CHAPTER 26

Polymers

Student Learning Outcomes

After studying this chapter, students will be able to::

- Define polymers as large molecules built up from many smaller molecules called monomers.
- Identify the repeating units and / or linkages in addition polymers and in condensation polymers.
- Deduce the structure or repeating unit of a condensation polymer from given monomers and vice versa, limited to:
  a. polyamides from a dicarboxylic acid and a diamine
  b. polyesters from a dicarboxylic acid and a diol.
- Describe the differences between addition and condensation polymerization.
- State that plastics are made from polymers.
- Describe how the properties of plastics have implications for their disposal.
- Describe the environmental challenges caused by plastics, limited to:
  - disposal in landfill sites
  - accumulation in oceans
  - formation of toxic gases from burning
- Describe the structure of:
  - nylon, a polyamide
  - PET, a polyester The full name for PET, polyethylene terephthalate, is not required.
- State that PET can be converted back into monomers and repolymerised
- Outline the importance of polymers in the textile industry. (Examples for polymers being used may be given along with their specific properties).

Subjective Type Questions

Long Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

26.1 Types of Polymers

26.2 Structures of Monomer from Polymer

Q.1: Describe the following:

- **Monomers** • **Polymerization** • **Types of polymers** • **Importance of polymers**

Ans. Monomers: Polymers or macromolecules are extremely large m[illegible]s 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.

Types of polymers: Carbohydrates, proteins and nucleic acids are the everyday examples of polymers which exist naturally. Whereas plastics, synthetic fibers, and natural rubber are the examples of man-made 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.

Importance of 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.

Q.2: Write a note on addition polymers.

Ans. Addition Polymers:

Addition Polymers are one of the main types of polymers. Addition polymers are formed when monomer molecules containing a double bond combine together through a covalent bond to give a very large molecule.

Example:

A large number of ethene molecules add together to give one very big molecule which is called polythene or polythene.

Explanation:

During this reaction C = C double bond in ethene breaks down to allow ethene molecules to join together. Polymerization reactions usually take place at high pressure and in the presence of a catalyst.

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

$$\underset{\text{Mononer}}{2CH_2 = CH_2} \longrightarrow \underset{\text{Repeat unit}}{+ CH_2 - CH_2 - CH_2 - CH_2 +}$$

$$nCH_2 = CH_2 \longrightarrow + \underset{\text{Polyethene}}{CH_2 - CH_2} +_n$$

Q.3: What are condensation polymers. How are they formed?

OR How is PET formed? Can you recycle this polymer?

Ans. Condensation Polymers:

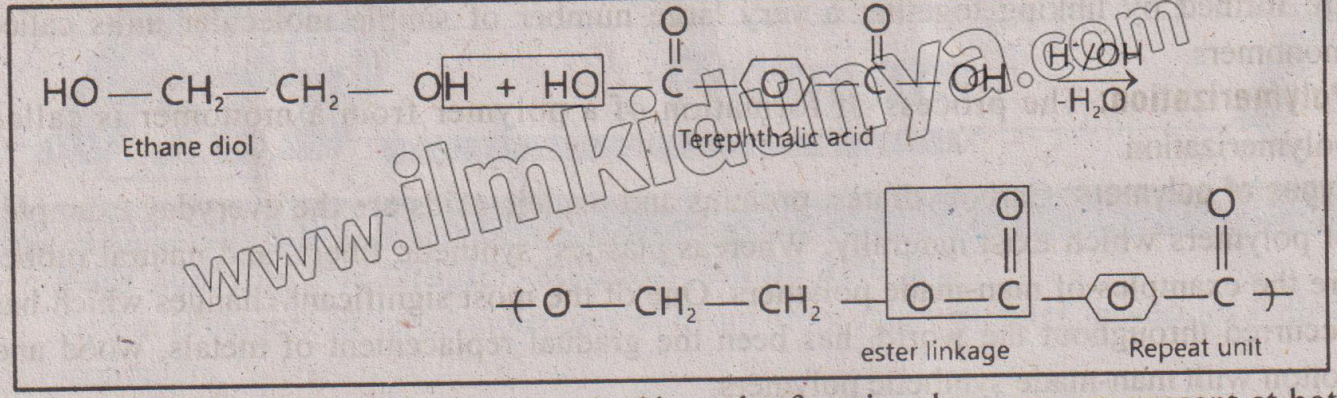
Condensation polymers are one of the main types of polymers.

