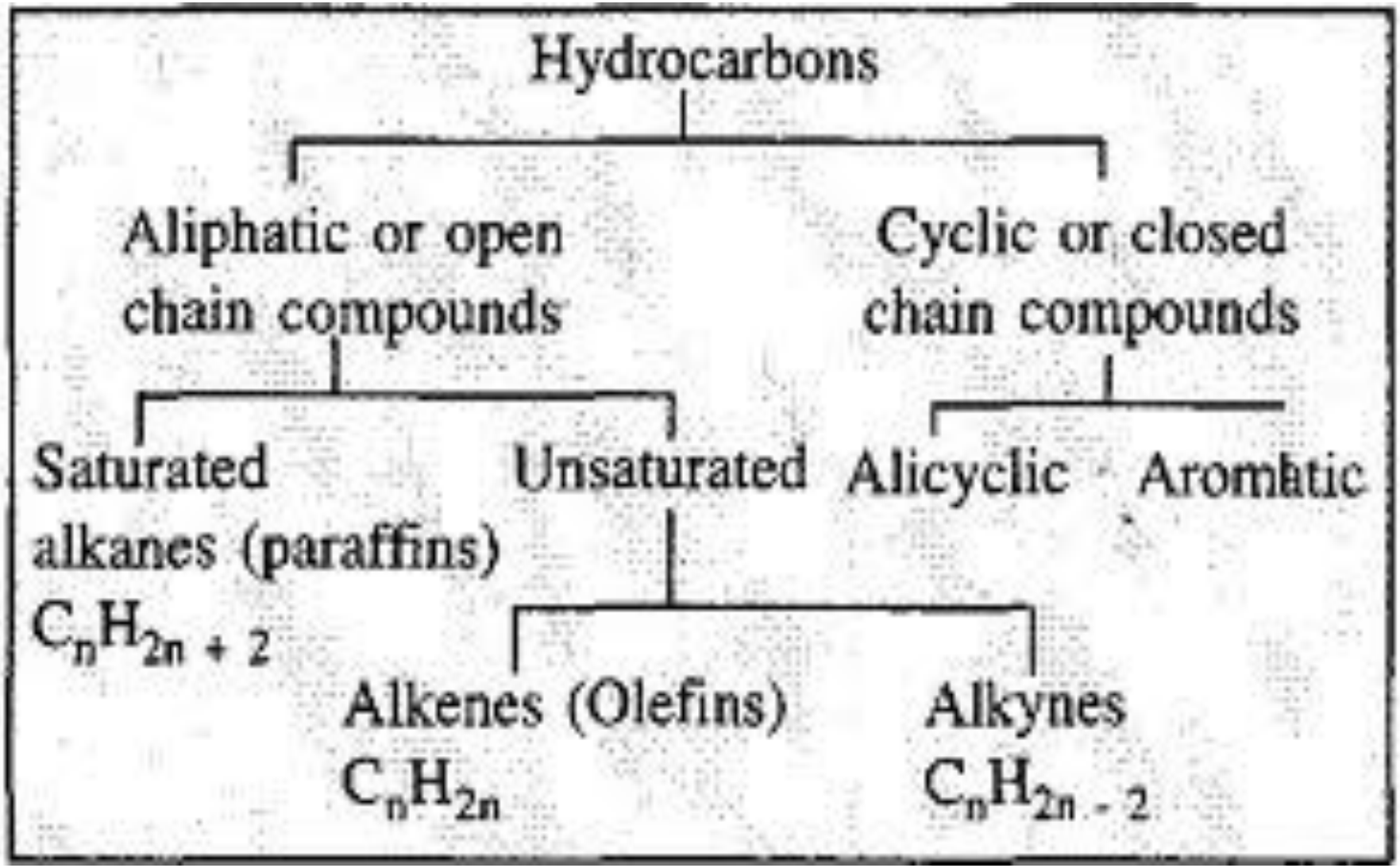
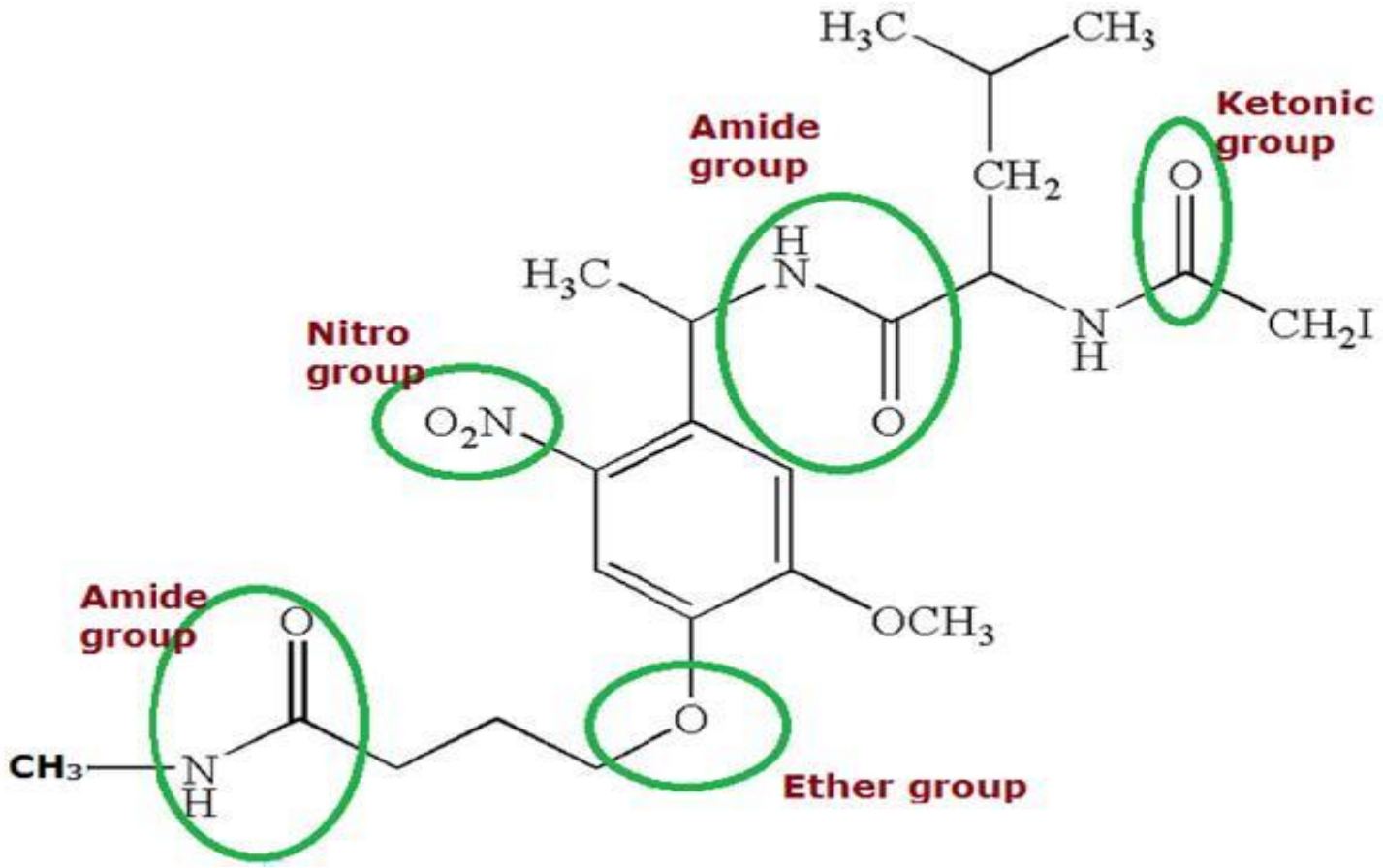
Organic Compounds

