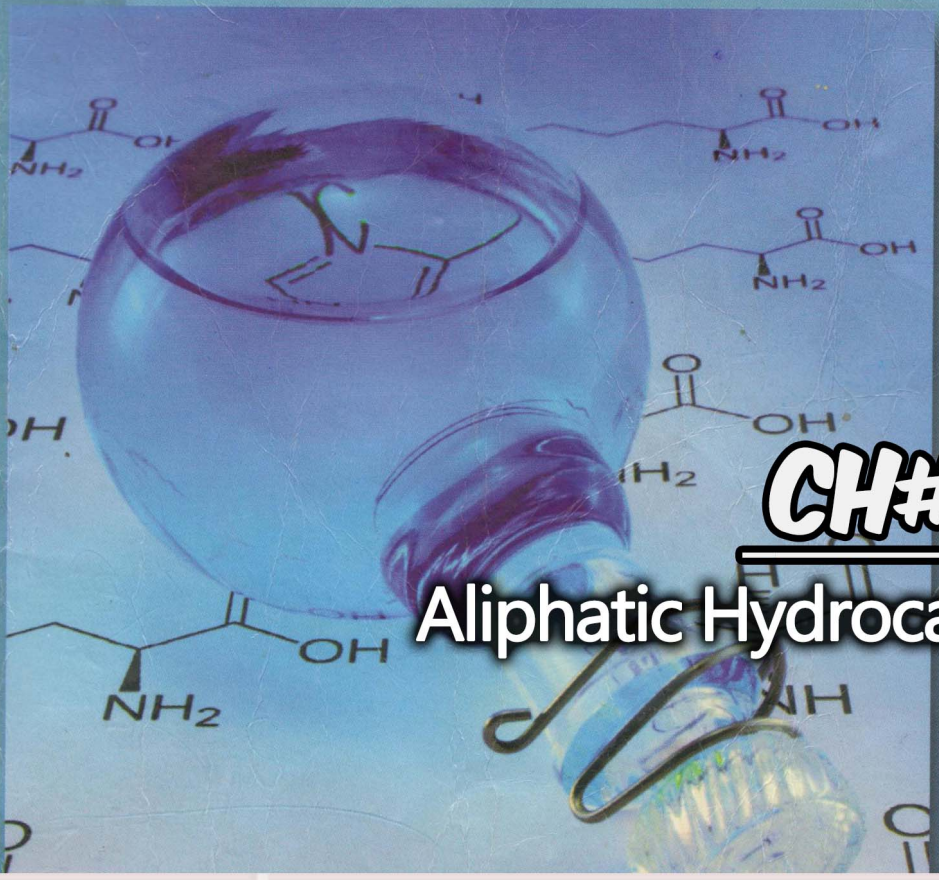
CHEMISTRY

12



CH#8

Aliphatic Hydrocarbons

These Notes Have been Prepared and Developed By

ADNAN SHAFIQUE

www.guldasta.pk

CHAPTER 8

ALIPHATIC HYDROCARBONS

The Compounds which Contain Hydrogen and Carbon only are called hydrocarbons.
e.g methane (CH_4), Ethane (C_2H_6).
There are two Classes of hydrocarbons
(1) Open Chain hydrocarbons
(2) Closed Chain hydrocarbons

(1) Open Chain HydroCarbons :-

HydroCarbons which contain open Chain of Carbon atoms are called open Chain hydro-Carbons or aliphatic hydrocarbons. ike open Chain hydrocarbons have two types.
(a) Saturated hydrocarbons (Alkanes)
(b) Unsaturated hydrocarbons (Alkenes and alkynes)

(a) Saturated HydroCarbons :-

The Hydrocarbons in which all Carbon atoms are bonded by single bonds are called Saturated hydroCarbons or alkanes or paraffins.
e.g methane, ethane, Pecpane etc.
In saturated hydrocarbons all four valencies of Carbon are fully satisfied. Hence it can not take up any more hydrogen

(b) Un-Saturated HydroCarbons :- The hydrocarbons which Contain either a double or a triple bond

are called unsaturated hydrocarbons. e.g $CH_2=CH_2$ (ethene), $CH_2=CH-CH_3$ (Propene), $CH\equiv C-CH_3$ (Propyne) etc. The unsaturated hydrocarbons have two types.

(i) **Alkenes**:- The unsaturated hydrocarbons which contain a double bond are called alkenes or olefins. e.g $CH_2=CH_2$, $CH_2=CH-CH_3$

(ii) **Alkynes**:- The unsaturated hydrocarbons which contain a triple bond are called alkynes or acetylenes. e.g $HC\equiv CH$ (Ethyne) $HC\equiv C-CH_3$ (Propyne)

(2) **Closed Chain Hydrocarbons**:-

The hydrocarbons which contain ring of carbon atoms are called closed chain hydrocarbons or cyclic hydrocarbons. There are two types of cyclic hydrocarbons.

(a) **Alicyclic Hydrocarbons**:- The hydrocarbons which contain ring of carbon atoms but resemble open chain hydrocarbons are called alicyclic hydrocarbons. e.g cyclo-propane, cyclobutane, cyclohexane

(b) **Aromatic Hydrocarbons**:- The hydrocarbons which contain at least one benzene ring are called aromatic hydrocarbons. e.g benzene, Toluene, Naphthalene etc

Nomenclature نام دینا، ناموں کی فہرست

Common or Trivial system:- In the early days organic compounds were named according to their history or method of preparation. These names were called Common or trivial names.

e.g (i) Methane as marsh gas because it is found in marshy places دلدلی جگہوں

(ii) Methyl alcohol is called as wood spirit

(iii) Acetic acid (Latin, acetum means vinegar سرکہ)

(iv) Barbituric acid taken from the name of chemist Barbara

The common names are applicable to all the isomers. e.g $CH_3-CH_2-CH_2-CH_3$, $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_3$

(n-butane) (iso-butane)

Three isomers of pentane are

$CH_3-CH_2-CH_2-CH_2-CH_3$, $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_3$, $CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_3$

(n-pentane) (iso-pentane) (neo-pentane)

The common names of alkenes end at "ylene"

$CH_2=CH_2$, $CH_3-CH=CH_2$, $CH_3-\underset{\underset{CH_3}{|}}{CH}=CH_2$

ethylene propylene iso-butylene

Defects of Common System:-

(i) Common system is not applied for all Compounds

(ii) Common system is not valid for Complex Compounds

(iii) Common system does not explain molecular structure

IUPAC System:- The systematic method of nomenclature was formulated (given) by the International Union of Pure and Applied Chemistry. It is called IUPAC system. In this field first key was made by International Chemical Congress in 1889. This Congress gave an incomplete report in 1892. In 1930, International union of Chemistry (IUC) gave Leige Rules for nomenclature. In 1947, Liege rules were modified by IUPAC. Since that date Union has been issuing rules for systematic nomenclature of organic Compounds. The most recent form of these rules was Published in 1979. IUPAC System is based on the following Principle

"Each different Compound Should have a different name"

By IUPAC system more than seven million Organic Compounds have been named.

Alkyl Groups:- When we remove one hydrogen atom from an alkane, we get an alkyl group. Its general symbol is R—. The name of an alkyl group ends in — yl. For example

$CH_4 \xrightarrow{-H} CH_3-$

(methane) methyl

CH_3-CH_3 (Ethane) $\xrightarrow{-H}$ CH_3-CH_2- Ethyl OR C_2H_5-

$CH_3-CH_2-CH_3$ (Propane) $\xrightarrow{-H}$ $CH_3-CH_2-CH_2-$ (n-Propyl) ; $CH_3-\underset{|}{CH}-CH_3$ (isopropyl)

Butane gives four types of butyl groups

$CH_3-CH_2-CH_2-CH_2-$ (n-butyl) , $CH_3-CH_2-\underset{|}{CH}-CH_3$ (sec-butyl)

$CH_3-CH(CH_3)-CH_2-$ (iso-butyl) , $CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-$ (Ter-butyl)

Nomenclature of alkanes :-

1 :- Select the longest continuous chain of Carbon atoms. It gives the parent name of alkane.

2 :- Numbering begins from that end which is nearer to the substituents (side groups)

3 :- Indicate the position of all substituents by the numbers.

4 :- The substituents are named in an alphabetical order (ترتیب حروف تہجی)

5 :- When two substituents are present on the same Carbon, use that number twice.

6 :- When two or more identical substituents are present, then we use Prefix di, tri, tetra etc..

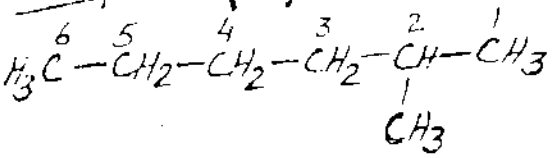
7:- In case of two equal chains, the chain with greater number of substituents is choosen.

8:- When branching occurs at an equal distance from either end, choose the chain which gives lower number at the first point of difference

9:- The names of first ten alkanes are methane ethane, propane, butane, pentane, hexane heptane, octane, nonane and decane.

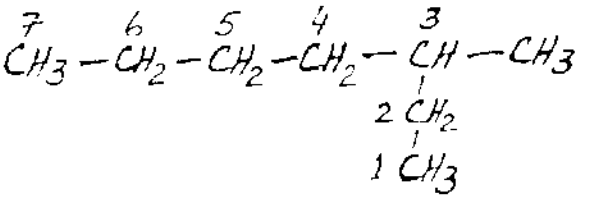
V. Imp Examples

(i)



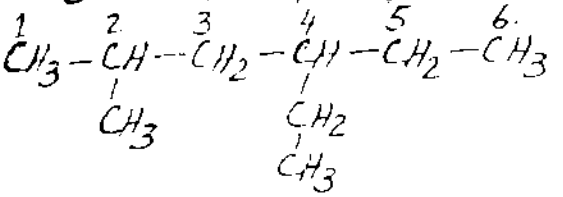
2-Methyl hexane

(ii)



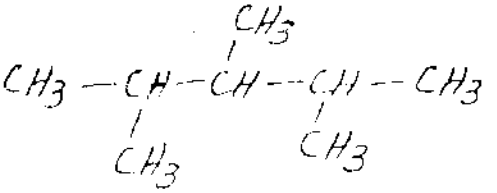
3-Methyl heptane

(iii)



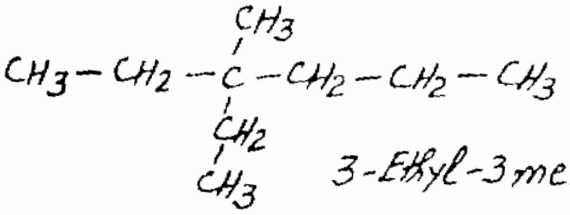
4-Ethyl-2 methyl hexane

(iv)



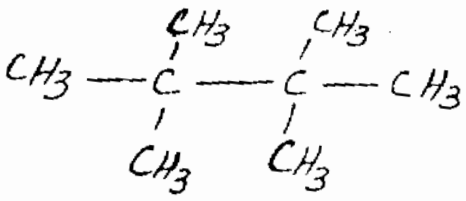
2,3,4-Trimethyl Pentane

(v)



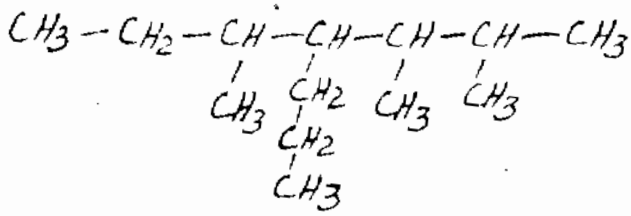
3-Ethyl-3 methyl hexane

(vi)



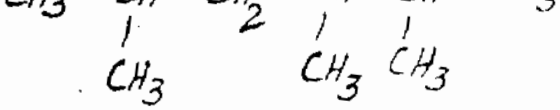
2, 2, 3, 3-Tetramethyl butane

(vii)



2, 3, 5 trimethyl – 4-propyl heptane

(viii)



2, 3, 5-Trimethyl hexane (Not 2, 4, 5-trimethyl hexane)

Nomenclature of Alkenes:-

1:- Select the longest continuous chain of Carbon atoms containing double bond (C=C

2:- Numbering begins from that end of Chain which is nearer to the double bond.