Formation of Condensation Polymers:

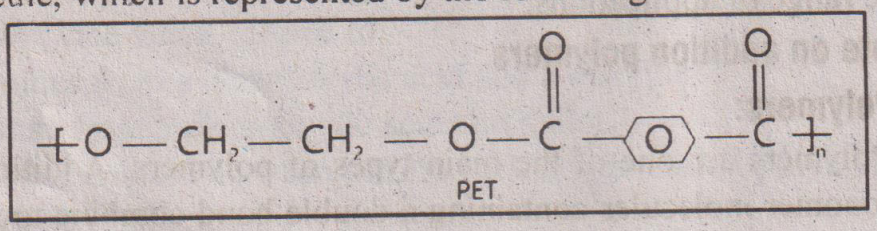
A condensation polymer is formed when two different molecules containing two different functional groups react together with the elimination of a small molecule like H_2O, HCl and NH_3 etc. The reaction takes place in the presence of an acid or a base.

Formation of Polyethene Terephthelate (PET):

Ethane diol reacts with a dicarboxylic acid (terephthalic acid) to give a polymer called Polyethylene Terephthalate group of the diol to give an ester linkage.



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, which is represented by the following structure.



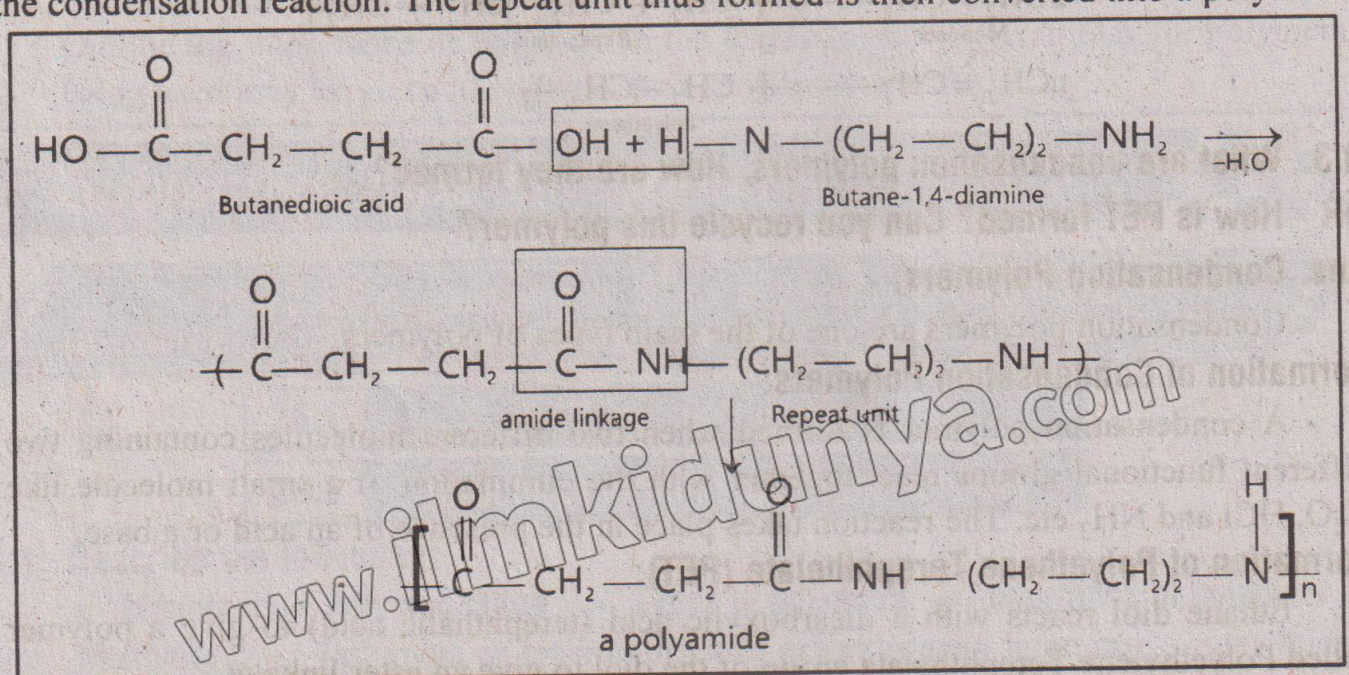
Recycling of PET:

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

Q.4: Write formation of polyamide.

Ans. Formation of a 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 $-NH_2$ 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.



Q.5: Differentiate between addition and condensation polymerizations.

Ans.

Addition Polymerization	Condensation Polymerization
A single monomer is used which should have a double or a triple bond.	This polymerization takes place between two monomers. The monomer molecules have two functional groups present one on each end of the molecule.
It involves an addition reaction and only a single product is formed.	It involves the condensation between two monomers with the elimination of a small molecule like H_2O, HCl or NH_3.
The molecular mass of the product polymer can be found by adding the molecular masses of all the monomers used.	The molecular mass of the polymer cannot be found by adding the molecular masses of all the monomers.
The polymer formed contains only the single bonds along the polymer backbone chain.	The polymer formed contains a specific linkage, e.g. ester linkage or amide linkage.
Examples of addition polymers are polyethene, polystyrene, polyvinylchloride (PVC), etc.	Example of condensation polymers are polyester, nylon, bakelite, etc.

