CHAPTER #15

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Catenation

- self Linking ability of carbon

Importance:

- multiple bond formation
- make long chains, rings branches to diverse compounds
- kinetic stability of organic compounds

Energy $\propto \frac{1}{\text{stability}}$

Homologus Series

- Have same functional in which adjacent member differ by CH_2 unit

Importance: • own functional group
• own general formula
• similar chemical properties, change in physical properties

Alkyl group: • Removal of 'H' from any alkane

Represented by (R)

Example:

$CH_3-CH_2-CH_3 \xrightarrow{-H} CH_3-\underset{\text{isopropyl (common name)}}{CH}-CH_3$

$CH_3-\underset{\text{isobutane}}{CH}(CH_3)-CH_3 \xrightarrow{-H} CH_3-\underset{\text{Tertiary butyl}}{C}(CH_3)_2-$

Homologus series example
- Methanol CH_3OH M.F
- G.F → CH_3OH
- Methanoic M.F → CH_2O_2
- C.F → $HCOOH$

types

Hydrocarbon

carbon + hydrogen

Types

Saturated
- C-C single bond
- Each C is bonded to 4H
- sp^3 hybridization

e.g propane
- Hexane
- pentane

Unsaturated
- C-C double / triple bond
- Each carbon is not bonded 4 H
- sp^2 and sp hybridization
- propene,
- propyne

Terminologies
- prefix: Branch attached to longest chain
  - e.g Alkyl group, halo group
- Stem: No. of C-atoms in longest carbon chain
- suffix: It shows saturation and unsaturation in parent chain
- suffix of principal: family name

Bromo + Hept + ane + ol
↓ position, prefix, ↓ no. of C, ↓ saturation, ↓ primary suffix

- Alkane suffix ane
- Haloalkane prefix = halo
- Ether prefix = Alkoxy

Formula

Molecular Formula
- Actual whole no ratio

Example:
Ethanol: C_2H_6O
2:6:1

Empirical Formula
- simplest whole no ratio

Example
$C_6H_{12}O_6$
1.5 : 3 : 1.5
1 : 2 : 1
CH_2O

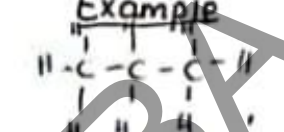
① Molecular Formula = n × empirical Formula

② $n = \frac{\text{molecular mass}}{\text{empirical Formula mass}}$

- Formula no. of moles = $\frac{\text{Given mass}}{\text{Molar mass}}$
- For percentage / = $\frac{\text{percentage}}{\text{molar mass}}$

Structural Formula
- Arrangement of atom in a molecule
- Type of functional group

Example

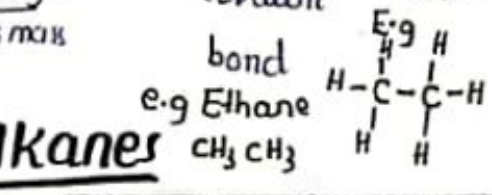


Condensed
- Relative position of atom in a molecule without showing the single covalent bond

e.g Ethane CH_3CH_3

2D
- Indicate all atoms and bonds among them in a molecule
- Dash is shown among atoms

E.g



Skeletal
- Complex and large organic molecule
- Each corner shows carbon atom

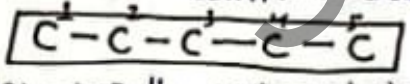
E.g Butane

Stereochemical
- Gives complete picture about all type of bonds in a molecule

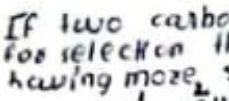
- H out of the plane
- (-) along the plane
- wedge line
- Inside the plane

Nomenclature of Alkanes

Alkane
- select the longest continous carbon chain

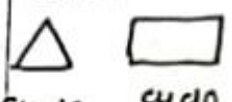


- Number the carbon chain from the end near the substituent
- Write the names and position of substituent
- Two identical substituents then write prefix di, tri, tetra etc
- If substituents are different then write their names in alphabetical order.
- If two or more identical substituents occur on same position then no. of carbon atom is repeated for each substituent
- If two carbon chain compete for selection then select c-chain having more substituent



2-methyl propane

Cycloalkane
- Prefix cyclo
- Branch name before parent name



cyclo propane, cyclo butane

Haloalkane
- H → replaced by halogen X
- Fluorine = fluoro
- Chlorine = chloro
- Bromine = Bromo
- $C_nH_{2n+1}X$

e.g CH_3-I
C.N = methyl iodide
IUPAC = 1-Iodomethane

Alkene / Alkyne

Alkene C_nH_{2n}

Alkyne = C_nH_{2n-2}

Bond suffix ene
Bond suffix yne

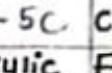
$CH_3CH=CH_2$ Prop 1-ene

Alcohol
- $C_nH_{2n+1}OH$
- 'e' is replaced by ol
- When OH group are more than one then we will retain 'e'

CH_3-CH_2-OH
C.N Ethyl alcohol
IUPAC ethanol

Aldehyde
- $C_nH_{2n+1}CHO$
- numbering starts from one, Terminal end
- Form : 1C
- Acet : 2C
- Propion : 3C
- Butyr : 4C
- Valer : 5C

Ketone
- $C_nH_{2n+1}CO$
- position 2 or mid
- suffix one drop 'e' and write 'one'



propanone

Ether / Amide
- $C-O-C$
- $C_nH_{2n+1}O C_mH_{2m+1}$
- Two carbon on both side of oxygen atom
- prefix alkoxy

$CH_3-CH_2-OCH_3$
methoxy ethane

Amine
- $C_nH_{2n+1}NH_2$
- R- replaced by Amine
- → Removal of alkane and add amine

Acid halide / Ester / Amide
- ic → oyl chloride
- $-C(=O)-OH \rightarrow -C(=O)-Cl$
- $-C(=O)-OH \rightarrow -C(=O)-NH_2$

etc is removed

Nitrile (cyanide)
- $C_nH_{2n+1}CN$
- $C\equiv N$ → cyanide
- 'e' is not omitted.

