO Based Multiple Choice Questions

Types of Polymers

8. Polymers are formed by linking many small molecules

19. PET is formed by the reaction of: *[10226038]*

called: [10226027]
(a) Atoms (b) Monomers (c) Ions (d) Elements

9. The process in which a polymer is formed from monomers is called: [10226028]
(a) Oxidation (b) Polymerization (c) Reduction (d) Combustion

10. Which of the following is a natural polymer? [10226029]
(a) Plastic (b) Synthetic fiber (c) Protein (d) Nylon

11. Which monomer forms polyethene? [10226030]
(a) Ethane (b) Ethene (c) Methane (d) Propane

12. In addition polymerization: [10226031]
(a) Water is produced (b) CO2 is produced (c) No by-product is formed (d) Oxygen is released

13. Addition polymerization occurs mainly at: [10226032]
(a) Low pressure (b) High pressure (c) Normal pressure (d) Vacuum

14. The bond broken in ethene during polymerization is: [10226033]
(a) Single bond (b) Double bond (c) Triple bond (d) Ionic bond

15. A condensation polymer is formed when: [10226034]
(a) One monomer combines to form a long chain (b) Two different monomers react together (c) Metals react with acids (d) Oxygen reacts with hydrogen

16. In condensation polymerization, which type of molecule is usually eliminated? [10226035]
(a) Large molecule (b) Polymer (c) Small molecule (d) Gas only

17. Which of the following can be eliminated during condensation polymerization? [10226036]
(a) H2O (b) HCl (c) NH3 (d) All of these

18. PET stands for: [10226037]
(a) Polyethylene terephthalate (b) Poly ethane tetra molecule (c) Poly ester tetra (d) Poly ethyl tetra

(a) Ethene and Methane (b) Ethane diol and terephthalic acid (c) Ethane diol and ethene (d) Ethene and formic acid

20. The linkage formed in PET polymer is: [10226039]
(a) Amide linkage (b) Ester linkage (c) Ionic linkage (d) Metallic linkage

21. Polyamide is formed when: [10226040]
(a) Acid reacts with alcohol (b) Dicarboxylic acid reacts with diamine (c) Alkane reacts with oxygen (d) Metal reacts with acid

22. During polyamide formation, which molecule is removed? [10226041]
(a) CO2 (b) H2 (c) H2O (d) O2

23. Addition polymerization usually uses: [10226042]
(a) Two types of monomers (b) Three types of monomers (c) One type of monomer (d) Four types of monomers

24. Which polymer is used for non-stick coating? [10226043]
(a) Polyethylene (b) Poly vinyl chloride (c) Polyamide (d) Teflon

25. In addition polymerization, the monomers usually contain: [10226044]
(a) Single bond (b) Double or triple bond (c) Ionic bond (d) Hydrogen bond

26. Condensation polymerization produces: [10226045]
(a) No by-product (b) Only polymer (c) Polymer and small molecules (d) Gas only

27. In an addition polymer, the backbone chain contains: [10226046]
(a) Single bond (b) Double bonds (c) Hydrogen bond (d) Ionic bond

28. Which one of the following is an example of an addition polymer? [10226047]
(a) Nylon (b) Polyester (c) Polyethene (d) Bakelite

29. Which polymer is formed by condensation polymerization? [10226048]
(a) Polystyrene (b) PVC (c) Nylon (d) Polythene

Structure of Monomer from Polymer

30. The repeating unit of polyethene is: [10226049]
(a) –CH3 (b) –CH2–CH2– (c) –CH2– (d) CH3–CH3–

31. Polyester contains which type of linkage? [10226050]
(a) Amide linkage (b) Ester linkage (c) Ionic linkage (d) Metallic linkage

32. PVC stands for: [10226051]
(a) Polyvinyl carbon (b) Polyvinyl chloride (c) Polyvinyl compound (d) Polyvinyl citrate

33. In condensation polymerization, the polymer contains: [10226052]
(a) Only single bond (b) Special linkages like ester or amide (c) Only ionic bonds (d) Only hydrogen bonds

Plastics

34. Plastics are produced by polymerization of: [10226053]
(a) Metals (b) Monomers (c) Salts (d) Acids

35. Polymerization of propylene gives: [10226054]
(a) Polyethylene (b) Polypropylene (c) Nylon (d)

37. Plastics are generally: [10226056]
(a) Heavy and brittle (b) Light and flexible (c) Hard and metallic (d) Very expensive

38. The use of plastic started from: [10226057]

Polyester

36. Polystyrene is a polymer of: *[10226055]*
(a) Ethylene (b) Vinyl chloride (c) Styrene (d) Propylene

(a) End of 19th century (b) Early 19th century (c) Early 20th century (d) Late 20th century