Q.6: (a) Write down reactions along with the conditions to prepare polyamide and polyester.

Ans. Preparation of Polyester:

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

$$\text{+CO-CH}_2\text{-CH}_2\text{-CO-O-CH}_2\text{-CH}_2\text{-O+}_n$$

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

$$\text{+CO-CH}_2\text{-CH}_2\text{-CO-O-CH}_2\text{-CH}_2\text{-O+}_n$$

$$n\ \text{+CO-CH}_2\text{-CH}_2\text{-CO-O-CH}_2\text{-CH}_2\text{-O+} \rightarrow$$

$$n\text{HO-CO-CH}_2\text{-CH}_2\text{-CO-OH} + n\text{H-O-CH}_2\text{-CH}_2\text{-O-H}$$

Preparation of Polyamide:

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

$$\text{+CO-CH}_2\text{-CH}_2\text{-CO-NH-(CH}_2\text{-CH}_2)_2\text{-NH+}_n$$

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

$$n\{CO - CH_2 - CH_2 - CO - NH - (CH_2 - CH_2)_2 - NH\}$$
$$\longrightarrow nHO-CO-CH_2-CH_2-CO-OH$$
$$+ nH-NH-(CH_2-CH_2)_2-NH-H$$

(b) Write down reaction alongwith the conditions to prepare addition polymer.

Ans. Addition Polymer:

(i) Write down the structure of addition polymer.

$\{CH_2\text{-}CH_2\}_n$

(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.

$$\{CH_2-CH_2\}_n \longrightarrow n\ \{CH_2-CH_2\} \longrightarrow CH_2=CH_2$$

26.3	Plastics
26.4	Importance of Polymers in the Textile Industry
26.5	Adverse Effects of Plastics

Q.7: Describe polymers of plastic and their uses.

Ans. Plastic Polymers: Polymerizatoin 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. These plastics are used to make all types of carry-home food containers, eg.,

Plastic products

Uses: 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. 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 any sphere of our daily life. Starting form early 20th century millions of tons of plastics are made every year

Q.8: Describe the role of synthetic polymers in the textile industry.

Ans. Synthetic Polymers:

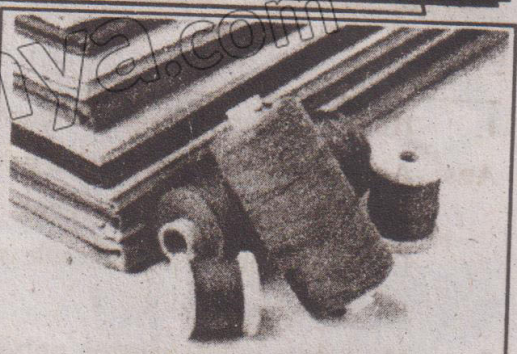
Polymers which are used in the textile industry are called synthetic fibers.

Examples: Nylon, polyester, rayon, acrylic etc.

Role of Synthetic Polymers in the Textile Industry:

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

1. They are cheaper in cost than natural fibers like cotton and silk.
2. They are stronger and more durable than natural fiber.
3. They do not shrink.
4. They resist wrinkling.
5. They are light weight and quick drying.
6. They are moth and insect resistant.



Polymers in textile

Q.9: Describe the effects of synthetic polymers on the environment.

Ans. 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 build up of huge amounts of plastics in the environment. Accumulation of suc a huge amount of different articles made of plastics has caused widespread environmental problems.

- **Plastic Pollution:**

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 to an extremely alarming level and has led to cause serious health problems.

- **Burning of discarded Plastic Articles:**

Discarded plastic articles we put in the binds are disposed of through burning, dumping in the landfill, 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 air.

Plastic pollution

26.1 Quick Check!

1. Give an example of a commercial product which is formed using polyethene.

Ans. Common commercial products include carry home food containers, soft drink bottles, water bottles and shopping bags.

2. Write three properties of synthetic polymers.

Ans. Properties of Synthetic Polymers:

(i) They do not shrink. **(ii)** They resist wrinking.

(iii) They are light weight and quick drying.

