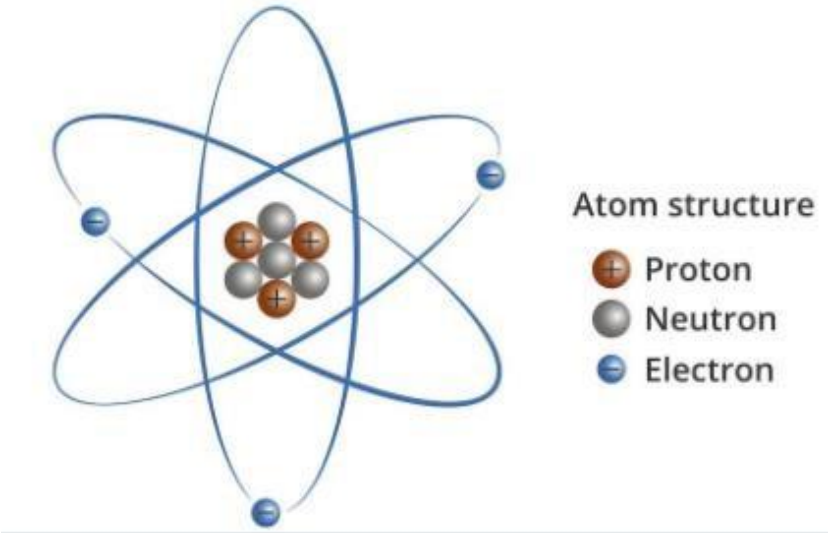
Atom :

The smallest portion of an element, that retain all of the properties of the element.

The number atoms in 1 gram t's 6.0235×1023 (Avogadro number) .

The atomic number of an element is the number of positive charges therefore the number of protons in the nucleus.

Atomic mass equal to the number of proton plus number of neutrons



Element :

Element are the building blocks of all matter.

An element can be defined as a substance that cannot be broken down into any simpler substance by ordinary chemical means.

(E.g. oxygen, iron, sodium,,,,,,ets) .

Elements can be classified as metals or non-metals according to their physical properties.

Physical Properties of Metals

1. State: Metals are solids at room temperature with the exception of mercury, which is liquid at room temperature (Gallium is liquid on hot days).

2. Luster: Metals have the quality of reflecting light from their surface and can be polished e.g., gold, silver and copper.

3. Ductility: Metals can be drawn into wires. For example, 100 g of silver can be drawn into a thin wire about 200 meters long.

4. Hardness: All metals are hard except sodium and potassium, which are soft and can be cut with a knife.

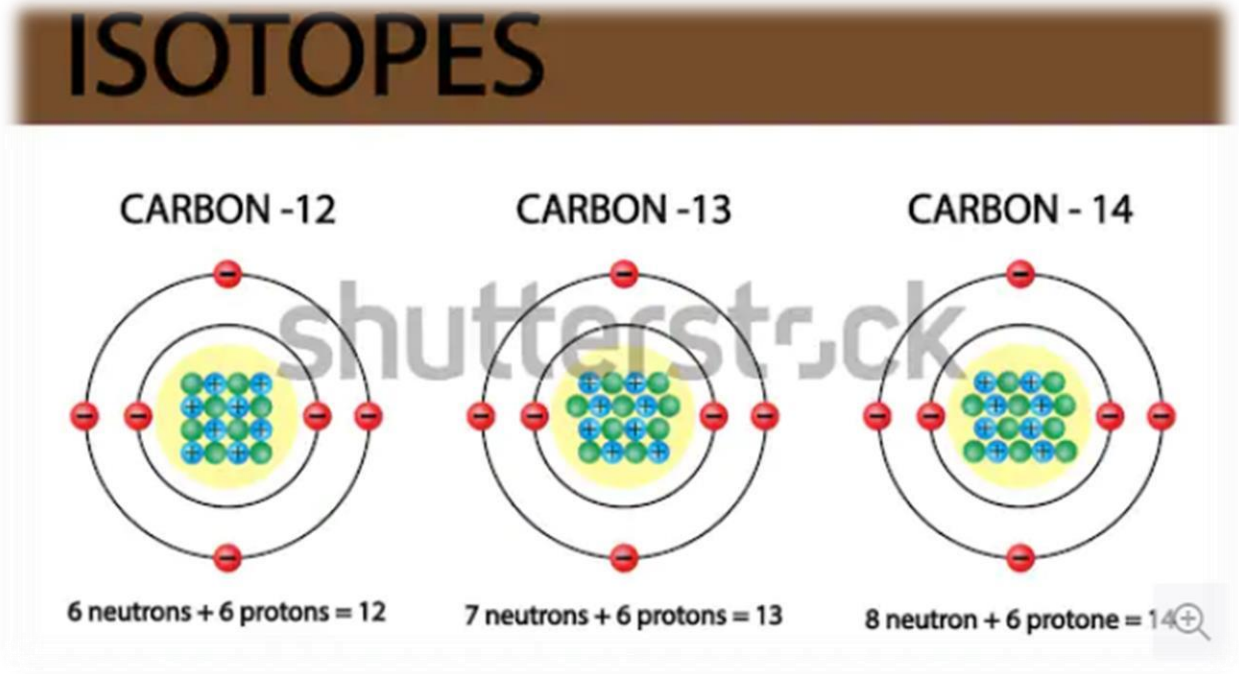
5. Valency: Metals typically have 1 to 3 electrons in the outermost shell of their atoms.

6. Conduction: Metals are good conductors because they have free electrons. Silver and copper are the two best conductors of heat and electricity. Lead is the poorest conductor of heat. Bismuth, mercury and iron are also poor conductors 7. Density: Metals have high density and are very heavy. Iridium and osmium have the highest densities whereas lithium has the lowest density.

8. Melting and Boiling Points: Metals have high melting and boiling points. Tungsten has the highest melting and boiling points whereas mercury has the lowest. Sodium and potassium also have low melting point

Isotopes :

Atoms of an element having the same atomic number but different mass number .



Radioisotopes:

Radioisotopes are the unstable form of an element that emit radiation to transform into a more stable form. Radiation is easily traceable and can cause changes in the substance it falls upon. These special attributes make radioisotopes useful in medicine, industry and other areas

Iodine -131 :

This isotopes is used in the diagnosis and treatment of thyroid .

Technetium -99 :

99Tc (m for metastable) is one of the most widely used radioisotopes for various types of scans.

Cobalt - 60:

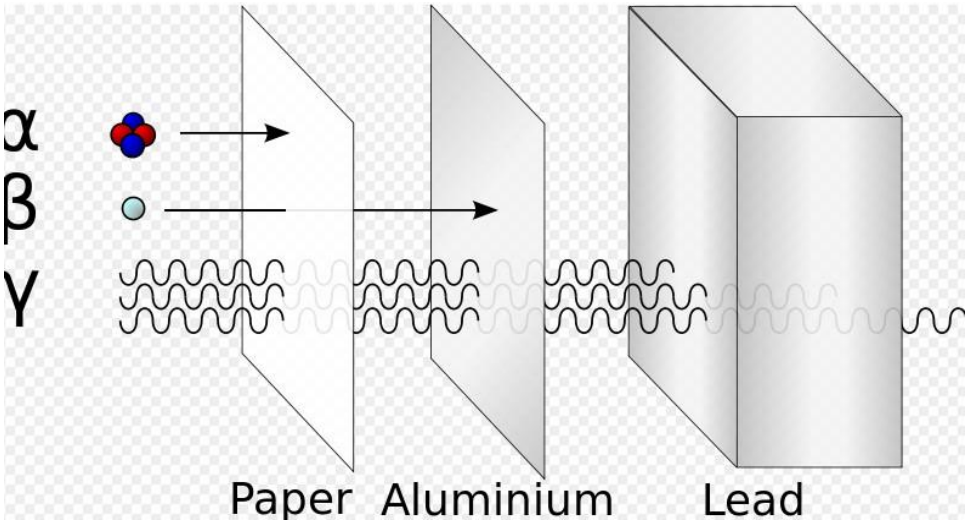
This radioisotopes is employed in the treatment of many different types of cancer.

Typeof radation :

1 - alpha particles are positively charged helium nuclei.

2- beta particles are high speed electrons and are negatively charged .

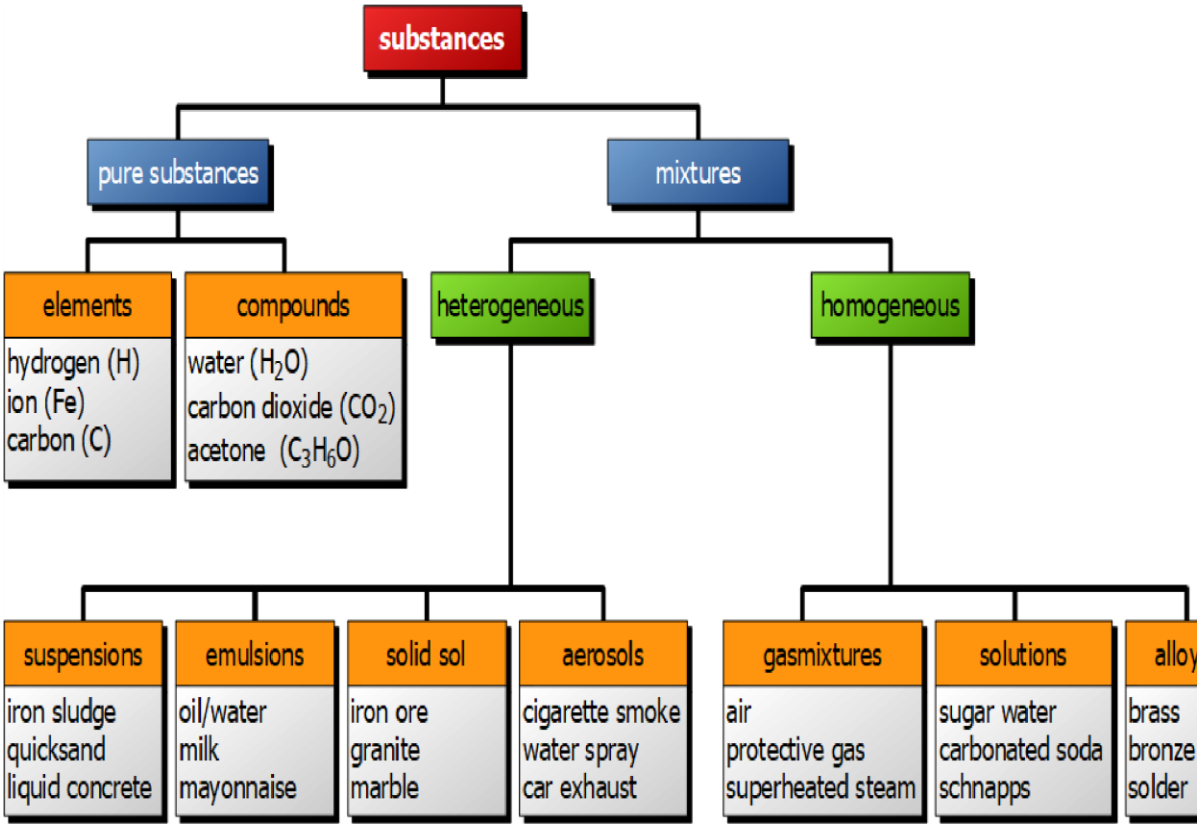
3- gamma rays are high - energy from electromagnetic radiation and have no charge .



1-3 This diagram demonstrates the ability to penetrate matter of different kinds of ionizing radiation. Alpha particles are stopped by a sheet of paper whilst beta particles halt to an aluminium plate. Gamma radiation is dampened when it penetrates matte

Dangerous of radiation:

Radiation is dangerous because it can damage cell in the body, the depends on the type of radiation and the length of time the person is exposed to the radiation. Very large dose can produce immediate damage and lead to death.



Matter :

Matter is anything that occupies space and has weight. States of Matter are solid, liquid ,and gas.

Classification of Matter

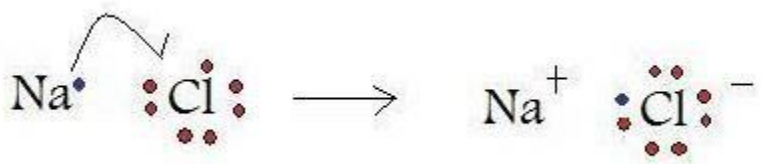
Chemical Bonds:

There are many types of chemical bonds and forces that bind molecules together. The two most basic types of bonds are characterized as either ionic or covalent. In ionic bonding, atoms transfer electrons to each other.

Chemical Bonds can be divided into :

1. **Ionic bond** : Ionic bonds require at least one electron donor and one electron acceptor

(occurs when one or more electrons are transferred from one



to another)

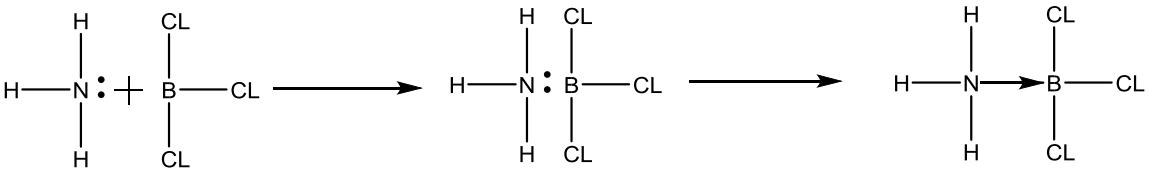
e.g. $CaCl_2$, AgCl …….. etc.

2. **Covalent bond** : Covalent bonding is the sharing of electrons between atoms his type of bonding occurs between two atoms of the same element or of elements close to each other in the periodic table.

e.g. $H^{\bullet} + H^{\bullet} \longrightarrow H_2$

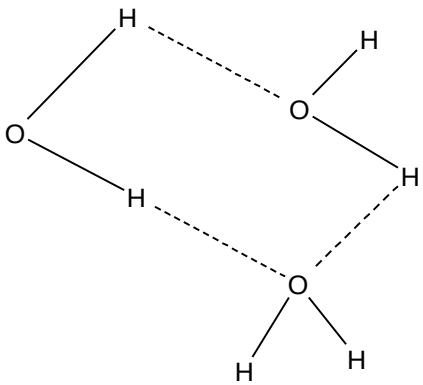
e.g. **C_2H_6 , C_2H_4 , C_2H_2 …… etc.**

3 - Coordinate covalent bond : where a pair of electrons from one atom is shared by two atoms.



e.g. NH_3BF_3

4 - Hydrogen bonding : A particularly strong dipole attraction occurs when hydrogen is covalently bonded to a very small highly electronegative element such as fluorine, oxygen or nitrogen.



