PREFACE

- This is an interactive self learning material exclusively meant for SSLC students of Kerala State Syllabus.
- This work is meant **only for** students appearing SSLC examinations , **march 2021**
- This is strictly in accordance with the Focus points suggested by SCERT
- **Scan the QR codes** given at each section to watch the video, related to the topic.
- You can also watch the videos using mobile,laptop etc by clicking / touching the QR codes. Make sure that the data connection is ON.
- Focus Points are marked as ♥♥♥
- Constructive suggestions for further improvement are always welcome

7 Chemical Reactions of Organic Compounds

♥♥♥Some important Chemical reactions of organic compounds are given below.

Sl No	Reaction
1	Substitution Reactions
2	Addition Reactions
3	Polymerisation
4	Combustion of Hydrocarbons
5	Thermal Cracking

♥♥♥1. Substitution Reactions

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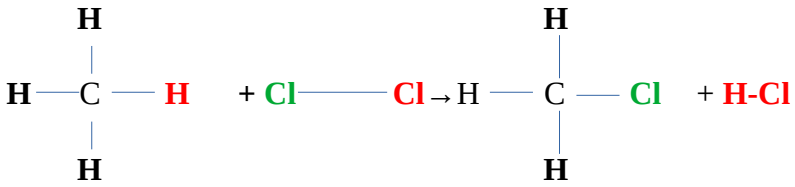
♥♥♥Examine the different stages of the reaction of methane (CH_4) with chlorine **in the presence of sunlight.**

Stage 1

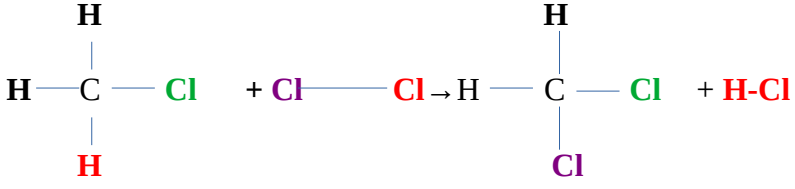


Chloromethane

(CH_4 + Cl_2 → CH_3-Cl + HCl)

Here, one hydrogen atom of methane molecule is replaced by one chlorine atom.
If this process continues..

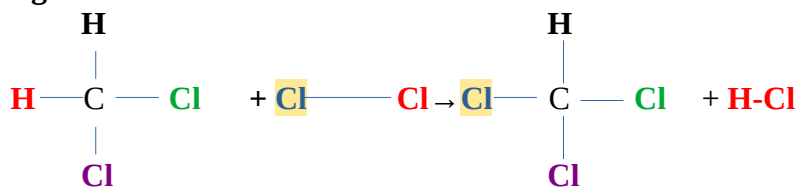
Stage 2



Dichloro methane

(CH_3Cl + Cl_2 → CH_2-Cl_2 + HCl)

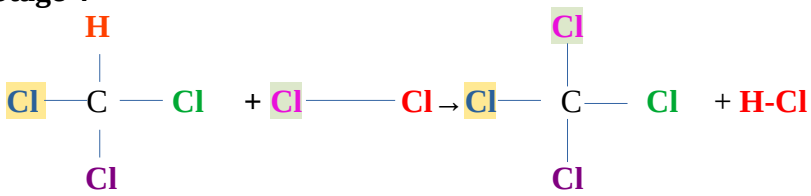
Stage 3



Trichloromethane
(Chloroform)

(CH_2Cl_2 + Cl_2 → $CH\text{-}Cl_3$ + HCl)

Stage 4



Tetrachloromethane
(Carbon tetra chloride)

($CHCl_3$ + Cl_2 → CCl_4 + HCl)

When methane reacts with chlorine each hydrogen atom of methane is replaced successively by chlorine atom. As a result, a mixture ofCH_3Cl (Chloromethane), CH_2Cl_2 (dichloromethane), $CHCl_3$(trichloromethane) and CCl_4 (Tetrachloromethane) is formed.

Such reactions are called Substitution reactions.