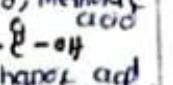
$CH_3-C\equiv N$
ethane nitrile

Carboxylic acid
- ic → oic acid
- → COOH terminal position

$H-C(=O)-OH$ Formic acid, methanoic acid

$CH_3-C(=O)-OH$ Ethanoic acid, Acetic Acid

Ester
- e → oate
- Alkyl carboxy group - oxy



methyl ethanoate

Isomerism

Same molecular formula but different structural formula

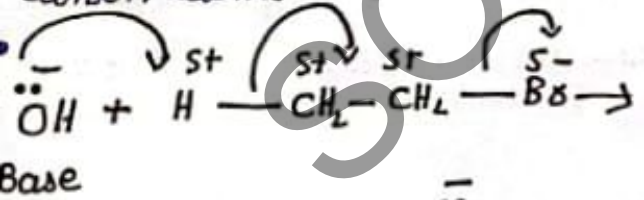
- No-of isomers increases with increase in number of carbon atoms.

Types

- **Structural isomerism**
  - same molecular Formula but different arrangement of atoms
  - Five types:
    - **Chain isomerism**
      - same molecular formula but different Carbon chain
      - $CH_3-CH_2-CH_2-CH_3$
      - Butane
    - **Positional isomerism**
      - Different position of functional group
      - $CH_3-CH_2-CH_2-OH$
      - Propan-1-ol
    - **Functional group isomerism**
      - Same molecular formula but different functional group
      - $CH_3-CH_2-CH_2-OH$
      - propan-1-ol
    - **Metamerism**
      - Different in distribution of carbon atoms on both sides
      - $CH_3-O-CH_2-CH_2-CH_3$
      - methoxy propane
    - **Tautomerism**
      - Two different form which are equilibrium with each other
      - shifting of proton
      - $CH_3-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-O-CH_3$ ⇌
      - Keto
      - $CH_3-\overset{OH}{\overset{|}{C}}=CH-\overset{O}{\overset{\|}{C}}-O-CH_3$
      - enol
- **stereoisomerism**
  - **Geometrical isomerism**
    - Same molecular and structural formula but different geometries
  - **optical isomerism**
    - shown by optically active compounds.
    - optically active compounds exist in two forms.

Elimination reaction

- Involve removal of atoms or group of atom in the form of molecule from two consecutive carbon atoms.



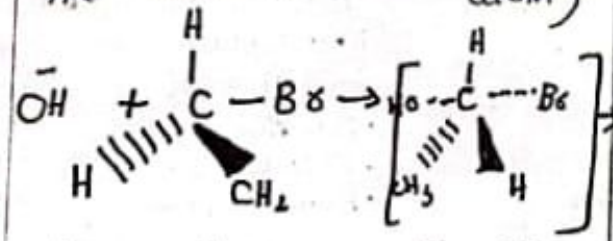
Base

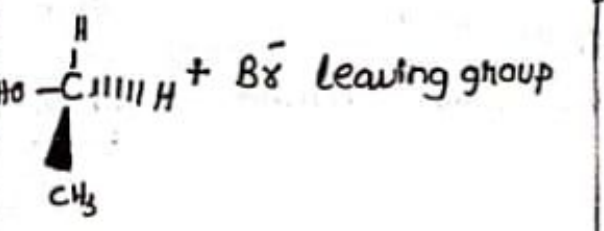
$CH_2=CH_2 + H_2O + Br^-$

consider bromoethane molecule having partial positive acidic hydrogen and partial negative bromine atom. A base (OH-) attack acidic hydrogen making water. The bromine atom, due to its higher electronegativity take away the bonding e- of c and leave molecule as bromide ion.

Nucleophilic substitution reactions

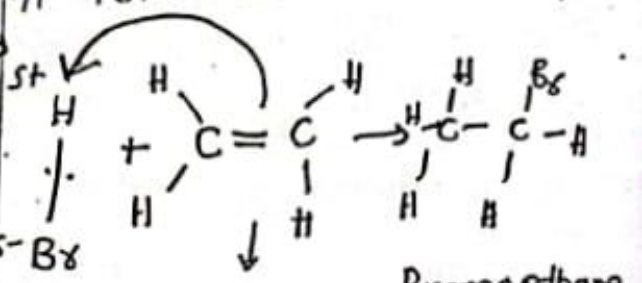
- A nucleophile attacks on the electrophilic carbon of halogenoalkane substituting the leaving group (halogen atom)





Electrophilic Addition reactions

- Involve attack of electrophile on multiple bond (Pi-π bond) and converts it to single covalent bond
- H ions act as electrophile



hydrogen bromide

Ethane

Bromoethane