26.2 Quick Check!

1. How an ester linkage between two monomers is formed?

Ans. An ester linkage between two monomers is formed through a chemical reaction between a carboxyl group (–COOH) and one monomer and a hydroxyl group (–OH) of another monomer. During this process, a molecule of water (H_2O) is released, creating the bond known as an ester linkage:

$R - C (= O) - O - R'$

2. How does condensation polymerization occur?

Ans. A condensation polymer is formed when two different molecules containing two different functional groups react together with the elimination of a small molecule like H_2O, HCl and NH_3 etc.

Example:

The formation of polyester (like PET) or polyamide (like Nylon).

26.3 Quick Check!

1. What do you understand by the term repeating unit?

Ans. **Repeating Unit:**

A repeating unit is the smallest part of a polymer chain that, when linked together repeatedly, forms the entire macromolecule.

- It represents the chemical structure derived from the original monomer(s) after the polymerization process is complete.
- In a chemical formula, the repeating unit is usually enclosed in brackets with a subscript 'n' [e.g., $(M)_n$] indicating that the unit repeats hundreds or thousands of times.

2. Draw the structure of a polyamide linkage.

Ans. A polyamide linkage (also called an amide bond) is the chemical connection formed between an amino group and a carboxyl group. It is the defining feature of polymers like Nylon.

The structure of the polyamide linkage is:

$–C(= O) – NH –$

In a polymer chain, it looks like this:

[Rest of chain – C (= O) – NH – Rest of Chain]

INTERESTING INFORMATION

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

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

Objective Type Questions

Additional MCQ's

Multiple Choice Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

26.1 Types of Polymers

26.2 Structure of Monomer from Polymer

1. What is another term used for polymers due to their extremely large size?
(a) Micromolecules (b) Macromolecules (c) Monomers (d) Isotopes

2. Which of the following is a naturally occurring polymer?
(a) Plastic (b) Nylon (c) Nucleic acids (d) PVC

3. Synthetic polymers have largely replaced which of the following materials?
(a) Wood (b) Cotton (c) Metals (d) All of these

4. Which property makes polymers useful for a wide range of applications?
(a) Resistance to chemicals (b) High strength
(c) Flexibility (d) All of these

5. Addition polymers are formed from monomers that specifically contain:
(a) Only single bonds (b) A double bond
(c) An ester linkage (d) An amide linkage

6. In addition polymerization, what is the by-product?
(a) Water (b) Ammonia
(c) Hydrogen chloride (d) No by product is formed

7. Which conditions are usually required for polymerization reactions?
(a) Low pressure and no catalyst (b) High pressure and a catalyst
(c) High pressure and oxygen (d) Vacuum and low temperature

8. Condensation polymerization occurs between monomers that have:
(a) Triple bonds (b) One functional group
(c) Two different functional groups (d) No functional groups

9. Which of these is a common small molecule eliminated during condensation?
(a) CH_4 (b) H_2O (c) O_2 (d) CO_2

10. Terylene (PET) is formed from which two monomers?
(a) Ethane diol and Terephthalic acid (b) Ethene and Propane
(c) Butane dioic acid and Diamine (d) Adipic acid and glycol

11. **A polyamide linkage (amide linkage) is represented as:**
(a) –COOH– (b) –CONH– (c) $-CH_2-CH_2-$ (d) –O–

12. **What does the subscript 'n' represent in a polymer structure?**
(a) Number of catalyst (b) Number of repeating units
(c) Number of double bonds (d) Temperature of reaction

13. **To identify the monomer of an addition polymer, you must change the single bond of the repeating unit into a:**
(a) Single bond (b) Double bond (c) Ester linkage (d) Amide linkage

14. **When identifying the monomers of a polyester, what is added to the dicarboxylic acid end?**
(a) –OH (b) –H (c) $-CH_3$ (d) $-NH_2$

15. **Which polymer is used for non-stick coating on pans (Teflon)?**
(a) PVC (b) Nylon
(c) Polytetrafluoroethylene (d) Bakelite

26.3 Plastics

26.4 Importance of Polymers in the Textile Industry

26.5 Adverse Effects of Plastics

16. **Which monomer is polymerized to produce polypropylene (PP)?**
(a) Propylene (b) Ethylene (c) Styrene (d) Vinyl Chloride

17. **Which monomer is polymerized to produce polyethylene (PE)?**
(a) Styrene (b) Ethylene (c) Vinyl chloride (d) Propylene

18. **Which of the following monomer is polymerized to produce polystyrene?**
(a) Ethylene (b) Vinyl chloride (c) Styrene (d) Propylene

19. **Polyethylene (PE), Polypropylene (PP) and Polystyrene (PS) are all common examples of:**
(a) Plastics (b) Proteins (c) Natural fibres (d) None of these

20. **Polymers used specifically in the textile industry are known as:**
(a) Natural fibers (b) Synthetic fibers (c) Catalysts (d) Plastics