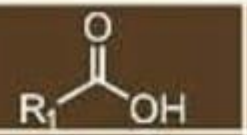
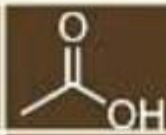
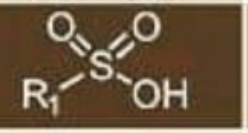
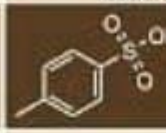
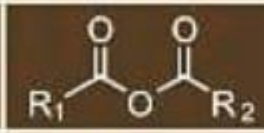
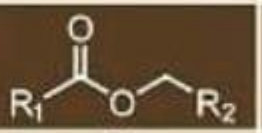
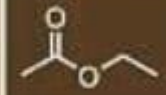
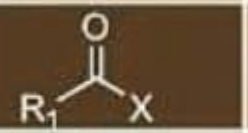
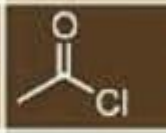
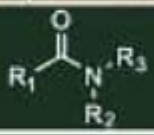
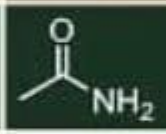
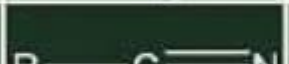
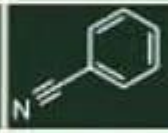
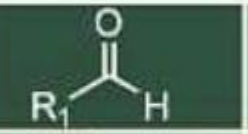
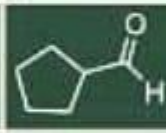
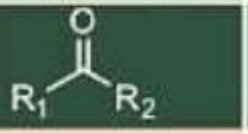
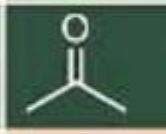
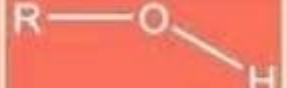
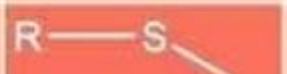
An **organic compound** is one that has carbon as the principal element

- Carbon is unique
  - It has 6 electrons in its outer shell arranges $1s^2 2s^2 sp^2$
  - Organic compounds have specific geometry around the carbon to carbon bond.
    - If there are four atoms or groups around a carbon atom, it has a **tetrahedral geometry**.


Hydrocarbons
Aliphatic or open chain compounds
Cyclic or closed chain compounds
Saturated alkanes (paraffins) C_nH_{2n+2}
Unsaturated
Alicyclic
Aromatic
Alkenes (Olefins) C_nH_{2n}
Alkynes C_nH_{2n-2}

- **Functional groups** are specific groups of atoms or bonds within molecules that are responsible for the characteristic chemical reactions of those molecules.



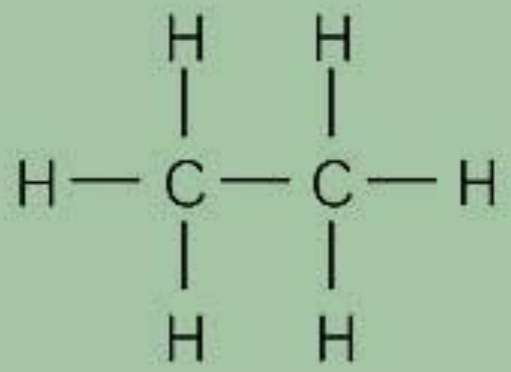
Name	Formula	Prefix	Suffix	Example	Notes
Carboxylic acid		*	-oic acid	 Ethanoic acid	Common are acetic acid (vinegar) and butyric acid (human vomit)
Sulphonic acid		*	- sulfonicic acid	 Tolene sulphonic acid	Used in batteries and dye production.
Anhydride		*	-anhydride	 Maleic anhydride	Used in production of polymers
Ester		*	R_1-...-R_2 oate	 Ethyl acetate	Often good smell and flavor
Acid halide		Haloformyl-	-R_1oyl halide	 Acetyl chloride	Usually lachrymatory
Amide		Amido-	-amide	 Ethan amide	Distinctive feature of proteins (hair, spider silk, enzymes)
Nitriles		Cyano-	-nitrile	 Benzo nitrile	Found in a lot of fruits and nuts, as well as application in medicine
Aldehyde		Oxo-	-al	 cyclo pentane carbaldehyde	Production of resins and plastics. Ingredients of flavours and parfumes.
Ketone		Oxo-	-one	 Propan-one	Solvents, precursor for polymers, pharmaceutics.
Alcohol		Hydroxy-	-ol	 Methanol	Favorite way to spend Friday evening.
Thiol		Mercapto-	-thiol	 Methane	Cysteine, many