3:- Indicate (i/ii/iii) the position (1/2/3) of the double bond by a number.

4:- Indicate the position of each substituent group by a number.

5:- The name of an alkene ends at "ene"

6:- More than one double bonds are indicated by diene, triene, tetraene and so on.

Examples

(i) $\overset{1}{CH_2}=\overset{2}{CH}-\overset{3}{CH_2}-\overset{4}{CH_3}$ 1-Butene

(ii) $CH_3-CH_2-CH_2-CH=CH_2$ 1-Pentene

(iii) $\overset{6}{CH_3}-\overset{5}{\underset{\overset{1}{CH_3}}{CH}}-\overset{4}{CH_2}-\overset{3}{CH}=\overset{2}{CH}-\overset{1}{CH_3}$

5-Methyl-2-hexene

(iv) $CH_3-CH=\underset{\overset{1}{CH_3}}{C}-CH_3$

2-Methyl-2-butene

(v) $CH_3-\underset{\overset{1}{CH_3}}{\overset{CH_3}{\overset{1}{C}}}-\overset{}{\underset{2}{CH_2}}-CH=\underset{\overset{1}{CH_3}}{C}-CH_3$

2,5,5-Trimethyl-2 hexene

(vi) $\overset{6}{CH_3}-\overset{5}{CH_2}-\overset{4}{CH_2}-\overset{3}{\underset{\overset{1}{CH_2}-CH_2-CH_3}{C}}=\overset{2}{CH}-\overset{1}{CH_3}$

3-Propyl-2 hexene

(vii) $CH_2=CH-CH=CH_2$

* 1, 3-Butadiene OR Buta-1,3-diene

(viii) $CH_2=CH-CH=CH-CH=CH_2$

1, 3, 5-Hexatriene

Nomenclature of Alkynes

1:- Select the longest continuous chain of Carbon atoms containing triple bond ($C\equiv C$)

2:- Numbering begins from that end of chain which is nearer to the triple bond

3:- Indicate the position of triple bond by a number

4:- Indicate the position of each substituent group by a number

5:- The name of an alkyne ends at "yne".

6:- A hydrocarbon containing more than one triple bonds is named as diyne, triyne tetrayne and so on.

7:- A hydrocarbon containing both double and triple bonds is called **enyne**. It is named as followed.

(a) If double and triple bonds are present at identical positions, the double bond is

given the lower number.

(b) If double and triple bonds are not present at identical positions, the lowest possible number can be given to a double or a triple bond.

Examples

(i) $CH \equiv CH$, $HC \equiv C-CH_3$

Ethyne Propyne

(ii) $CH \equiv C-CH_2-CH_3$ 1-Butyne

(iii) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CH_2-C \equiv CH$

5-Methyl-1-hexyne

(iv) $CH \equiv C-CH_2-CH_2-C \equiv CH$

1, 5 Hexadiyne

(V) $CH \equiv C-CH=CH-CH_3$

3-Pentene-1-yne

(Vi) $CH_2=CH-C \equiv C-CH_3$

1-Pentene-3-yne

(Vii) $CH \equiv C-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH=CH_2$

3-Methyl-1-Penten-4-yne

Alkanes OR Paraffins

Hydrocarbons in which all Carbon atoms are bonded by single bonds are called Saturated Hydrocarbons or alkanes or Paraffins.

e.g Methane (CH_4), Ethane (C_2H_6), Propane and butane etc. Their general formula is C_nH_{2n+2}. In these compounds all four valencies of Carbon are fully satisfied. Hence they can not take up any more hydrogen

Preparation of Alkanes

(1) By hydrogenation of Alkenes or alkynes (Sabatier and Sendern's Reaction)

Hydrogenation of alkene or alkyne in Presence of Nickel at 200–300°C gives alkane. It is called Sabatier and Sendern's reaction

e.g

$$\underset{\text{(Alkene)}}{R-CH=CH_2} + H_2 \xrightarrow[200-300^\circ C]{Ni} \underset{\text{(alkane)}}{R-CH_2-CH_3}$$

$$\underset{\text{Ethene}}{CH_2=CH_2} + H_2 \xrightarrow[200-300^\circ C]{Ni} \underset{\text{ethane}}{CH_3-CH_3}$$

In hydrogenation Platinum or Palladium can be also used as catalyst. But they are very expensive (گراں) than Nickel.

(2) From alkyl halide :-

When alkyl halide reacts with zinc in presence of an aqueous acid, then alkane is produced. Examples are given below.

$$\underset{\text{(alkyl halide)}}{R-X} + Zn + \overset{+}{H} + \bar{X} \longrightarrow \underset{\text{(alkane)}}{R-H} + ZnX_2$$

$$\underset{\text{(methyl iodide)}}{CH_3-I} + Zn + \overset{+}{H} + \bar{I} \longrightarrow \underset{\text{(methane)}}{CH_4} + ZnI_2$$

$$\underset{\text{2-bromobutane}}{CH_3-\underset{Br}{CH}-CH_2-CH_3} + Zn + \overset{+}{H} + \bar{Br} \longrightarrow \underset{\text{n-Butane}}{CH_3-CH_2-CH_2-CH_3} + ZnBr_2$$

Hydrogenolysis :- Addition of hydrogen accompanied by bond cleavage is called hydrogenolysis. Reaction of alkyl halide with H_2 in presence of Palladium-Charcoal gives alkane.

$$R-X + H_2 \xrightarrow[\Delta]{Pd/Charcoal} R-H + H-X$$

(3) By decarboxylation of mono-Carboxylic Acid

Removal of carbon dioxide from a compound is called decarboxylation. The reaction of sodium salt of carboxylic acid with soda lime gives an alkane.

$$R-\underset{}{COO}\overset{+}{Na} + NaOH \xrightarrow{CaO} R-H + Na_2CO_3$$

$$\underset{\text{Sodium Propionate}}{CH_3-CH_2-COONa} + NaOH \xrightarrow{CaO} CH_3-CH_3 + Na_2CO_3$$

(4) Kolbe's Method:- It is an electrolytic method for Preparation of an alkane. The electrolysis of Solution of Sodium salt of mono-Carboxylic acid gives alkane. This method is used only for Preparation of Symmetrical alkane (R–R)

$$2RCOO^{-}Na^{+} + 2H_2O \xrightarrow{\text{Electrolysis}} R-R + 2CO_2 + H_2 + 2NaOH$$

$$2CH_3COOK + 2H_2O \xrightarrow{\text{Electrolysis}} CH_3-CH_3 + 2CO_2 + 2KOH + H_2$$

The mechanism of reaction is given below.

$$2CH_3COOK \underset{\text{ionization}}{\overset{\text{Water}}{\rightleftharpoons}} 2CH_3COO^{-} + 2K^{+}$$

Pot. acetate

$$2CH_3COO^{-} \longrightarrow 2CH_3COO^{\cdot} + 2e^{-}$$

$$2CH_3COO^{\cdot} \longrightarrow 2CH_3^{\cdot} + 2CO_2$$

$$CH_3^{\cdot} + CH_3^{\cdot} \longrightarrow CH_3-CH_3$$

} At anode

$$2H_2O + 2e^{-} \longrightarrow 2OH^{-} + H_2$$

$$2K^{+} + 2OH^{-} \longrightarrow 2KOH$$

} At Cathode

Kolbe's method can not be used for the Preparation of methane

(5) From Grignard Reagents :- Reaction of Grignard reagent with water or aqueous acid gives alkane.

$$CH_3\overset{-\delta}{-}Mg\overset{+\delta}{-}Br + H\overset{+\delta}{-}\overset{-\delta}{O}H \xrightarrow[H^+]{\text{Ether}} CH_4 + Mg\begin{matrix}Br\\OH\end{matrix}$$

$$CH_3\overset{-\delta}{-}CH_2\overset{+\delta}{-}Mg\overset{+\delta}{-}Br + H\overset{+\delta}{-}\overset{-\delta}{O}H \xrightarrow[H^+]{\text{Ether}} \underset{\text{(Ethane)}}{CH_3-CH_3} + Mg\begin{matrix}Br\\OH\end{matrix}$$

Ethyl Magnesium Bromide

(6) From Carbonyl Compounds (Aldehydes or Ketones)

Aldehydes and Ketones are called Carbonyl compounds Their reduction gives alkanes

(i) Clemmenson Reduction :-

Reduction of Ketone in Presence of Zinc amalgam and Hydrochloric acid gives alkane In this case Carbonyl group of Ketone is reduced to methylene group ($-CH_2-$)

$$\underset{\text{acetone}}{CH_3-\overset{O}{\overset{\|}{C}}-CH_3} + 4[H] \xrightarrow[HCl]{Zn-Hg} \underset{\text{(Propane)}}{CH_3-CH_2-CH_3} + H_2O$$

(ii) Wolf-Kishner's Reduction :-

The reduction of an aldehyde in Presence of Hydrazine (N_2H_4) and KOH gives alkane.
In this case Carbonyl group of an aldehyde is reduced to methyl group.

$$\underset{\text{acetaldehyde}}{CH_3-\overset{O}{\overset{\|}{C}}-H} + 4[H] \xrightarrow[200^\circ C]{N_2H_4/KOH} \underset{\text{(Ethane)}}{CH_3-CH_3} + H_2O$$

Physical Properties of alkanes

(i) Physical state:- First four alkanes are colourless and odourless gases. The next 13 members ($C_5 - C_{17}$) are colourless, odourless liquids and higher members are waxy(ish) solid

(ii) Solubility:- Alkanes are soluble in non-polar solvents like benzene, ether, CCl_4 etc. It is due to their non-polar nature. Moreover their solubility decreases with increase in molecular mass.

(iii) Melting points:- The melting points of alkanes increase with the increase of the molecular mass but this increase is not very regular.

(iv) Boiling Points:- The boiling points of alkanes increase with the number of Carbon atoms in a regular way. e.g boiling point increases by 20–30°C for addition of each $-CH_2-$ group in alkanes. Moreover the normal or straight chain isomer has higher boiling point than its branched chain isomer. For example boiling point of n-butane is higher (55°C) than iso butane (−10.2°C)

Reactivity of alkanes:- Alkanes or paraffins are less reactive compounds. (Latin: Parum = little, Affins = affinity) The un-reactivity of alkanes is due to their non-polar bonds and inertness of σ-bonds. The electronegativity of Carbon (2.5) and hydrogen (2.1) are nearly same. So bonding electrons show equal sharing between C–C and C–H bonds. Thus bonds in alkanes are non-polar.

Inertness of σ-bond:- In a σ-bond the electrons are very tightly bound between the nuclei. So a σ-bond is very stable and a lot of energy is required to break it. Thus electrons of a σ-bond can neither attack on an electrophile nor a nucleophile can attack on them. It is called inertness of σ-bond. However alkanes can show two types of reactions

(i) Substitution reactions

(ii) Thermal and Catalytic reactions

(1) Combustion (جلنا):- The burning of a substance in presence of oxygen is called combustion. The complete combustion of alkane gives CO_2, H_2O and heat. The amount of heat evolved when one mole of hydrocarbon is burnt to CO_2 and H_2O is called heat of combustion. e.g

$$CH_4 + 2O_2 \xrightarrow{\text{Flame}} CO_2 + 2H_2O + 891\ kj\ mol^{-1}$$

(2) Oxidation:- Incomplete oxidation of CH_4 gives CO and Carbon. It occurs in limited supply of oxygen

$$3CH_4 + 4O_2 \xrightarrow{\text{Flame}} 2CO + 6H_2O + C$$

Catalytic Oxidation:- The catalytic oxidation of methane occurs at high temperature and Pressure. It gives many useful Products

$$CH_4 + [O] \xrightarrow{Cu,\ 400^\circ C/200\ atm} CH_3OH \text{ (methyl alcohol)}$$

$$CH_3OH + [O] \xrightarrow{Cu,\ 400^\circ C/200\ atm} HCHO + H_2O$$

$$HCHO + [O] \xrightarrow{Cu,\ 400^\circ C/200\ atm} HCOOH \text{ (Formic acid)}$$
(Formaldehyde)

$$HCOOH + [O] \xrightarrow{Cu,\ 400^\circ C/200\ atm} CO_2 + H_2O$$

(3) **Nitration:-** The substitution reaction in which hydrogen atom of an alkane is replaced by nitro group ($-NO_2$) is called Nitration. e.g

$$CH_4 + HNO_3\ (conc) \xrightarrow{450^\circ C} CH_3NO_2 + H_2O$$
(Nitromethane)

The nitroalkanes are used as fuels, Solvents and in organic synthesis.

