

Chapter - 2

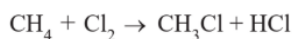
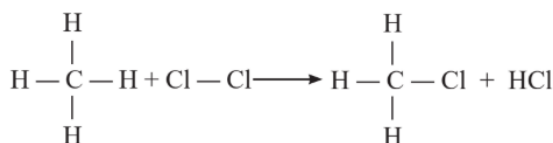
CHEMICAL REACTIONS OF ORGANIC COMPOUNDS

Types of Organic Reactions

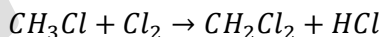
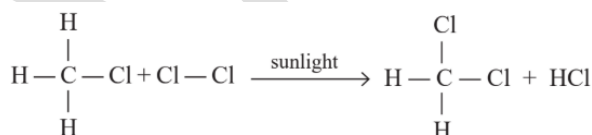
- ✓ Major organic reactions are
 - A. Substitution reactions
 - B. Addition reactions
 - C. Polymerisation
 - D. Thermal cracking
 - E. Combustion

A. Substitution reactions

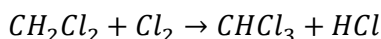
- ✓ Substitution reactions are chemical reactions in which an atom or group of atoms is replaced with another atom or group of atoms in a compound.
- Example 1 : Reaction of methane with chlorine in the presence of sunlight.



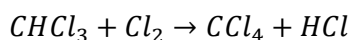
Reaction of chloromethane (CH_3Cl) further with chlorine in the presence of sunlight



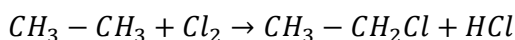
Reaction of dichloromethane (CH_2Cl_2) further with chlorine in the presence of sunlight



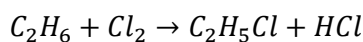
Reaction of trichloromethane (CHCl_3) further with chlorine in the presence of sunlight



- Example 2 : Reaction of ethane with chlorine

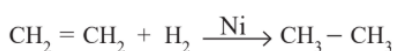
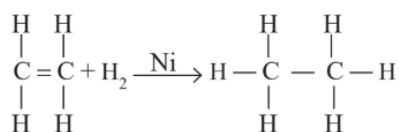


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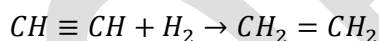


B. Addition reactions

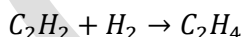
- ✓ Addition reactions are reactions in which unsaturated organic compounds with double or triple bonds combine with certain molecules to form saturated compounds.
- ✓ The reactions in which triple bonded organic compounds partially combine with small molecules to form double bonded compounds are also addition reactions.
- Example 1 : The reaction between ethene (C_2H_4) and hydrogen, in the presence of nickel (Ni) as catalyst



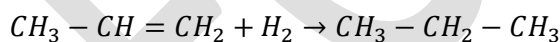
- Example 2



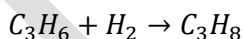
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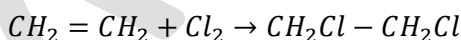
- Example 3



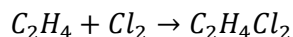
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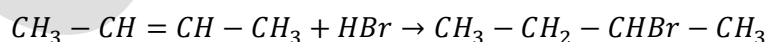
- Example 4



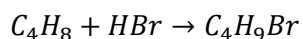
OR



- Example 5



OR



C. Polymerisation reactions

- ✓ Polymerisation is the process by which simple molecules join together to form large complex molecules.
- ✓ The simple molecules are called monomers and the large complex molecules formed as a result of polymerisation are called polymers.
- ✓ Based on the method of polymerisation, polymers are classified into two

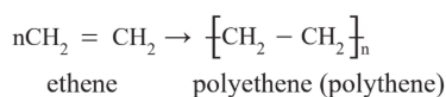
i. addition polymers

ii. condensation polymers.

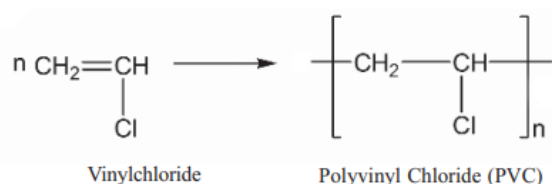
Addition Polymers

✓ Addition polymers are obtained by the repeated addition reaction of monomers.