CH_3OH , CH_3COOH ……..etc.

Lac2+3 addition to question and solution

The Analytical process

Analytical chemistry deal with determine chemical structure , type and quaint of the substance or mixture in sample.

Analytical chemistry divided to two type a- **Qualitative analysis**: deal with constituents in the analytical sample.

b- **Quantitative analysis**: deal with determination quantitative substance in the sample.

Types of quantitative analysis:

1. **Gravimeter analysis:** usually involves the selective separation of the analytical by precipitation, form the weight of the precipitate and knowledge of chemical composition, the weight of analyst in the desired from is calculated.

1. **Volumetric analysis:**

The analytical react with a measured volume of reagent know concentration, in process called titration.

2. **Instrumental analysis :** determine the amount of substance by measurement the physical or chemical properties like density, color and conductive .

Errors and statistics Accuracy:

The accuracy is the degree of agreement between the measured value and standard sample, other meaning is concordance between it and the true or most probable value (relative error) **Precision :**

Precision may by defined as the concordance a series of measurements of the same quantity .

Classification of errors :

The errors may be divided into :

A) Systematic Errors

These are errors that follow a specific system positive or negative, In other words, it is either an increase or a decrease, and it is possible to correct regular errors by creating mathematical relationships that represent the error.

1 instrumental errors : Impurities in reagents.

2 Methodic errors : Solubility of a precipitate, in complete reaction

3 Operative errors : loss of precipitate, in complete reaction 4- Personal errors :

Indeterminate errors (Random errors) :

Indeterminate errors are frequently called accidental or random, errors, such errors can be attributed to no known cause nor can they be predicted as to magnitude or direction for any single measurement standing alone.

Express of concentration

We shall classify under the general heading of physical and chemical methods.

Physical method :

The simplest ways of expressing the strength of solution are the in terms of the amount of solute present per unit amount of solvent or solution, such as.

1. Grams solute per liter solution, grams solute per liter solvent and solute per unit weight of solution.
2. Percentage methods is equal to

a. The number of gram of solute in 100gm of solution
b. The number of gram of solute in 100ml of solution.

$$\text{Weight – weight percent (wt/wt\%)} = \frac{\text{Weight of solute(gram)}}{\text{Weight of solution(gram)}} \times 100$$

$$\text{Weight –volume percent (wt/vol\%)} = \frac{\text{Weight of solute(gram)}}{\text{Volume of solution(gram)}} \times 100$$

3. **Part per million :**

Common unite for expressing trace concenteration. ppm is equal one milligram of solute in liter of solution.

$$\text{Ppm} = \frac{\text{Weight of solute(mgm)}}{\text{Volume of aqueous solution(L)}}$$

$$\text{Ppm} = \frac{\text{Weight of solute(mgm)}}{\text{Weight of sample (mgm)}}$$

Ex: 12.6 gm sample of plant tissue was analyzed and found to contain 1.6mgm of Zinc. What is the concentration of Zinc in the plant in Ppm.

Solution:

$$\text{Ppm} = \frac{\text{Weight of solute(mgm)}}{\text{Weight of sample (mgm)}} \times 10^6$$

$$\text{Ppm} = \frac{1.6\ \text{(mgm)}}{12.6 \times 10\ \text{(mgm)}} \times 10^6 = 127\text{Ppm}$$

concentration.

Chemical methods

The chemical units are widely employed, the mole and the equivalent, which is used directly in chemical calculation involving solution.

Molar method :

Molar concentration or molarity is defined as the amount of molar solute solute per a liter of solution (or the number of millimoles per millimeter)

$$\textbf{Molarity} = \frac{\text{Number of moles solute}}{\text{Liter of solution}}$$

$$\textbf{Molarity} = \frac{\text{grams solute}}{\text{Molecular weight}} \times \frac{1000\text{ml/liter}}{\text{Volum of solution in (ml)}}$$

Moles of solute = molarity X liters of solution

Grams of solute = molarity X liters of solution X molecular weight **Equivalent method**

(equivalents) of a substance dissolved in one litter of solution (or milliequivalents per millimeter).

The equivalent weight of substance depends upon the type of reaction it undergoes.

$$\textbf{normality} = \frac{\text{solute equivalents}}{\text{Liters of solution}}$$

$$N = \frac{Wt}{Eqwt} \times \frac{1000}{V\ ml}$$

$$\mathbf{M} = \frac{\mathbf{Wt}}{\mathbf{Mwt}} \times \frac{\mathbf{1000}}{\mathbf{V\ ml}}$$

$$\mathbf{Eqwt} = \frac{\mathbf{Mwt}}{\mathbf{Nomber\ of\ H\ \ or\ OH}}$$

Ex$_1$: prepare 500 ml of 0.1N Ca (OH)$_2$? Ca = 40 O =16 H =1

$$\mathbf{N} = \frac{\mathbf{Wt}}{\mathbf{Eqwt}} \times \frac{\mathbf{1000}}{\mathbf{V(ml)}}$$

$$\mathrm{Wt} = \frac{\mathrm{N\ x\ V(ml)\ x\ eq.wt}}{1000}$$

$$\mathrm{Eqwt} = \frac{\mathrm{Mwt}}{\mathrm{Nomber\ of\ H\ \ or\ OH}}$$

$$\mathrm{Eqwt} = \frac{(40\mathrm{x}1)+(16x2)+(2x1)}{2}$$

$$\mathrm{Eqwt} = \frac{74}{2} = 37$$

$$\mathrm{Wt} = \frac{0.1\ \mathrm{x}\ 500(\mathrm{ml})\ \mathrm{x}\ 37}{1000}$$

Wt = 1.85 gm

Weight 1.85 gm of $Ca(OH)_2$ using a watch glass, transfer in the beaker, add distilled water (mix using a stirrer) transfer the solution into a volumetric flask of 500 ml .

Ex$_2$: prepare 250 ml of 0.3M KOH ? K =39 O = 16 H =1

$$\mathbf{M} = \frac{\mathbf{Wt}}{\mathbf{M.wt}} \times \frac{\mathbf{1000}}{\mathbf{V(ml)}}$$

$$\mathrm{Wt} = \frac{\mathrm{M\ x\ V(ml)\ x\ M.wt}}{1000}$$

$$\mathrm{M.wt} = (39\mathrm{x}1) + (16x1) + (1x1)$$

$$M.wt = 39 + 16 + 1 = 56 \text{ gm}$$

$$Wt = \frac{0.3 \text{ X}250(\text{ml}) \text{ x}56}{1000}$$

Wt = 4.2 gm

Weight 4.2 gm of KOH using a watch glass, transfer in a volumetric flask, add distilled water until the mark 250ml (mix using a stirrer) .

dilutions low

C1V1 = C2V2

Ex3: prepare 250 ml of 0.3N from H_2SO_4 5N ?

Chemical Equilibrium:-

chemical equilibrium is the state in which both reactants and products are present in concentrations which have no further tendency to change with time, so that there is no observable change in the properties of the system. Usually, **this state results when the forward reaction proceeds at the same rate as the reverse reaction**. **The reaction rates of the forward and backward reactions are generally not zero, but equal**. Thus, there are no net changes in the concentrations of the reactants and products.

In a solution of acetic acid, two reactions occurring simultaneously

$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$$

That is manning

$$CH_3COOH + H_2O \longrightarrow CH_3COO^- + H_3O^+ \quad ...(1)$$

and

$$CH_3COO^- + H_3O^+ \longrightarrow CH_3COOH + H_2O \quad ...(2)$$

Also chemical equilibrium a rises when the reaction **velocity in the direct direction is equal to that in the opposite direction, and this is present, for example, in reverse reactions**. This does not mean that the reaction velocity is zero, but only that the reaction velocity in the direct direction is equal to the vilocity of the reverse reaction; this is expressed by the fact that the reaction is in a mechanical equilibrium (kinetic equilibrium). It is used to describe a balanced or reversible two-arrow interaction between the substances involved in the reaction and the resulting substances.

Equilibrium constant

The equilibrium constant is the division of the products by the reactant, the general equation for a chemical equilibrium

$$aM + bN \rightleftharpoons cP + dQ$$

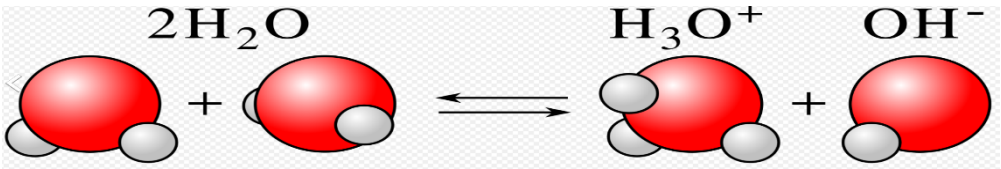
Express of the equilibrium constant for a chemical reaction

$$K_e = \frac{[P]^a [Q]^b}{[M]^c [N]^d}$$

Where the [P] and [Q} are products concentration, and [M] and [N] are reactant concentration ; and a, b, and d are the **stoichiometric coefficients** from the balance reaction.

Ionization of water:

Aqueous solution always contain small amounts of hydronium and hydroxide ion as a consequence of the dissociation reaction



$2H_2O \rightleftarrows H_3O^+ + OH^-$

Or

$H_2O \rightleftarrows H^+ + OH^-$

The equilibrium constant for this reaction

$$K_e = \frac{[H_3O^+][OH^-]}{[H_2O]^2}$$

When the $[H_2O]$ is constant, we have

$[H_3O^+][OH^-] = K_w$…….(1)

K_w is called the ion product constant, $[H_3O^+][OH^-]$ is the product of ionic concentration, and $[H^+][OH^-]$ is the product of ionic concentration

$K_w = [H^+][OH^-]$ when $[H^+] = [OH^-]$ and assume $y = [H^+]$

Hence $y = [H^+] = [OH^-]$

Substituting in equation 1 have

$K_w = y^2$ at 25 ^oC,

10^{-14} , that meaning $y^2 = 1x10^{-14}$ and $y= 1x10^{-7}$

There for in pure water (neutral medium)
$[H^+] =[OH^-]= 1x10^{-7}$

In acidic medium $[H^+]> [OH^-]$

In basic medium $[OH^-] < [H^+]$

PH and POH concept:

PH and POH are terms used to specify the hydrogen concentration and hydroxide concentration in aqueous solution,

$PH= - \log[H^+]$ ……. When the $[H^+]= 1x10^{-7}$

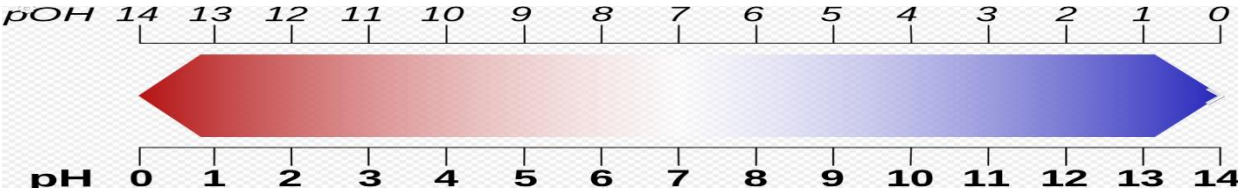
$PH= -\log[1x10^{-7}]$ and $POH = - \log [OH^-]$ So it

PH=7 and POH = 7

$\log K_W = \log [H^+] + \log [OH^-]$

$PK_w= PH+ POH$

14 = PH+ POH



The red is the acidic scale, and the blue is the base scale.

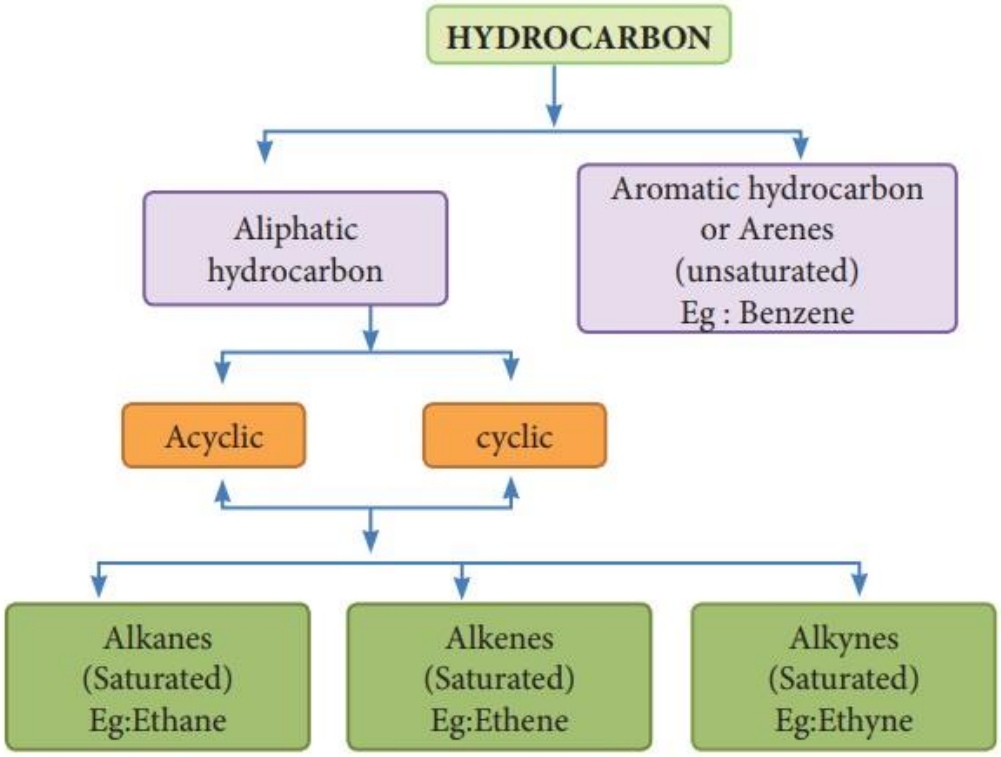
medium	Concentration of H and OH	Value of PH and POH

Acid solution	$[H^+] > 10^{-7}$	PH < 7
	$[OH^-] < 10^{-7}$	POH > 7
Neutral solution	$[H^+] = 10^{-7}$	PH = 7
	$[OH^-] = 10^{-7}$	POH =7
Base solution	$[H^+] < 10^{-7}$	PH > 7
	$[OH^-] > 10^{-7}$	POH <7

Second Semester

ORGANIC CHEMISTRY

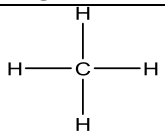
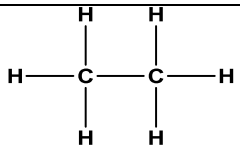
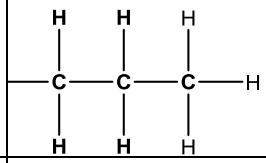
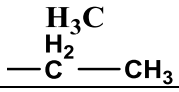
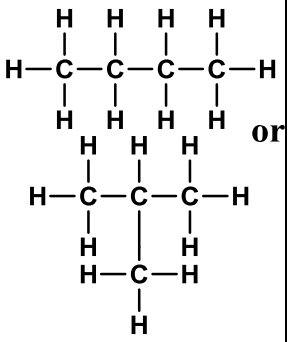
Organic chemistry is the chemistry of the compounds of carbon. Certain organic compounds contain only two elements, hydrogen and carbon are known as hydrocarbon which are divided as follow:



Alkanes

The general formula for alkanes is ($C_n H_{2n+2}$) where n represents the number of carbon atoms. That is, if a compound contains n carbon atoms the number of hydrogen atoms is twice n plus two more.