(4) **Halogenation:-** The substitution reaction in which one or more hydrogen atoms of an alkane are replaced by halogen atoms is called halogenation. It takes place in Presence of Sunlight or UV light. The reaction of Iodine with alkane is highly violent and gives a mixture of Carbon, HF and fluorinated alkane.

The order of reactivity of halogens is

$$F_2 > Cl_2 > Br_2 > I_2$$

e.g $$CH_4 + Cl_2 \xrightarrow{RD} CH_3Cl + HCl$$

The reaction proceeds through free radical mechanism and involves following three steps

Step I :- $Cl-Cl \xrightarrow{h\nu} \dot{Cl} + \dot{Cl}$ (Initiation)

Step II :- $CH_3-H + \dot{Cl} \xrightarrow{h\nu} \dot{CH_3} + HCl$

$\dot{CH_3} + Cl-Cl \xrightarrow{h\nu} CH_3-Cl + \dot{Cl}$ (Propagation)

Step III :- $\dot{CH_3} + \dot{Cl} \longrightarrow CH_3-Cl$ (Termination)

(methyl chloride)

When step II repeat again and again, a mixture of Products is obtained

$CH_3-Cl + \dot{Cl} \longrightarrow \dot{CH_2}Cl + HCl$

$\dot{CH_2}Cl + Cl-Cl \longrightarrow CH_2Cl_2 + \dot{Cl}$

(Dichloromethane)

$CH_2Cl_2 + \dot{Cl} \longrightarrow \dot{C}HCl_2 + HCl$

$\dot{C}HCl_2 + Cl-Cl \longrightarrow CHCl_3 + \dot{Cl}$

(Chloroform or trichloromethane)

$CHCl_3 + \dot{Cl} \longrightarrow \dot{C}Cl_3 + HCl$

$\dot{C}Cl_3 + Cl-Cl \longrightarrow CCl_4 + \dot{Cl}$

Carbon tetrachloride

or Tetrachloromethane

Thus we may say that reaction of methane with chlorine in presence of sunlight gives a mixture of products. These products are CH_3Cl, CH_2Cl_2, $CHCl_3$ and CCl_4. These products are important but this reaction is not synthetically important

Uses of Methane :-

(i) Methane is used as a fuel (ایندھن)
(ii) Methane is used as an illuminating gas
(iii) Methane is used for preparation of Carbon black which is used in paints, inks and tyres
(iv) Methane is used in manufacturing of Urea.
(v) Methane is used for industrial preparation of methyl alcohol, formaldehyde, H_2 and HCN.
(vi) Methane is used for preparation of CH_3Cl, CH_2Cl_2, $CHCl_3$ (Chloroform) and CCl_4.

Alkenes

The unsaturated hydrocarbons which contain a double bond are called alkenes or olefins.
e.g $CH_2=CH_2$ (ethene), $CH_3-CH=CH_2$ (Propene)
Olefin is a Latin word which means an oil forming compound. It is due to the reason that lower alkenes give oily products with Cl_2 or Br_2.
Alkenes containing one double bond are called **mono-enes**. Their general formula is C_nH_{2n}
Alkenes containing two double bonds are called **dienes** and so on.
The simplest alkene (olefin) is ethene, C_2H_4

Preparation of alkenes

(1) By dehydrohalogenation of alkyl halides

Removal of hydrogen halide (HX) from two adjacent carbon atoms of a compound is called dehydrohalogenation. e.g

$$CH_3-CH_2Br + KOH(alc) \longrightarrow CH_2=CH_2 + H_2O + KBr$$

Ethyl bromide (ethene)

$$CH_3-CH_2-CH_2-Br + KOH(alc) \longrightarrow CH_3-CH=CH_2 + H_2O + KBr$$

(n-Propyl bromide) (Propene)

(2) By dehydration of alcohols:-

Removal of water molecule from a substance is called dehydration. In this reaction Al_2O_3, P_4O_{10}, Conc H_2SO_4 or H_3PO_4 is used as dehydrating agent. e.g

$$CH_3-CH_2OH \xrightarrow[180^\circ C]{Conc\ H_2SO_4} CH_2=CH_2 + H_2O$$

The order of dehydration of alcohols is in the following:

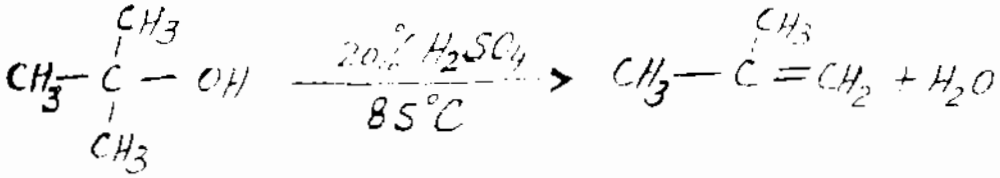
Tert. alcohol > Sec. alcohol > Pri-alcohol

$$CH_3-CH_2-CH_2-CH-CH_3 \xrightarrow{H_2SO_4} CH_3-CH_2-CH=CH_2 + H_2O$$

(Pentan-2-ol)

$$CH_3-CH-CH-CH_3 \xrightarrow{H_2SO_4} CH_3-CH_2-\underset{CH_3}{\overset{OH}{C}}H + H_2O$$

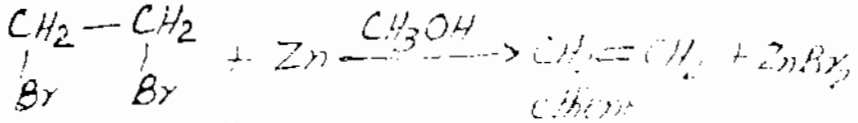
Secondary alcohol



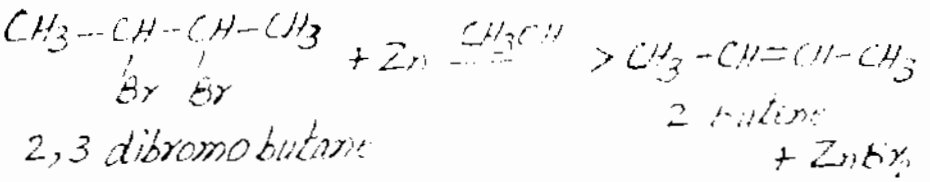
Tertiary alcohol

(3) Dehalogenation of Vic-Dihalides

The dihalides having two halogen atoms on two adjacent (ألف-ألف) carbon atoms are called vicinal dihalides. The dehalogenation (removal of halogens) of vic-dihalide gives alkene



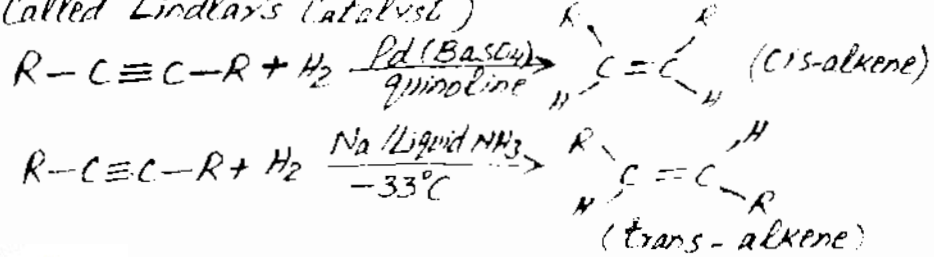
1, 2 dibromo ethane



2, 3 dibromo butane

(4) By Partial hydrogenation of alkynes:-

The partial or controlled hydrogenation of alkynes give alkenes. It is done in presence of suitable catalyst For example, in presence of Lindlar's catalyst an alkyne gives cis alkene. (The finely divided Palladium supported on $BaSO_4$ and poisoned by quinoline is called Lindlar's catalyst)



(5) By electrolysis of Salt of dicarboxylic Acid (Kolbe's electrolytic method)

The electrolysis of aqueous solution of sodium succinate gives ethene. It is called Kolbe's method.

$$\begin{matrix} CH_2-COONa \\ | \\ CH_2-COONa \end{matrix} + 2H_2O \xrightarrow{\text{Electrolysis}} CH_2=CH_2 + 2CO_2 + H_2 + 2NaOH$$

Sodium Succinate.

The mechanism of reaction is given below

$$\begin{matrix} CH_2-COONa \\ | \\ CH_2-COONa \end{matrix} \underset{\text{ionization}}{\overset{H_2O}{\rightleftharpoons}} \begin{matrix} CH_2-COO^- \\ | \\ CH_2-COO^- \end{matrix} + 2Na^+$$

$$\begin{matrix} CH_2-COO^- \\ | \\ CH_2-COO^- \end{matrix} \longrightarrow \begin{matrix} CH_2\cdots COO^{\cdot} \\ | \\ CH_2-COO^{\cdot} \end{matrix} + 2e^-$$

$$\begin{matrix} CH_2-COO^{\cdot} \\ | \\ CH_2-COO^{\cdot} \end{matrix} \longrightarrow CH_2=CH_2 + 2CO_2$$

(At anode)

$$2H_2O + 2e^- \longrightarrow 2OH^- + H_2$$

$$2Na^+ + 2OH^- \longrightarrow 2NaOH$$

(At Cathode)

Physical Properties:- (i) First three alkenes are gases, C_5 to C_{15} are liquids and higher are solids

(ii) They are water insoluble but alcohol soluble.

(iii) They have particular Smell.

(iv) They are weakly Polar molecules.

Reactivity of a π-bond :-

A π-bond is formed by Parallel overlap of p-orbitals. In this case overlap of the p-orbitals is not as good as in a σ-bond. So π-electrons are less firmly held by the atoms. Thus π-bond is a weak bond as Compared to a σ-bond. Therefore. it breaks easily due to attack of electrophilic reagent. Hence alkenes Show electrophilic reactions.

Reactions of Alkenes

(1) Addition of Hydrogen (Hydrogenation)

The reaction in which hydrogen is added to an alkene in Presence of a Catalyst at a Pressure of 1–5 atm is called hydrogenation. e.g

$$CH_2=CH_2 + H_2 \xrightarrow[200-300^\circ C]{Ni} CH_3-CH_3$$

$$CH_3-\overset{CH_3}{\overset{|}{C}}H-CH=CH_2 + H_2 \xrightarrow[300^\circ C]{Ni} CH_3-\overset{CH_3}{\overset{|}{C}}H-CH_2-CH_3$$

3-methyl-1-butene

Raney Nickel:- When Ni–Al alloy is treated with NaOH, then Nickel is obtained in the form of fine suspension. It is called **Raney Nickel**. It is used as Catalyst in hydrogenation

$$Ni-Al + NaOH + H_2O \longrightarrow Ni + NaAlO_2 + \frac{3}{2}H_2$$

e.g  $+ 3H_2 \xrightarrow{Ni}$  Cyclohexane

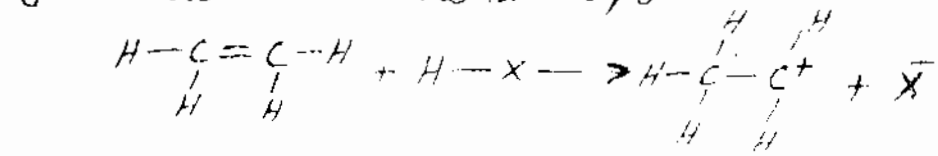
(2) Addition of Hydrogen Halide :-

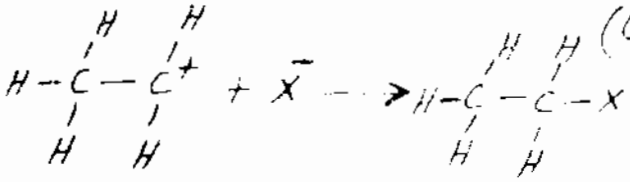
Addition of hydrogen halide (Halogen acid) to an alkene gives alkyl halide. e.g

$$CH_2=CH_2 + HCl \longrightarrow CH_3-CH_2Cl$$

$$CH_3-CH=CH_2 + HBr \longrightarrow CH_3-\underset{Br}{CH}-CH_3$$

The mechanism of reaction is given below. It involves two steps.