Importance of Polymer in Textile Industry

39. Polymers used in the textile industry are called: *[10226058]*
(a) Synthetic fibers (b) Natural fibers (c) Metallic fibers (d) Chemical fibers

40. Which of the following is a synthetic fiber? *[10226059]*
(a) Cotton (b) Wool (c) Nylon (d) Silk

41. Synthetic fibers are generally: *[10226060]*
(a) More expensive than natural fibers (b) Cheaper than natural fibers (c) Very weak (d) Easily destroyed

42. Which of the following synthetic fibers is commonly used in clothing? *[10226061]*
(a) Polyester (b) Nylon (c) Acrylic (d) All of these

43. What percentage of all the material used in clothing do polyesters and Nylon make up? *[10226062]*
(a) 60% (b) 65% (c) 67% (d) 69%

Adverse Effects of Plastics

44. Plastics generally take about how long to decompose? *[10226063]*
(a) 10 years (b) 50 years (c) 100 years (d) upto 1000 years

45. Plastics do not undergo: *[10226064]*
(a) Oxidation (b) Polymerization (c) Biodegradation (d) Condensation

46. Plastic pollution is found in: *[10226065]*
(a) Land only (b) Water only (c) Air only (d) Land, air and water

47. Which disposal method contributes to plastic pollution? *[10226066]*
(a) Burning (b) Landfilling (c) Throwing in drains (d) All of these

Answer Key (Q. 1 – 47)

1	d	2	b	3	a	4	c	5	a	6	c	7	c
8	b	9	b	10	c	11	b	12	c	13	b	14	b
15	b	16	c	17	d	18	a	19	b	20	b	21	b
22	c	23	c	24	d	25	b	26	c	27	b	28	c
29	c	30	b	31	b	32	b	33	b	34	b	35	b
36	c	37	b	38	c	39	a	40	c	41	b	42	d
43	d	44	d	45	c	46	d	47	d				

SHORT ANSWER QUESTIONS (EXERCISE)

B. *Write Short Answers.*

1. Give two examples each of addition polymers and condensation polymers. *[10226067]*

Ans.

- **(i) Addition polymers:** The examples of addition polymers are polyethene, polystyrene, polyvinylchloride (PVC), etc.
- **(ii) Condensation polymers:** The examples of condensation polymers are polyester, nylon, bakelite, etc.

2. How are polymers useful for us? *[10226068]*

Ans. Polymers are important in our daily life due to their high strength, flexibility and resistance to heat and chemicals. These properties make them useful for us for a wide range of applications like the clothing industry, shopping bags, soft drink bottles, buckets, plastic furniture, food wrappers and electric accessories etc.

3. How are synthetic fibers different from natural fibers? *[10226069]*

Synthetic Fibers	Natural Fibers
Synthetic fibers are man-made polymers by chemicals.	Natural fibers come from plants and animals.
These are stronger and more durable, light weight and wrinkle resistant.	These are less durable and more expensive.
These are non-biodegradable.	These are biodegradable.

4. Are natural polymers hazardous for the environment? Explain why. *[10226070]*

Ans. No, natural polymers are not hazardous because they are biodegradable. Microorganisms can break them down easily so they do not accumulate in the environment.

5. Draw the structures of the following polymers: (a) Polypropylene (b) Polystyrene *[10226071]*

Ans. The structures of the polypropylene and polystyrene are:

(a) Polypropylene: —[CH2—CH(CH3)]n—

(b) Polystyrene: —[CH2—CH(C6H5)]n—

SLO Based Short Answer Questions

Introduction / Types of Polymers

6. What are polymers and monomers? *[10226072]*

Ans. Polymers: Polymers or macromolecules are extremely large molecules which are formed by linking together a very large number of simple molecular units called monomers.

Monomers: Monomers are small molecules that join together to form polymers.

7. Define polymerization. *[10226073]*

Ans. Polymerization: The process of formation of a polymer from a monomer is called polymerization. This reaction usually occurs under high pressure and in the presence of a catalyst.

8. Name the two types of polymers. *[10226074]*

Ans. These are the two main types of polymers:

- (a) Addition polymer
- (b) Condensation polymer

9. What are addition polymers? Give examples. *[10226075]*

Ans. Addition polymers: Addition polymers are formed when one type of monomer containing double bonds combine together without the loss of any small molecule.

Examples: Polyethene, poly vinyl chloride (PVC) etc.