A reaction in which an atom or a group in a compound is replaced by another atom or a group is called substitution reaction

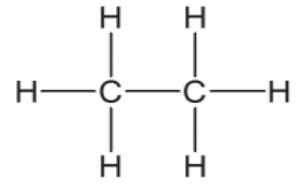
1.What are the compounds formed when CH_3 -CH_3 (C_2H_6 ,ethane)undergoes substitution reaction with chlorine?

Answer:

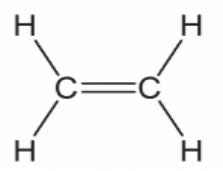
C_2H_6	+	Cl_2	→	C_2H_5Cl	+	HCl
C_2H_5Cl	+	Cl_2	→	$C_2H_4Cl_2$	+	HCl
$C_2H_4Cl_2$	+	Cl_2	→	$C_2H_3Cl_3$	+	HCl
$C_2H_3Cl_3$	+	Cl_2	→	$C_2H_2Cl_4$	+	HCl
$C_2H_2Cl_4$	+	Cl_2	→	C_2HCl_5	+	HCl
C_2HCl_5	+	Cl_2	→	C_2Cl_6	+	HCl

♥♥♥ 2. Addition Reactions

Look at the structural formulae of ethane and ethene.



Ethane



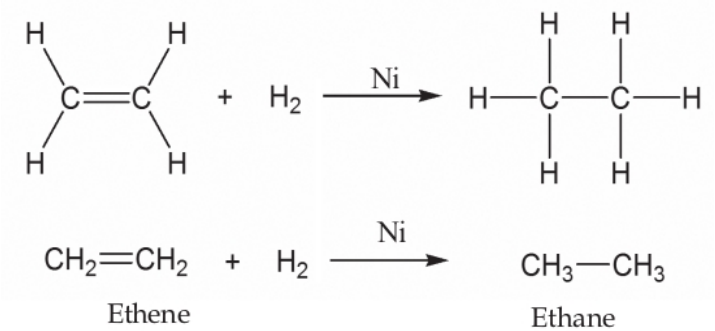
Ethene

*What is the peculiarity of the carbon - carbon bond in ethene?

Ethene is an ***unsaturated*** compound due to the presence of the carbon - carbon ***double bond.*** When unsaturated compounds take part in chemical reactions they tend to form saturated compounds

Let us examine a chemical reaction of ethene molecule.

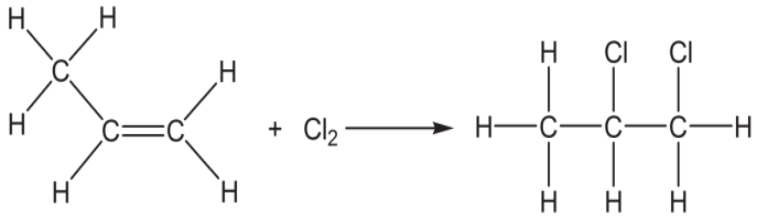
The chemical equation of ***ethene reacting with hydrogen in the presence of the nickel (Ni)*** catalyst at high temperature is given.



* What do we get as the product?

Answer: Ethane (CH_3-CH_3 or C_2H_6)

Let us examine another similar reaction.



$CH_3—CH=CH_2 + Cl_2 \longrightarrow CH_3—CHCl—CH_2Cl$

Propene — 1, 2 - Dichloropropane

* Which hydrocarbon is the reactant here?
  Answer: Propene (CH_3-CH=CH_2)
* Is the product saturated or unsaturated?
  Answer: Saturated

2. ♥♥♥ Identify the products in the following addition reactions and complete table

Chemical reaction	Product	IUPAC name of the product
$CH_2=CH_2 + Cl_2$	.....	.....
$CH_2=CH_2 + HCl$	.....	.....
$CH_3–CH=CH_2 + H_2$	.....	.....
$CH_3–CH=CH–CH_3 + HBr$	.....	.....