(Carbocation)

Markownikov's Rule :- The rule states that in the addition of an unsymmetrical reagent to an unsymmetrical alkene, the negative part of adding reagent goes to that Carbon which has the least number of hydrogen atoms.

e.g (i) $CH_3-CH=CH_2 + HBr \longrightarrow CH_3-\underset{Br}{CH}-CH_3$

Propene — 2-bromopropane

(ii) $CH_3-\underset{CH_3}{C}=CH_2 + HBr \longrightarrow CH_3-\underset{Br}{\overset{CH_3}{C}}-CH_3$

2-Methyl-Propene — 2-Bromo-2 methyl Propane

(3) **Addition of H_2SO_4:-** When an alkene reacts with cold conc H_2SO_4, then alkyl hydrogen sulphate is formed. Then ethyl H-sulphate reacts with boiling water to give alcohol The overall reaction is the addition of water to an alkene. So it is called hydration reaction. e.g

$$CH_2 = CH_2 + H-O-SO_3H \longrightarrow CH_3-CH_2-O-SO_3H$$

Ethyl hydrogen sulphate

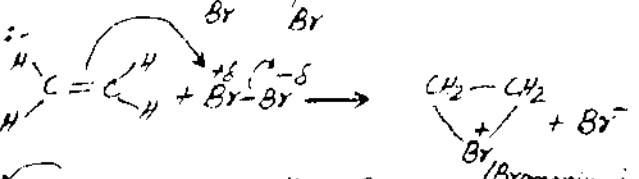
$$CH_3-CH_2-O-SO_3H + H_2O \xrightarrow{100^\circ C} CH_3-CH_2-OH + H_2SO_4$$

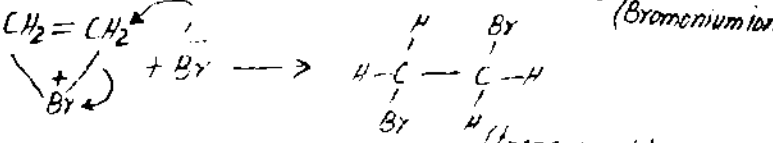
(4) **Addition of Halogens:-** Reaction of an alkene with halogen gives a vicinal dihalide (1,2 dihalo alkane)

$$CH_2=CH_2 + X_2 \xrightarrow{CCl_4} \underset{X}{CH_2}-\underset{X}{CH_2}$$

$$CH_2=CH_2 + Br_2 \longrightarrow \underset{Br}{CH_2}-\underset{Br}{CH_2}$$ vicinal dihalide

Mechanism:-





(trans 1,2 dibromoethane)

In this reaction brown colour of bromine is discharged This test is used for the detection of a double bond.

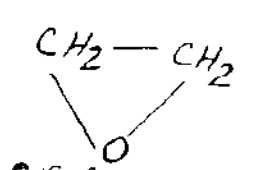
(5) **Addition of Hypohalous Acid (HOX):-** Aqueous solution of halogen reacts with an alkene and gives halohydrin or halohydrin. In this reaction solvent molecule (H_2O) also react.

$$X_2 + H_2O \longrightarrow HOX + HX$$

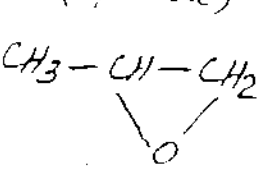
$$CH_2=CH_2 + HOX \longrightarrow \underset{X}{CH_2}-\underset{OH}{CH_2}$$ (Halohydrin)

Oxidation Reactions of Alkenes

(1) Addition of Oxygen:- Alkenes react with oxygen in presence of Silver as a catalyst and give epoxides. e.g

(i) $CH_2=CH_2 + \frac{1}{2}O_2 \xrightarrow[300^\circ C]{Ag_2O}$ 

Ethylene oxide (Epoxide)

$CH_3-CH=CH_2 + \frac{1}{2}O_2 \xrightarrow[300^\circ C]{Ag_2O}$ 

(Propylene oxide)

The epoxides are starting materials for preparation of glycols.

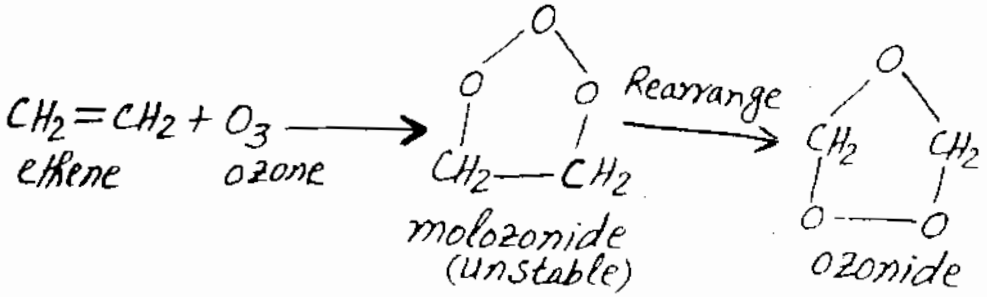
(2) Combustion:- Alkenes burn in air to produce CO_2 and H_2O.

$$\underset{\text{Ethene}}{C_2H_4} + 3O_2 \longrightarrow 2CO_2 + 2H_2O + \text{heat}$$

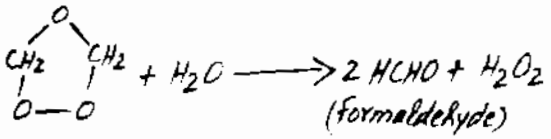
(3) Hydroxylation:- When an alkene is treated with 1% alkaline solution of $KMnO_4$ (Baeyer Reagent) then vicinal glycol is formed. It is called hydroxylation. In this reaction Pink colour of $KMnO_4$ discharges. It is called **Baeyer's test**. It is used for detection of a double bond in an organic molecule. e.g

$$3CH_2=CH_2 + 2KMnO_4 + 4H_2O \xrightarrow[\bar{O}H]{Cold} \underset{\text{Ethylene glycol}}{3\,CH_2(OH)-CH_2(OH)} + 2KOH + 2MnO_2$$

(4) Ozonolysis:- Ozone (O_3) reacts with an alkene to form an unstable **molozonide**. It further rearranges to form an **Ozonide**



The ozonide reacts with zinc and H_2O to form aldehyde or ketone.



$$H_2O_2 + Zn \longrightarrow ZnO + H_2O$$

This whole reaction is called Ozonolysis
It is used to locate the position of a double bond in an alkene

Polymerization:- The process in which small organic molecules (monomers) combine together and give larger (giant) molecules is called Polymerization and the product is called Polymer. e.g

$$n\,CH_2=CH_2 \xrightarrow[0.01\%\ Oxygen]{400^\circ C,\ 100\ atm} \{CH_2-CH_2\}_n$$

Polythene

If $Al(C_2H_5)_3$ and $TiCl_4$ are used as catalysts then a good quality polythene is obtained.

Uses of Ethene :-

(i) Ethene is used for artificial ripening of the fruit

(ii) Ethene is used as anaesthetic

(iii) Ethene is used for manufacture of polythene which is used for making toys, bags, cables

(iv) Ethene is used as a starting material for many chemicals e.g. glycol, ethyl alcohol etc.

(v) Ethene is used for preparation of **Mustard gas.** The mustard gas is used as chemical weapon. It was used in World War I. It is a powerful vesicant and causes blisters. Its smell is mustard like. It is not a gas but high boiling liquid. It spreads in air like a mist.

$$2\,CH_2=CH_2 + S_2Cl_2 \longrightarrow S\begin{matrix}\diagup CH_2-CH_2-Cl \\ \diagdown CH_2-CH_2-Cl\end{matrix} + S$$

sulphur monochloride

Mustard gas
(β-β'-dichloro ethyl sulphide)

(vi) Oxy-ethylene flame is used for welding and cutting metals.

Alkynes

The unsaturated hydrocarbons which contain a triple bond are called alkynes. Their general molecular formula is C_nH_{2n-2}. The first member of alkynes series is ethyne (Acetylene) Its formula is C_2H_2

Preparation of alkynes

(1) By dehydrohalogenation of dihalides

Removal of two molecules of hydrogen halide from two adjacent carbon gives an alkyne.

$$R-\underset{X}{CH}-\underset{X}{CH}-R + 2KOH \xrightarrow{\text{Alcohol}} R-C\equiv C-R + 2KX + 2H_2O$$
(An alkyne)

e.g.

$$\underset{Br}{CH_2}-\underset{Br}{CH_2} + KOH \xrightarrow{\text{Alcohol}} \underset{Br}{CH}=CH_2 + KBr + H_2O$$

$$\underset{Br}{CH}=CH_2 + KOH \xrightarrow{\text{alcohol}} CH\equiv CH + KBr + H_2O$$
(Ethyne)

(2) By dehalogenation of tetrahalide

Removal of two molecules of halogens from a vicinal tetrahalide gives an alkyne

$$\begin{matrix} Br & Br \\ | & | \\ CH-CH \\ | & | \\ Br & Br \end{matrix} + Zn \longrightarrow \underset{Br}{CH}=\underset{Br}{CH} + ZnBr_2$$

$$\begin{matrix} CH=CH \\ | \quad\quad | \\ Br \quad Br \end{matrix} + 2Zn \longrightarrow CH \equiv CH + ZnBr_2$$

(3) By Kolbe's Electrolytic method:-

The electrolysis of aqueous solution of Potassium maleate gives ethyne.

$$\begin{matrix} CH-COOK \\ || \\ CH-COOK \end{matrix} + 2H_2O \xrightarrow{Electricity} \begin{matrix} CH \\ ||| \\ CH \end{matrix} + 2CO_2 + 2KOH + H_2$$

Potassium maleate (Ethyne)

The mechanism of the reaction is given as

$$\begin{matrix} CH-COOK \\ || \\ CH-COOK \end{matrix} \xrightarrow[ionization]{Electricity} \begin{matrix} CH-COO^- \\ || \\ CH-COO^- \end{matrix} + 2K^+$$

$$\left.\begin{matrix} \begin{matrix} CH-COO^- \\ || \\ CH-COO^- \end{matrix} \longrightarrow \begin{matrix} CH-COO^{\cdot} \\ || \\ CH-COO^{\cdot} \end{matrix} + 2\bar{e} \\ \begin{matrix} CH-COO^{\cdot} \\ || \\ CH-COO^{\cdot} \end{matrix} \longrightarrow \begin{matrix} CH \\ ||| \\ CH \end{matrix} + 2CO_2 \end{matrix}\right] \text{At cathode}$$

$$\left.\begin{matrix} 2K^+ + 2\bar{e} \longrightarrow 2K \\ 2K + 2H_2O \longrightarrow 2KOH + H_2 \end{matrix}\right] \text{At Anode}$$

Industrial Preparation of Ethyne:- Reaction of Calcium Carbide with Water gives ethyne (C_2H_2)

$$CaO + 3C \xrightarrow{Electric\ furnace} CaC_2 + CO$$

$$CaC_2 + 2H_2O \longrightarrow C_2H_2 + Ca(OH)_2$$

Physical Properties:-

(i) Alkynes are colourless and odourless but ethyne has a garlic like odour.