10. Write equations for the formation of polyethene from its monomer. *[10226076]*

Ans. The equations for the formation of polyethene are:

2CH2=CH2 → —CH2—(CH2—CH2)—CH2— (Monomer → Repeat unit)

nCH2=CH2 → –[CH2–CH2]n– (Ethene → Polyethene)

11. What are condensation polymers? Give examples. *[10226077]*

Ans. Condensation polymers: Condensation polymers are formed when two different monomers react together with the elimination of a small molecule such as water, HCl or NH3.

Example: Ethane diol reacts with a dicarboxylic acid (terephthalic acid) to give a polymer called polyethylene terephthalate (PET).

12. What are the characteristics of condensation polymerization? *[10226078]*

Ans. Characteristics of condensation polymers:

- Monomers having two different functional groups join together to form condensation polymers.
- It involves elimination of small molecules like H2O, HCl and NH3.
- Polymers formed contain a specific linkage like ester linkage or amide linkage.

13. What is PET? What type of linkage is present in PET? *[10226079]*

Ans. PET is polyethylene terephthalate, a condensation polymer formed from ethanediol and terephthalic acid. Ester linkage is present in PET.

14. What is a repeat unit? *[10226080]*

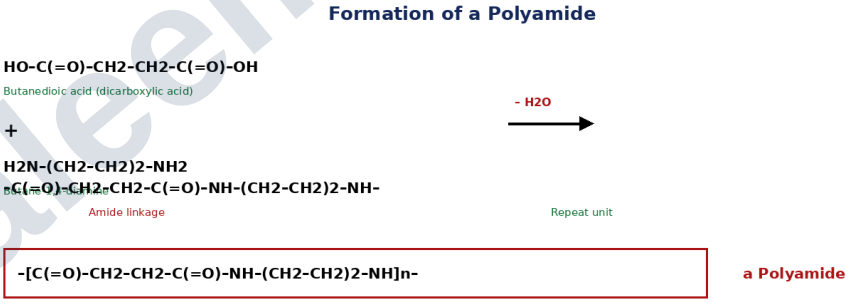
Ans. A repeat unit is the basic structural unit of a polymer that repeats many times to form a long polymer chain.

15. How can PET be recycled? *[10226081]*

Ans. PET can be recycled by chemically breaking it down into its monomer units by heating in the absence of oxygen.

16. What is polyamide? *[10226082]*

Ans. A polyamide is a condensation polymer formed when a dicarboxylic acid reacts with a diamine. Each –COOH group of the dicarboxylic acid reacts with each –NH2 group present in diamine to form an amide linkage. A water molecule is lost during the condensation reaction.



Formation of a polyamide (see Fig. 26.3)

17. What type of bonding is present in addition and condensation polymers? *[10226083]*

Ans. Addition polymers: The polymer formed contains only a single bond along the polymer backbone chain.

Condensation polymers: A condensation polymer contains a specific linkage like ester linkage or amide linkage.

18. Give examples of addition and condensation polymers. *[10226084]*

Ans. Addition polymers:

- Polyethene
- Polystyrene

- Poly vinyl chloride (PVC) etc.

Condensation polymers:

- Polyester
- Nylon
- Bakelite etc.

Structure of Monomer from Polymers

19. How can the monomer be identified from an addition polymer? *[10226085]*

Ans. (i) Write down the structure of the addition polymer.

(ii) Identify the repeating unit in the polymer. Remove the brackets and the subscript n. Change the single bond in the repeating unit into a double bond to obtain the monomer.

$$-[CH_2-CH_2]_n- \rightarrow n\ -[CH_2-CH_2]- \rightarrow CH_2=CH_2$$

20. How is the monomer identified in condensation polymers? *[10226086]*

Ans. The monomer is identified as follows:

(i) Write down the structure of a condensation polymer, polyester.

$$-[CO-CH_2-CH_2-CO-O-CH_2-CH_2-O]_n-$$

(ii) Identify the repeating unit in the polymer. Remove the brackets, the extended bonds at both ends and the subscript n. Break the bond between CO and O of the ester linkage. Add OH to each end of the dicarboxylic acid monomer. Add H to each end of the diol monomer.

$$n\ -[CO-CH_2-CH_2-CO-O-CH_2-CH_2-O]- \rightarrow$$
$$n\ HO-CO-CH_2-CH_2-CO-OH + n\ H-O-CH_2-CH_2-O-H$$

Plastic

21. What are plastics? *[10226087]*

Ans. Plastics are polymers produced by polymerization of monomers such as ethylene, propylene and styrene etc.

22. Name three common plastics. *[10226088]*

Ans. Common plastics are:

- Polyethylene (PE)
- Polypropylene (PP)
- Polystyrene (PS)

23. Write properties of plastics. *[10226089]*

Ans. The properties of plastics are:

- Lightweight
- Flexible
- Durable
- Resist wrinkling
- Do not shrink

24. Give uses of plastics. *[10226090]*

Ans. Plastics are used almost everywhere. Some of the uses of plastics are:

- Used in shopping bags

- Water bottles
- Kitchenware
- Chairs and tables etc.