21. **Which of the following is an example of a synthetic fiber?**
(a) Cotton (b) Silk (c) Wool (d) Nylon

22. **Approximately what percentage of global clothing industry materials do polyester and nylon account for?**
(a) 50% (b) 69% (c) 85% (d) 99%

23. **Which synthetic fiber is specifically noted for providing warmth and being soft?**
(a) Polyethylene (b) Nylon (c) Acrylic (d) Polystyrene

24. **How long can it take for some plastic articles to break down in the environment?**

(a) 10 years (b) 50 years
(c) 100 years (d) up to 1000 years

25. **Which property of plastic allows them to be formed into almost any desired shape?**

(a) Transparency (b) High density
(c) Mould easily (d) Heat conductivity

ANSWERS:

1.	(b)	2.	(c)	3.	(d)	4.	(d)	5.	(b)	6.	(d)	7.	(b)
8.	(c)	9.	(b)	10.	(a)	11.	(b)	12.	(b)	13.	(b)	14.	(a)
15.	(c)	16.	(a)	17.	(b)	18.	(c)	19.	(a)	20.	(b)	21.	(d)
22.	(b)	23.	(c)	24.	(d)	25.	(c)						

Additional Short Questions

Short Answer Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

26.1 Types of Polymers

26.2 Structure of Monomer From Polymer

1. What are polymers?

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.

2. Define polymerization.

Ans. Polymerization: The process of formation of a polymer from a monomer is called polymerization.

3. Distinguish between natural and man-made polymers.

Ans. Natural Polymers: Natural polymers occur naturally in nature.

Examples: Carbohydrates, proteins and nucleic acids.

Man-made Polymers: These are the polymers created by humans.

Examples: Plastic, synthetic fibers and natural rubber (processed).

4. What are two main types of polymers?

Ans. Types of Polymers: Two main types of polymers are:

- Addition Polymers
- Condensation Polymers

5. Why have synthetic polymers replaced materials like metals, wood and cotton?

Ans. Synthetic polymers are preferred because of their high strength, flexibility and resistance to heat and chemicals making them more versatile for modern applications.

6. What are addition polymers?

Ans. Addition Polymers: Addition polymers are formed when monomer molecules containing a double bond combine together through a covalent bond to give a very large molecule.

Example: A large number of ethene molecules add together to give one very big molecule which is called polyethene or polythene.

7. What are the necessary conditions for addition polymerization?

Ans. These reactions usually take place under high pressure and in the presence of a catalyst.

8. Define condensation polymers.

Ans. Condensation Polymers: A condensation polymer is formed when two different molecules containing two different functional groups react together with the elimination of a smal molecule like H_2O, HCl and NH_3 etc.

9. What is PET (Polyethylene Terephthalate)?

Ans. PET (Polyethylene Terephthalate) is a common polyester formed by the condensation reaction between ethane diol and terephthalic acid. It is widely used in making plastic bottles.

10. How is a polyamide formed?

Ans. Polyamide is a condensation polymer, which is formed when butanedioic acid reacts with diamine. Each –COOH group of the dicarboxylic acid reacts with each $–NH_2$ 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.

11. What is a repeating unit?

Ans. A repeating unit is the specific part of a polymer chain that is derived from the monomers and repeats many times to make up the complete macromolecule.

12. What happens to the C = C double bond during addition polymerization?

Ans. The double bond breaks down to allow ethene molecules to join together.

13. Why is no by product formed in addition polymerization?

Ans. No by product is formed in addition polymerization because it involves an addition reaction where no molecule is eliminated; all atoms of the monomers are retained in the polymers.

14. Give three examples of addition polymers.

Ans. Three exampels of addition polymers are:

- Polyethene (Polythene)
- Polystyrene
- Polyvinylchloride (PVC)

15. How is the molecular mass of an addition polymer calculated?

Ans. The molecular mass of an addition polymer is calculated by addition the molecular masses of all the monomers used.

16. Name three small molecules eliminated during condensation.

Ans. Three small molecules eliminated during condensation are water (H_2O), Hydrochloric acid (HCl) and Ammonia (NH_3).

17. How can PET be recycled?

Ans. PET can be recycled by chemically breaking down to the monomer units.

18. How can chemical recycling be done?

Ans. Chemical recycling can be done through heating the polymer in the absence of oxygen.

19. Give some examples of condensation polymers.

Ans. Some examples of condensation polymers are:

- Polyester
- Nylon
- Bakelite

20. What is the specific use of Teflon?

Ans. Teflon is used as non-stick coating for pans.