Number of carbon atoms	Name	Molecular formula	Structural formula	Compound structural formula

1	**Methane**	**CH_4**		**CH_4**
2	**Ethane**	**C_2H_6**		**CH_3 — CH_3**
3	**Propane**	**C_3H_8**		
4	**Butane**	**C_4H_{10}**		CH_3–$(CH_2)_2$–CH_3 Or CH_3–CH–CH_3 | CH_3
5	**Pentane**	**C_5H_{12}**	**3 Isomers ***	
6	**Hexane**	**C_6H_{14}**	**5 Isomers**	
7	**Heptane**	**C_7H_{16}**	**9 Isomers**	
8	**Octane**	**C_8H_{18}**	**18 Isomers**	
9	**Nonane**	**C_9H_{20}**	**35 Isomers**	
10	**Decane**	**$C_{10}H_{22}$**	**75 Isomers**	

*The number of isomer increases rapidly as the compound contains more carbon a tomes.

Alkyl Group

When a hydrogen atom is removed from an alkane , an alkyl group is formed. The names of the alkyl groups are obtained by changing the eniting of the name from (ane) to (yl) .

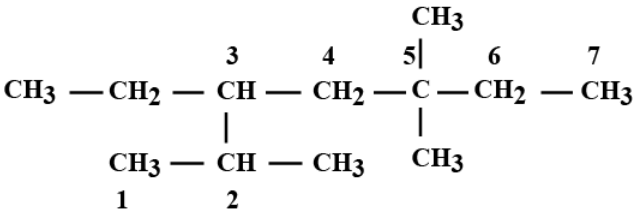
Naming Hydrocarbons :

An international system of nomenclature for organic compounds has been devised and is recognized and used by chemists all over the word. This system was devised and approved by the International Union of pure and Applied Chemistry and is frequently designated by the initials IUPAC.

The rules of IUPAC sustem are:

1. Pick out the longest continuous chain of carbon atoms.
2. Identify that chain as an alkane.
3. Pick out the alkyl groups attached to that chain.
4. Number the carbons in the chain , starting at whichever end of the chain will give the smallest numbers to the carbons to which the alkyl groups are attached. Continue the numbering of this carbon chain in the same direction from one end to other.
5. List the numbers and the names of alkyl groups
6. Use commas between numbers and a dash between a number and a letter.

Examples :

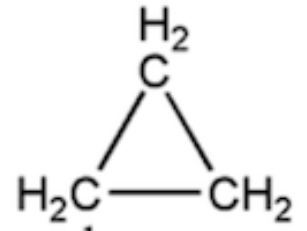


3-ethyl-2,5,5-trimethyl heptane

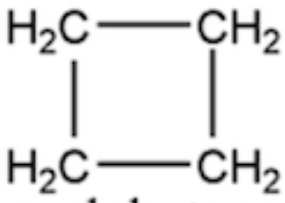
Cycloalkanes:

Alkanes also exist in the shape a ring. Such structures are called cycloalkanes. They are named by placing the prefix cyclo before the name of the corresponding

straight chain alkanes, thus the cyclic alkane : of three carbons is called cyclo propane. Its structure is



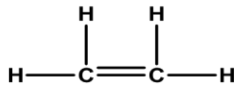
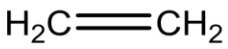
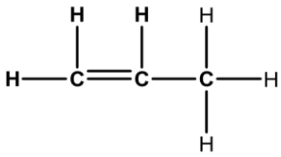
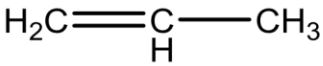
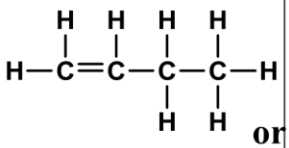
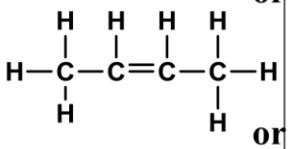
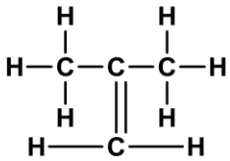
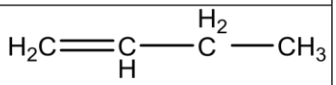
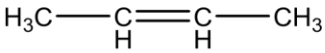
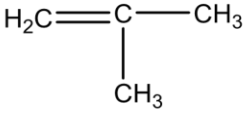
cyclopropane



cyclobutane

Alkenes

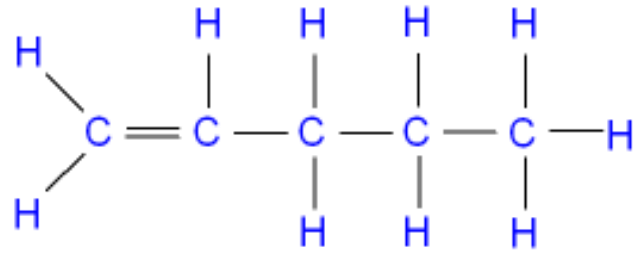
Alkenes have a double bond (two bonds) between two of the carbon atoms. The general formula for alkenes is C_nH_{2n}

Number of carbon atoms	Name	Molecular formula	Structural formula	Compounds structural formula
1	Ethene	C_2H_4		
2	Propene	C_3H_6		
3	Butene	C_4H_8	 or  or 	  
4	Pentene	C_5H_{10}	6 Isomers	
5	Hexene	C_6H_{12}	15 Isomers	
6	Heptene	C_7H_{14}	30 Isomers	
7	Octene	C_8H_{16}	66 Isomers	

Changing the position of the double bond in an alkene makes a different isomer.

Butene and pentene exist as different isomers. Compare these with the isomers of butane and pentane on the previous pages.

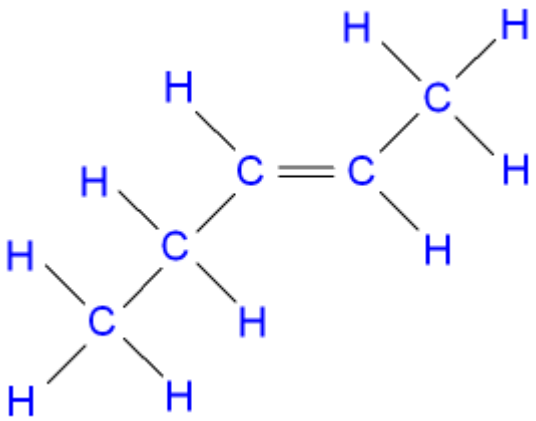
Pentene (C_5H_{10}) is commonly represented by the molecule pent-1ene which has the structural formula



(1)

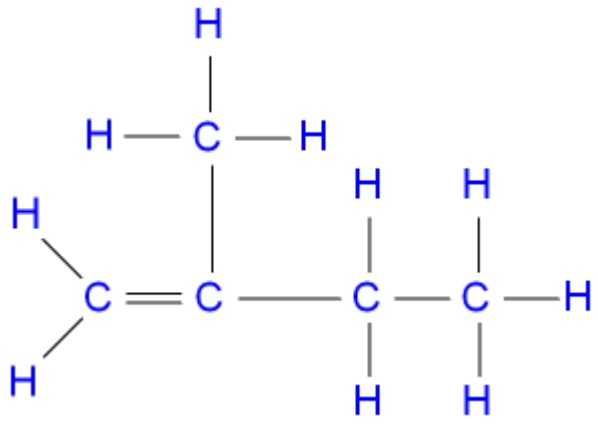
Other isomers of pentene can be drawn by changing the place of the double bond or by changing the way that the carbon atoms are joined to each other.

The other isomers of pentene are pent-2-ene represented by the structural formula



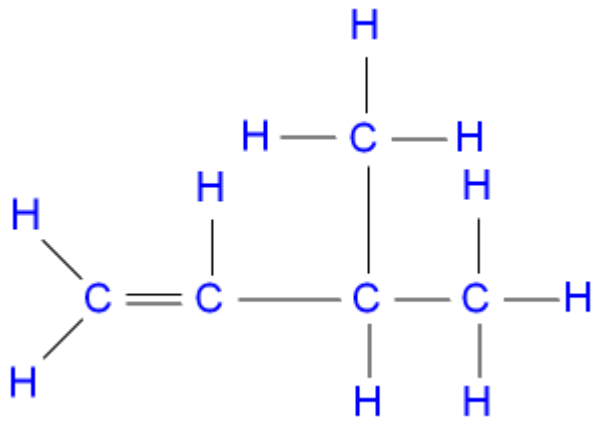
(2)

2-methylbut-1-ene, represented by the structural formula



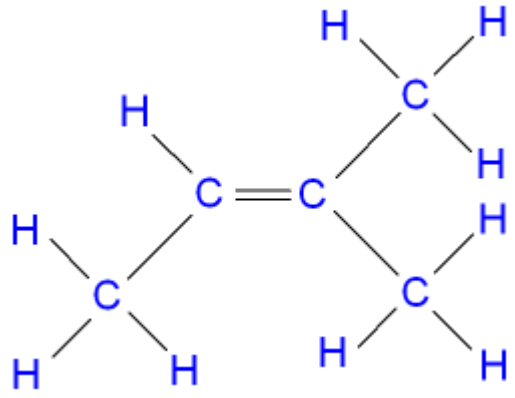
(3)

3-methylbut-1-ene, represented by the structural formula

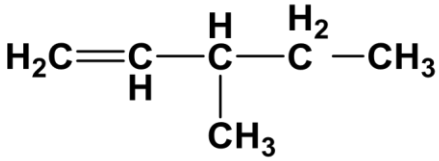


(4)

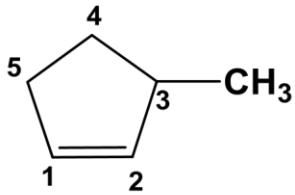
and 2-methylbut-2-ene, represented by the structural formula



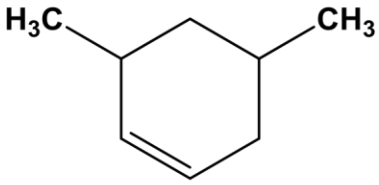
re the double lines between the carbon atoms represent a double covalent bond. The single lines represent single covalent bonds. Note that each carbon atom has four bonds (valency 4), and each hydrogen atom has one bond (valency 1). Valency is the combining power of an atom.



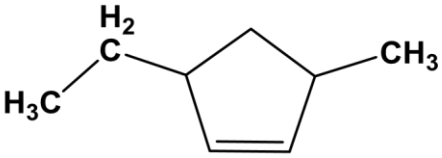
3 - methyl - 1 - pentene



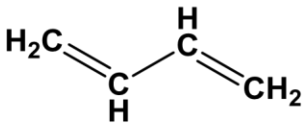
3 - methyl cyclo pentene



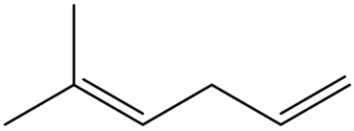
3,5-dimethylcyclohexene



3-ethyl-5-methylcyclopentene



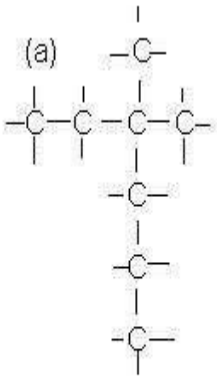
1,3-butadiene

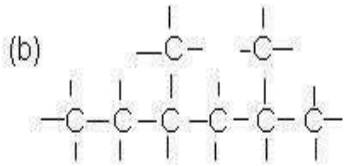


5-methylhexa-1,4-diene

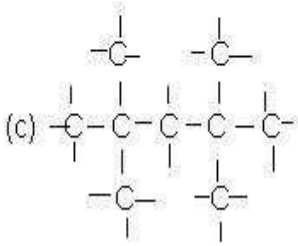
1. **Name the following compounds using IUPAC rules.**

a) 3,3 – dimethyl hexane





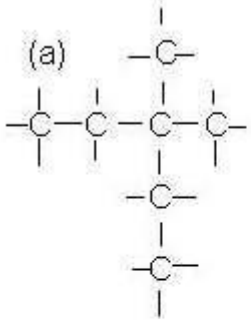
b) 2,4 – dimethyl hexane



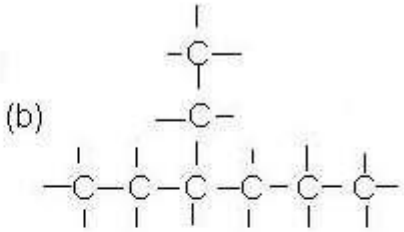
c) 2,2,4,4 – tetramethyl pentane

2. Draw the following structural formulas:

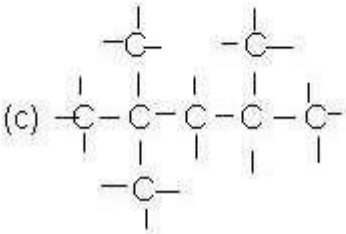
(a) 3,3-dimethylpentane (b) 3-ethylhexane (c) 2,2,4-trimethylpentane



(a) 3,3-dimethylpentane



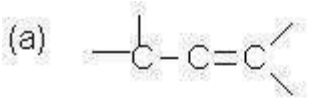
(b) 3-ethylhexane



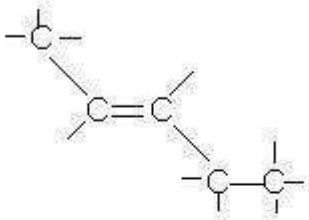
(c) 2,2,4-trimethyl pentane

3- Draw the structural isomers of hexane and name each isomer.