Thiol		Mercapto-	-thiol	 Methane thiol	Cysteine, many cofactors
Amine		Amino-	-amine	 Methan amine	Amino acids, dyes, drugs
Alkene		•	•	Ethene	Plastic manufacture, fuel
Alkyne		•	•	Ethyne	Pharmaceuticals, some plants
Alkane		•	•	Ethane	Heating and cooking purposes
Ether		[group] oxy-	•	 Methoxy ethane	Solvents, anesthetics
Halide/ Pseudohalide	-X	Halo-	*	 Chloro ethane	Used in lamps, photography

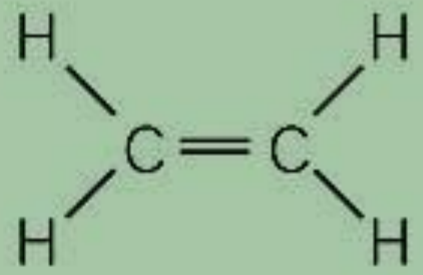
Hydrocarbons

- Introduction
  - A **hydrocarbon** is a compound consisting of only hydrogen and carbon.
  - The carbon to carbon can be single, double, or triple bonds.
  - The bonds are always nonpolar.
  - **Alkanes** are hydrocarbons with only single bonds.
- (a “family” of hydrocarbons)
- C_nH_{2n+2}

- Carbon-to-carbon bonds can be
- (A) single
-
- (B) double,
- (C) triple

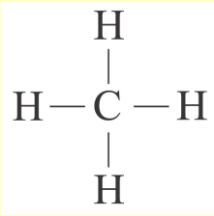
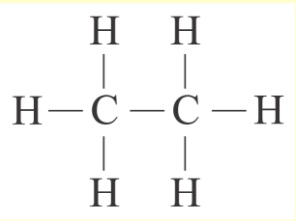
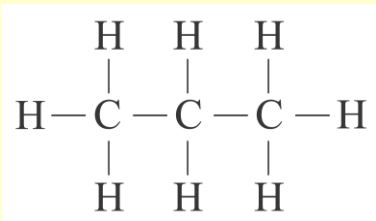
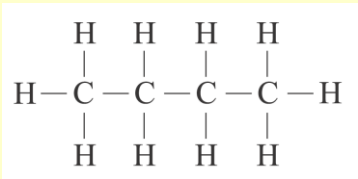


A Ethane



B Ethene

C Ethyne

Number of carbon atom(s)	IUPAC name	Molecular formula	Condensed structural formula	Structural formula
1	Methane	CH_4	CH_4	
2	Ethane	C_2H_6	CH_3CH_3	
3	Propane	C_3H_8	$CH_3CH_2CH_3$	
4	Butane	C_4H_{10}	$CH_3CH_2CH_2CH_3$	

The first four members of straight-chain alkanes

- IUPAC nomenclature

names of radicals (alkyl groups):

CH_3- "methyl" CH_3Cl methyl chloride

CH_3OH methyl alcohol, etc.

CH_3CH_2- "ethyl"

$CH_3CH_2CH_2$- "*n*-propyl"

CH_3CHCH_3 "isopropyl"

|

- Reactions of alkanes:
- alkane + H_2SO_4 → no reaction (NR)
- alkane + NaOH → NR
- alkane + Na → NR
- alkane + $KMnO_4$ → NR
- alkane + H_2,Ni → NR
- alkane + Br_2 → NR
- alkane + H_2O → NR
- (Alkanes are typically non-reactive. They don't react with acids, bases, active metals, oxidizing agents, reducing agents, halogens, etc.)

Reactions of alkanes :