(ii) First three alkynes are gases, next eight members are liquids and higher members are solids

(iii) The melting points, boiling points and densities of alkynes increase gradually with molecular mass.

(iv) Alkynes are soluble in non-polar solvent like ether, benzene and CCl_4

Reactivity of alkynes

Alkynes have Carbon to Carbon triple bond. In a triple bond, one bond is σ and two are π-bonds. The electrons are tightly held by two atoms. Thus these electrons are not easily available to the electrophilic reagents.

Addition Reactions

(1) Addition of Hydrogen:-

Hydrogenation of alkynes gives an alkene

$$CH \equiv CH + H_2 \xrightarrow[\text{Heat}]{Ni} CH_2 = CH_2$$

$$CH_2 = CH_2 + H_2 \xrightarrow[\text{Heat}]{Ni} CH_3 - CH_3$$

(2) Addition of Halogens:-

$$HC \equiv CH + Cl_2 \xrightarrow{CCl_4} \underset{Cl}{\overset{Cl}{CH}} = \underset{Cl}{\overset{Cl}{CH}}$$

1,2 dichloro ethene

$$\underset{Cl}{\overset{Cl}{CH}} = \underset{Cl}{\overset{Cl}{CH}} + Cl_2 \xrightarrow{CCl_4} \underset{Cl}{\overset{Cl}{CH}} - \underset{Cl}{\overset{Cl}{CH}}$$

1,1,2,2 tetrachloro ethane

(3) Addition of Halogen acids:-

Ha Alkynes react with halogen acids (H–X) to form dihaloalkanes.

$$CH\equiv CH + HBr \longrightarrow CH_2=CHBr$$

vinyl bromide

$$CH_2=CHBr + HBr \xrightarrow[\text{addition}]{\text{Markownikov}} CH_3-CHBr_2$$

1,1 dibromoethane

(4) Addition of Water:-

Alkynes react with water to form an enol which rearranges to give aldehyde or ketone.

e.g

(i) $$CH\equiv CH + H-OH \xrightarrow[75\,^\circ C]{HgSO_4,\ H_2SO_4} CH_2=CHOH$$

vinyl alcohol (enol)

$$CH_2=CHOH \xrightarrow[\text{isomerization}]{\text{Rearrangement}} CH_3-CHO$$

(acetaldehyde)

(ii) $$CH_3-C\equiv CH + H_2O \xrightarrow[75\,^\circ C]{HgSO_4,\ H_2SO_4} CH_3-\overset{OH}{\overset{|}{C}}=CH_2$$

enol

$$CH_3-\overset{OH}{\overset{|}{C}}=CH_2 \xrightarrow{\text{Rearrangement}} CH_3-\overset{O}{\overset{\|}{C}}-CH_3$$

(enol) Acetone

(5) Addition of NH_3 and Hydrogen Cyanide:-

$$CH\equiv CH + NH_3 \xrightarrow[300\,^\circ C]{Al_2O_3} CH_3-C\equiv N + H_2$$

(methyl Nitrile)

$$CH\equiv CH + HCN \xrightarrow[\text{Heat}]{Cu_2Cl_2 + NH_4Cl} CH_2=CHCN$$

Vinyl Cyanide (Acrylonitrile)

6) Oxidation Reactions of alkynes :-

(i) Oxidation of ethyne gives glyoxal and further oxidation of glyoxal gives oxalic acid. It takes place in presence of strong alkaline $KMnO_4$

$$CH\equiv CH + 2H_2O + 2[O] \xrightarrow{KMnO_4} \begin{matrix} OH & OH \\ | & | \\ HC & -- & CH \\ | & | \\ OH & & OH \end{matrix}$$

$$\begin{matrix} OH & OH \\ | & | \\ HC & -- & CH \\ | & | \\ OH & & OH \end{matrix} \xrightarrow{-2H_2O} \begin{matrix} O & O \\ \| & \| \\ H-C & -- & C-H \end{matrix} \text{ (glyoxal)}$$

$$\begin{matrix} O & O \\ \| & \| \\ H-C & -- & C-H \end{matrix} + 2[O] \xrightarrow{KMnO_4} \begin{matrix} COOH \\ | \\ COOH \end{matrix} \text{ (oxalic acid)}$$

(ii) **Combustion of alkyne** :- An alkyne burns in air or oxygen and gives CO_2, H_2O and Heat. e.g Combustion of acetylene is highly exothermic and oxyacetylene flame is used for welding and cutting metals

$$2\,HC\equiv CH + 5O_2 \longrightarrow 4CO_2 + 2H_2O + Heat$$
(acetylene)

(7) **Polymerization** :- Alkynes show polymerization and give linear and cyclic compounds. It depends upon temperature and catalyst. It gives low molecular weight polymers

(i) **Linear Polymerization** :- Linear polymerization of acetylene gives vinyl acetylene and di vinyl acetylene.

$$HC\equiv CH + HC\equiv CH \xrightarrow[\text{Several hours}]{Cu_2Cl_2 + NH_4Cl} HC=C-C\equiv CH$$
Acetylene

$$H_2C=CH-C\equiv CH + HC\equiv CH \xrightarrow[NH_4Cl]{Cu_2Cl_2} CH_2=CH-C\equiv C-CH=CH_2$$

(divinyl acetylene)

Hexa-1,5 diene-3-yne

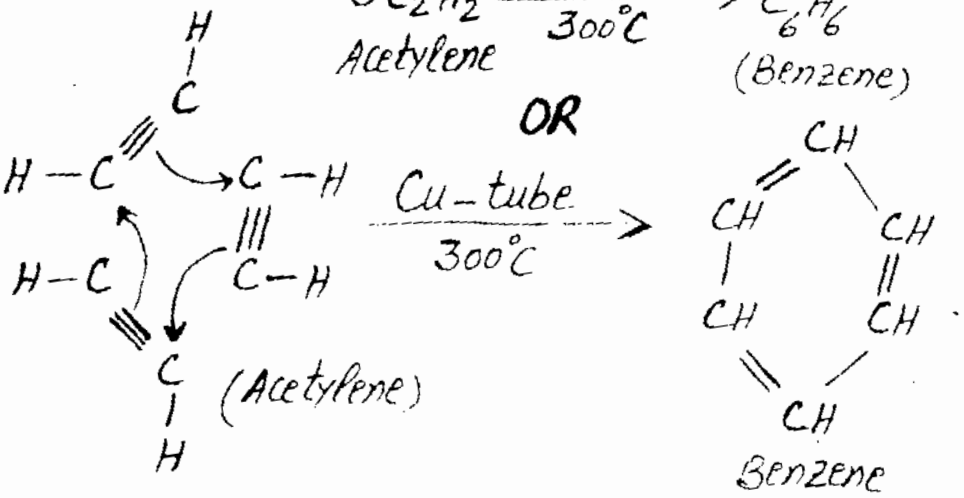
(ii) Cyclic Polymerization:-

The cyclic polymerization of acetylene gives benzene It takes place by passing acetylene through a copper tube at 300°C

$$3C_2H_2 \xrightarrow[300^\circ C]{Cu-tube} C_6H_6$$

Acetylene (Benzene)

OR



Acidic Nature of Alkynes:-

Ethyne and any other terminal alkyne shows acidic properties. There is sp-hybridization in ethyne. An sp-hybrid orbital has 50% S-character and approaches spherical shape. So electrons are close and strongly held by Carbon atom. Therefore H-atom becomes slightly acidic e.g.

$$\overset{+\delta}{H}-\overset{-\delta}{C}\equiv\overset{-\delta}{C}-\overset{+\delta}{H}$$

For example

$$HC\equiv CH + 2Na \longrightarrow \overset{+}{Na}\,\overset{-}{C}\equiv\overset{-}{C}\,\overset{+}{Na} + H_2$$

Acetylene — Sodium Acetylide

$$R-C\equiv CH + NaNH_2 \longrightarrow R-C\equiv\overset{-}{C}\overset{+}{Na} + NH_3$$

Sodamide — Sodium Alkynide

Copper acetylide is prepared by reaction of acetylene with ammonical cuprous Chloride

$$HC\equiv CH + Cu_2Cl_2 + 2NH_4OH \longrightarrow CuC\equiv CCu + 2NH_4Cl + 2H_2O$$

Copper acetylide

Silver acetylide is formed as follows.. (red ppt)

$$HC\equiv CH + 2AgNO_3 + 2NH_4OH \longrightarrow AgC\equiv CAg + 2H_2O + 2NH_4NO_3$$

Disilver acetylide (White ppt)

Acetylides react with dilute acids to regenerate acetylene.

$$AgC\equiv CAg + H_2SO_4(dil) \longrightarrow HC\equiv CH + Ag_2SO_4$$

$$AgC\equiv CAg + 2HNO_3(dil) \longrightarrow HC\equiv CH + 2AgNO_3$$

Uses :- Acetylides (Alkynides) are used for the Preparation, Purification and Separation of alkynes

(ii) Acetylides are used to identify the terminal and non-terminal alkynes. Terminal alkynes give acetylides e.g $CH_3-C\equiv CH$ (Propyne)

Non-terminal alkynes do not give acetylides (2-Butyne)

Uses of Ethyne :-

(i) Ethyne is used for artificial ripening of fruit.

(ii) Oxy-acetylene flame is used for cutting and welding metals

(iii) Acetylene is used for preparation of alcohol acetic acid and acetaldehyde

(iv) Acetylene is used for manufacture of PVC, Polyvinyl acetate, Orlon and neoprene rubber.

(v) Acetylene is used to Prepare acetylene tetrachloride which is used as Solvent for rubber, Varnish, resins.

Chloroprene and Neoprene

Vinyl acetylene reacts with Conc HCl to give a Product called Chloroprene

$$CH_2=CH-C\equiv CH + HCl \longrightarrow CH_2=CH-\underset{Cl}{C}=CH_2$$

Vinyl acetylene — (Chloroprene)

2-Chloro-1,3-butadiene

The Chloroprene on Polymerization gives neoprene which is used as synthetic rubber

Chloroprene $\xrightarrow{\text{Polymerization}}$ neoprene (Synthetic rubber)

Soda Lime :-

When lime (CaO) is Soaked with Solution of NaOH. Then the dried Product is called Soda-Lime.

Comparison of Reactivities of alkanes, alkenes and alkynes.

The reactivity of alkanes, alkenes and alkynes decrease in the following order.

Alkenes > Alkynes > Alkanes

Alkanes have all σ-bonds. A σ-bond is a strong bond and can not be easily broken. Alkenes have double bond in which one is σ-bond and other is π-bond. The π-bond is a weak bond and breaks easily. Thus an electrophile can attack π-electrons of alkenes Alkynes have a triple bond. In a triple bond, one is σ-bond and other two are π-bonds. The bond length of two triply bonded Carbons is very short. So electrons are tightly held by two atoms. Thus π-electrons in alkynes are not available to the electrophilic reagents Hence Order of reactivity is.

Alkenes > Alkynes > Alkanes

Hydrogenation of vegetable oils

The vegetable oils are unsaturated compounds When hydrogen is added to vegetable oil in presence of Nickel, then vegetable ghee is produced It is called hydrogenation or hardening of oils.

EXERCISE

Q1. *Fill in the Blanks.*

(i) Ozone reacts with ethene to form_____.
(ii) Lindlar's catalyst is used for _____ of alkynes.
(iii) Divinylacetylene is a _____acetylene.
(iv) Vicinal dihalides have two halogens on_____carbon atoms.
(v) Ethyne is acidic in character because of_____hybridization.
(vi) Halohydrins are formed due to addition of_____in ethene.
(vii) Ethylene glycol is produced when _____reacts with cold alkaline $KMnO_4$ solution.
(viii) Mustard gas is a highly boiling_____.
(ix) Ethyne has _____like odour.
(x) Ethyne is obtained by the reaction of_____with calcium carbide.