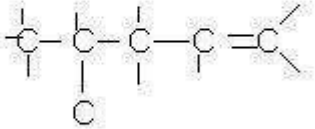
4- Give the IUPAC names for the following alkenes:

(a) 

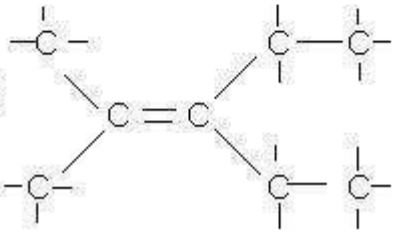
(a) propene

(b) 

(b) 2 – pentene

(c) 

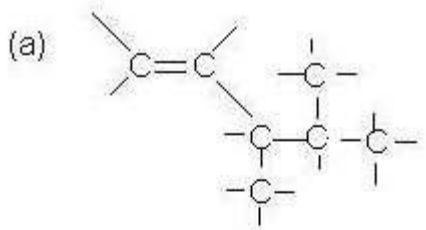
(c) 4 – methyl – 1 – pentene

(d) 

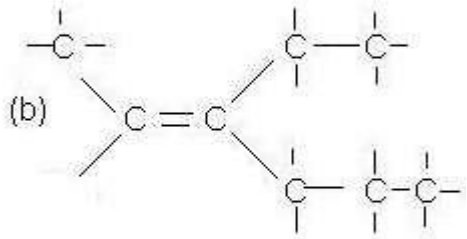
(d) 3 – ethyl – 2 – methyl – 2 – pentene

5- Draw the following structural formulas:

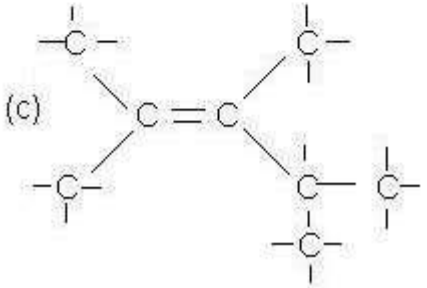
(a) 3,4-dimethyl-1-pentene (b) 3-ethyl-2-hexene (c) 2,3,4-trimethyl-2-pentene



(a) 3,4 – dimethyl -1 -pentene



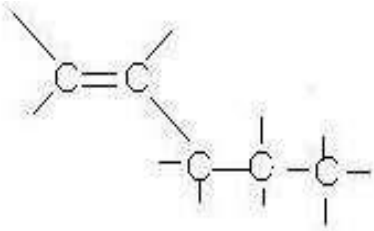
(b) 3-ethyl-2-hexene



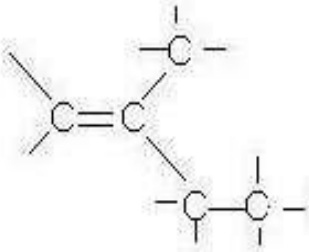
(c) 2,3,4-trimethyl-2-pentene

6- Draw the structural isomers of pentene and name each isomer.

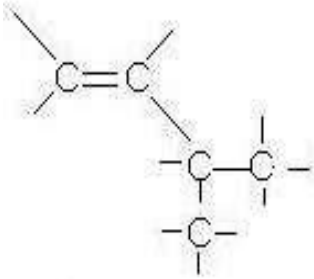
7- Draw the structural isomers of pentene and name each isomer.



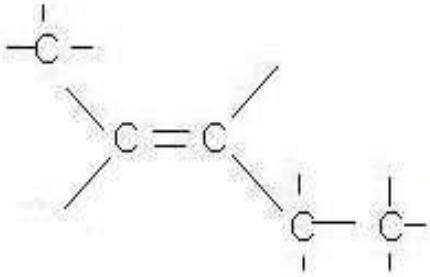
1 - pentene



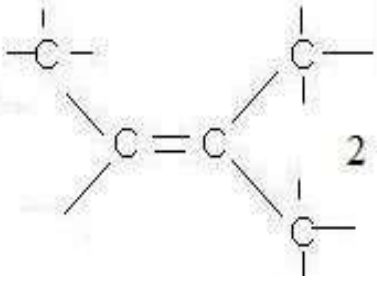
2 - methyl - 1 - butene



3 - methyl - 1 - butene



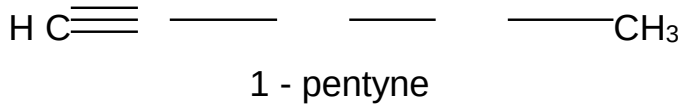
2 - pentene



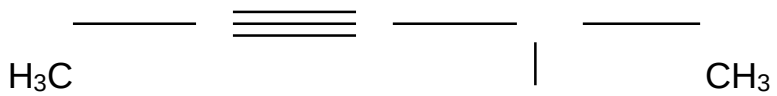
2 - methyl -2 - butene

Alkyne

Consider two carbon atoms connected by a triple bond . ethylene or acetylene HC≡CH . The general formula for alkynes is C_nH_{2n-2}



1 - pentyne



4 - methyl - 2 - pentyne

Reactions

1. substitution reactions

Saturated hydrocarbons react by a process known as substitution .

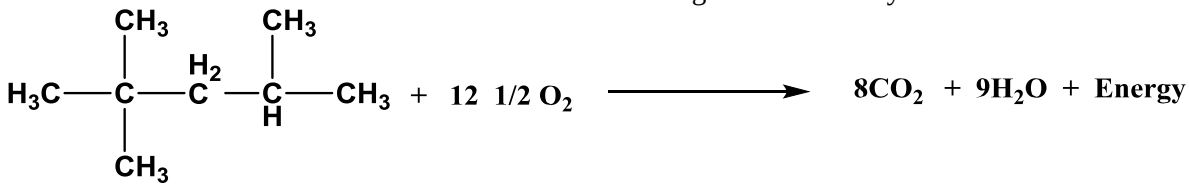
$$CH_4 + Cl_2 \xrightarrow{\text{Light}} CH_3Cl + HCl$$

Further chlorination may substitute additional chlorines for hydrogen.

2. Oxidation reaction

Alkanes may be oxidized to yield carbon dioxide , water, and energy.

$$CH_4 + 2O_2 \longrightarrow CO_2 + H_2O + \text{Energy}$$

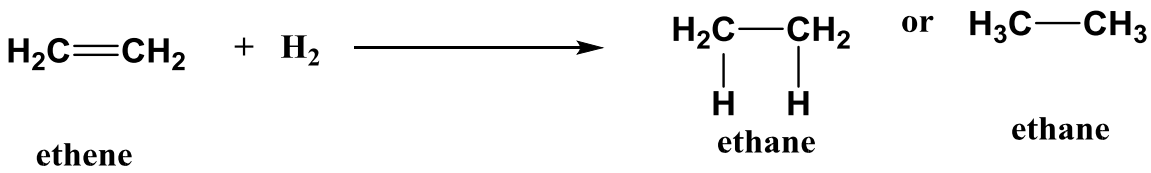


2 , 2 , 4 - trimethyl pentane

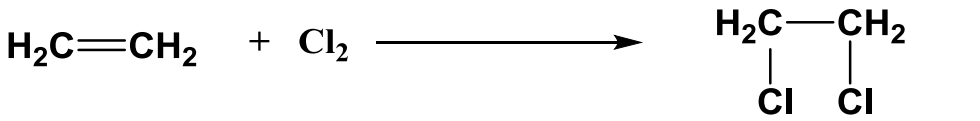
Incomplete oxidation (combustion) of alkanes yield carbon monoxide in place of carbon dioxide :

$$CH_4 + 2\,O_2 \longrightarrow CO_2 + 2H_2O + \text{Energy}$$

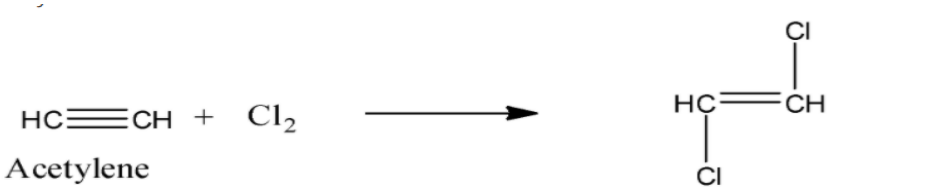
Unsaturated hydrocarbons react by process known as addition.



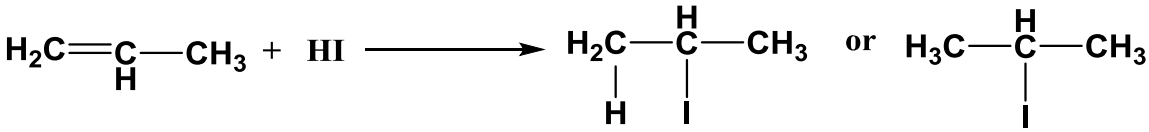
ethene ethane ethane



ethene 1,2 - dichloro ethane



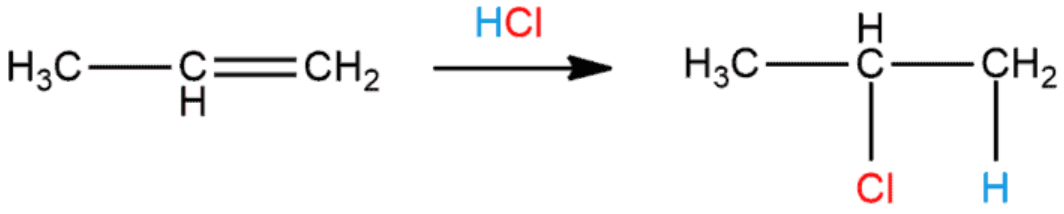
Acetylene 1,2-dichloroethene



propene 2-iodo propane 2-iodo propane

Markownikoff rule :

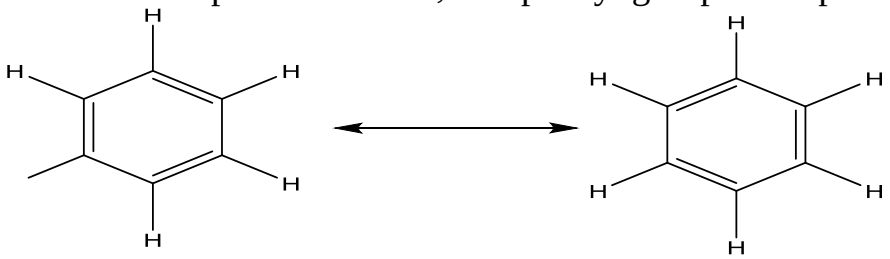
When an asymmetrical reagent (e.g. HI) adds to an asymmetrical ethylenic linkage (e.g. propene) , the + ve part (hydrogen) will go to carbon atom holding the greatest number of hydrogen atoms and - ve part (halogen) will go to carbon atom holding the smallest number of hydrogen atoms.



Aromatic hydrocarbon :

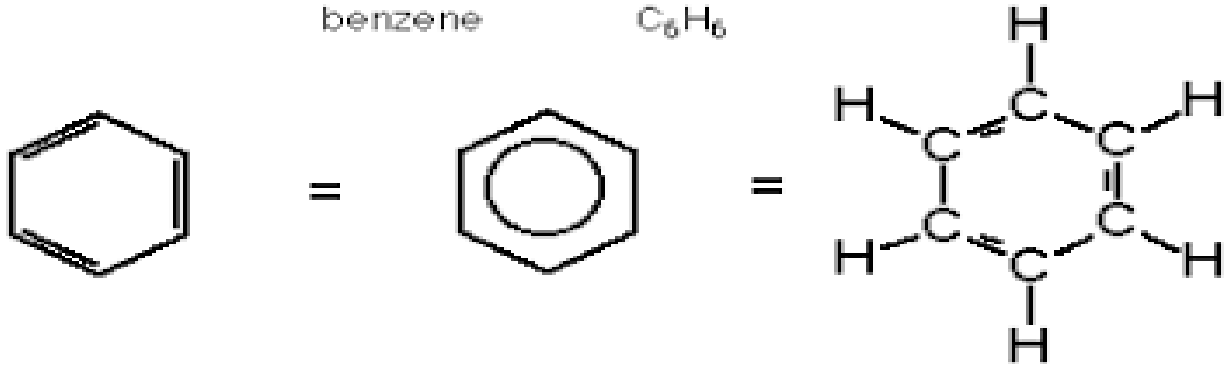
Aromatic compounds are those chemical compounds (most commonly organic) that contain one or more rings with pi electrons delocalized all the way around them. In contrast to compounds that exhibit aromaticity, aliphatic compounds lack this delocalization, many such compounds have a sweet or pleasant odour; however, not all aromatic compounds have a sweet odour, and not all compounds with a sweet odour are aromatic. Aromatic hydrocarbons, or arenes, are aromatic organic compounds containing solely carbon and hydrogen atoms. The configuration of six carbon atoms in aromatic compounds is called a "benzene ring", after the simple

aromatic compound benzene, or a phenyl group when part of a larger compound

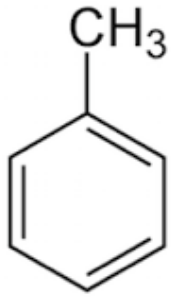


Benzene is a liquid, colorless, insoluble in water but is soluble in alcohol and ether. Benzene is toxic when taken internally. Contact with the skin is harmful and continued inhalation of benzene vapors decreases red and white blood cell count. Benzene is now considered to be mildly carcinogenic and care must be taken with it use.