1- Combustion : generally

C_nH_{2n+2} + excess O_2 → $nCO_2 + (n+1)H_2O$

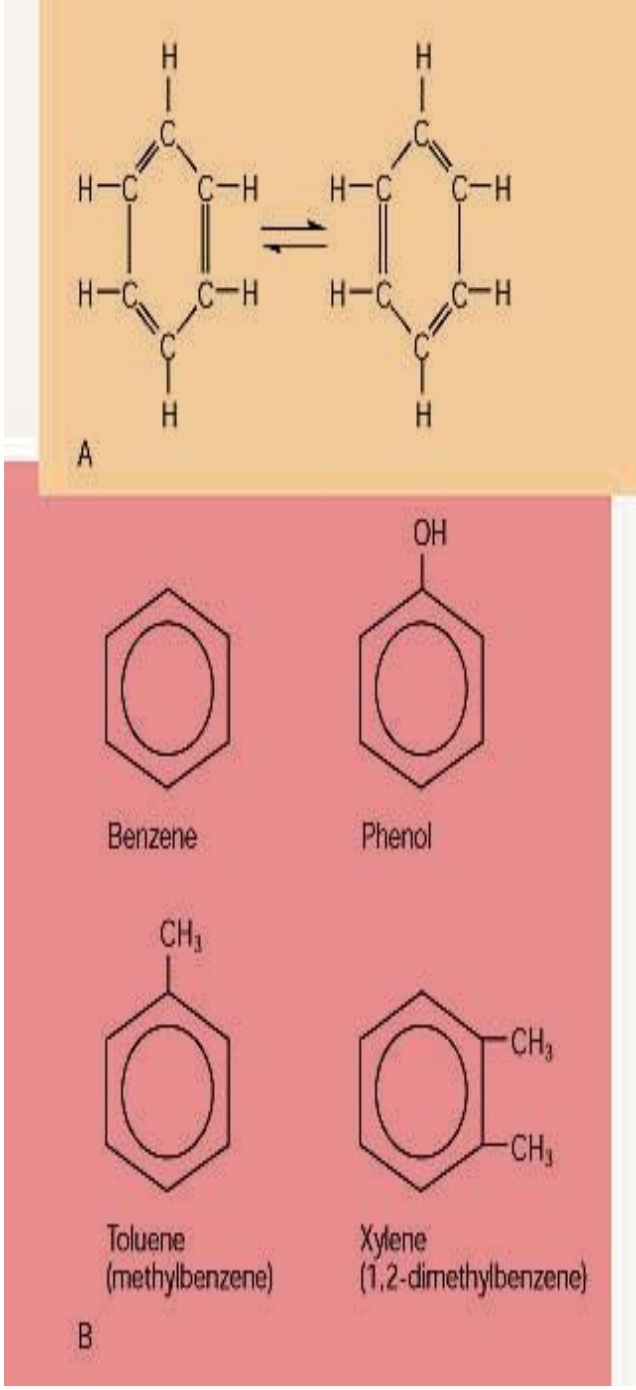
1-$C_5H_{12} + 8O_2$ → $5CO_2 + 6H_2O$

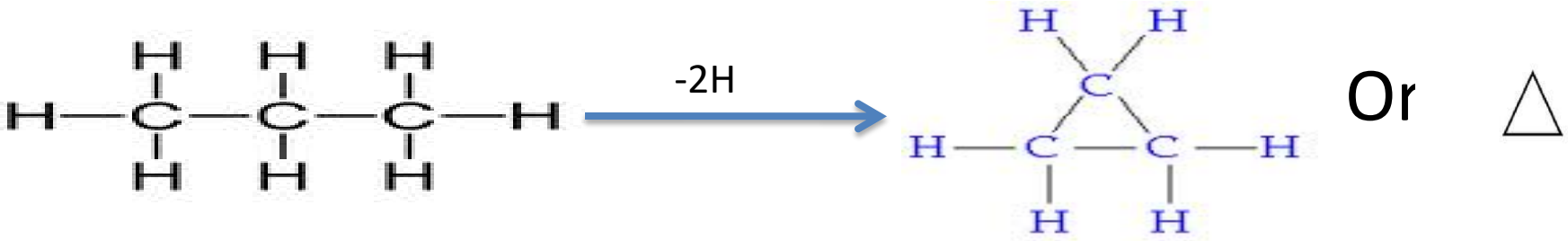
Q\Ethane+ O_2 → ? +?

- Cycloalkanes and Aromatic Hydrocarbons
  - **Cycloalkanes** are alkanes (only carbon to carbon single bonds) which form a ring structure.
  - An **aromatic compound** is one that is based on the benzene ring.
  - A **benzene ring** that is attached to another compound is given the name phenyl.

- (A)The bonds in C_6H_6 are something between single and double, which gives it different chemical properties than double-bonded hydrocarbons.

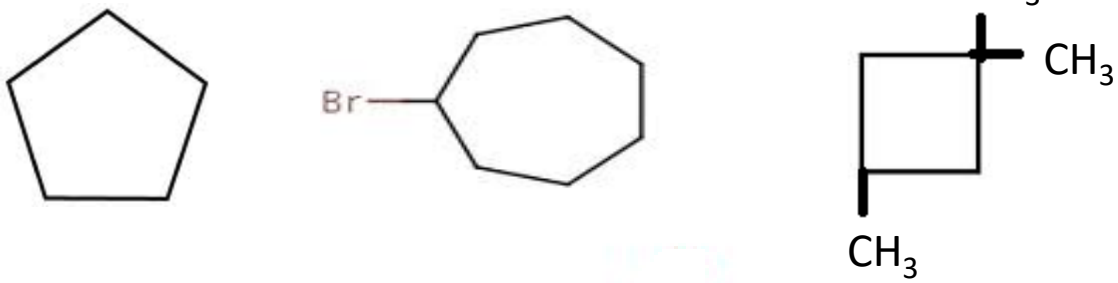
- (B) The six-sided symbol with a circle represents the benzene ring. Organic compounds based on the benzene ring are called aromatic hydrocarbons because of their aromatic character.