Answer:

Chemical reaction	Product		IUPAC name of the product
$CH_2=CH_2 + Cl_2$	CH_2-CH_2 (Cl, Cl)		1,2-Dichloroethane
$CH_2=CH_2 + HCl$	CH_3-CH_2-Cl	Cl-CH_2-CH_3	Chloroethane
CH_3-CH=CH_2 + H_2	CH_3-CH_2-CH_3		Propane
CH_3-CH=CH-CH_3 + HBr	CH_3-CH_2-CH(Br)-CH_3	CH_3-CH(Br)-CH_2-CH_3	2-Bromobutane

♥♥♥ Similarly, take note of the following chemical reactions

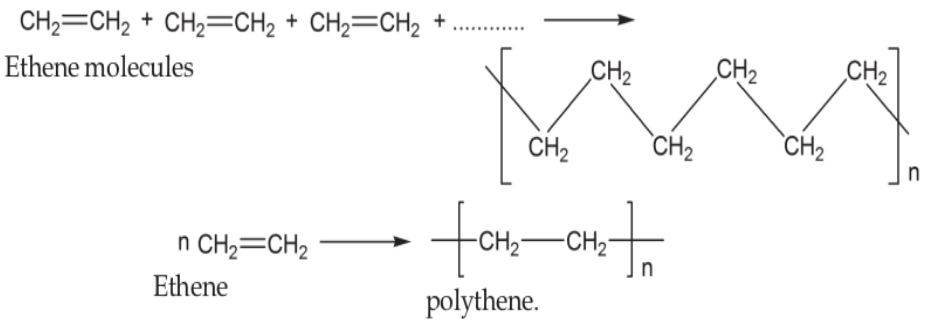
Chemical reaction	Product
$CH{\equiv}CH + H_2$ Ethyne	$CH_2{=}CH_2$ Ethene
$CH_2{=}CH_2 + H_2$ Ethene	$CH_3{-}CH_3$ Ethane
$CH_3{-}C{\equiv}CH + H_2$ Propyne	$CH_3{-}CH{=}CH_2$ Propene
$CH_3{-}CH{=}CH_2 + H_2$ Propene	$CH_3{-}CH_2{-}CH_3$ Propane

Reactions in which unsaturated organic compounds with double bond or triple bond react with other molecules to form saturated compounds are called addition reactions

♥♥♥ 3. Polymerisation

We have learned that ethene molecules undergo addition reaction to form saturated compounds.

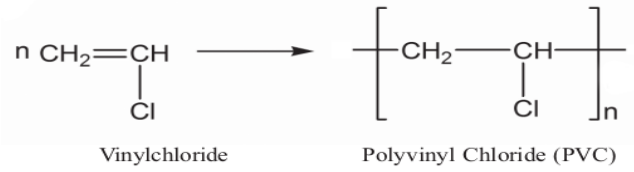
Consider the reaction in which a ***large number of ethene molecules combine under high pressure and temperature in the presence of a catalyst***. The ***product*** formed here ***is polythene***.



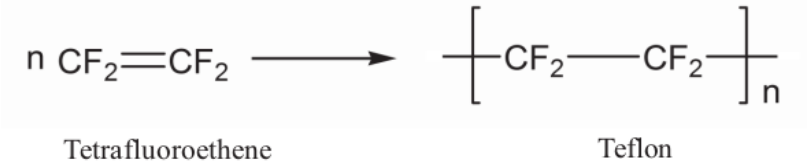
> Polymerisation is the process in which a large number of simple molecules combine under suitable conditions to form complex molecules. The product molecules are called polymers

The simple molecules which combine in this manner are called monomers.

We use a number of natural and man - made polymers in our daily life.
PVC (Polyvinyl Chloride) is a polymer commonly used for making pipes. It is formed by the polymerisation of a large number of chloroethene (Vinyl chloride) molecules.



Teflon is a polymer which is familiar to us. It is used ***for coating on the inner surface of non-stick cookware. Its monomer is tetrafluoroethene.***



3.♥♥♥ Complete the following table suitably.

Monomer	Polymer	Use
. . . . .	PVC	. . . . .
Ethene	. . . . .	. . . . .
Isoprene	Natural rubber (Polyisoprene)	. . . . .
. . . . .	Teflon	. . . . .