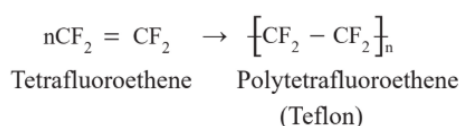
• Example 1



• Example 2



• Example 3



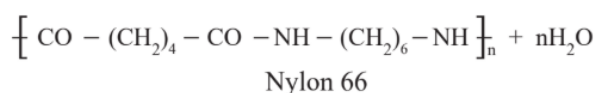
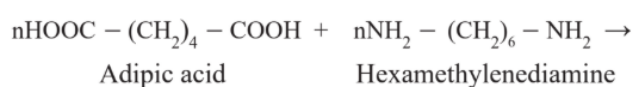
Monomer	Polymer	Uses
Vinyl chloride	PVC	Manufacture of pipes, plastic furniture, coating of electric conductors.
Ethene	Polythene	Manufacture of tarpaulin sheets, carry bags.
Isoprene	Natural rubber	Manufacture of tyres.
Tetrafluoroethene	Teflon	Coating of the inner surface of non stick cookware.
Acrylonitrile (Vinyl cyanide)	Orlon	Manufacture of synthetic fibres.

ii. Condensation polymers

✓ Condensation polymerisation is the process in which different monomers combine together to form larger compounds accompanied by the removal of simple molecules.

• Example 1

Nylon 66 is obtained by the condensation polymerisation of adipic acid and hexamethylenediamine



Monomer	Polymer	Use
i. Adipic acid ii. Hexamethylenediamine	Nylon 66	Manufacture of fabrics, combs, bristles of brushes
i. Phenol ii. Formaldehyde	Phenol formaldehyde resin (bakelite)	Manufacture of switches, handles of pressure cookers
i. Ethylene glycol ii. Terephthalic acid	Polyethylene terephthalate (polyester)	Manufacture of tarpaulin, bottles, fabrics

D. Thermal Cracking

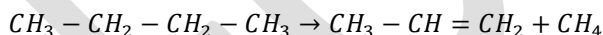
- ✓ When heated in the absence of air, some hydrocarbons with high molecular weight decompose into hydrocarbons with lower molecular weight. This process is called thermal cracking.
- ✓ When saturated hydrocarbons undergo thermal cracking, the products include saturated and unsaturated hydrocarbons.
- ✓ Certain plastic wastes can be broken down into lighter molecules by thermal cracking. This helps to control pollution to some extent.

• Example 1

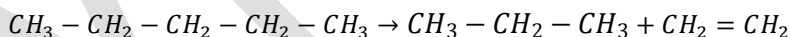
Heating of propane in the absence of air



• Example 2



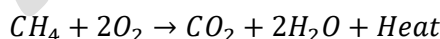
• Example 3



E. Combustion of Hydrocarbons

- ✓ When hydrocarbons burn, they combine with oxygen in air to form CO_2 and H_2O along with heat and light. This process is called combustion.

• Example 1 : Burning of methane in air



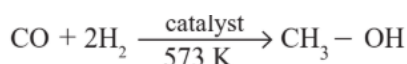
• Example 2 : Burning of methane in air



Some Important Organic Compounds

Methanol or Methyl alcohol ($CH_3 - OH$)

- ✓ Methanol or methyl alcohol is the first member of the alcohol family.
- ✓ Methanol is also called wood spirit.
- ✓ Methanol is a poisonous substance.
- ✓ Methanol is industrially produced by treating carbon monoxide with hydrogen in the presence of catalysts.



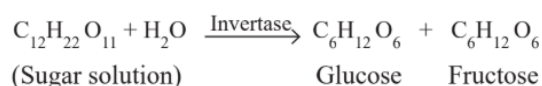
Uses of methanol

- ✓ For manufacturing varnish, paint etc.
- ✓ For the manufacture of formic acid, formaldehyde etc. (40% solution of formaldehyde is formalin)

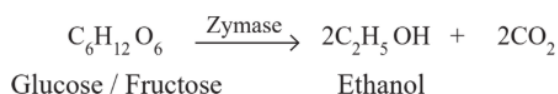
Ethanol or Ethyl alcohol ($CH_3 - CH_2 - OH$)

Industrial Preparation of Ethanol

- ✓ Ethanol is manufactured by the fermentation of molasses.
- ✓ The fermentation is carried out by adding yeast to the dilute molasses.
- ✓ The enzyme invertase present in yeast converts sugar solution to glucose and fructose.



- ✓ Then another enzyme zymase, converts glucose and fructose into ethanol.