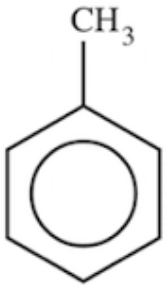
benzene C_6H_6



if substituted in one positon

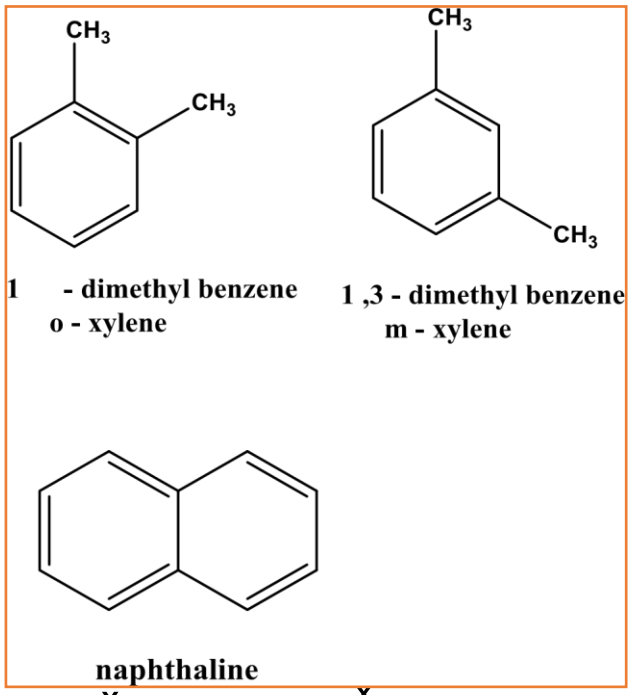


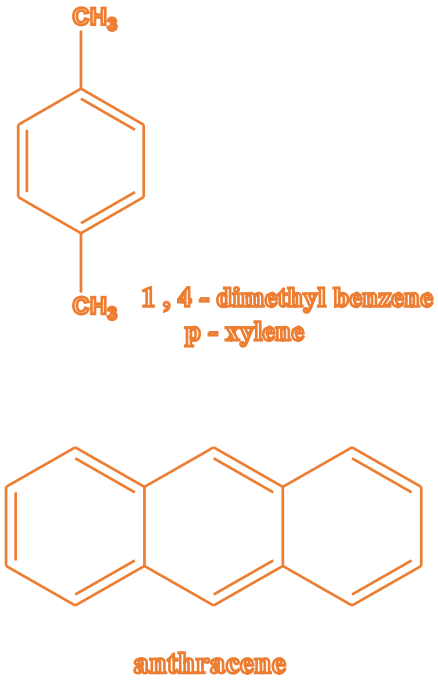
toluene

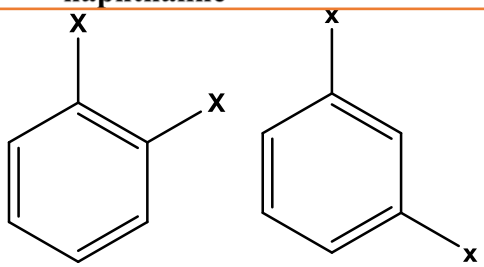


toluene

If more than one hydrogen is substituted , a three possible distributed benzenes are obtained.

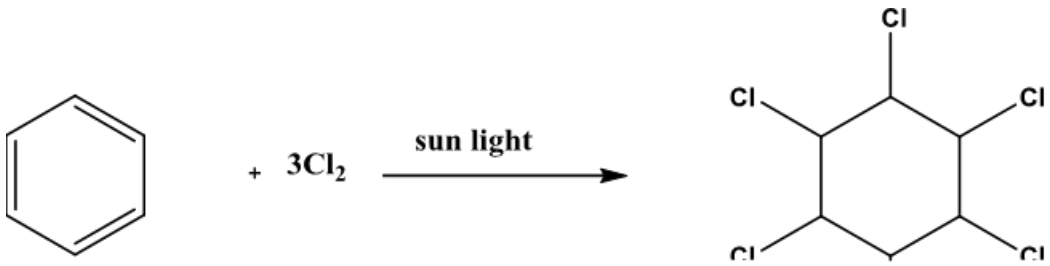




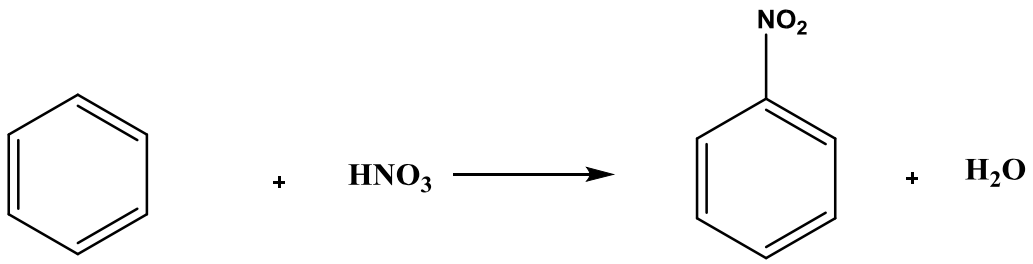


Reaction of Aromatic compound

Halogenation Catalyst known as halogen carrier

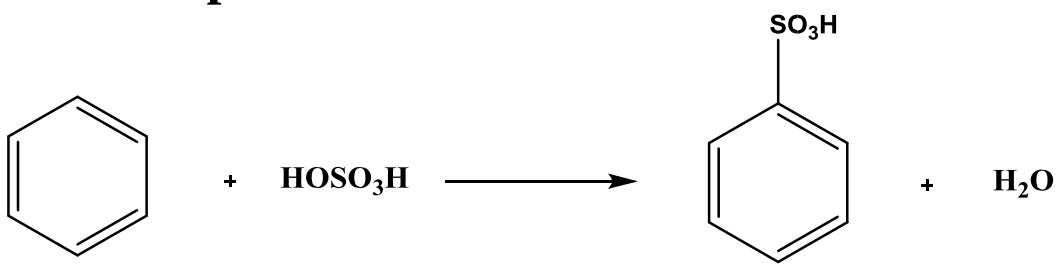


Nitration



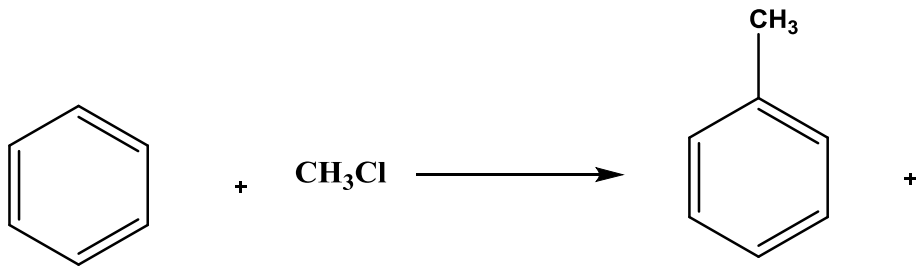
nitrobenzene

Sulphonatio



benzene sulphonate

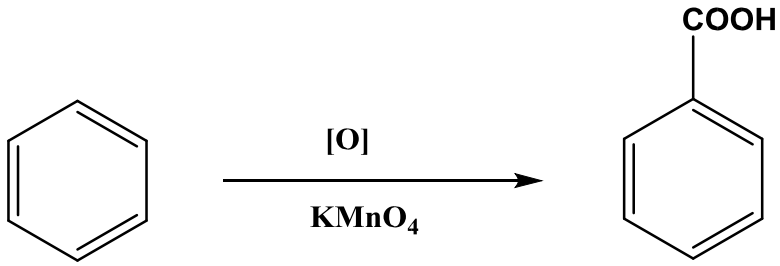
Alkylation



methyl benzene

HCl

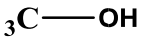
Oxidation



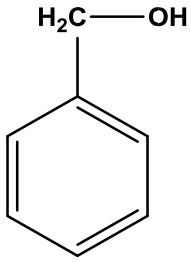
Benzoic acid

Alcohols and phenols :

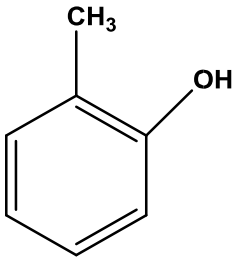
Alcohols and phenols are hydrocarbons in which one or more hydrogen atoms are replaced by (- OH) hydroxyl groups. If (- OH) group is attached directly to an aromatic ring , the compound is phenol. All other hydroxide compounds are alcohols.



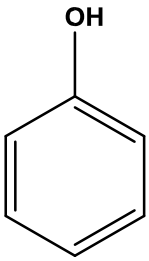
methyl alcohol
r methanol



benzyl alcohol



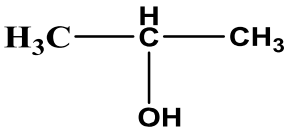
o - cresol



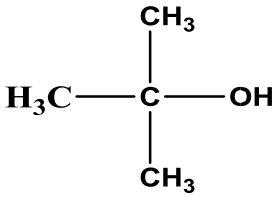
phenol

primary alcohol CH_3CH_2OH

secondary alcohol

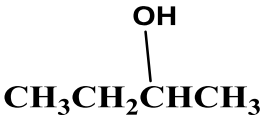


tertiary alcohol



CH_3OH
methanol

$CH_3CH_2CH_2OH$
propanol



2- butanol

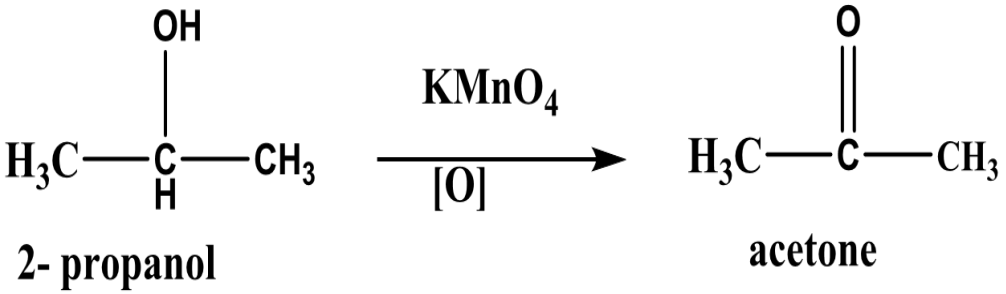
Reaction of alcohols

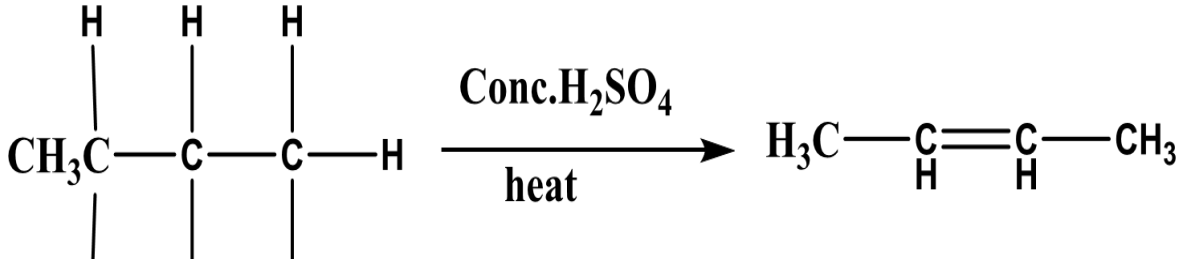
$$CH_3COOH + C_2H_5OH \longrightarrow CH_3COOC_2H_5 + H_2O$$

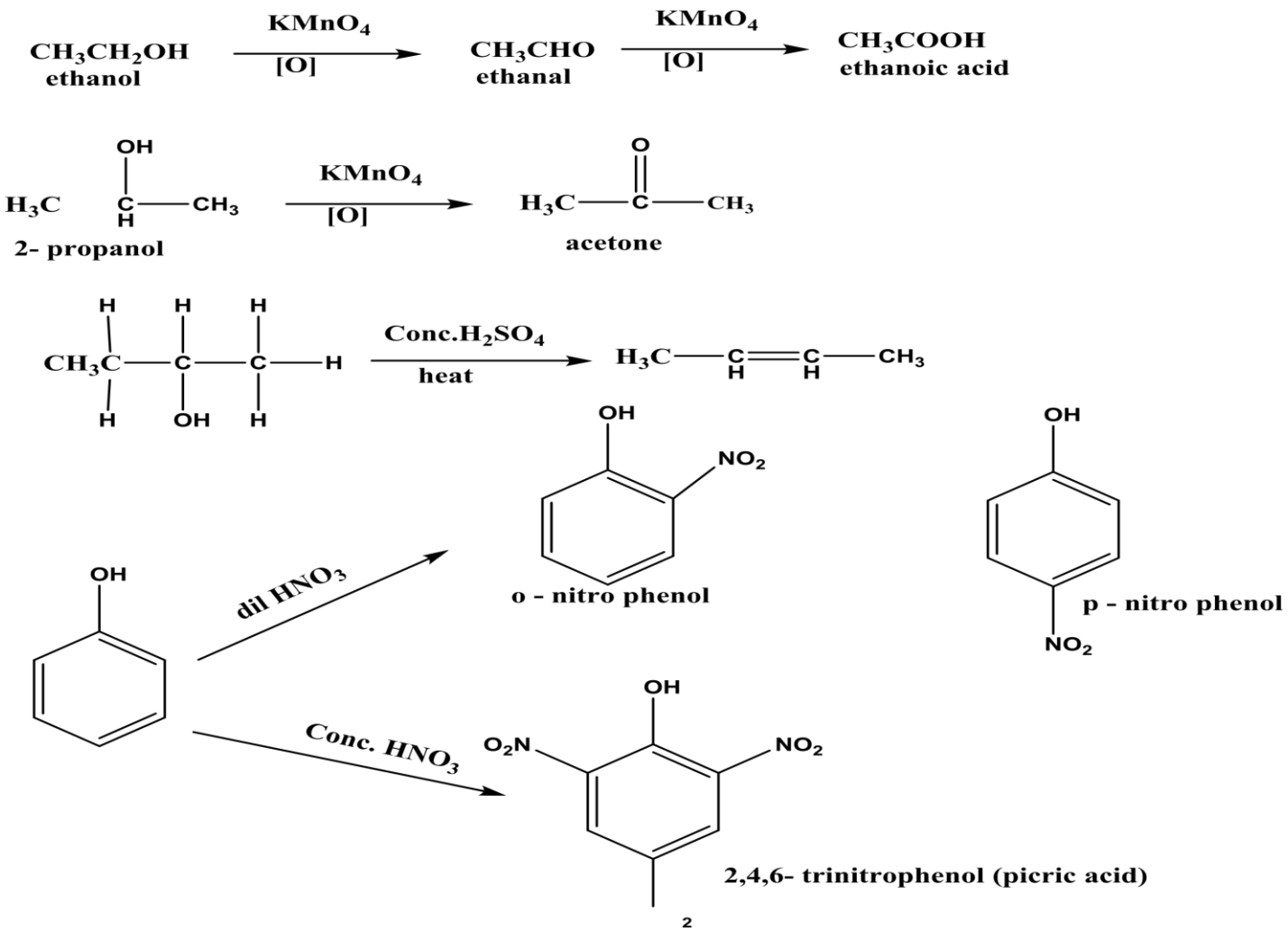
ethyl acetate

$$CH_3OH + HCl \longrightarrow CH_3Cl \quad H_2O$$

$$\underset{\text{ethanol}}{CH_3CH_2OH} \xrightarrow[{[O]}]{KMnO_4} \underset{\text{ethanal}}{CH_3CHO} \xrightarrow[{[O]}]{KMnO_4} \underset{\text{ethanoic acid}}{CH_3COOH}$$