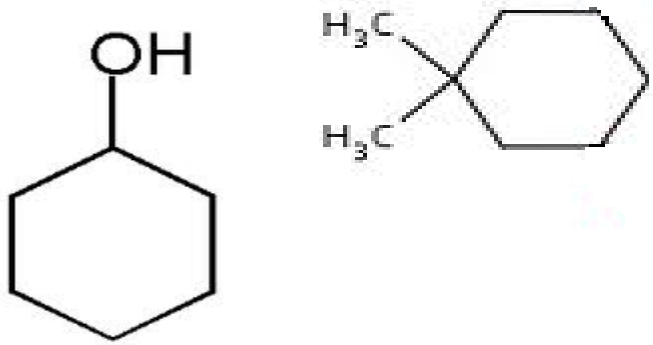




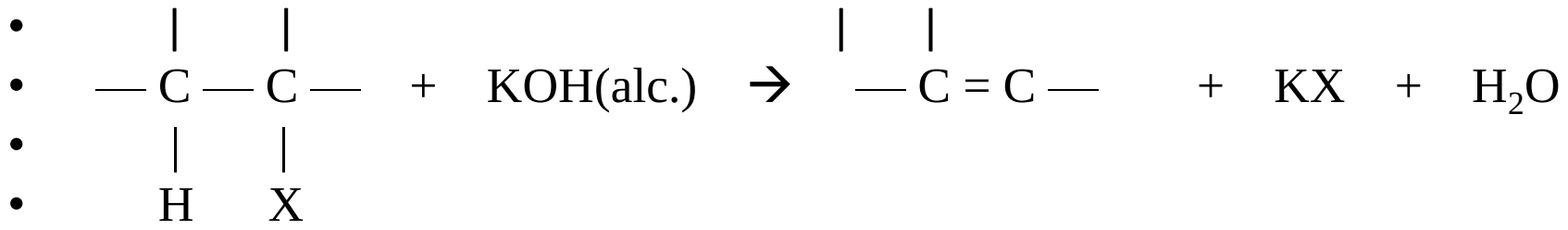
Nomenclature

Cyclo +alkane → cycloalkane

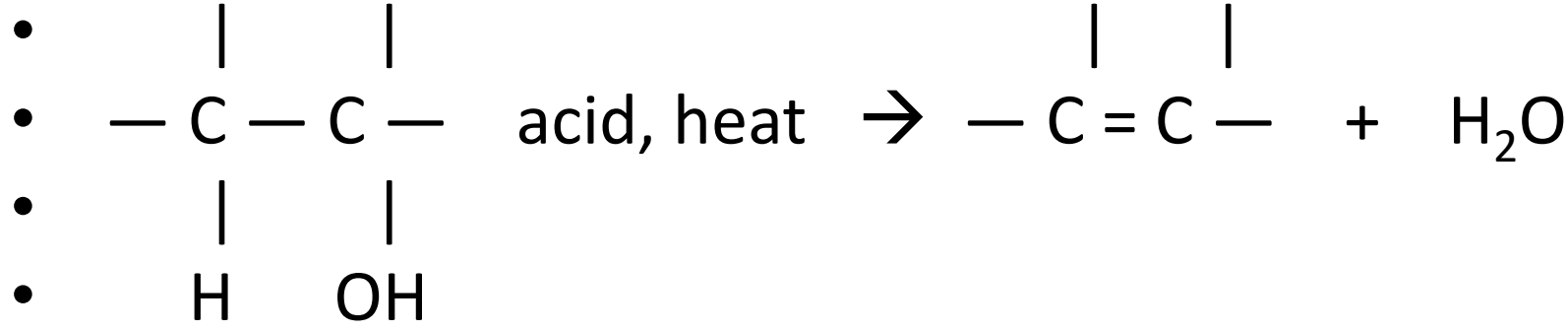




1. dehydrohalogenation of alkyl halides



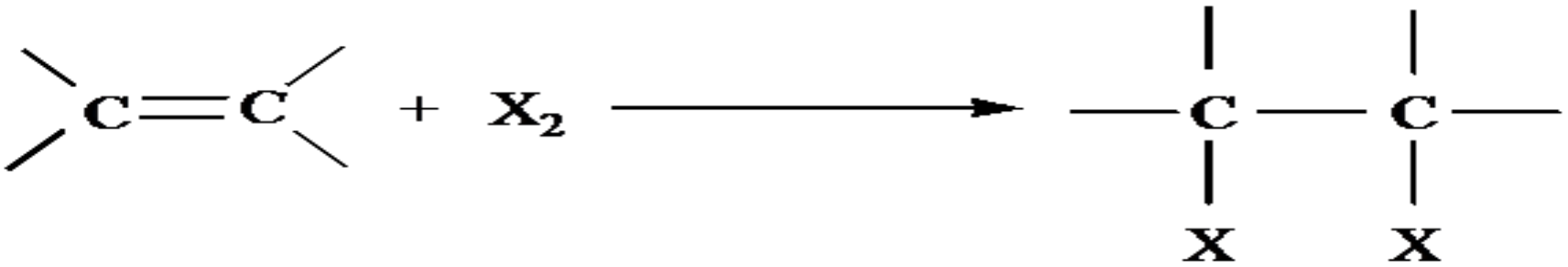
2. dehydration of alcohols:



Double bond reaction :

Involve addition reactions

1- Halogenation : i.e addition of $X_2 = Cl_2 , Br_2 , I_2$ as a general



Dienes

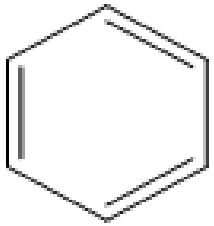
a diene or diolefin in oranic chemistry is a hydrocarbon that contains two carbon double bonds

Dienes can be divided into three classes, depending on the relative location of the double bonds:

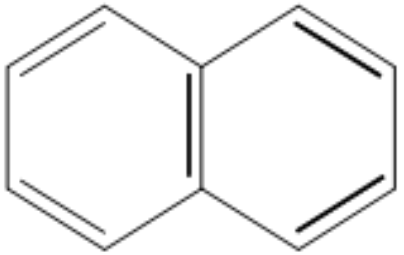
1.Cumulated dienes have the double bonds sharing a common atom as in a group of compounds called allenes (R-C=C=C-R)
2.Conjugated dienes have conjugated double bonds separated by one single bond (R-C=C-C=C-R).
3.Unconjugated dienes (isolated) have the double bonds separated by two or more single bonds. They are usually less stable than isomeric conjugated dienes. This can also be known as an isolated diene (R'-C=C-R-C=C-R')

Aromatic compounds :

Are benzene & compounds that resemble benzene in chemical behavior aromatic HCs characterized by a tendency to undergo ionic substitution reactions .



Benzene

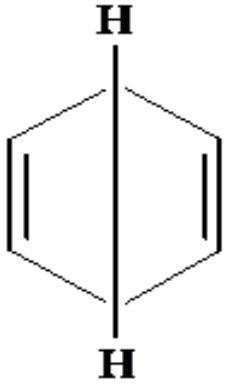


naphthalene

Resonance :

Molecules with alternating single and double bonds , gives the stability for benzene molecules for this reason it undergoes substitution reaction rather than addition reaction .

Kekule structure

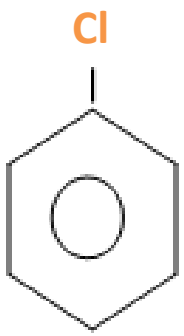


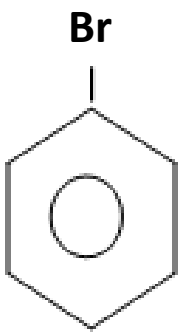
James dewar devised the dewar structure in 1867 .

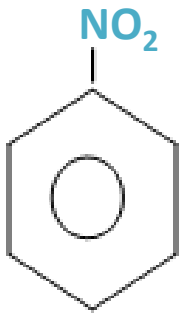
Dewar structure of benzene

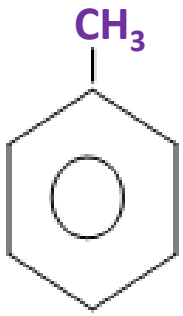
Nomenclature of benzene derivatives

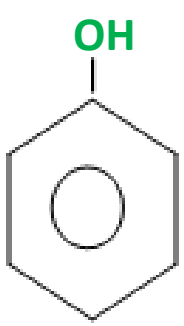
1- Mono substituted derivatives :

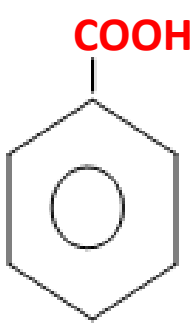


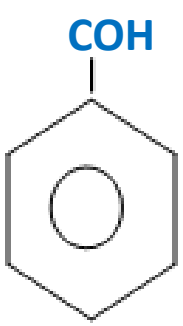


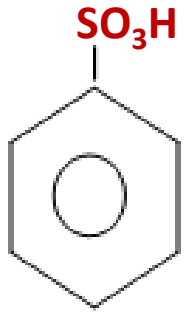










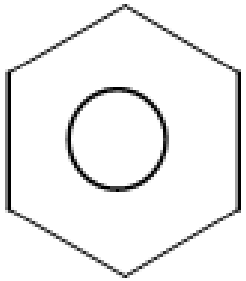


Q / Define resonance then write kekule & Dewar structure of benzene ?