- | |
|---|
| <ul style="list-style-type: none">• 8-10% ethanol thus obtained is known as 'wash'. |
| <ul style="list-style-type: none">• When wash is subjected to fractional distillation, 95.6% of ethanol is obtained. This is known as rectified spirit.• |
| <ul style="list-style-type: none">• 100% of ethanol is known as absolute alcohol. |
| <ul style="list-style-type: none">• Power alcohol is a mixture of 20% absolute alcohol and 80% of petrol.• Power alcohol is used as fuel in vehicles. |
-
- | |
|--|
| <ul style="list-style-type: none">• toxic substances like are added to ethanol in order to prevent its misuse as a beverage. Ethanol thus obtained is called denatured spirit.• When denaturing is done with methanol, the resulting ethanol is called methylated spirit. |
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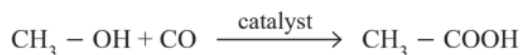
Uses of Ethanol

- ✓ Production of power alcohol.
- ✓ As a solvent for medicines.
- ✓ Manufacture of paints.
- ✓ As preservatives.
- ✓ Production of organic compounds.

Ethanoic acid or Acetic acid ($CH_3 - COOH$)

Industrial Preparation of Ethanoic acid

- ✓ Ethanoic acid can be prepared industrially by treating methanol with carbon monoxide in the presence of a catalyst.



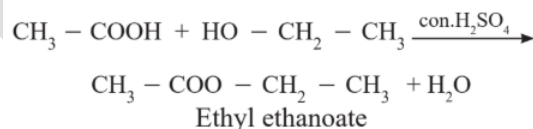
- Fermentation of ethanol with acetobacter bacteria in the presence of air yields less concentrated (5-8%) ethanoic acid. This is called vinegar.

Uses of Ethanoic acid

- ✓ Manufacture of vinegar.
- ✓ Production of acetic anhydride, acetate ester, synthetic fibres etc.
- ✓ Solvent of polymers and resins.
- ✓ Manufacture of disinfectants.
- ✓ Manufacture of medicines.

Esters

- ✓ Esters are formed when alcohols react with carboxylic acids. This reaction is called **esterification**.
- Example The formation of the ester, ethyl ethanoate



The ester, ethyl ethanoate is formed when ethanoic acid reacts with ethanol in the presence of concentrated sulphuric acid.

- ✓ The general formula of esters is **$R - \text{COO} - R'$** Here R, R' are alkyl groups.
- ✓ As esters have the fragrance of flowers and fruits, they are **used to make artificial perfumes and juices**.

Name of carboxylic acid	Name of alcohol	Name of ester	Fragrance
Ethanoic acid	Isoamyl alcohol	Isomyl acetate	Banana
Ethanoic acid	Benzyl alcohol	Benzyl ethanoate	Jasmine
Ethanoic acid	Octyl alcohol	Octyl ethanoate	Organe
Butanoic acid	Ethyl alcohol	Ethyl butanoate	Pineapple

Medicines

The category and functions of certain medicines used in modern methods of medical therapy are given in the table below

Category	Function	Examples
Analgesics	Relieve pain	Aspirin
Antipyretics	Reduce body temperature	Paracetamol
Antiseptics	Control microorganism	Dettol
Antibiotics	Destroy infectious microorganisms and prevent their growth	Penicillin

- ✓ Paracetamol and aspirin are commonly used medicines in the allopathic treatment system.
- ✓ Paracetamol is used both as an antipyretic and as an analgesic.
- ✓ As aspirin has anti-blood coagulant property, it is used to prevent heart attack. Aspirin is used as an analgesic too.

Let us assess

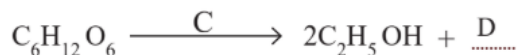
1. a. In which of the following situation is methane converted to chloromethane?
 - i. Chlorine + sunlight
 - ii. Hydrochloric acid + sunlight
 - iii. Oxygen + temperature
 - iv. Heating in the absence of oxygen
- b. Write the name of such types of reactions.
2. a. How many hydrogen molecules are required to convert $CH \equiv CH$ (ethyne) into C_2H_6 (ethane)?
- b. Write the chemical equation of the reaction.
- c. To which category does this chemical reaction belong?
3. a. Complete the chemical equation.
 - i. $CH \equiv CH + HCl \rightarrow \dots A \dots$
 - ii. $n A \rightarrow \dots B \dots$
- b. Write the IUPAC names of the molecules A and B.
- c. To which category does each of these chemical reactions belong?
4. a. Which of the given polymers is used to coat the inner surface of cookware?

(Polythene, polyvinyl chloride, teflon)
- b. What is the monomer of this polymer?
5. a. Which among the following is a condensation polymer?

(Polyvinyl chloride, nylon 66, teflon)

b. What are the monomers of nylon 66?

6.



a. Identify A, B, C and D in the given chemical reactions.

b. What is wash?