Answer:- (i) ozonide (ii) partial hydrogenation (iii) polymer of (iv) adjacent (v) sp- (vi) hypohalous acid (vii) ethene (viii) liquid (ix) garlic (x) water

Q2. *Indicate True or False.*

(i) Addition of HX to unsymmetriacal alkenes takes place according to Markowinkov's rule.
(ii) Methane reacts with Bromine water and its colour is discharged.
(iii) Mustard gas is a blistering agent.
(iv) Baeyer's reagent is used to locate a double bond in an alkene.
(v) Ethyne is a saturated compound.
(vi) Baeyer's reagent is used to locate a double bond in an alkene.
(vii) Alkanes usually undergo substitution reactions.
(viii) Benzene is a polymer of ethene.
(ix) Acrylonitrile can be obtained from ethyne.
(x) Ethyne is more reactive towards electrophilic reagents than ethene.

Answer:- (i) true (ii) false (iii) true (iv) true (v) false (vi) true (vii) true (viii) false (ix) true (x) false

Q3. Multiple Choice questions. Encircle the correct answer.

(i) Preparation of vegetable ghee involves.
(a) Halogenation (b) Hydrogenation
(c) Hydroxylation (d) Dehydrogenation

(ii) Formula of Chloroform is.
(a) CH_3Cl (b) CCl_4 (c) CH_2Cl_2 (d) $CHCl_3$

(iii) The presence of double bond in a compound is the sign of
(a) Saturation (b) Unsaturation (c) Substitution (d) None

(iv) Vinylacetylene combines with HCl to form
(a) Poly acetylene (b) Benzene
(c) Chloroprene (d) Divinyl acetylene

(v) The addition of unsymmetrical reagent to an unsymmetrical alkene is in accordance with the rule
(a) Hund's rule (b) Markowinkiov's rule
(c) Pauli's Exclusion Principle (d) Auf bau Principle

(vi) Synthetic rubber is made by Polymerization of
(a) Chloroform (b) Acetylene (c) Divinylacetylene (d) Butene

(vii) β-β' – dichloroethyl sulphide is commonly known as
(a) Mustard gas (b) Laughing gas (c) Phosgene gas (d) Bio-gas

(viii) When methane reacts with Cl_2 in the presence of diffused light the products obtained are.
(a) Chloroform only (b) Carbon Tetrachloride only
(c) Chloromethane and dichloromethane (d) Mixture of a,b,c

(ix) Which one of the following gases is used for artificial ripening of fruits.
(a) Ethene (b) Ethane (c) Methane (d) Propane

Answer:- (i) b (ii) d (iii) b (iv) c (v) b
(vi) b (vii) a (viii) d (ix) a

Q4. Write the Structural formula for each of the following compounds.
(i) 2-Methylpropane (ii) Neopentane.
(iii) 3-Ethypentane (iv) 4-Ethyl-3,4-dimethylheptane.
(v) 2,2,3,4-Tetramethylpentane (vi) 4-iso-Propylheptane
(vii) 2,2,-Dimethylbutane. (viii) 2,2-Dimethylpropane.

Answer:-

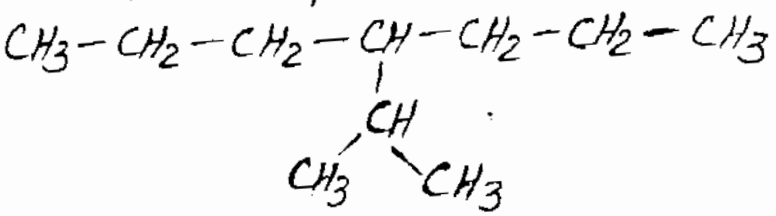
(i) 2-Methyl Propane $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{|}}{CH}-CH_3$ (ii) Neopentane $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{|}}{C}-CH_3$

(iii) 3-Ethyl-Pentane $CH_3-CH_2-\underset{\displaystyle C_2H_5}{\overset{\displaystyle CH}{|}}-CH_3-CH_3$

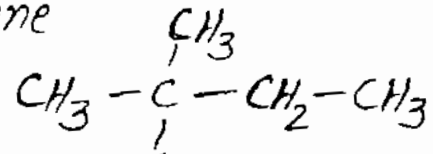
(iv) 4-Ethyl-3,4 dimethyl Reptane $CH_3-CH_2-\underset{\displaystyle CH_3}{\overset{\displaystyle CH}{|}}-\underset{\displaystyle CH_3}{\overset{\displaystyle C_2H_5}{|}}{C}-CH_2-CH_2-CH_3$

(V) 2,2,3,4 tetramethyl Pentane $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH}{|}}-\underset{\displaystyle CH_3}{\overset{\displaystyle CH}{|}}-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{|}}{C}-CH_3$

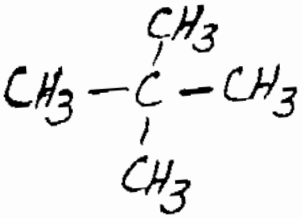
(vi) 4- isopropyl heptane



(vii) 2,2 Dimethyl butane



(viii) 2,2 Dimethyl Propane



(neo pentane)

Q5. Write down names of the following compounds according to IUPAC system.

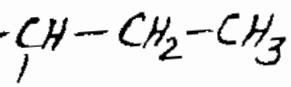
(i) $H_3C-CH_2-CH(CH_2CH_3)-CH(CH_3)-CH_3$ (ii) $(CH_3)_2CH-CH_2-C(CH_3)_3$

(iii) $H_3C-CH(CH_3)-CH_2-CH(CH_3)-CH_3$ (iv) $(CH_3)_2CH-CH(CH_3)-CH(CH_3)_2$

(v) $CH_3CH_2C(CH_3)_2CH(CH_2CH_3)CH_3$ (vi) $(CH_3CH_2)_3CH$

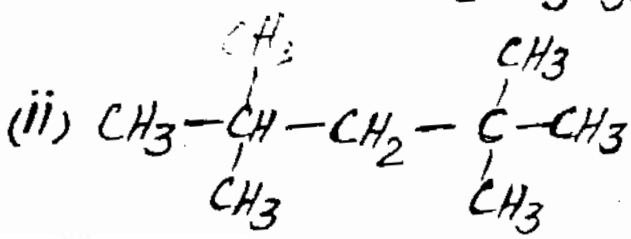
(vii) $CH_3C(CH_3)_2(CH_2)_2CH_3$ (viii) $(C_6H_5)_3CH$

Answer:- (i)



3-Ethyl Pentane

(ii)



2,2,4-trimethyl Pentane

(iii) $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH\begin{matrix}\nearrow CH_3\\ \searrow CH_3\end{matrix}$ 2,4 dimethyl Pentane

(iv) $(CH_3)_2CH-\underset{\underset{CH_3}{|}}{CH}-CH(CH_3)_2$

$CH_3-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{CH_3}{|}}{CH}-CH_3$ 2,3,4 trimethyl Pentane

(v) $CH_3CH_2C(CH_3)_2CH(CH_2CH_3)CH_3$

$CH_3-CH_2-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-\underset{\underset{CH_2}{|}}{\underset{\underset{CH_3}{|}}{CH}}-CH_3$ 3,3,4 trimethyl hexane

(vi) $(CH_3CH_2)_3CH$, $CH_3-CH_2-\underset{\underset{CH_2}{|}}{\underset{\underset{CH_3}{|}}{CH}}-CH_2-CH_3$

3-ethyl-Pentane

(vii) $CH_3C(CH_3)_2(CH_2)_2CH_3$

$CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2-CH_2-CH_3$ 2,2 dimethyl Pentane

(viii) $(C_6H_5)_3CH$. $C_6H_5-\underset{\underset{C_6H_5}{|}}{CH}-C_6H_5$

Triphenyl-methane

Q6. What are the rules for naming alkanes? Explain with suitable examples.

Answer:- see page No. 35

Q7. **(a)** Write down the structural formulas for all the isomeric hexanes and name them according to IUPAC system.

(b) The following names are incorrect. Give the correct IUPAC names.

(i) 4-Methylpentane (ii) 3,5,5,-Trimethylhexane

(iii) 2-Methyl-3ethylbutane

Answer:- (a) *isomers of hexanes :-*

(i) $CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$ n-hexane

(ii) $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_2-CH_3$ 2 methyl-Pentane

(iii) $CH_3-CH_2-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_3$, 3 methyl pentane

(iv) $CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2-CH_3$ 2,2 dimethyl Butane

(v) $CH_3-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{CH_3}{|}}{CH}-CH_3$ 2,3 dimethyl Butane.

(b) (i) $CH_3-CH_2-CH_2-\underset{\underset{CH_3}{|}}{CH}-CH_3$

4-Methyl-Pentane (incorrect)

2-Methyl-Pentane (correct)

(ii) $CH_3-CH_2-\underset{\underset{CH_3}{|}}{CH}-CH_2-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_3$

3,5,5 trimethyl hexane (incorrect)

2,2,4 trimethyl hexane (correct)

(iii) $CH_3-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{CH_2-CH_3}{|}}{CH}-CH_3$ 2-methyl 3-ethyl butan. (incorrect)

2,3-Dimethyl-Pentane (Correct name)

Q8. (a) **Explain why alkanes are less reactive than alkenes? What is the effect of branching on the melting point of alkanes?**

(b) **Three different alkenes yield 2-methylbutane when they are hydrogenated in the presence of a metal catalyst. Give their structures and write equations for the reactions involved.**

Answer:- (a) see page No. 46

(b)

$$CH_2=\underset{\displaystyle CH_3}{\overset{|}{C}}-CH_2-CH_3 + H_2 \xrightarrow{Ni} CH_3-\underset{\displaystyle CH_3}{\overset{|}{CH}}-\underset{}{CH_2}-CH_3$$

$$CH_3-\underset{\displaystyle CH_3}{\overset{|}{C}}=CH-CH_3 + H_2 \xrightarrow{Ni} CH_3-\underset{\displaystyle CH_3}{\overset{|}{CH}}-CH_2-CH_3$$

$$CH_3-\underset{\displaystyle CH_3}{\overset{|}{CH}}-CH=CH_2 + H_2 \xrightarrow{Ni} CH_3-\underset{\displaystyle CH_3}{\overset{|}{CH}}-CH_2-CH_3$$

3-methyl 1-butene — 2-Methyl Butane

Q9. (a) **Out line the methods available for the preparation of alkanes.**

(b) **How will you bring about the following conversion?**

(i) **Methane to ethane** **(iii)** Ethane to methane

(iii) **Acetic acid to ethane** **(iv)** Methane to nitromethane

Answer:- (a) see page No. 41, 42, 43

(b)

(i) Methane into ethane

$$CH_4 + Cl_2 \xrightarrow{\text{sunlight}} CH_3Cl + HCl$$

$$2\,CH_3Cl + 2Na \longrightarrow CH_3-CH_3 + 2NaCl$$

(ii) Ethane into methane

$$CH_3-CH_3 + Cl_2 \xrightarrow{\text{sunlight}} CH_3-CH_2Cl + HCl$$

$$CH_3-CH_2Cl + KOH \xrightarrow{Aq} CH_3CH_2OH + KCl$$

$$CH_3-CH_2-OH + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3-CHO + H_2O$$

ethyl alcohol

$$CH_3-CHO + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3COOH$$

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

$$CH_3COONa + NaOH \xrightarrow{CaO} CH_4 + Na_2CO_3$$

(iii) Acetic acid to ethane :-

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

$$2\,CH_3COONa + 2H_2O \xrightarrow[Current]{Electric} CH_3-CH_3 + 2CO_2 + 2NaOH + H_2$$

(iv) Methane to nitromethane :-

$$CH_4 + \underset{(Conc)}{HNO_3} \xrightarrow{450^\circ C} \underset{Nitromethane}{CH_3NO_2} + H_2O$$

Q10. (a) What is meant by octane number? Why does a high octane fuel has a less tendency to knock in an automobile engine?

