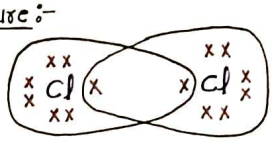
CARBON AND ITS COMPOUNDS

Covalent Compounds :- A compound formed by sharing of electrons between two atoms.

Formation of Cl_2 :-

Cl (17) = 2, 8, 7
↓ valence shell

e⁻ dot structure :-



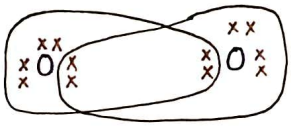
2, 8, 8. —

Cl — Cl
↓
single covalent Bond

Formation of O_2 :-

O (8) = 2, 6 To attain stability O needs 8e⁻ in last/Valence shell. Complete Octet

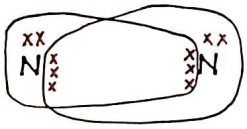
e⁻ dot structure :-



O = O
↓
Double covalent Bond

Formation of N_2 :-

N (7) = 2, 5 e⁻ dot structure



N ≡ N
↓
Triple covalent Bond

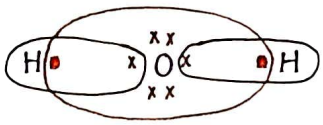
✡ Covalent Compound is formed between a non-metal + non-metal.
(C, S, N, O, H, Cl, F, Br)

Example :- H_2, O_2, N_2, Cl_2

H_2O (water), NH_3 (Ammonia), CH_4 (methane)

Formation of H_2O (water) :-

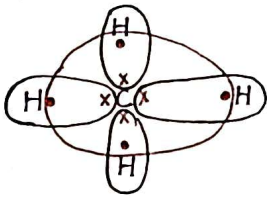
O (8) = 2, 6 +2
H (1) = 1 +1

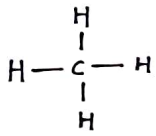


H — O — H

Formation of CH_4 (Methane) :-

C (6) = 2, 4 +4
H (1) = 1 +1



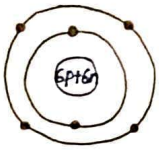


Carbon :- (C)

- Atomic No = 6
- C (6) = 2, 4 To attain Noble gas configuration. (octet 8e⁻)

Carbon has to
- lose $4e^-$ → C^{4+} (Requires lot of energy as 6 protons in nucleus will pull e⁻ strongly)
- Gain $4e^-$ → C^{4-} (difficult to hold 10e⁻ with 6 protons in nucleus.)

✡ So Carbon shares $4e^-$ and always form covalent Bonds and covalent compound.

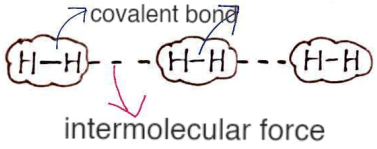


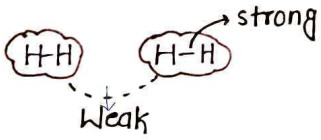
Properties of Covalent Compounds :-

(1) Generally Poor conductor of electricity
- Because electron are shared between atoms and no charged particles are formed.
- Absence of ions.

(2) Generally low melting and Boiling points.
- Because they have weak intermolecular forces.

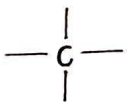
Note :- Covalent Bond is strong • intermolecular forces are weak.





Nomenclature - IUPAC :-

(1) C = 4 Valency
6 = 2, 4



Learn

	✡ (learn)
1C → Meth	6C → Hex
2C → Eth	7C → Hept
3C → Prop	8C → Oct
4C → But	9C → Non
5C → Pent	10C → Dec

(2) Carbon ke sath kuch laga hai to theek. varna H laga ke valency khatam karo. 'C' or 'H' bhai bhai.