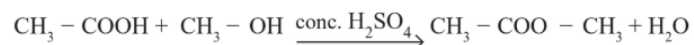
c. How is rectified spirit obtained from wash?

d. What is the purpose of denaturing rectified spirit?

7. a. How is ethanoic acid prepared industrially?

b. 5 – 8% ethanoic acid is called

8. Analyse the equation and answer the following questions.



a. What is the name of this chemical reaction?

b. What is the name of the ester formed?

c. Write any two uses of esters.

Answers

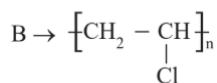
1. a. (i) Chlorine + sunlight

b. Substitution reactions

2. a. Two hydrogen molecules



3. a. $A \rightarrow CH_2 = CH_2$



b. IUPAC name of A = *Ethene*

IUPAC name of B = *Polyvinylchloride (PVC)*

c. i. Addition reaction

ii. Addition polymerisation

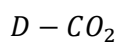
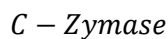
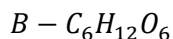
4. a. Teflon

b. Tetrafluoroethene

5. a. *Nylon 66*

b. Hexamethylenediamine, adipic acid

6. a. A – *Invertase*



b. 8 – 10% ethanol is known as ‘wash

c. By the fractional distillation of wash

d. In order to prevent its misuse as a beverage

7. a. Ethanoic acid can be prepared industrially by treating methanol with carbon monoxide in the presence of a catalyst.

b. Vinegar

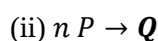
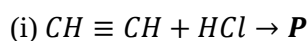
8. a. Esterification

b. Methyl ethanoate

c. Used to make artificial perfumes and juices

Question bank and Answers

1. Some chemical reactions are given.



Write the structures and names of **P** and **Q**.

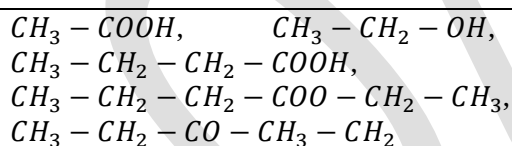
2. A chemical reaction is given



a. Write the structural formula of **A**.

b. Write the chemical equation for the reaction that produces ethanoic acid from **A**.

3. Some compounds are given

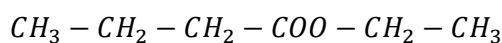


a. Choose an ester from this.

b. Write the IUPAC name of the acid and alcohol that must be reacted to prepare this ester.

c. Write the equation for the chemical reaction of formation of this ester.

4. Esters generally have the pleasant smell of flowers and fruits. The structural formula of an ester is given.



a. Which fruit's smell does this ester have?

b. Write the name of the carboxylic acid used to prepare this ester.

5. Various organic compounds are formed through organic chemical reactions.

- Write the structural formula of the compound formed when ethyne reacts with hydrogen chloride.
- What is the name of the compound formed when this compound undergoes polymerisation ?
- Write the chemical equation representing the formation of this polymer.

6. Two statements are given.

Statement 1 : Octyl ethanoate has the smell of pineapple.

Statement 2 : For preparing octyl ethanoate, ethanol and octanoic acid are needed.

Which of the following is correct regarding the given statements?

- Statements 1 and 2 are not correct.
- Statement 1 is correct but statement 2 is not correct.
- Statement 2 is correct but statement 1 is not correct.
- Statements 1 and 2 are correct.

7. Starting from ethyne, how will you produce the following?

- Ethene
- Polythene
- Chloroethane

8. a. What is condensation polymerisation?

b. Write one example for a condensation polymer and write the names of its monomers.

9. Match the following.

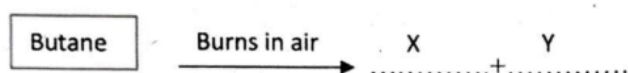
Category	Function
(a) Analgesics	(i) Reduce body temperature
(b) Antipyretics	(ii) prevent the growth of infectious micro organisms
(c) Antibiotics	(iii) Relieve pain

Choose the correct answer from the options given below.

- | | | | |
|---|-------|-------|-------|
| | (a) | (b) | (c) |
| A | (ii) | (i) | (iii) |
| B | (i) | (ii) | (iii) |
| C | (iii) | (i) | (ii) |
| D | (ii) | (iii) | (i) |

10. a. What is meant by combustion?

b. Identify X and Y.