Q/ Explain why benzene ring undergoes neucleophilic substitution reaction ?

Q /Draw chemical structure for the : Benzoic acid , Toluene , Benzaldehyde

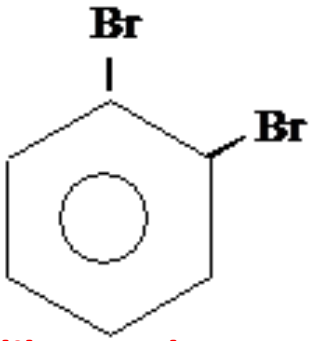
2- Disubstituted :



o← Ortho position

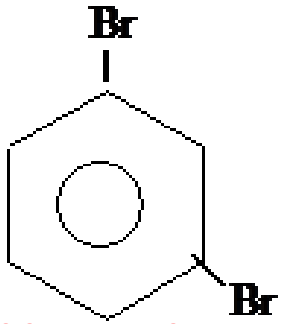
m←meta position

p← para position



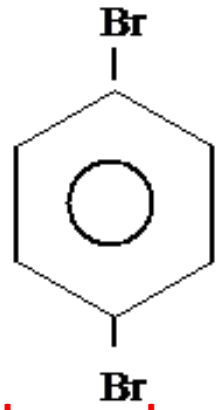
1,2- dibromo benzene

o- dibromo benzene



1,3- dibromo benzene

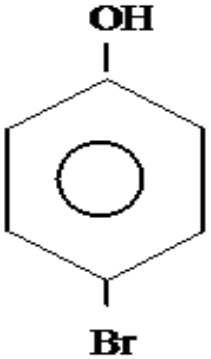
m- dibromo benzene



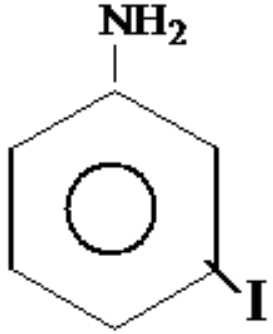
1,4- dibromo benzene

p- dibromo benzene

3 isomers different in position

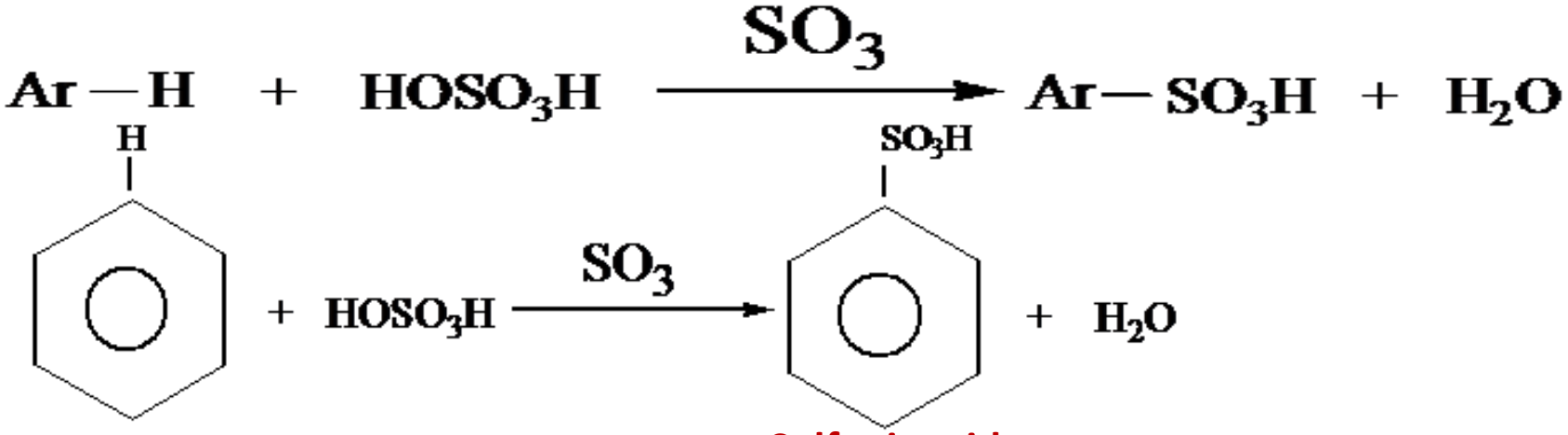


p- bromophenol



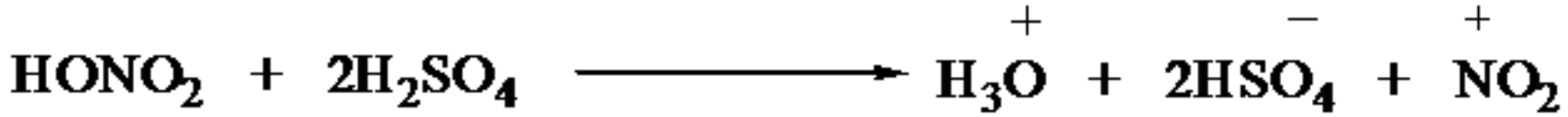
m- Iodoaniline

2- Sulfonation of benzene

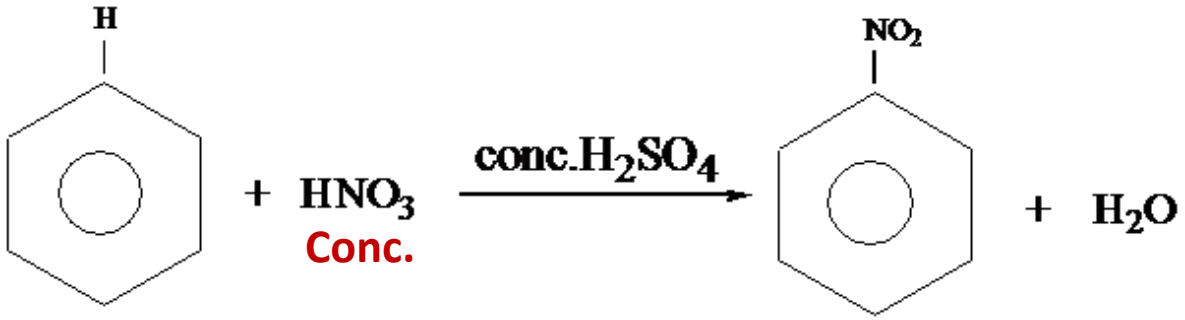


Sulfonic acid

3- Nitration :replacement of H^+ with NO_2^+



As a weak base — Strong acid — acid — base — Nitronium ion

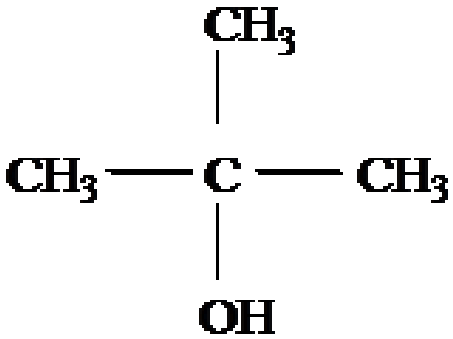


Nitro benzene

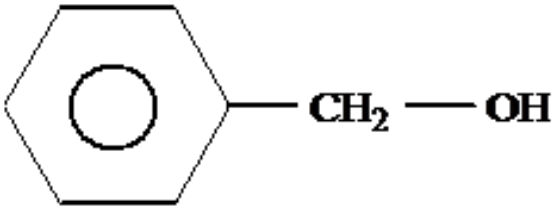
Alcohols

Are compounds of general formula ROH . The functional group is the hydroxyl (-OH) group .

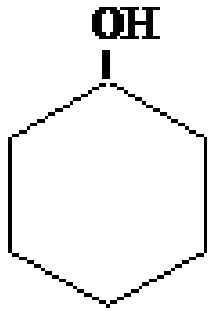
R, may be an alkyl or any substituted alkyl group like:



Tert. butyl alcohol (common name)
or 2- methyl -2-propanol (systemic name)



Benzyl alcohol



Cyclohexanol