Alkanes — Carbon Carbon single bond – ane

CH_4 ⟶ Methane

H_3C-CH_3 ⟶ Ethane

$H_3C-CH_2-CH_3$ ⟶ propane

$H_3C-H_2C-H_2C-CH_3$ ⟶ Butane

$H_3C-H_2C-H_2C-H_2C-CH_3$ ⟶ Pentane

Homologous Series(HS)

1	2	3	4	5
CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}

formula - C_nH_{2n+2}

Carbon Carbon double bond = ene

$H_2C=CH_2$ Ethene

$H_3C-HC=CH_2$ Propene

$H_3C-H_2C-HC=CH_2$ Butene

~~Methene~~

Homologous series (HS) :- C_2H_4 → C_3H_6 → C_4H_8 → C_5H_{10} (+CH_2 each step)

formula :- C_nH_{2n}

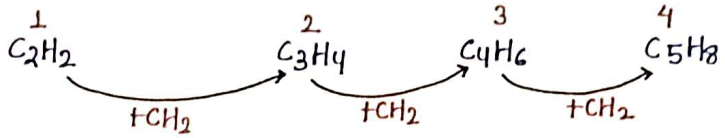
carbon Carbon triple Bond ≡ yne

$HC \equiv CH$ Ethyne

$H_3C-C \equiv CH$ Propyne

$H_3C-H_2C-C \equiv CH$ Butyne

Homologous series :- (HS)



formula :- C_nH_{2n-2}

Functional Groups :- Gives chemical properties to a compound.

(1) Cl (chloro), Br (Bromo) 'Prefix' {pehle lagao}

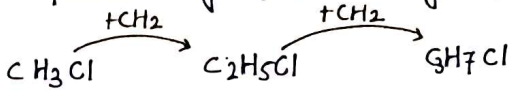
H_3C-Cl chloromethane

H_3C-H_2C-Cl chloroethane

$C-C-C-Cl$ chloropropane

Homologous series :- (HS) same functional group increasing CH_2.

formula :- X



(2) $-OH \rightarrow$ Alcohol 'ol' suffix { Baad में lagao}

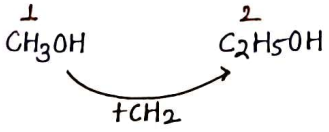
H_3C-OH Methan ol Methanol

H_3C-H_2C-OH Ethan ol Ethanol (C_2H_5OH)

$C-C-C-OH$ Propan ol propanol

Homologous series (HS) :- same functional group increasing CH_2.

formula :- X



(3) $-CHO$ or $-\overset{O}{\overset{\|}{C}}-H$ Aldehyde 'al' suffix

$H-\overset{O}{\overset{\|}{C}}-H$ Methan al Methanal

$C-CHO$

$H_3C-\overset{O}{\overset{\|}{C}}-H$ Ethan al Ethanal

$C-C-CHO$

$H_3C-H_2C-\overset{O}{\overset{\|}{C}}-H$ propan al Propanal

Homologous series (HS) :- same functional group increasing CH_2

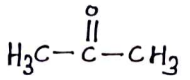
formula :- $C_nH_{2n}O$ CH_2O C_2H_4O C_3H_6O

(4) $-\overset{O}{\overset{\|}{C}}-$ ketone 'one' suffix

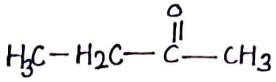
Dono Taraf carbon chahiye

✡ ye hamesha beech me hoga

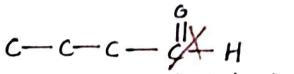
At least 3C chahiye



propanone



Butanone

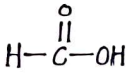


Aldehyde

Homologous series (HS) :- same functional group increasing CH_2.