26.3	Plastics
26.4	Importance of Polymers in the Textile Industry
26.5	Adverse Effects of Plastics

21. Which monomers are used to create common plastics?

Ans. Monomers like ethylene, propylene and styrene are polymerized to produce polyethylene (PE), Polypropylene (PP) and Polystyrene (PS).

22. What are some common uses of plastics in the food industry?

Ans. Plastics are used to make 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 wrapers, cups and plates etc.

23. List four physical properties of plastics that make them useful.

Ans. Plastics are lightweight, flexible, durable and can be easily moulded into almost any desired shape.

24. Name common household items made of plastic.

Ans. Kitchen-wares, buckets, tables, chairs, shopping bags, cups and plates.

25. What are synthetic fibers?

Ans. Polymers which are used in the textile industry are called synthetic fibers.
Examples: Nylon, Polyster, rayon, a cyclic etc.

26. What is the global significance of polyester and nylon in clothing?

Ans. The polyesters and nylon are the two common polymers which account for 69% of all the material used in clothing industry worldwide.

27. What are the specific uses of polyester and acrylic?

Ans. **Use of polyester:** Polyester is an important fiber for its strength and resistance to shrinking. It is commonly used in sports wear and hoisery.
Use of Acrylic: Acrylic is light weight, soft and provides warmth.

28. Why do plastics pose a major environmental threat?

Ans. Unlike other materials, plastics do not undergo biodegradation. They can take up to 1000 years to break down.

29. Where is plastic pollution most commonly found?

Ans. It is found almost everywhere on land, in the air, and in all water bodies including rivers, ponds, lakes, seas and oceans.

30. What are the common methods of disposing of plastic waste?

Ans. Discarded plastics articles we put in the bins are disposed of through burning, dumping in the landfill, thrown in the drains from where they make their way to rivers and oceans.

31. How does plastic waste reach the oceans?

Ans. Plastics thrown into drains eventually make their way into rivers and then into the oceans.

32. Why is the burning of plastic articles dangerous?

Ans. Burning of plastic articles is dangerous because it releases dangerous gases in air.

33. How can 3D printing use polymers?

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

Exercise Questions (Solved)

A. Multiple Choice Questions

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

1. Which of the following polymer is a synthetic polymer:

(a) Starch (b) Cellulose (c) Animal fat (d) Polyster

2. Which polymer has an amide linkage:

(a) Polyester (b) Polyamide (c) Polyethene (d) Polystyrene

3. Identify an ester linkage:

(a) $R-\overset{\overset{O}{\|}}{C}-O-R$ (b) $R-\overset{\overset{O}{\|}}{C}-R$

(c) $R-\overset{\overset{O}{\|}}{C}-O-NH-R$ (d) $R-\overset{\overset{O}{\|}}{C}-NH-R$

4. The structure of the monomer of the following polymer is:

$$[-CH_2-\underset{\underset{OCOCH_3}{|}}{CH}-]_n$$

(a) $CH_2 = CH_2$ (b) $CH_2 = CH_2 - CH_3$

(c) $CH_2 = CH - OCOCH_3$ (d) $CH_2 = CH - CO - O - CH_3$

5. Which of the following polymers can be recycled?

(a) PET (b) Polystyrene (c) PVC (d) Epoxy

6. Which of the following polymers is biodegradable?

(a) Polyamide (b) Polyester (c) Starch (d) PET

7. Which of the following polymers is obtained by condensation polymerization?

(a) Polyvinyl chloride (b) Polystyrene

(c) Polyamide (d) Polyethene

ANSWERS:

1. (d) 2. (b) 3. (a) 4. (c) 5. (a) 6. (c) 7. (c)

B. Short Answer Questions

26.1 Give two examples each of addition polymers and condensation polymers.

Ans. Examples of Addition Polymers: Two examples of addition polymers are:

- Polyethene
- Polystyrene

Examples of Condensation Polymers: Two examples of condensation polymers are:

- Polyethylene Terephthalate (PET)
- Polyamide

26.2 How polymers are useful for us?

Ans. Polymers are important in our daily life due to their high strength, flexibility and resistance to heat and chemicals. They are used in food containers, clothing, kitchen ware and furniture.

26.3 How synthetic fibers are different from natural fibers?

Ans. Synthetic fibers are different from natural fibers in the following ways:

- They are chepaer in cost than natural fibers like cotton and silk.
- They are stronger and more durable than natural fiber.
- They do not shrink.
- They resist wrinkling.
- They are light weight and quick drying.
- They are moth and insect resistant.

26.4 Are natural polymers hazardous for the environment? Explain why?

Ans. No. Natural polymers (like starch and cellulose) are biodegradable, meaning they are broken down by microorganisms and do not accumulate as pollution.