11. One ethyne molecule is allowed to react with two chlorine molecules.

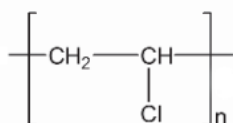
- a. Write the structural formula of the product obtained.
 - b. Write the IUPAC name of the product obtained.
12. A polymer is used to coat the inner side of cookwares. Write the common name and IUPAC name of the polymer.
13. Nylon 66 is a very useful polymer.
- a. What are the monomers of nylon 66?
 - b. Write any one use of nylon 66.
14. a. Starting from carbon monoxide how will you prepare the following compounds?
- i. Methanol
 - ii. Ethanoic acid
- b. Write the chemical equation of reaction for the formation of compound (ii)
15. When ethyl alcohol is treated with a carboxylic acid, in presence of concentrated H_2SO_4 , a compound having the smell of pineapple is obtained.
- a. What is the general name of the product obtained?
 - b. Write the chemical equation of formation of this product.
 - c. Write the IUPAC name of the product.
16. PVC is a widely used polymer.
- a. Starting from ethyne how will you prepare PVC?
 - b. Write the names of reactions involved in each step of preparation.

Answers

1. Structure of P is $CH_2 = CHCl$

Name of P is **Vinyl chloride (Chloroethene)**

Structure of Q is



Name of Q is **Polyvinyl chloride (PVC)**

2. a. $CH_3 - OH$

b. $CH_3 - OH + CO \xrightarrow{\text{catalyst}} CH_3 - COOH$

3. a. $CH_3 - CH_2 - CH_2 - COO - CH_2 - CH_3$,

b. Acid – Butanoic acid

Alcohol – Ethanol

c. $CH_3 - CH_2 - CH_2 - COOH + HO - CH_2 - CH_3 \rightarrow$

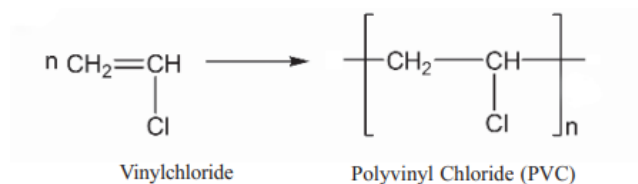


4. a. Pineapple

b. Carboxylic acid – Butanoic acid

5. a. **$CH_2 = CHCl$**

b. Polyvinyl chloride (PVC)



c.

6. A. Statements 1 and 2 are not correct.

7. a. $CH \equiv CH + H_2 \rightarrow CH_2 = CH_2$

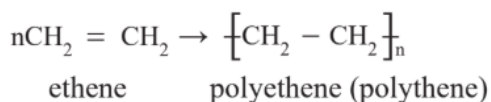
Ethyne

Ethene

b. $CH \equiv CH + H_2 \rightarrow CH_2 = CH_2$

Ethyne

Ethene



c. $CH \equiv CH + H_2 \rightarrow CH_2 = CH_2$

Ethyne

Ethene



Ethene

Chloroethane

8. a. Condensation polymerisation is the process in which different monomers combine together to form larger compounds accompanied by the removal of simple molecules.

b. polymer = Nylon 66

Monomers are **adipic acid** and **hexamethylenediamine**

9. C

10. a. When hydrocarbons burn, they combine with oxygen in air to form CO_2 and H_2O along with heat and light. This process is called combustion.

b. CO_2 and H_2O

11. a. $CH \equiv CH + 2Cl_2 \rightarrow CHCl_2 - CHCl_2$

Structural formula of the product is $CHCl_2 - CHCl_2$

b. 1,1,2,2 – Tetrachloroethane

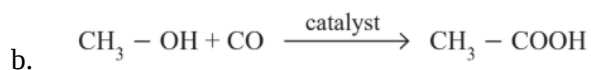
12. Teflon and Polytetrafluoroethane

13. a. Adipic acid and Hexamethylenediamine

b. Manufacture of fabrics

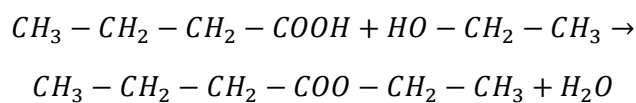
14. a. (i) By treating carbon monoxide with hydrogen in the presence of catalysts.

(ii) By treating methanol with carbon monoxide in the presence of a catalyst.

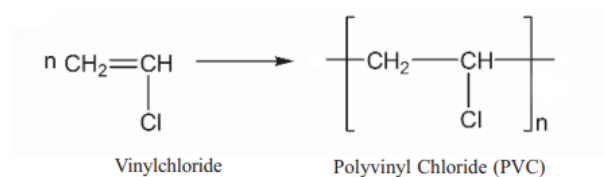


15. a. Ester

b.



c. Ethyl butanoate



b. Addition reaction and polymerisation reaction