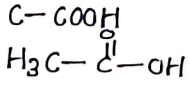
formula:- $C_nH_{2n}O$. $\overset{1}{C_3H_6O}$ $\overset{2}{C_4H_8O}$ $\overset{3}{C_5H_{10}O}$

(5) $-\overset{O}{\overset{\|}{C}}-OH$ or $-COOH$ Carboxylic acid 'oic' suffix



Methanoic acid

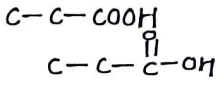
Methanoic acid



(CH_3COOH)

ethanoic acid

ethanoic acid



formula:- X

✡✡

Name	IUPAC	structure	Formula
Alkane	ane	C – C	C_nH_{2n+2} → CH_4, C_2H_6
Alkene	ene	C = C	C_nH_{2n} → 1st member 2C
Alkyne	yne	C ≡ C	C_nH_{2n-2}
chloro, Bromo	pehle chloro, Bromo	C – Cl	X
Alcohol	ol	C – OH	X
Aldehyde	al	side me $-\overset{O}{\overset{\|}{C}}-H$	$C_nH_{2n}O$ → 
Ketone	one	Beech me $-\overset{O}{\overset{\|}{C}}-$	$C_nH_{2n}O$ → 1st member 3C
Carboxylic acid	oic acid	$-\overset{O}{\overset{\|}{C}}-OH$	X

Homologous series :- A series of compound with same functional group, same General formula and similar chemical properties where each consecutive member differs by $-CH_2$.

Example

Alkane = C_nH_{2n+2}

Alkene = C_nH_{2n}

CH_4 —(14amu)→ C_2H_6 —(14amu)→ C_3H_8

C_2H_4 C_3H_6

C = 12 amu
H = 1 amu
O = 16 amu
N = 14 amu

(1) Molecular mass increase moving up homologous series.

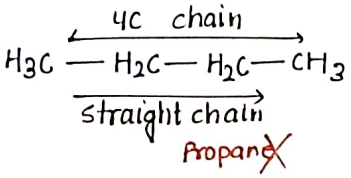
CH_4 —(+CH_2)→ C_2H_6 14 amu

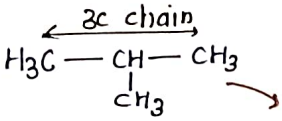
(2) Melting and boiling point increase up the series.
Reason:- They increase with molecular mass Gradation in other physical properties like solubility

(3) chemical properties are same for a homologous series.
Reason- chemical properties are same because of functional group which remains same in HS.

Isomers :- Compounds with same molecular formula but different structure and this phenomenon is called isomerism.

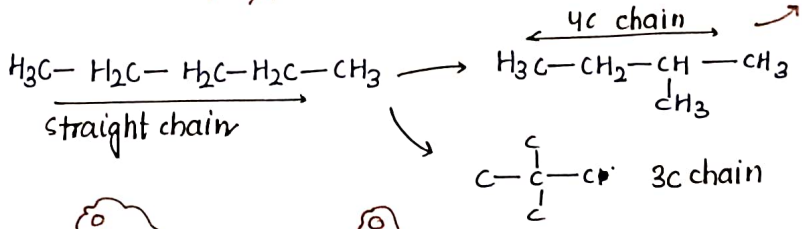
(1) Butane (4C)
C_4H_{10}



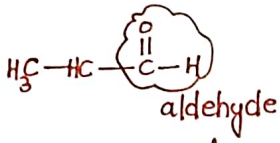


Branched chain

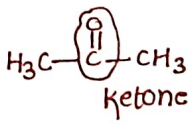
(2) Pentane (5C)
C_5H_{12}



C_3H_6O



propanal



propanone

Saturated Compounds

✓ which has carbon-carbon single bonds only

C–C C–C–C

C_nH_{2n+2}

✓ stable

Unsaturated Compounds

✓ which has Carbon-Carbon Double or triple Bond.

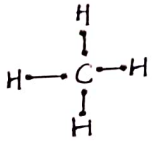
C=C C≡C

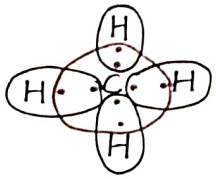
C_nH_{2n} C_nH_{2n-2}

✓ Reactive unstable.