(b) Explain free radical mechanism for the reaction of chlorine with methane in the presence of sunlight.

Answer: (a) see page No. 11, 12

(b) see page No. 47, 48

Q11. (a) Write structural formulas for each of the following compounds.

(i) iso-Butlyene (ii) 2,3,4,4-Tetramethyl-2-pentene

(iii) 2,5-Heptadiene (iv) 4,5-Dimethyl-2-hexene

(v) Vinylacetylene (vi) 1,3-Pentadliene

(vii) 1-Butyne (viii) 3-n-Propyl 1,4-pentadiene

(ix) Vinylbromide (x) But-3-en-1-yne

(xi) 4-Methyl-2-pentyne (xii) iso-Pentane

(b) Name the following compounds by IUPAC system.

(i) $H_3C-CH=CH(CH_2)_2CH_3$ (ii) $(CH_3)_2C=CH_2$

(iii) $CH_3-CH_2-CH_2-\underset{\displaystyle CH(CH_3)_2}{\overset{\displaystyle |}{C}}=CH_2$ (iv) $CH_2=CH-CH=CH_2$

(v) $CH_2=C(C_2H_5)-CH_2CH_3$ (vi) $CH\equiv C-CH_3$

(vii) $CH_3-C\equiv C-CH_3$ (viii) $CH_2=CH-C\equiv C-CH=CH_2$

(ix) $CH\equiv C-CH=CH-C\equiv CH$ (x) $CH_2=CH-C\equiv CH$

Answer:-

(i) $CH_3-C(CH_3)=CH_2$ (isobutylene)

(ii) 2, 3, 4, 4 tetramethyl 2-Pentene

$CH_3-C(CH_3)=C(CH_3)-C(CH_3)_2-CH_3$

(iii) 2, 5-Heptadiene

$CH_3-CH=CH-CH_2-CH=CH-CH_3$

(iv) 4, 5-dimethyl-2-hexene

$CH_3-CH=CH-CH(CH_3)-CH(CH_3)-CH_3$

(v) Vinyl acetylene

$CH_2=CH-C\equiv CH$

(vi) 1, 3 Pentadiene

$CH_2=CH-CH=CH-CH_3$

(vii) 3-n-Propyl 1, 4 Pentadiene

$CH_2=CH-CH(CH_2CH_2CH_3)-CH=CH_2$

(viii) Vinyl Bromide

$CH_2=CH-Br$

(ix) 1-Butyne

$CH\equiv C-CH_2-CH_3$

(x) But-3-ene-1-yne, $CH\equiv C-CH=CH_2$

(xi) 4-Methyl, 2-Pentyne, $CH_3-C\equiv C-\underset{CH_3}{CH}-CH_3$

(xii) isoPentane $CH_3-\underset{CH_3}{CH}-CH_2-CH_3$

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

2-Hexene

(ii) $(CH_3)_2C=CH_2$ or $CH_3-\underset{CH_3}{C}=CH_2$

2-Methyl Propene

(iii) $CH_3-CH_2-CH_2-\underset{CH-CH_3}{\underset{|}{C}}=CH_2$ (CH3)

2-Isopropyl-1-Pentene

(iv) $CH_2=CH-CH=CH_2$, 1, 3 butadiene

(v) $CH_2=\underset{CH_2CH_3}{\underset{|}{C}}-CH_2-CH_2-CH_3$ 2-ethyl 1-Pentene

(vi) $CH\equiv C-CH_3$ Propyne, (vii) $CH_3-C\equiv C-CH_3$ 2-Butyne

(viii) $CH_2=CH-C\equiv C-CH=CH_2$

1, 5 Hexadiene-3-yne

(ix) $CH\equiv C-CH=CH-C\equiv CH$

3-hexene, 1, 5 diyne

(x) $CH_2=CH-C\equiv CH$ But 1-ene, 3-yne

Q12. (a) Describe different methods for the preparation of alkenes. How would you establish that ethylene contains a double bond?

(b) Give structural formulas of the alkenes expected to form by the dehydrogenation of the following compounds by a strong base.

(i) 1-Chloropentane (ii) 3-Chloro-2-methyl butane

(iii) 1-Chloro-2,2-dimethylpropane.

Answer:- (a)see page No. 50, 51, 52

(b)

(i) $CH_3-CH_2-CH_2-CH_2-CH_2Cl + KOH \xrightarrow[100^\circ C]{alc} CH_3CH_2CH_2CH=CH_2 + KCl + H_2O$

1-Chloro Pentane — 1-Pentene

(ii)

$$CH_3-\underset{Cl}{CH}-\underset{CH_3}{CH}-CH_3 + KOH \xrightarrow[100^\circ C]{alc} CH_3-CH=\underset{CH_3}{C}-CH_3 + KCl + H_2O$$

2-Chloro-3methyl Butane — 2-Methyl 2-Butene

(iii)

$$CH_2-\underset{Cl}{\overset{CH_3}{C}}-CH_3 + KOH \xrightarrow{alc} \text{NO Reaction}$$

In this case no reaction takes place because B-hydrogen is not available

Q13. (a) Write down chemical equation for the preparation of propene from the following compounds.

(i) $CH_3-CH_2-CH_2OH$ (ii) $CH_3-C\equiv CH$

(iii) iso-Propyl chloride

(b) Write skeleton formula showing only the arrangement of carbon atoms for all the possible alkenes of the molecular formula C_5H_{10}.

Answer:- (a)

(i) $CH_3-CH_2-CH_2OH \xrightarrow[170^\circ C]{Conc\ H_2SO_4} CH_3-CH=CH_2 + H_2O$

1-Propanol — Propene

(ii) $CH_3-C\equiv CH + H_2 \xrightarrow[BaSO_4]{Pd} CH_3-CH=CH_2$

Propyne — Propene

(iii) $CH_3-\underset{Cl}{CH}-CH_3 + KOH \xrightarrow{alc} CH_3-CH=CH_2 + KCl + H_2O$

Cl (isopropyl chloride) — Propene

(b) :- Skeleton formulas of all possible alkenes of molecular formula C_5H_{10}

(i) $CH_2=CH-CH_2-CH_2-CH_3$ 1-Pentene

(ii) $CH_3-CH=CH-CH_2-CH_3$ 2-Pentene

(iii) $CH_2=\underset{CH_3}{C}-CH_2-CH_3$ 2 methyl-1-Butene

(iv) $CH_2=CH-\underset{CH_3}{CH}-CH_3$ 3-methyl-1-Butene

(v) $CH_3-\underset{CH_3}{C}=CH-CH_3$ 2 methyl-2-Butene

Q14. (a) How may ethene be converted into ethyl alcohol?

(b) Starting from ethene outline the reactions for the preparation of following compounds.

(i) Ethylene dibromide (ii) Ethyne (iii) Ethane (iv) Ethylene glycol

(c) How will you bring about the following conversions.

(i) 1-Butene to 1-Butyne

(ii) 1-Propanol to $CH_2-CH-CH_2Cl$ (OH)

Answer:- (a) $CH_2=CH_2 + H_2O \xrightarrow[HgSO_4]{10\%\ H_2SO_4} CH_3-CH_2OH$

ethene — Ethyl alcohol

(b) (ii) $CH_2=CH_2 + Br_2 \longrightarrow \underset{Br}{CH_2}-\underset{Br}{CH_2}$

$\underset{Br}{CH_2}-\underset{Br}{CH_2} + 2KOH \xrightarrow{alc} CH\equiv CH + 2KBr + 2H_2O$

Ethyne

For parts (ii), (iii) and (iv) see reactions of alkenes

(C):- (i) $CH_2=CH-CH_2-CH_3 + Br_2 \longrightarrow CH_2(Br)-CH(Br)-CH_2-CH_3$

1-Butene

$CH_2(Br)-CH(Br)-CH_2-CH_3 + 2KOH \xrightarrow{alc} HC\equiv C-CH_2-CH_3 + 2KBr + 2H_2O$

1-Butyne

(ii) $CH_3-CH_2-CH_2OH \xrightarrow{H_2SO_4} CH_3-CH=CH_2 + H_2O$

1-Propanol

$CH_3-CH=CH_2 + HOCl \longrightarrow CH_3-CH(OH)-CH_2(Cl)$

Q15. Show by means of chemical equations how the following cycle of changes may be affected.

Ethane ⟶ Ethene ⟶ Ethyne ⟶ Ethane

Answer:-

(i) $CH_3-CH_3 + Cl_2 \xrightarrow{sunlight} CH_3-CH_2Cl + HCl$

$CH_3-CH_2Cl + KOH \xrightarrow{alc} CH_2=CH_2 + KCl + H_2O$

(ii) $CH_2=CH_2 + Br_2 \longrightarrow CH_2(Br)-CH_2(Br)$

$CH_2(Br)-CH_2(Br) + 2KOH \xrightarrow{alc} CH\equiv CH + 2KBr + 2H_2O$

Ethyne

(iii) $CH\equiv CH + H_2 \xrightarrow{Ni} CH_2=CH_2$

$CH_2=CH_2 + H_2 \xrightarrow{Ni} CH_3-CH_3$ (ethane)

Q16. Write down structural formulas for the products that are formed when

1-butene will react with the following regents.

(i) H_2, Pt (ii) Br_2 in CCl_4 (iii) Cold dil. $KMnO_4$, OH^-

(iv) HBr (v) O_2 in the presence of Ag (vi) HOCl (vii) dil.H_2SO_4

Answer:- (i) $CH_2=CH-CH_2-CH_3 + H_2 \xrightarrow{Pt} CH_3-CH_2-CH_2-CH_3$

1-Butene n-Butane

(ii) $CH_2=CH-CH_2-CH_3 + Br_2 \xrightarrow{CCl_4} CH_2(Br)-CH(Br)-CH_2-CH_3$

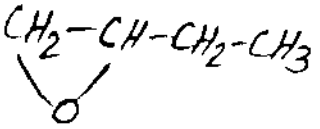
(iii) $3CH_2=CH-CH_2CH_3 + 2KMnO_4 + 4H_2O \xrightarrow{\bar{O}H} CH_2(OH)-CH(OH)-CH_2CH_3$

1,2 Butanediol

$+ 2KOH + MnO_2$

(iv) $CH_2=CH-CH_2CH_3 + HBr \longrightarrow CH_3-CH(Br)-CH_2-CH_3$

2-Bromo-Butane

(v) $CH_2=CH-CH_2-CH_3 + \frac{1}{2}O_2 \xrightarrow{Ag}$ 

Butylene Oxide

(vi) $CH_2=CH-CH_2-CH_3 + HOCl \longrightarrow CH_2(Cl)-CH(OH)-CH_2-CH_3$

1-Chloro-2-butanol.

(vii) $CH_2=CH-CH_2CH_3 + H_2O \xrightarrow{dil\ H_2SO_4} CH_3-CH(OH)-CH_2-CH_3$

Q17. In the following reactions, identify each lettered product.

(i) Ethyl alcohol $\xrightarrow{\text{Conc } H_2SO_4}$ A $\xrightarrow{Br_2}$ B $\xrightarrow{KOH(alc)}$ C

(ii) Propene $\xrightarrow{Br_2}$ D $\xrightarrow{KOH(alc)}$ E $\xrightarrow{HCN}$ F

Answer:- (i) $CH_3-CH_2OH \xrightarrow{Conc\ H_2SO_4} CH_2=CH_2 + H_2O$

$CH_2=CH_2 + Br_2 \longrightarrow CH_2(Br)-CH_2(Br)$

$$CH_2(Br)-CH_2(Br) + 2KOH \xrightarrow{alc} CH\equiv CH + 2KBr + 2H_2O$$

(ii) $CH_2=CH-CH_3 + Br_2 \longrightarrow CH_2(Br)-CH(Br)-CH_3$

Propene

$$CH_2(Br)-CH(Br)-CH_3 + 2KOH \xrightarrow{alc} HC\equiv C-CH_3 + 2KBr + 2H_2O$$

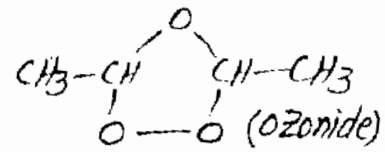
$$HC\equiv C-CH_3 + HCN \longrightarrow CH_2=C(CN)-CH_3$$

Propyne — 2-Cyanopropene

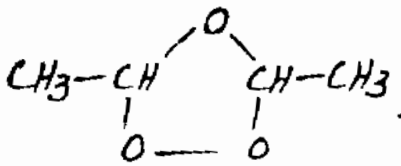
Q18. After an ozonolysis experiment, the only product obtained was acetaldehyde, CH_3CHO. The chemist who did the experiment correctly claimed that two possible starting materials can give this product. Can you guess the structural formulas of these compounds.