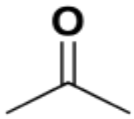


Aldehydes and ketones

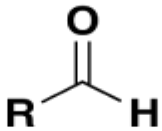
Aldehydes and ketones contain the carbonyl group. Aldehydes are considered the most important functional group. They are often called the formyl or methanoyl group. Aldehydes derive their name from the *dehyd*ration of *al*cohols. Aldehydes contain the carbonyl group bonded to at least one hydrogen atom.

Ketones contain the carbonyl group bonded to two carbon atoms.

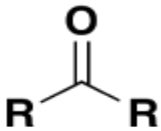
Aldehydes and ketones are organic compounds which incorporate a **carbonyl functional group**, C=O. The carbon atom of this group has two remaining bonds that may be occupied by hydrogen, alkyl or aryl substituents. If at least one of these substituents is hydrogen, the compound is an **aldehyde**. If neither is hydrogen, the compound is a **ketone**.



carbonyl group

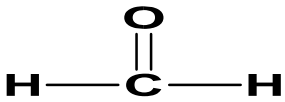


aldehyde

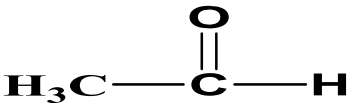


ketone

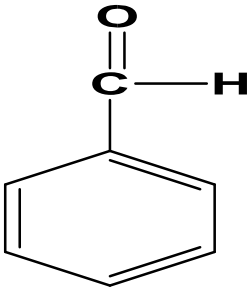
.



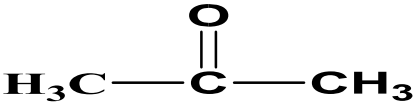
methanal (formaldehyde



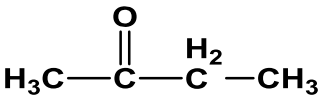
ethanal (acetaldehyde)



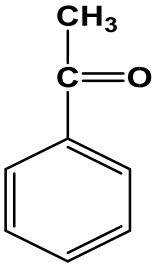
benzaldehyde



acetone



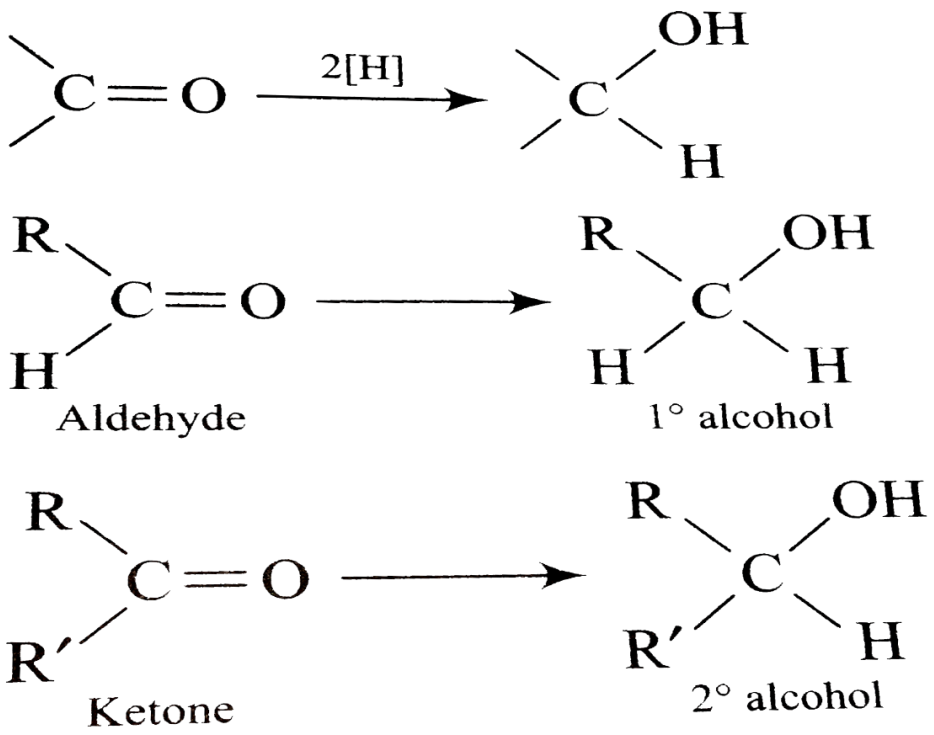
ethyl methyl ketone



methyl phenyl ketone (acetophenone)

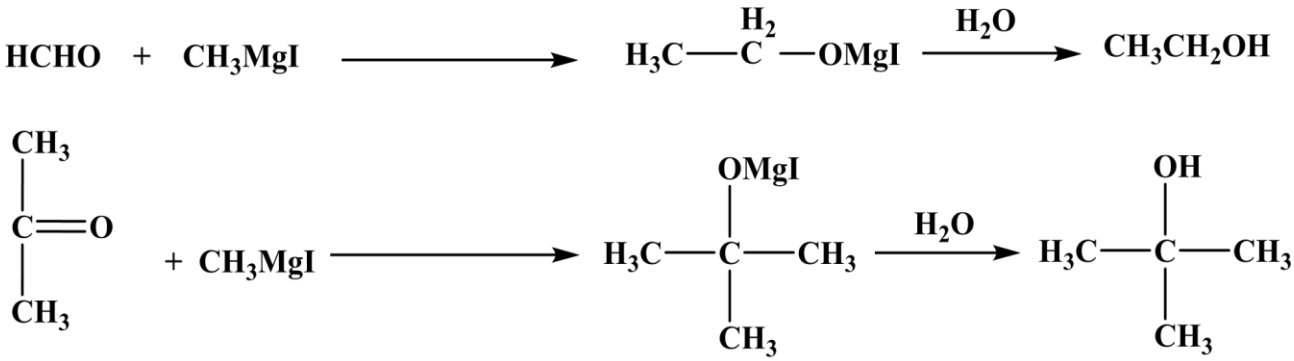
Reactions of aldehydes and ketones

Reduction and Oxidation of aldehyde and ketone



[H] means "hydrogen from a reducing agent"

$$CH_3CHO + H_2 \longrightarrow CH_3CH_2OH$$

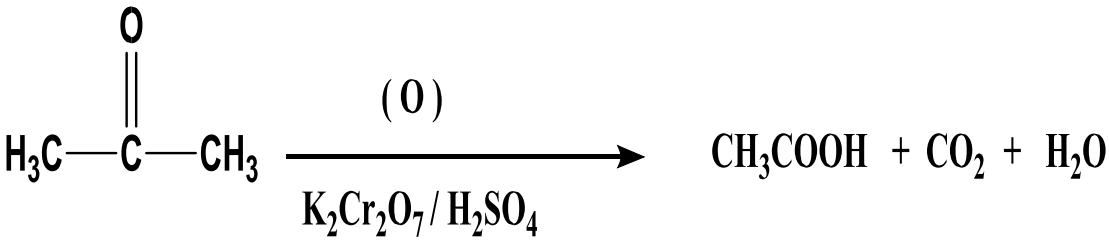


$$CH_3CHO \xrightarrow{(O)} CH_3COOH$$

acetaldehyde

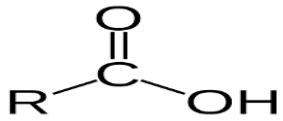
$$CH_3CHO + Cu^{++}(Fehling) \xrightarrow{(O)} CH_3COOH + CuO \downarrow$$

$$CH_3CHO + Ag(NH_3)_2OH \ (Tollen) \xrightarrow{(O)} CH_3COOH + Ag\ (mirror)$$



Carboxylic acids

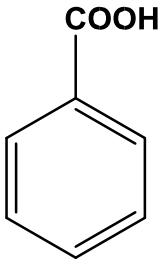
The carboxylic acids compound are those containing carboxylic group



According to the I.U.P.A.C system the acid is named after the alkane from which it is derived by adding suffix oic dropping – e.

CH_3COOH e hanoic acid acetic acid

HCOOH methanoic acid formic acid



Benzoic acid

Reaction of carboxylic acids

1- Salt formations :

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

$$CH_3COOH + NH_3 \longrightarrow CH_3COONH_4$$

2 –Ester formations :

$$CH_3COOH + C_2H_5OH \longrightarrow CH_3COOC_2H_5 + H_2O$$

3- Formation of acid chloride:

$$CH_3COOH + PCl_5 \longrightarrow CH_3COCl + POCl_3 + HCl$$

$$C_6H_5COOH + SOCl_2 \longrightarrow C_6H_5COCl + SO_2 + HCl$$

4- Halogenation:

$$H_3CH_2COOH \xrightarrow{Br_2 / P} CH_3CHBrCOOH \xrightarrow{Br_2 / P} CH_3CBr_2COOH$$

Reaction of salts of acids

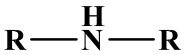
1- Preparation of alkanes

$$CH_3COONa + \underset{\text{sodalime}}{NaOH(CaO)} \longrightarrow CH_4 + Na_2CO_3$$

$$CH_3COONa + 2H_2O \xrightarrow{\text{hydrolysis}} CH_3CH_3 + 2CO_2 + 2NaOH + H_2$$

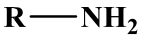
Amines

Amines are organic bases, they can be considered as substituted ammonia compounds. The amines are classified into primary , secondary and tertiary amines.



secondary amine

tertiary amine



primary amine

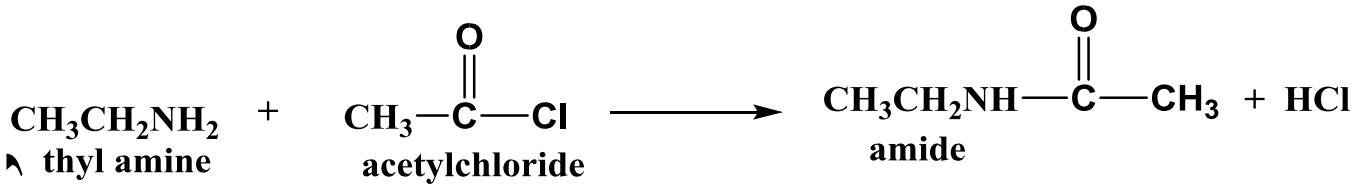
CH_3NH_2	methyl amine
$(CH_3)_2NH$	dimethyl amine
$(CH_3)_3N$	trimethyl amine
$(C_2H_5)_2NCH_3$	diethyl methyl amine

Reactions of amines:

1- Salt formation:

$$CH_3NH_2 + HCl \longrightarrow CH_3\overset{+}{N}H_3Cl^-$$

2- Acylation (amine to amide)



Carbohydrates (CHO)

Biochemistry

Biochemistry is the branch of science that explores the chemical processes within and related to living organisms. It is a laboratory based science that brings together biology and chemistry. By using chemical knowledge and techniques, biochemists can understand and solve biological problems

Biochemistry is the study of life itself :

1 - The interrelationships of the carbohydrate, fats, and proteins . 2- The need for enzymes , vitamins , and hormones in various body processes .

3- The formation and excretion of waste products .

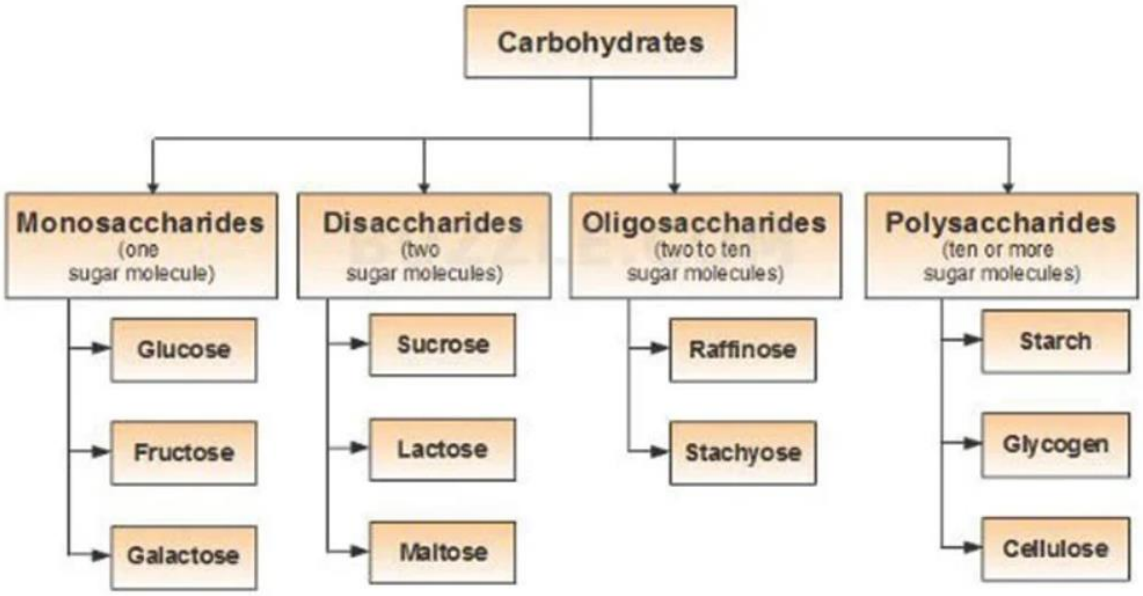
4 - The properties nd function of the body's fluids , including blood and urine.