Electron Dot structure

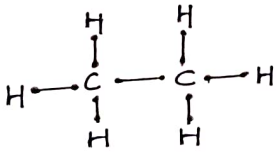
(1) Methane (CH_4)

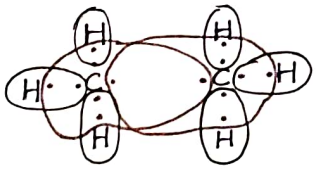




(2) Ethane (C_2H_6)

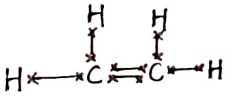
C – C

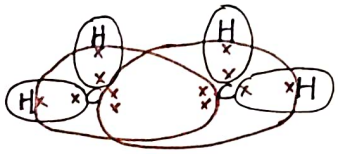




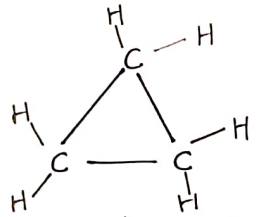
(3) Ethene (C_2H_4)

$H_2C = CH_2$

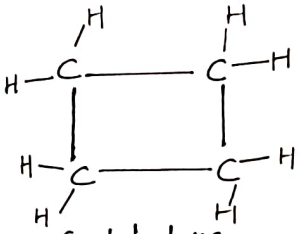




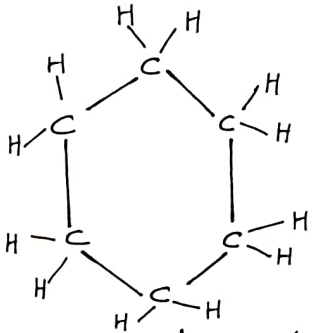
Ring of Carbon



Cyclopropane



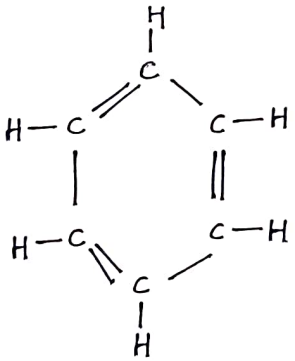
Cyclobutane



Cyclohexane (C_6H_{12})

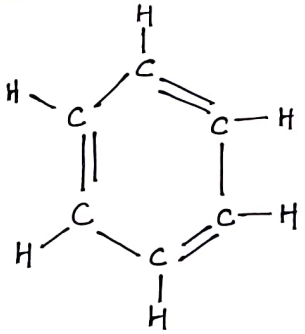
✡ saturated compound

Benzene



Benzene (C_6H_6)

or



✡ Unsaturated compound

Reactions

PAR USSEY PEHLE
YE DO COMPOUND YAAD KARO

ETHANOL

CH_3-CH_2-OH

ETHANOIC ACID

CH_3-COOH or $H_3C-\overset{O}{\overset{\|}{C}}-OH$

ETHANOL CH_3-CH_2-OH ke Reactions

(1) $2CH_3-CH_2-\underset{\text{Acid}}{\underset{|}{O}H} + 2Na \longrightarrow \underset{\text{sodium ethoxide}}{2CH_3-CH_2-ONa} + H_2 \uparrow$ Burns with popsound