26.5 Draw the structures of the following polymers.

(a) Polypropylene **(b) Polystyrene**

Ans. (a) Polypropylene: $\{CH_2 - CH(CH_3)\}_n$

(b) Polystyrene: $\{CH_2 - CH(C_6H_5)\}_n$

C. Constructed Response Questions

26.1 Why is it dangerous to burn discarded articles made of plastics?

Ans. Burning plastics is hazardous primarily due to the toxic emissions released into the atmosphere. Plastics are synthetic polymers often containing chlorine, fluorine, or various chemical additives.

- **Toxic Gases:** They release harmful gases such as hydrogen chloride (HCl), Dioxins and Furans. Dioxins are highly toxic and can cause reproductive and developmental problems, damage the immune system and cause cancer.
- **Particulate Matter:** Burning produces thick black smoke containing the particulates that cause respiratory issues like asthma and bronchitis.
- **Carbon Monoxide:** In complete combustion produces CO, which is a poisonous gas that interferes with the blood's ability to carry oxygen.

26.2 Why is it not advisable to dump discarded synthetic articles in oceans?

Ans. Dumping synthetic materials (like plastics and nylon) in oceans creates a reverse environmental crisis known as marine pollution.

- **Non–Biodegradability:** Most synthetic articles do not decompose. They remain in the ocean for hundreds of years.
- **Threats to Marine Life:** Animals often mistakenly take plastic for food (e.g; sea turtles mistakenly consider plastic bags for jelly fish). This leads to starvation or internal injuries. Additionally, animals can become entangled in discarded plastic rings.
- **Microplastics:** Over time, sunlight break large plastics into tiny fragments called microplastics. These enter the food chain, absorbing toxins that eventually reach humans when we consume sea food.

26.3 What is the role of catalyst in addition polymerization?

Ans. In addition polymerization (like the formation of Polyethene), the catalyst serves three main purposes:

- **Initiation:** It breaks down to create an active species that attacks the double bond of the monomer.
- **Activation:** It lowers the activation energy required for the reaction to occur, allowing the polymerization to happen at lower temperatures and pressures.
- **Rate of Reaction:** It significantly increases the speed at which monomers link

together to form long polymer chains.

26.4 Deduce the monomer from the following addition polymers.

(i) $+CH_2-\underset{Cl}{\underset{|}{CH}}+_n$ (ii) $+CH_2-\underset{CN}{\underset{|}{CH}}+_n$

To find the monomer from an addition polymer, we identify the repeating unit remove the extending bonds (the brackets and 'n'), and replace the single bond between the carbon atoms with a double bond (C = C).

(i) $+CH_2-\underset{Cl}{\underset{|}{CH}}+_n$

Polymer: $[CH_2 - CH(Cl)]_n$ (Polyvinyl chloride or PVC)

Monomer: Vinyl Chloride (Chloroethene)

Structure: $CH_2 = CH - Cl$

(ii) $+CH_2-\underset{CN}{\underset{|}{CH}}+_n$

Polymer: $[CH_2 - CH(CN)]_n$ (Polyacrylonitrile or PAN)

Monomer: Acrylonitrile (Cyanoethene)

Structure: $CH_2 = CH - CN$

D. Descriptive Questions

26.1 How is PET formed? Can you recycle this polymer?

Ans. For answers see Q.3

26.2 Differentiate between addition and condensation polymerizations.

Ans. For answers see Q.5

26.3 Write down reactions alongwith the conditions to prepare polyamide and polyester.

Ans. For answers see Q.6 (a)

26.4 Describe the role of synthetic polymers in the textile industry.

Ans. For answers see Q.8

26.5 Describe the effects of synthetic polymers on the environment.

Ans. For answers see Q.9

Pairing Scheme / Instructions for Preparation of Exam Paper of Chemistry for Class-10

ESSENTIAL INSTRUCTIONS FOR PAPER SETTERS

The paper of Chemistry (General) for class 10 will consist of 60 marks. Timing of the paper will be two hours. The paper will be made as per following details:

Objective: **Q-1:** $1 \times 12 = 12$

12 Multiple Choice Questions

The detail is as follows:

Chapter	14	15	16	17	18	19	20	21	22	23	24	26
No. of MCQs	1	1	1	1	1	1	1	1	1	1	1	1

Subjective: **Q-2:**

Part-I: 5 short answer questions have to be answered out of 8. $2 \times 5 = 10$

The detail is as follows:

Chapter	14	15	16	17	18
No. of Short Questions	2	1	1	2	2

Q-3:

Five (5) short answer questions have to be answered out of Eight (8). The detail is as follows: $2 \times 5 = 10$

Chapter	19	20	21	22
No. of Short Questions	2	2	2	2

Q-4:

Five (5) short answer questions have to be answered out of Eight (8). The detail is as follows: $2 \times 5 = 10$

Chapter	23	24	25	26
No. of Short Questions	2	2	2	2

Subjective: This section will contain three detailed questions $2 \times 9 = 18$

Part-II: bifurcated in two-part **a & b** (carrying 5 & 4 marks each) and students have to attempt 2 questions The detail is as follows:

Q-5:

Chapter	14	15
Part	a	b

Q-6:

Chapter	20	22
Part	a	b

Q.7:

Chapter	23	25
Part	a	b

Model Paper of Chemistry For Class-10

Objective Type

Time Allowed: 15 Min | Max. Marks: 12

Note: Four possible answers A, B, C and D to each question are given. The choice which you think is correct, fill that circle with marker or pen ink in the answer-book. Cutting or filling two or more circles will result in zero mark in that question.

1. Select the correct answer. (1×12=12)

(i) Which gas will diffuse at the fastest rate?

(a) HCl (b) SO_2 (c) ✓ H_2S (d) CO_2

(ii) Volume occupied by 15 moles of ammonia gas at RTP

(a) 224 dm^3 (b) 160 dm^3 (c) ✓ 360 dm^3 (d) 265 dm^3

(iii) Which of the following metal is the highest in the electrochemical series?

(a) Tin (b) Iron (c) ✓ Magnesium (d) Zinc

(iv) The shape of the crystal of NaCl is:

(a) ✓ Cubic (b) Hexagonal (c) Rhombic (d) Trigonal

(v) The oxide that is neutral in character:

(a) Al_2O_3 (b) SO_2 (c) CO_2 (d) ✓ NO

(vi) The pH of distilled water is:

(a) 6.5 (b) 8.5 (c) ✓ 7 (d) 7.5.

(vii) Select the general formula of alkyne family.

(a) C_nH_{2n+1} (b) C_nH_{2n} (c) C_nH_{2n-1} (d) ✓ C_nH_{2n-2}

(viii) Which of the following is not used as a fuel?

(a) LPG (b) CNG (c) Diesel (d) ✓ Asphalt

(ix) Which of the following acids is present in apple?

(a) Citric acid (b) Tartaric acid (c) Acetic acid (d) ✓ Malic acid

(x) If the reactants posses an energy higher than the activation energy, than the reaction will be:

(a) Slow (b) ✓ Fast (c) Not affected (d) Instantaneous

(xi) Which polymer can be recycled?

(a) ✓ PET (b) Polystyrene (c) PVC (d) Epoxy

(xii) Which catalyst other than H_3PO_4 can also be used for hydration of alkenes.

(a) NaOH (b) ✓ H_2SO_4 (c) CH_3COOH (d) Ni

Time Allowed: 1:45 Hrs

Subjective Type (Part I)

Max. Marks: 30

Q.2: Write short answers to any five (05) questions: (2 × 5 = 10)

(i) Is condensation an endothermic process?
(ii) Why ice melts when the pressure is exerted on it?
(iii) Why is percentage yield important?
(iv) What are the main objectives of electroplating?
(v) Give any two features of the catalytic action of an enzyme.
(vi) From where do molecules get energy to attain higher energy state?
(vii) Name two insoluble carbonates.
(viii) What is crystal lattice?

Q.3: Write short answers to any five (05) questions: (2 × 5 = 10)

(i) How nitrogen is obtained from air?
(ii) How fossil fuels produce SO_2?
(iii) What is trachoma disease?
(iv) What is the difference between sedimentation and filteration?
(v) Define structural isomerism.
(vi) Write down the structural formula of Butan-2-ol.
(vii) How an alkene can be identified?
(viii) Why is oxyacetylene flame so hot?

Q.4: Write short answers to any five (05) questions: (2 × 5 = 10)

(i) Give any two disadvantages of fermentation reaction
(ii) How ethanol is prepared from ethene?
(iii) What is esterification reaction?
(iv) How does ethanol react with propanoic acid?
(v) What is the role of enzyme in our body? (vi) What is glycoside linkage?
(vii) What is the role of catalyst in addition polymerization?
(viii) How does condensation polymerization reaction occur?

Subjective Type (Part II)

Note: Attempt any two questions

Q5: (a) Differentiate between evaporation and boiling. (5)
(b) How would you identify the limiting reactant in a chemical reaction? (4)

Q6: (a) What is fertilizer? Mention the essential qualities of a good fertilizer. (5)
(b) Describe two methods of preparation for ethene. (4)

Q7: (a) Describe the applications of ethanol in pharmaceutical and cosmetic industries. (5)
(b) What are carbohydrates? Describe their classification with examples. (4)