5 - The cause and cure of certain pathologic conditions .

6 -The study of human reproduction and its molecular basis as evidenced by the study of DNA .

Carbohydrates

Carbohydrates (Which contain the elements carbon, hydrogen, and oxygen) are a class of organic compounds that includes sugars, starches, and cellulose. Carbohydrates were considered to be hydrates of carbon. The formula for glucose, $C_6H_{12}O_6$, was written as $C_6(H_2O)_6$. Likewise sucrose,$C_{12}H_{22}O_{11}$, was written as $C_{12}(H_2O)_{11}$. Carbohydrates are defined as polyhydroxyaldehydes or polyhydroxyketones or substances that yield these compounds on hydrolysis.



Monosaccharides: -

Monossaccharides (mono-means one) are simple sugars. They cannot be changed into simpler sugars upon hydrolysis (reaction with water).

Monossaccharides are called either aldoses or ketoses, depending upon whether they contain an aldehyde (R-CHO) or a ketone R1(CO)R2, group. Aldoses and ketoses are further classified according to the number of carbon atoms they contain e.g. pentose (five carbon atom) glucose (six carbon atoms).

Classification of Monosaccharides

No. of Carbon	Type of sugar	Aldoses	Ketoses
3	TRIOSES	Glyceraldehydes	Dihydroxyacetone
4	TETROSES	Erythrose	Erythrulose
5	PENTOSES	Ribose, Xylose	Ribulose, xylulose
6	HEXOSES	Glucose, Galactose	Fructose
7	HEPTOSES	Glucoheptose	Sedoheptulose

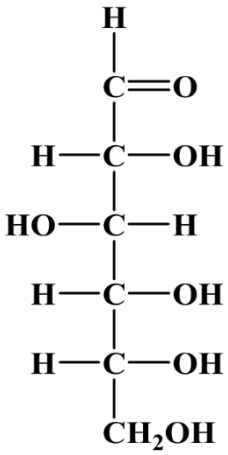
Optical activity:

Optical activity is the ability of a chiral molecule to rotate the plane of plane-polairsed light, measured using a polarimeter. When the atom attach with four different functional groups call chiral cnter. monosaccharides with different functional groups attached gives rise to optical activity. Monosaccharides are optically active, which means that if polarized light is passed through a solution of these compounds, the plane of light will be rotated to the left (levorotatory or l-form) or to the right (dextrorotatory or d-form).

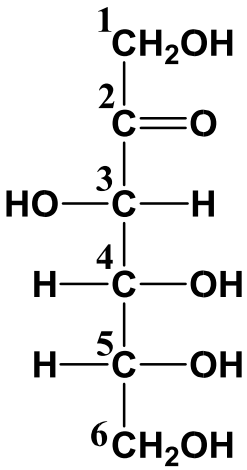
Monosaccharides of the d-form are nutritionally important because most naturally occurring monosaccharides are d-stereoisomers and metabolic and digestive enzymes are specific for them. The number of optical isomers depends upon the number of asymmetric carbon atoms present in a compound and may be calculated by using the formula 2^n , where n is the number of asymmetric carbons. e.g. glucose has four asymmetric carbons and so has $(2)^4$ or 16 optical isomers

Fischer projections of monosaccharides:

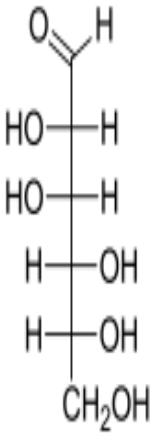
Glucose, galactose, and fructose are the most important monosaccharides. Fischer Projections of Monosaccharides Learning Goal Use Fischer projections to draw the D or L stereoisomers of glucose, galactose, and fructose



D-glucose



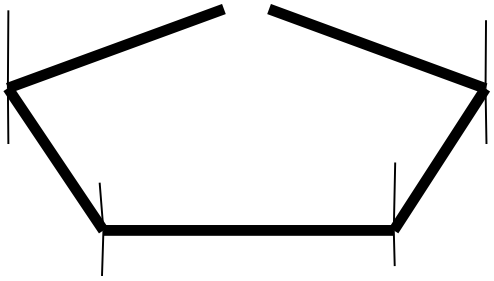
D-fructose



D-mannose

Haworth projective

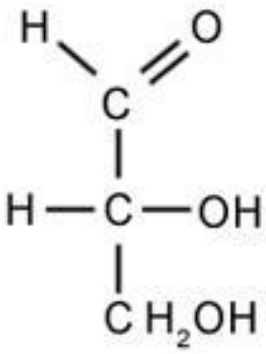
A Haworth projection is a common way of writing a structural formula to represent the cyclic structure of monosaccharides with a simple three-dimensional perspective. Organic chemistry and especially biochemistry are the areas of chemistry that use the Haworth projection the most.



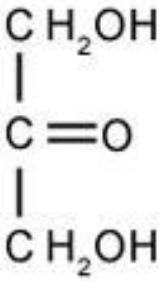
Are the major food supply and energy sources they occurs in grain , starch , vegetable and ligaments .

Definition Of CHO : They are depend as the aldehyde and keton derivatives of the polyhydric alcohol the ratio of H:O is the same ratio of water .

EX: The Simplest (CHO) are the following :



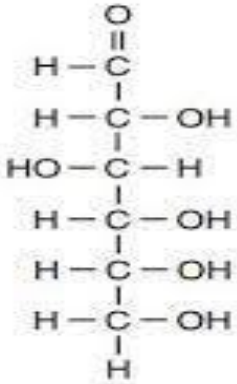
D-Glyceraldehyde



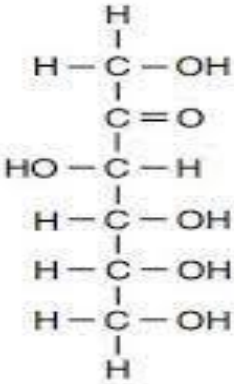
Dihydroxyacetone

Classification of (CHO) :- Simple Sugar

1. Monosaccharide :- Its having the following properties :
   a) Can not be hydrolyzed by any matter .
   b) Are called (Trioses , Tetroses , Pentoses , Hexoses) Depending on the number of carbon atom (3,4,5 …….Etc) .
   c) They called (aldoses or ketosis) depending to their oxidized functional group .



Glucose



Fructose

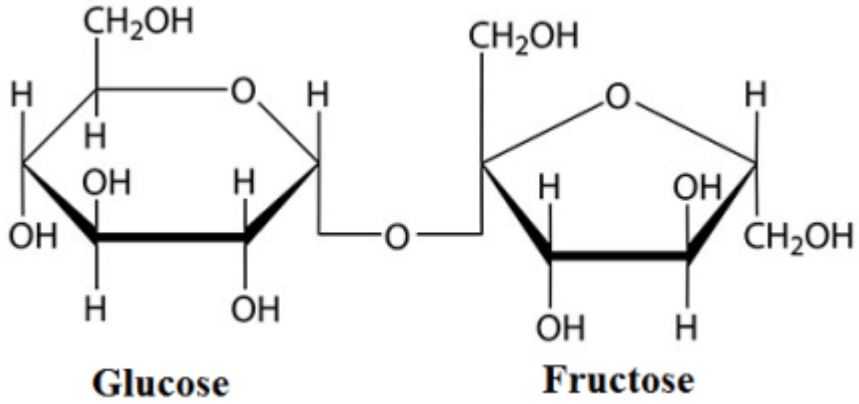
2. Disaccharide: A compounds of two monosaccharide molecules (either the same or different unit) Linked together by glycosidic bond .

Maltose → Glucose + Glucose .

Lactose → Glucose + Galactose .

Sucrose → Glucose + Fructose .

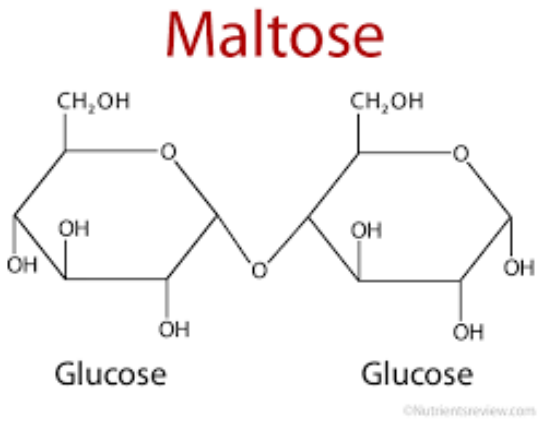
3. Oligosaccharide : It Contains up to (12) unit :
   a) Monosaccharide molecules linked together by O – glycosidic bond .
   b) The glycosidic bond in disaccharide linked between the aldehyde group of one monosaccharide with carbon atom (No.4) of the other monosaccharide (Lactose , Maltose) or the linkage between aldehyde group of the other monosaccharide to form disaccharide .



Sucrose

In this case there is no reducing properties because there is no free aldehyde or keton group

c) If the aldehyde or keton group of one monosaccharide is linked to the (OH) group of the other monosaccharide as the follow:

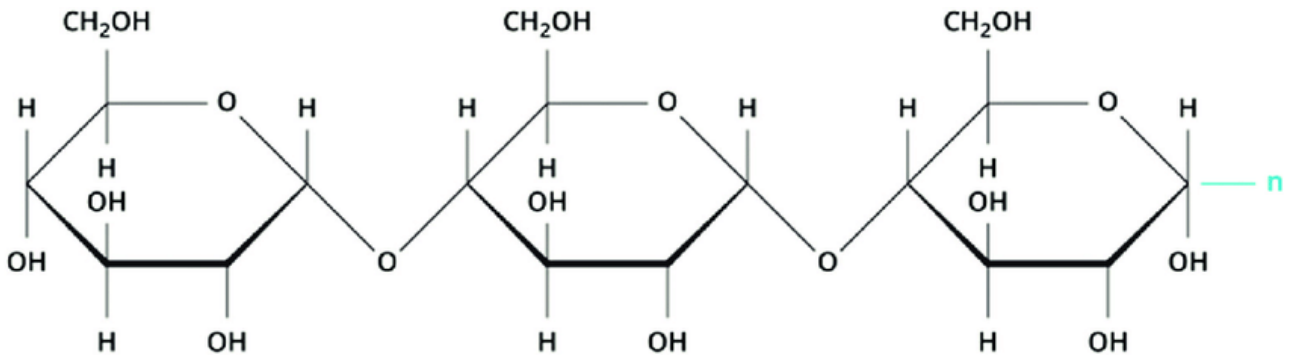


In this Case the disaccharide (Maltose) has a reducing properties because having free carbonyl group (Ald).

4. Polysaccharide: Many monosaccharide molecules are linked together to form polysaccharide molecule Ex. Starch, glycogen and cellulose , a molecule of polysaccharide may contain (25 – 2500) glucose unit linked together by (1 – 4) linkage or (1 – 6) linkage glycosidic bond or both of them like starch . Polysaccharide is homoploysaccharide or herteropolysaccharide , So that its polymers formed from monosaccharide D – Glucose is the most common monosaccharide found in nature , most of it stored as food for plant and animal , its less soluble in water .

Homopolysaccharide :

1. Starch: The storage form of glucose and the major source of (CHO) in the human diet it is a mixture of 20% of amylase and 80% of amylopectin .



Glycogen : The reverse of CHO in animals , it has similar structure as amylopectin but it is more highly branched and more compact .

Glycogen Is hydrolyzed to glucose as needed by the body during fasting or between .

Functions of CHO :

1. This primary energy source for nervous system and brain, each (gm) of CHO release 4Kcal. of energy .
2. Acts as structural components of cell wall and cell membrane .
3. Acts as metabolic intermediate . eig . glucose – 6 – phosphate (G6P) .
4. Are component of nucleotide that form DNA and RNA .

Sterio Isomers : (L and D) are used to identify one of two possible isomer they must have the same molecular formula but they differ in arrangement .

Isomers : Is the same formula but differ in arrangement in space .

Enantiomers : L. and D. is sterio isomers that are images of one another molecule that are capable of existing in enantiomers form are called Chiral molecules .

Asymmetric or chiral : Carbon atomes that have four different group bounded to it :

Ex:

H – C	H – C
= O	= O

H – C – OH		H – C – OH
HO – C – H	In Liver Epimer →	HO – C – H
HO– C – H		H – C – OH
H – C – OH		H – C – OH
CH2OH		CH2OH
Galactose		**Glucose**

Carbohydrate derivatives :

1. Phosphorylated Sugar : Carbohydrate may contains phosphate group , I.e glucose and fructose may be phosphorylated on carbon (1 & 6) or phosphate group may linked sugar to neucleotide (UDP – glucose) .
2. Amino sugar : Amino (group may be linked to sugar like glucose amino and galactose amine , antibiotics (erythromycin , Carbomycin contain amino sugar .
3. Sulphated Sugar : Sulphated group are often found on sugar like glycosamine glycans .