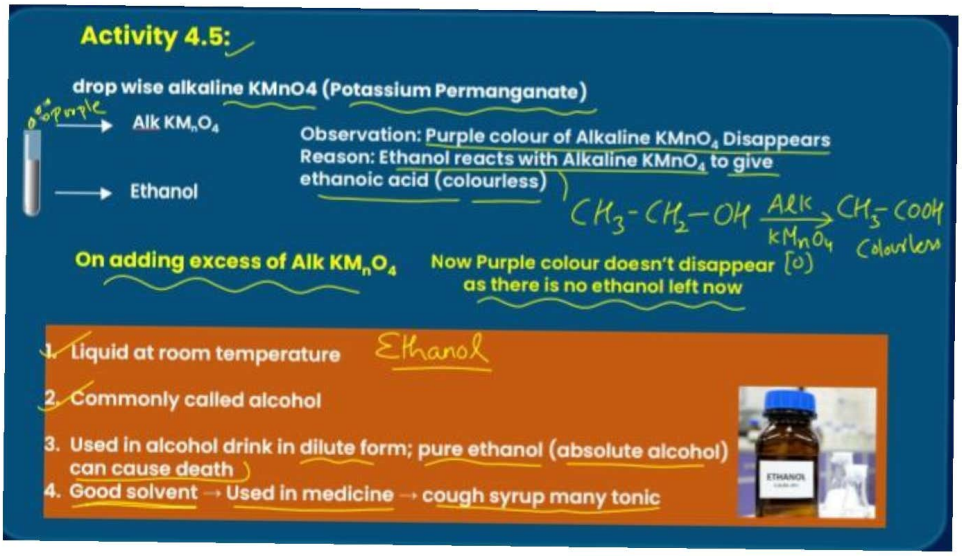
(2) $CH_3-CH_2-\underset{|}{O}H \xrightarrow[\text{Heat}]{443K\ .\ \text{Excess Conc.}H_2SO_4} \underset{\text{ethene}}{CH_2=CH_2} + H_2O$

Conc. H_2SO_4 Dehydrating agent hai (pani nikalnewala)
This Reaction is called *Dehydration of Ethanol.*

(3) $\underset{\text{ethanol}}{CH_3-CH_2-OH} \xrightarrow[\text{OR}]{\text{1) Alkaline } KMnO_4 \text{ (Alkaline Potassium permanganate)}} \underset{\text{ethanoic acid (colourless)}}{CH_3-COOH}$

2) Acidified $K_2Cr_2O_7$ (Acidified Potassium dichromate)
OR O_2

1 and 2 are oxidising agent. This is oxidation of ethanol. Addition of oxygen to ethanol happens. Purple colour of Alkaline $KMNO_4$ disappears.



ETHANOIC ACID CH_3-COOH ke Reactions

Reaction of Acid ⟶ H^+ ions release

(1) $CH_3-COO\overset{+}{H} + Na\overset{-}{O}H \longrightarrow CH_3COONa + H_2O$

Acid — Base — sodium ethanoate (sodium salt) — water

(2) $2CH_3-COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + CO_2 + H_2O$

Acid — Metal carbonate

$CH_3-COOH + NaHCO_3 \longrightarrow CH_3COONa + CO_2 + H_2O$

Acid — Metal bicarbonate

Test for gas CO_2 ⟶ turns lime water milky and milkiness disappear in passing excess of gas

(3) Esterification — Ethanoic acid + Ethanol

$CH_3-COO\overset{+}{H} + CH_3-CH_2-\overset{-}{O}H \underset{\text{reversible reaction}}{\overset{\text{acid}\to\text{catalyst}}{\rightleftharpoons}} CH_3COO-CH_2-CH_3 + H_2O$

Acid — Base — ester

✡ Ester are sweet smelling substances, used in making perfumes and flavouring agents.

(4) Saponification - Ester + NaOH

$CH_3-CO\overset{-}{O}\overset{+}{C}H_2-CH_3 + Na\overset{-}{O}H \longrightarrow CH_3-CH_2-OH + CH_3COONa$

ethanol — soap jaisa

Ethanoic Acid ⟶ weak acid

(1) Ethanoic acid commonly called acetic acid

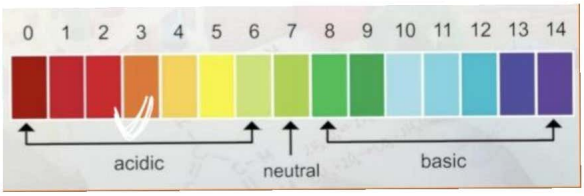
(2) 5-8% solution of acetic acid in water ⟶ vinegar used as preservative in pickles.