Answer:

Monomer	Polymer	Use
Vinyl Chloride (Chloroethene)	PVC	For making pipes,electronic equipments ,buckets, vinyl flooring, table cloths etc
Ethene	Polythene	For making Polythene bags,rain coats etc.
Isoprene	Natural Rubber (Poly Isoprene)	For making tyres, foot wares etc
Tetra Fluoroethene	Teflon (Poly Tetra Fluoroethene)	For coating on the inner surface of non-stick cookware

♥♥♥ 4. Combustion of Hydrocarbons*

8BL4RA

Most of the hydrocarbons are used as fuels.
Examples: Kerosene, Petrol, LPG

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

***Complete combustion**

Example: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + Heat + Light

Hydrocarbons are used as fuels because of the exothermic nature of the combustion process.

♥♥♥ More worked out examples.

1.

Unbalanced	Balanced
$CH_4 + O_2 \rightarrow CO_2 + H_2O$	**$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + Heat + Light**
$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$	$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ + Heat + Light
$C_5H_{12} + O_2 \rightarrow CO_2 + H_2O$	**$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$ + Heat + Light**
$C_7H_{16} + O_2 \rightarrow CO_2 + H_2O$	$C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$ + Heat + Light
$C_6H_{12} + O_2 \rightarrow CO_2 + H_2O$	**$2\ C_6H_{12} + 9\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$ + Heat + Light**

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Unbalanced	Balanced
$C_2H_6 + O_2 \rightarrow CO_2 + H_2O$	**$2\ C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$ + Heat + Light**
$C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$	**$2\ C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$ + Heat + Light**
$C_6H_{14} + O_2 \rightarrow CO_2 + H_2O$	**$2\ C_6H_{14} + 19\ O_2 \rightarrow 12CO_2 + 14H_2O$ + Heat + Light**
$C_6H_6 + O_2 \rightarrow CO_2 + H_2O$	**$2\ C_6H_6 + 15\ O_2 \rightarrow 12CO_2 + 6H_2O$ + Heat + Light**
$C_3H_6 + O_2 \rightarrow CO_2 + H_2O$	**$2\ C_3H_6 + 9\ O_2 \rightarrow 6CO_2 + 6H_2O$ + Heat + Light**

Hint: Balance Hydrogen atoms first,then balance carbon atoms . ***Finally balance Oxygen atoms*.**
If It is a fraction like 5/2 , 7/2 ,15/2 etc, multiply all by 2 , like a mathematical equation.

Explanation

Example

$C_2H_6 + O_2 \rightarrow CO_2 + H_2O$

a. Balancing Hydrogen atoms

$C_2H_6 + O_2 \rightarrow CO_2 + 3H_2O$

b. Balancing Carbon atoms

$C_2H_6 + O_2 \rightarrow 2CO_2 + 3H_2O$

c. Balancing Oxygen atoms

$C_2H_6 + O_2 \rightarrow 2CO_2 + 3H_2O$

Total number of oxygen atoms on the right side = (2 x 2)+ (3x 1)=4+3 = 7

To get 7 oxygen atoms on the left side , multiply O_2 with 7/2

$C_2H_6 + 7/2\ O_2 \rightarrow 2CO_2 + 3H_2O$

Since 7/2 is a fraction, multiply all by 2

$2 \times C_2H_6 + 2 \times (7/2)O_2 \rightarrow 2 \times 2CO_2 + 2 \times 3H_2O$

Answer: $2\ C_2H_6 + 7O_2 \rightarrow 4\ CO_2 + 6\ H_2O$ + Heat + Light

3. Butane is one of the important components in the domestic fuel , LPG.
Write the balanced chemical equation for the combustion of butane (C_4H_{10})
Answer:

$2\ C_4H_{10} + 13\ O_2 \rightarrow 8CO_2 + 10H_2O$ + Heat + Light

♥♥♥ 5. Thermal Cracking

Some hydrocarbons with high molecular masses, when heated in the absence of air undergo decomposition to form hydrocarbons with lower molecular masses.
This process is called Thermal cracking.A number of products are made in this way.
Propane is one of the simplest hydrocarbons which can undergo thermal cracking.
Examine the equation for the thermal cracking of propane.