Proteins

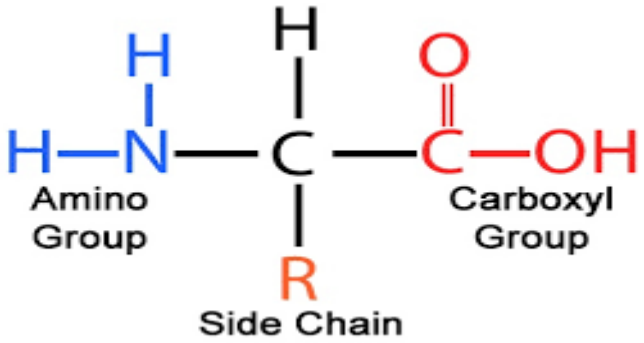
Proteins : it is organic compounds contained C,H,O and N may be contain Sulphur or iodine , The average nitrogen content is about 16% , its most important for life because its present in all living cells such as muscle , bone , blood , tissue , tendon , …..etc .

Proteins has high molecular weight and composed of high number of simple molecular named α – Amino acid which is linked together by peptide bond .

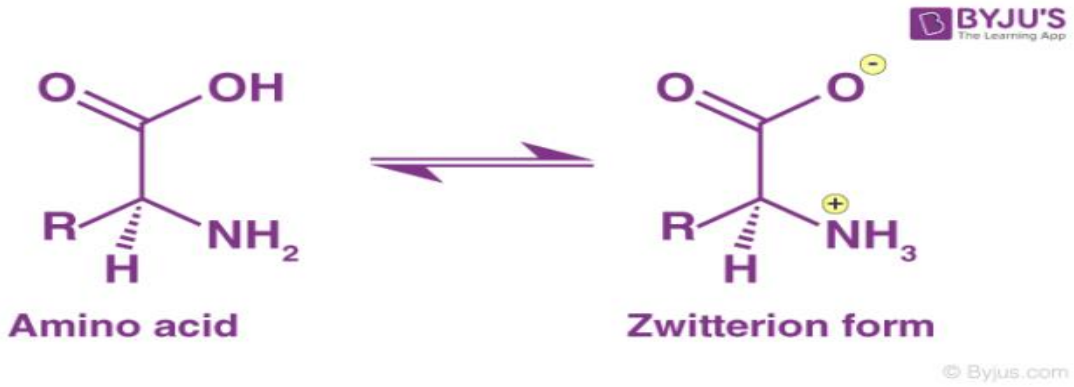
Proteins can be hydrolyzed by acids , alkaline and enzymes to form α – Amino acids .

α – Amino acid (α – a a) : its organic acid has (COOH) group which donate proton (Proton donating) and the (NH_2) which accept proton (Proton accepting) in the Alpha position .

CooH

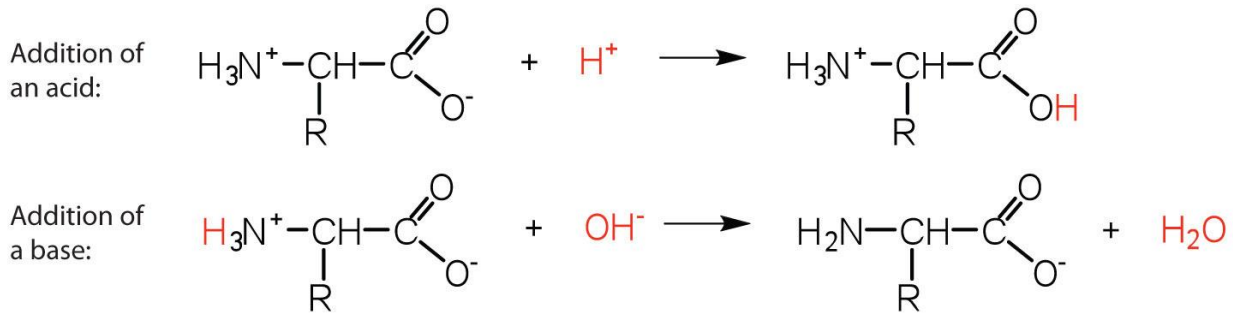


At (PH 7) the amino acids dissociated to form (Zwitter ion) as follows :



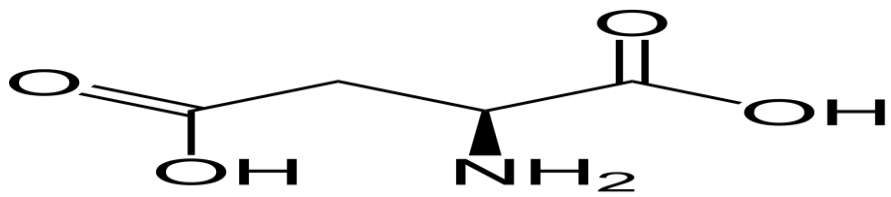
+

The zwitterion can react with acids or alkaline for this reactions prloteins in the body acts as buffer solution as follows :



If an amino acid contains more than one (COOH) group it is called acidic amino acid like

aspartic acid .

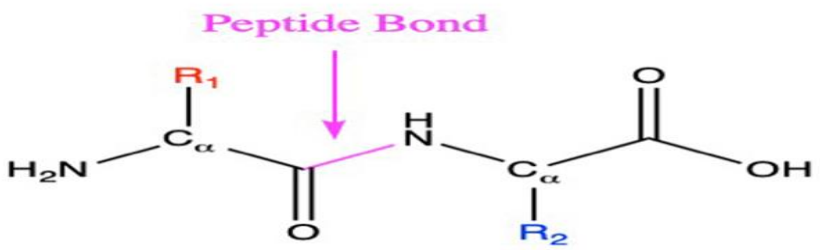


But If an amino acid contains more than one (NH_2) group it called acidic amino acid like

Arginine .

Amino acids can react with one another by peptide bond to form dipeptide , tripeptide , poly peptide .

Peptide Bond :- its covalent bond linkages amino group with carboxyl group .



Peptide bond has polar properties in structure .

1. Peptide bond has partial double bond character .

Dipeptide : Are two amino acid links together by peptide bond
Tripeptide : Are three amino acid linked together by peptide bond .

Residue : Residue main any amino acid with in poly peptide chain .

Essential a.a : Which cant by synthesized in body are required in diet .

Ex :- Isoleucin , Leucin , Valine , theronine , Methonine , Phenyl alanine , tryptophan , Argnine , Histidine .

Non – Essential Amino acid : They can be synthesized in human body .
Ex : Glutamine , Glutamate , praline , Aspargine , Alanine , Glycin , serine , tyrosin , cystine .

Complete Protein : Is the protein Contains essential and non essential (a.a) ex : like animal protein .
Incomplete Protein : Is the protein missing one or more of the Essential a.a (ex) Plant protein , Vegetable .

Classification of protein : Protein Can be classified in several ways :

1- Solubility :
   a) Water soluble (albumin) .
   b) Soluble in weak solvent (gelatin) .
   c) Soluble in strong salt such as histone .
   d) Soluble in acid or base such as gluteins .
   e) Insoluble in all solvents like Keratins , elastine .
2- Structure :
   a) Primary structure .
   b) Secondary structure .
   c) Tertiary Structure .
   d) Quaternary Structure .
3- Over all Shape :
   a) Fibrous Protein . (Myosin) .
   b) Globular Protein (Insulin) .

Functions :

1. enzyme biological catalysis that are vital to all living system such as amylase , ACP , ALP .

2. Structural protein or Mechanical Support like collagen .
3. Hormone protein such as insulin .
4. Protective protein like (Ig) defense protein .
5. Blood clotting factor .
6. Storage function such as ferritin .
7. Transport protein such as (Hb) .
8. Control genetic protein like activator receptor .
9. Coordinate motton like Action of myosin .

Digestion and absorption of Protein :

1. Protein is degradation start in the stomach under the action of the enzyme pepsin PH (3 – 4) .
2. In the small intestine (Jejunum , duodenum) pepsin is inactive at (PH 6.5) , bur protein digestions continue on the actions of the enzyme from pancreatic juice , trypsin , chemotrypsin and elastase all are named endopeptidase . Endopeptase means an enzyme that cleaves the interior peptide .
3. The carboxyl peptidase of the pancreas and the amino peptidase , that hydrolysis , the amino acid at the carboxyl and amino end of poly peptidase .
4. Some free amino acid are liberated by this digestion in the intestinal lumen others are di , and tripeptidase which hydrolyzed on the bursh border by the enzyme , lipopeptidase another protein of di and tripeptidase are activity absorbed and hydrolyzed with in the mucosal cells by cytoplasm peptidase to free (A.A) .

Amino Acid Pool

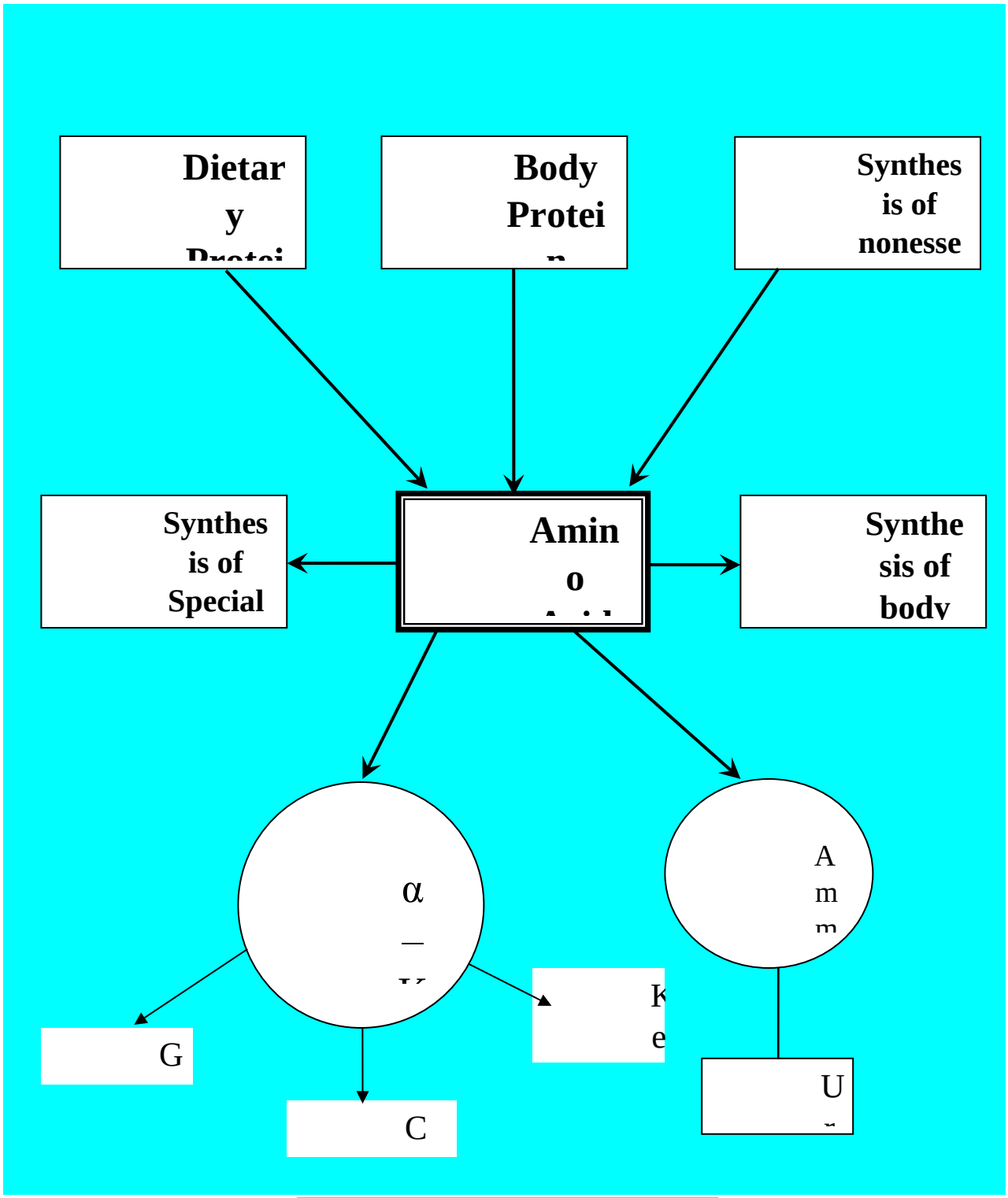
Free amino acid distributed in the body are about 100gm and they are called amino acid pool . about 50% is in the form of glutamate and glutamine .

Source of amino acid Pool :

1. Dietary proteins .
2. Hydrolysis of body proteins .
3. Synthesis of nonessential amino acid .

Fate of amino acid

1. Anabolic Pathway :
   a. Synthesis of protein , tissue proteins , enzyme , hormone etc .
   b. Synthesis of specialized product such as glycine , rnters in synthesis of creatine , Hem .
   c. Synthesis of small peptide like glutathione .
2. Catabolic pathway :
   a. Removed of amino acid group from amino acids by transamination and deamniation process .
   b. The Resulting products are , ammonia , urea , and α – Keto acids .
   c. The α – Keto acid further metabolized and completely oxidized in to Co2 , H2O or may be converted to glucose or fattey acid and Ketons



Fate of (A . A) Pool

Clinical significance of plasma Proteins :

A. Hypoprotenemia ↓ Serum total Protein < 6mg /100ml :-
   1. Nephrotic syndrome
   2. Salt retention syndrome .
   3. Sever burns , Extensive bleeding or open wonds .
   4. Starvation and malabsorption of (A.A) .
   5. Pregnancy .
   6. Treatment with estrogen .

B. Hyperprotenemia ↑ Serum total protein :-
   1. Multiple myloma .
   2. Dehydration .
   3. Treatment with some hormone (eig , anabolic steroid endrogen , corticostemod , GH , progesterone , insulin , thyroxin .
   4. Certain drug (eig , colfibrate , digtals) .

N.V of serum total protein
= 6.5 – 8.5 g/100ml serum .

Urinary protein : Glumeruli excluded protein has molecular mass greater than 100.000 Dalton , but allow the passage of protein lesser molecular mass down to 30.000 Dalton , How ever only . V. Small amount of protein is excreted in urine , Most are reabsorbed and broken down by the cell of tubules .

Clinical significance :
Nil → Healthy individual (12mg /100ml → 100mg / 100ml) / 24hrs .

Trace→Primary renal disease,fever, thyroid disorder , heart disease , cold .
(+)→Acute glumerular nephrited .
(++)→Chronic glumerular nephrites , Nephrotic syndrome .
(+++)→ Lipid nephroses , Nerphrosclrosis .