As the compound aromatic ring attached to hydroxyl group we say that is phenol not alcohol such as :

Starch $\xrightarrow[\text{fermentation}]{\text{Yeast}}$ CH_3CH_2OH + Fusel oil or liquor

Fusel oil or liquor :is the mixture of ĭ alcohol such as 1- propanol , isobutyl alcohol (2- methyl -1-propanol) and active amyl alcohol (2-methyl-1-butanol)

Carboxylic acids

Organic compounds that show weak acidity , their functional group is carboxyl group attached to either alkyl (RCOOH) or aryl groups (ArCOOH)

Ex

HCOOH

Formic acid
Methanoic acid

$CH_3(CH_2)_{10}COOH$

Lauric acid
Dodecanoic acid

$CH_3(CH_2)_{16}COOH$

Stearic acid

$^{18}CH_3(CH_2)_7{}^{10}CH{=}{}^{9}CH(CH_2)_7COOH$

Oleic acid

$HO{}^{3}O{}^{2}C{}^{1}CH_2COOH$

Propane dioic acid

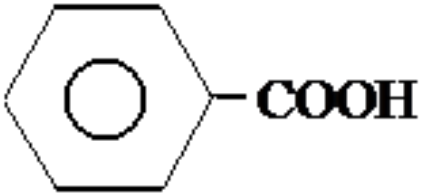
CH3CH2COOH

Propanoic acid

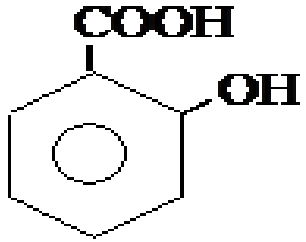
$CH_2{=}CHCOOH$

Acrylic acid

Propenoic acid



Benzoic acid



O-hydroxyl benzene

Carboxylic acid

Or o- hydroxyl benzoic acid

Preparation of carbocxylic acids by Oxidation of alcohol

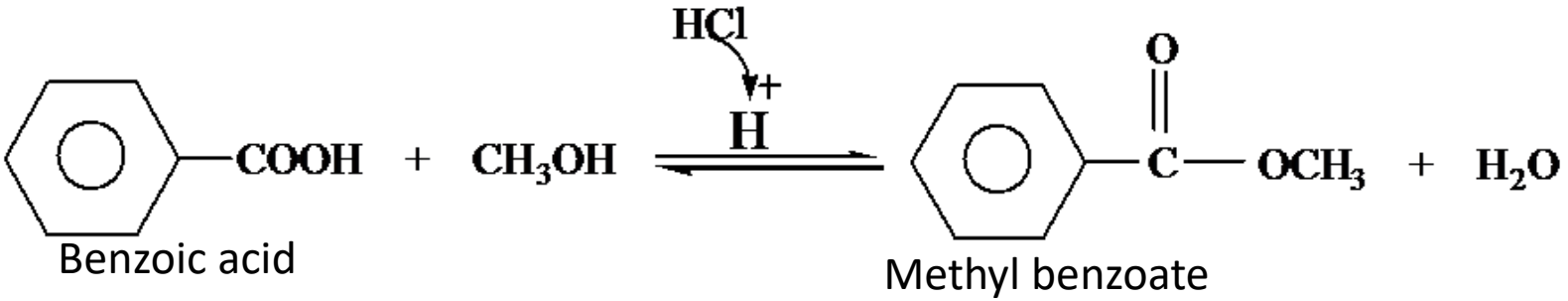
Reactions of carboxylic acids

1- conversion into esters

Reactivity of R`OH : 1° > 2° > 3°

more reactive — Less reactive

ex

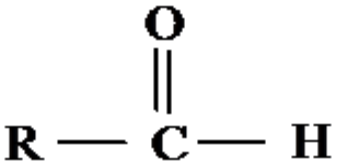


Benzoic acid

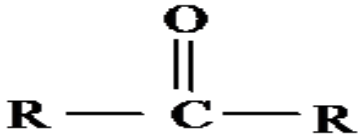
Methyl benzoate

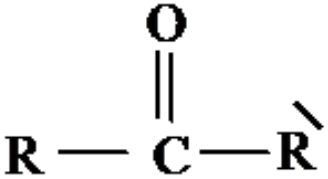
Aldehydes :