$CH_3\text{-}CH_2\text{-}CH_3 \rightarrow CH_2{=}CH_2 + CH_4$
Propane Ethene Methane

Another example is given below
$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3 \rightarrow CH_3 - CH_2 - CH_2 - CH_3 + CH_3 - CH = CH_2$
Heptane Butane Propene
The same question can be answered in may ways . Look at a few of those

$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$ →	$CH_3 - CH_2 - CH_3$ +	$CH_3\text{-}\ CH_2 - CH = CH_2$
7 Carbon atoms	3 Carbon atoms	4 Carbon atoms
$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$ →	$CH_3 - CH_2 - \ CH_2\text{-}CH_2{-}CH_3$ +	$CH_2 = CH_2$
7 Carbon atoms	5 Carbon atoms	2 Carbon atoms
$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$ →	$CH_3 - CH_3$ +	$CH_3\text{-}CH_2\text{-}CH_2 - CH = CH_3$
7 Carbon atoms	2 Carbon atoms	5 Carbon atoms
$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$ →	CH_4 +	$CH_3 - CH_2 - CH{=}\ CH - CH_2 - CH_3$
7 Carbon atoms	One carbon atom	6 Carbon atoms

[Here we have 7 carbon atoms. The number 7 can be split in may ways (4+3 ,5+2,6+1) . Double bond can be given in between any two carbon atoms. Total number of C, H & O should be the same on both sides.]

When hydrocarbons with larger number of carbon atoms undergo thermal cracking, the carbon chain can undergo cleavage or breaking in a number of ways. The products formed as a result of thermal cracking depend on the nature of the hydrocarbons getting cracked, temperature and pressure.
When saturated hydrocarbons are subjected to thermal cracking the products formed contain both saturated and unsaturated hydrocarbons.
Plastic wastes, which are polymers can be converted to simpler molecules by thermal cracking. This helps to control pollution to some extent.

♥♥♥ Complete the table containing chemical reaction of hydrocarbons

$CH{\equiv}CH + H_2$	→	.....
$CH_3Cl + Cl_2$	→	..... + HCl
.....	→	$\left[CH_2{-}CH_2\right]_n$
CH_4 + ...	→	$CO_2 + H_2O$
..... + H_2	→	$CH_3{-}CH_3$

Answer:

$CH{\equiv}CH + H_2$	→	$CH_2{=}CH_2$
$CH_3Cl + Cl_2$	→	CH_2Cl_2 + HCl
$n\ CH_2{=}CH_2$	→	$\left[CH_2{-}CH_2\right]_n$
$CH_4 + O_2$	→	$CO_2 + H_2O$
$CH_2{=}CH_2 + H_2$	→	$CH_3{-}CH_3$

♥♥♥ Find out the appropriate reactions and match the columns A ,B and C suitably

Reactants (A)	Products (B)	Name of the reaction (C)
$CH_3{-}CH_3 + Cl_2$	$CO_2 + H_2O$	Addition reaction
$C_2H_6 + O_2$	$CH_2{=}CH_2$	Thermal cracking
$nCH_2{=}CH_2$	$CH_2{=}CH_2 + CH_4$	Substitution reaction
$CH_3{-}CH_2{-}CH_3$	$CH_3{-}CH_2Cl + HCl$	Polymerisation
$CH{\equiv}CH + H_2$	$\left[CH_2{-}CH_2\right]_n$	Combustion

Answer:

Reactants (A)	Products (B)	Name of the reaction (C)
$CH_3{-}CH_3 + Cl_2$	$CH_3{-}CH_2Cl + HCl$	**Substitution reaction**
$C_2H_6 + O_2$	$CO_2 + H_2O$	**Combustion reaction**
$nCH_2{=}CH_2$	$\left[CH_2{-}CH_2\right]_n$	**Polymerisation**
$CH_3{-}CH_2{-}CH_3$	$CH_2{=}CH_2 + CH_4$	**Thermal cracking**
$CH{\equiv}CH + H_2$	$CH_2{=}CH_2$	**Addition reaction**