Importance of Polymers in Textile Industry

25. What are synthetic fibers? *[10226091]*

Ans. Polymers used in the textile industry are called synthetic fibers. These fibers are produced by chemical processes and are used to manufacture clothes and fabrics.

Examples: Nylon, polyester, rayon, and acrylic etc.

26. Write some properties of synthetic fibers. *[10226092]*

Ans. These fibers are important because they are:

- Strong
- Lightweight
- Durable
- Resistant to chemicals and wrinkles

27. Why are synthetic fibers cheaper than natural fibers? *[10226093]*

Ans. Synthetic fibers are cheaper because they are produced industrially from chemical substances and can be manufactured in large quantities. Natural fibers come from plants and natural sources; as they are not available in higher quantity, they are more expensive than synthetic fibers.

28. Why do synthetic fibers not shrink easily? *[10226094]*

Ans. Synthetic fibers do not shrink easily because they have strong polymer chains which resist shrinking.

29. What are the common synthetic fibers used in the textile industry? *[10226095]*

Ans. The fibers used in the textile industry are:

- Nylon
- Polyester
- Rayon
- Acrylic etc.

30. What is acrylic? *[10226096]*

Ans. Acrylic is light weight, soft and provides warmth. Acrylic fibers are used in the textile industry.

31. Why are plastics harmful to the environment? *[10226097]*

Ans. Plastics are harmful because they do not biodegrade and remain in the environment for a very long time.

32. What is plastic pollution? *[10226098]*

Ans. Plastic pollution is the accumulation of plastic waste in the environment causing environmental and health problems.

CONSTRUCTED RESPONSE QUESTIONS

1. Why is it dangerous to burn discarded articles made of plastics? *[10226099]*

Ans. Burning plastics releases toxic gases such as carbon monoxide and harmful chemicals. These gases cause air pollution and serious health problems.

2. Why is it not advisable to dump discarded synthetic articles in oceans? *[10226100]*

Ans. Synthetic polymers do not biodegrade and remain in water for a very long time. They pollute oceans and harm marine life because animals may swallow plastic or get trapped in it. They cause clogging of gills among fish.

3. What is the role of catalyst in addition polymerization? *[10226101]*

Ans. A catalyst increases the rate of the polymerization reaction and helps monomers join together more easily to form polymers.

4. Deduce the monomer from the following addition polymers: (i) –[CH2–CH]n– / Cl (ii) –[CH2–CH]n– / CN *[10226102]*

Ans. (i) The monomer of the polymer can be deduced as:

(a) Structure of the addition polymer:

–[CH2–CH]n– / Cl (Polyvinyl chloride)

(b) Identify the repeating unit; remove the brackets, the extended bonds from each side and the subscript n; change the single bond to a double bond:

–[CH2–CH]n– / Cl → –CH2–CH– / Cl → CH2=CH–Cl (Monomer: vinyl chloride)

(ii) The monomer of the polymer can be deduced as:

(a) Structure of the addition polymer:

–[CH2–CH]n– / CN (Poly acrylonitrile, PAN)

(b) Identify the repeating unit; remove the brackets, the extended bonds from each side and the subscript n; change the single bond to a double bond:

–[CH2–CH]n– / CN → –CH2–CH– / CN → CH2=CH–CN (Monomer: acrylonitrile)

DESCRIPTIVE QUESTIONS (EXERCISE)

1. How is PET formed? Can you recycle this polymer? *[10226103]*

Ans. See Q.3 from theory section — ethane diol reacts with terephthalic acid (a dicarboxylic acid) to form an ester linkage, giving PET; the polymer can be recycled by chemically breaking it down into monomer units by heating in the absence of oxygen.

2. Differentiate between addition and condensation polymerizations. *[10226104]*

Ans. See Q.4 from theory section for the full comparison table.

3. Write down reactions along with the conditions to prepare polyamide and polyester. *[10226105]*

Ans. See Q.3 from theory section — Fig. 26.2 (PET/polyester formation) and Fig. 26.3 (polyamide formation), both formed under acid/base-catalyzed condensation with elimination of water.

4. Describe the role of synthetic polymers in the textile industry. *[10226106]*

Ans. See Q.7 from theory section (Importance of Polymers in Textile Industry).

5. Describe the effects of synthetic polymers on the environment. *[10226107]*

Ans. See Q.8 from theory section (Adverse Effects of Plastics).

— End of Chapter 26: Polymers —