Are organic compounds of the general formula



↘carbonyl group is F.g with H

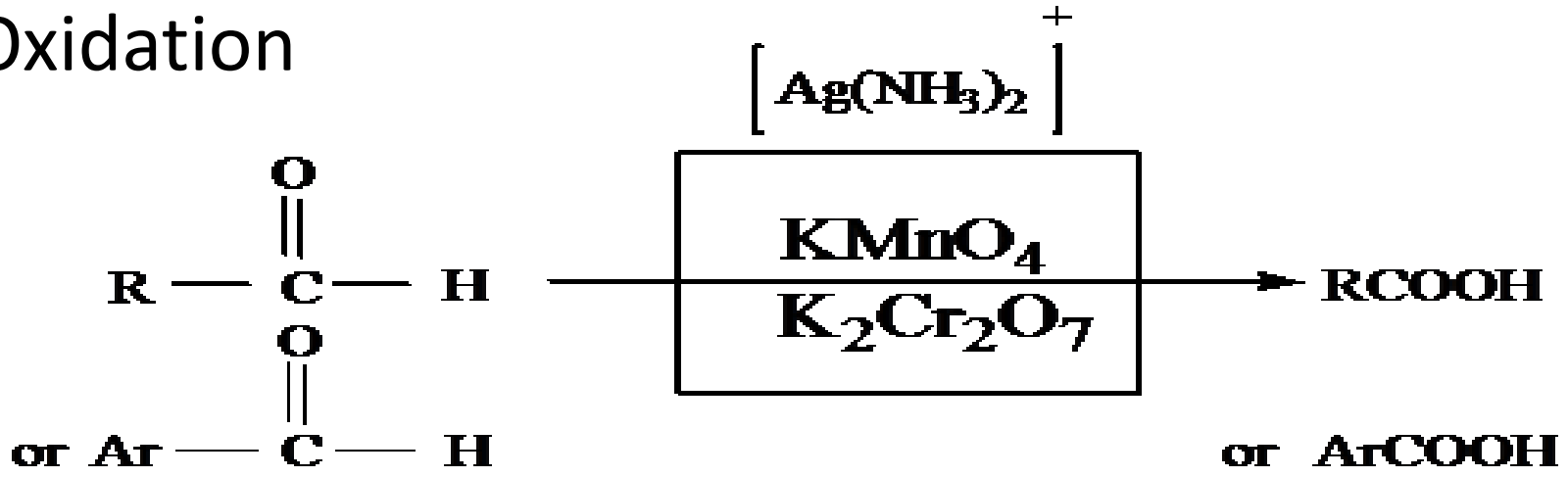
But ketones their general  or



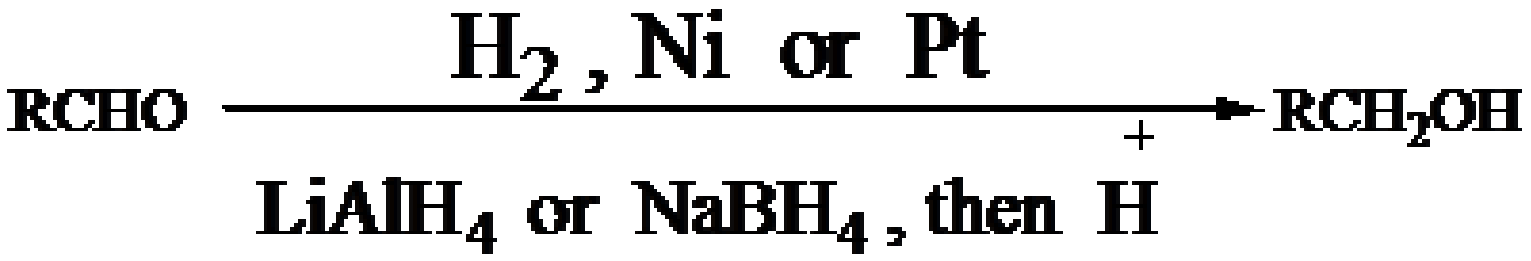
only carbonyl group is F.g

Reactions of aldehyde

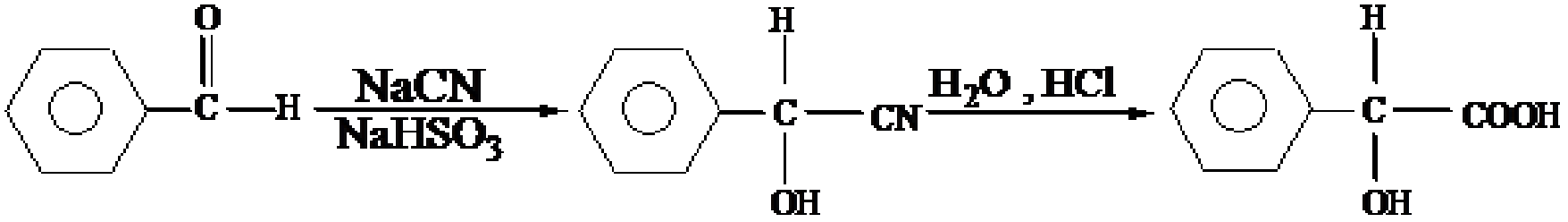
1- Oxidation



2- Reduction to alcohols



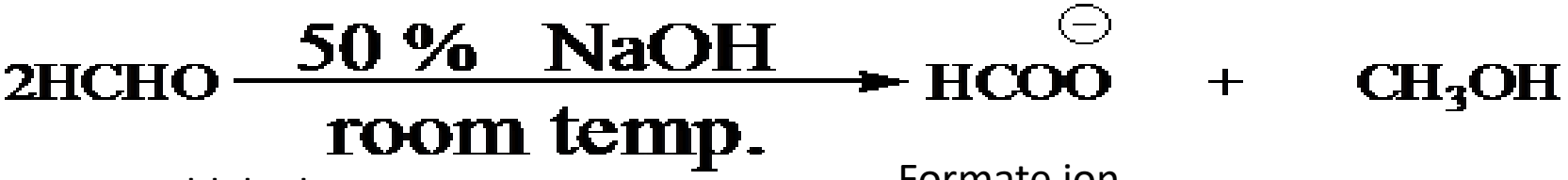
Ex



benzaldehyde

4- Cannizzaro reaction :

Mandelic acid



An aldehyde without α- hydrogen

Formate ion acid salt

Preparation of aldehyde

1- Oxidation of ĺ alcohols