Answer:- The ozonolysis of Propene or 2-Butene gives acetaldehyde. But acetaldehyde (CH_3CHO) is the only Product obtained by ozonolysis of 2-Butene. It is given below.

$$CH_3-CH=CH-CH_3 + O_3 \longrightarrow$$



(Ozonide)



$$+ Zn \xrightarrow[Boil]{H_2O} 2CH_3-CHO + ZnO$$

Acetaldehyde

Q.19.(a) The addition of Sulphuric acid to an alkene obeys Markownikov's rule. Predict the structures of the alcohols obtained by the addition of the acid to the following compounds.

(i) Propene (ii) 1-Butene (iii) 2-Butene

(b) Predict the most likely product of the addition of hydrogen chloride to 2-methyl-2-butene. Explain the formation of this product.

Answer:- (a) (i) $CH_2=CH-CH_3 + H_2SO_4 \longrightarrow CH_3-CH(OSO_3H)-CH_3$

$$CH_3-CH(OSO_3)-CH_3 + H_2O \longrightarrow CH_3-CH(OH)-CH_3 + H_2SO_4$$

2-Propanol

(ii) $CH_2=CH-CH_2-CH_3 + H_2SO_4 \longrightarrow CH_3-\underset{\underset{OSO_3H}{|}}{CH}-CH_2-CH_3$

$CH_3-\underset{\underset{OSO_3H}{|}}{CH}-CH_2-CH_3 + H_2O \dashrightarrow \underset{\underset{2\text{-Butanol}}{OH}}{CH_3-\underset{|}{CH}-CH_2-CH_3} + H_2SO_4$

(iii) $\underset{\text{2-butene}}{CH_3-CH=CH-CH_3} + H_2SO_4 \longrightarrow CH_3-\underset{\underset{OSO_3H}{|}}{CH_2}-CH-CH_3$

$CH_3-CH_2-\underset{\underset{OSO_3H}{|}}{CH}-CH_3 + H_2O \longrightarrow \underset{\underset{OH}{|}}{CH_3-CH_2-CH}-CH_3 + H_2SO_4$

(b) :- $CH_3-\underset{\underset{CH_3}{|}}{C}=CH-CH_3 + \overset{+\delta\ -\delta}{HCl} \longrightarrow CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{Cl}{|}}{C}}-CH_2-CH_3$

2-Methyl 2-Butene — 2-Chloro, 2 methyl butane

This addition takes place according to Markownikov's rule.

Q.20. Why are some hydrocarbons called structured and others unsaturated? What type of reactions are characteristics of them?

Answer:- see page No. 31, 32

Q21. (a) Describe methods for the preparation of Ethyne.
(b) How does ethyne react with:
(i) Hydrogen (ii) Halogen acid (iii) Alkaline $KMnO_4$
(iv) 10% H_2SO_4 in the presence of $HgSO_4$. (v) Ammonicalcuprous chloride
(c) Mention some important uses of methane, ethene and ethyne.

Answer:- see page No. 59, 60, 61

Q22. Describe how you could distinguish ethane, ethene and ethyne from one another by means of chemical reactions.

Answer:- Distinction between Ethane, Ethene and Ethyne

(i) Reaction with $KMnO_4$:- Ethane does not react with alkaline $KMnO_4$ but ethene and ethyne react

with $KMnO_4$ and decolourise its pink colour.

$$CH_3-CH_3 + KMnO_4 \xrightarrow{\bar{O}H} \text{No reaction}$$

$$3CH_2=CH_2 + 2KMnO_4 + 4H_2O \xrightarrow{\bar{O}H} 3\underset{\text{ethene}}{} \underset{OH\ OH}{CH_2-CH_2} + 2KOH + 2MnO_2$$
(ethylene glycol)

$$3CH\equiv CH + 8KMnO_4 + 4H_2O \xrightarrow{\bar{O}H} 3\underset{\text{ethyne}}{} \underset{COOH}{\overset{COOH}{|}} + 8KOH + 8MnO_2$$
oxalic acid

(ii) Reaction with Br_2 Water:- Ethane does not decolourise Br_2 water but ethene and ethyne decolourise bromine water.

$$CH_3-CH_3 + Br_2 \longrightarrow \text{No reaction}$$

$$CH_2=CH_2 + Br_2 \longrightarrow \underset{Br\ \ Br}{CH_2-CH_2}$$

$$CH\equiv CH + 2Br_2 \longrightarrow \underset{Br\ \ Br}{\overset{Br}{|}CH-\overset{Br}{|}CH}$$

(iii) Reaction with Ammonical Silver Nitrate

Ethane and ethene do not react with ammonical $AgNO_3$ but ethyne forms white ppt of silver acetylide.

$$CH\equiv CH + 2AgNO_3 + 2NH_4OH \longrightarrow \underset{\text{(Silver acetylide)}}{AgC\equiv CAg} + 2NH_4NO_3 + 2H_2O$$

(iv) Ethane and ethene do not react with ammonical Cuprous Chloride but acetylene forms red ppt with ammonical Cuprous Chloride.

$$HC\equiv CH + Cu_2Cl_2 + 2NH_4OH \longrightarrow \underset{\text{red ppt of Cuprous acetylide}}{CuC\equiv CCu} + 2NH_4Cl + 2H_2O$$

Q23. (a) How will you synthesize the following compounds starting from ethyne.

(i) Acetaldehyde (ii) Benzene (iii) Chloroprene
(vi) Glyoxal (v) Oxalic acid (vi) Acrylonitrile
(vii) Ethane (viii) Methyl nitrile

(b) Write a note on the acidity of ethyne.

Answer:- (a) see page No. 61, 62, 63
(b) see page No. 64

Q24. (a) Compare the reactivity of ethane, ethene and ethyne.
(b) Compare the physical properties of alkanes, alkenes and alkynes.

Answer:- see page No. 67

Q25. How does propyne react with the following reagent.

(a) $AgNO_3/NH_4OH$ (b) Cu_2Cl_2/NH_4OH (c) $H_2O/H_2SO_4, HgSO_4$

Answer:-

(a) $CH_3-C\equiv CH + AgNO_3 + NH_4OH \longrightarrow CH_3-C\equiv CAg + NH_4NO_3 + H_2O$
Propyne — Silver Propylide

(b) $2CH_3-C\equiv CH + Cu_2Cl_2 + 2NH_4OH \longrightarrow 2CH_3-C\equiv CCu + 2NH_4Cl + 2H_2O$
Propyne — (Copper Propylide)

(c) $CH_3-C\equiv CH + H_2O \xrightarrow{10\%\ H_2SO_4} CH_3-\overset{OH}{\overset{|}{C}}=CH_2$

$CH_3-\overset{OH}{\overset{|}{C}}=CH_2 \xrightarrow{\text{rearrangement}} CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ (acetone)

Q26. A compound has a molecular formula C_4H_6, when it is treated with excess hydrogen in the presence of Ni-catalyst, a new compound C_4H_{10} is formed. When C_4H_6 is treated with Ammonical silvernitrate a white precipitate is formed. What is the structure formula of the given compound.

Answer:- Reaction of Compound (C_4H_6) with H_2 indicates that compound contains two double bonds or one triple bond in it. But reaction of the compound with ammonical Silver nitrate indicates the

Presence of acidic hydrogen or terminal triple bond. Thus the Compound (C_4H_6) is 1-butyne.

The reactions of 1-Butyne with H_2 and ammonical $AgNO_3$ are given below.

$$HC\equiv C-CH_2-CH_3 + 2H_2 \xrightarrow{Ni} CH_3-CH_2-CH_2-CH_3$$

1-butyne → n-butane

$$HC\equiv C-CH_2-CH_3 + AgNO_3 + NH_4OH \longrightarrow AgC\equiv C-CH_2-CH_3 + NH_4NO_3 + H_2O$$

Q27. (a) Identify A and B.

$$CH_3CH_2CH_2OH \xrightarrow{\text{Conc } H_2SO_4} A \xrightarrow{Br_2} B$$

(b) Give the general mechanism of electrophilic addition reactions of alkenes.

Answer:-

(a) $$CH_3-CH_2-CH_2OH \xrightarrow{\text{Conc } H_2SO_4} CH_3-CH=CH_2 + H_2O$$

Propene

$$CH_3-CH=CH_2 + Br_2 \longrightarrow CH_3-\underset{Br}{CH}-\underset{Br}{CH_2}$$

1,2 dibromo-Propane

گلدستہ ڈاٹ پی کے کی جانب سے خوش آمدید

السلام علیکم ورحمتہ اللہ وبرکاتہ

مختصر تعارف

کافی عرصہ سے خواہش تھی کہ ایک ایسی ویب سائٹ بناؤں جس پر طالب العلموں کیلئے کچھ تعلیمی مواد جمع کر سکوں۔ اللہ تعالیٰ نے توفیق دی اور میں نے ایک سال کی محنت کے بعد ایک سائٹ "گلدستہ ڈاٹ پی کے" کے نام سے بنائی جو کہ قرآن و حدیث، اصلاحی، دلچسپ، تاریخی قصے واقعات، اُردو انگلش تحریریں، شاعری و اقوال زریں، F.Sc اور B.Sc کے مضامین کے آن لائن نوٹس، اسلامک، تفریحی، معلوماتی وال پیپرز، حمد و نعت، فرقہ واریت سے پاک اسلامی بیانات، پنجابی نظمیں و ترانے اور کمپیوٹر و انٹرنیٹ کی دنیا کے بارے میں ٹپس، آن لائن کمائی کرنے کے مستند طریقہ کار۔ کے ساتھ ساتھ اور بھی بہت سی چیزوں پر مشتمل ہے۔ اور انشاء اللہ میں مزید وقت کے ساتھ ساتھ اضافہ کرتا جاؤں گا۔ آپ کی قیمتی رائے کی ضرورت ہے۔ عرنان شفیق

اہم نوٹ

ذیل میں جو نوٹس مہیا کیے گئے ہیں وہ کئی گھنٹوں کی لگاتار محنت کے مرتب ہوئے ہیں۔ اور آپ کو بالکل مفت مہیا کر رہے کیے جارہے ہیں۔ آپ سے ان کی قیمت صرف اتنی سی متوقع ہے کہ ایک بار **درودّ ابراھیمی** اپنی زبان سے ادا کر دیں۔

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

اَللّٰهُمَّ صَلِّ عَلٰى مُحَمَّدٍ

وَّعَلٰى اٰلِ مُحَمَّدٍ كَمَا صَلَّيْتَ

عَلٰى اِبْرَاهِيْمَ وَعَلٰى اٰلِ اِبْرَاهِيْمَ

اِنَّكَ حَمِيْدٌ مَّجِيْدٌ ۝

اَللّٰهُمَّ بَارِكْ عَلٰى مُحَمَّدٍ وَّعَلٰى

اٰلِ مُحَمَّدٍ كَمَا بَارَكْتَ عَلٰى

اِبْرَاهِيْمَ وَعَلٰى اٰلِ اِبْرَاهِيْمَ

اِنَّكَ حَمِيْدٌ مَّجِيْدٌ ۝