(3) Glacial acetic acid - melting point of pure ethanoic acid is 290K (17°C) hence it often freezes in winter in cold climates.

(4) Carboxylic acids are weak acids compared to HCl.

pH = 2.4 acetic acid — colour Red yellow universal indicator

pH = 1 HCl — colour Red universal indicator



pH ↑ acid weak

Addition Reaction

(1) Unsaturated Compounds Alkene, Alkynes

$CH_2 = CH_2 + H_2 \xrightarrow[\text{Plantium catalyst}]{\text{Nickel catalyst}} CH_3-CH_3$

ethene → ethane (saturated)

- Hydrogenation - Addition of Hydrogen to unsaturated Compounds to give saturated compound.
- Reaction is used in Hydrogenation of vegatable oil (long unsaturated Carbon chains)

Substitution Reaction

(1) for saturated compounds Alkane

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

(methane) → (chloromethane)

- Saturated Compound are less reactive

Combustion

(1) Complete Combustion (in supply of air) $\longrightarrow CO_2 + H_2O$ + Heat

$CH_4 + O_2 \longrightarrow CO_2 + H_2O$ + Heat

$CH_3CH_2OH + O_2 \longrightarrow CO_2 + H_2O$ + Heat

(2) Saturated Hydrocarbons → clean blue flame → Alkane
Unsaturated Hydrocarbons → yellow flame with lot of black smoke. → ene, yne

(3) Camphor and Napthalene → yellow flame ? → Ans Unsaturated Hydrocarbon

(4) Incomplete Combustion → limited supply of air → yellow flame

products are H_2O, CO & C (black carbon soot)

Allotropy :-

- The phenomenon of existence of an element in two or more forms which have different physical properties but identical chemical properties.

Carbon exist in different forms in nature like Diamond and Graphite

This phenomenon is called allotrophy and these different forms are called allotropes.

Graphite is smooth & slippery

Diamond is hardest substance.

Catenation :- • property of carbon to self link and form long chains of carbon atoms, branched chain of carbon atoms or rings of carbon atoms.

- This is the biggest reason that carbon forms millions of compounds. Food, paper, clothes, Human body all contains carbon compounds.
- Silicon also shows catenation but to lower extent that Carbon.

Soaps :-

- Molecules of soaps are sodium or potassium salts of long chain Carboxylic acids.

$$---C-C-C-C-C-COONa$$

(15-17 carbon की chain) ↓ पानी में

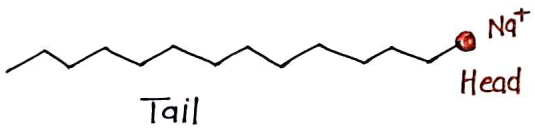
$$---C-C-C-C-C-COO^- \; Na^+$$

→ water

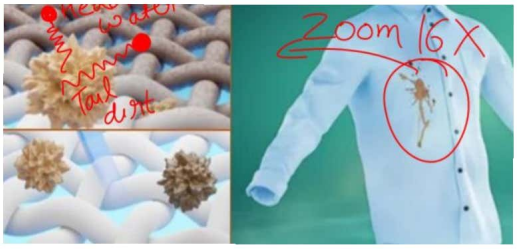
Hydrophobic (Tail) पानी से डर

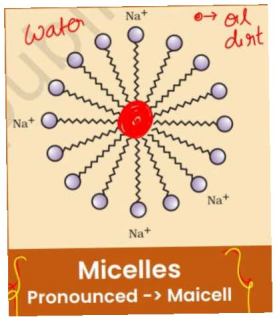
Hydrophillic (Head) पानी Lobe

Representation of Soap molecule

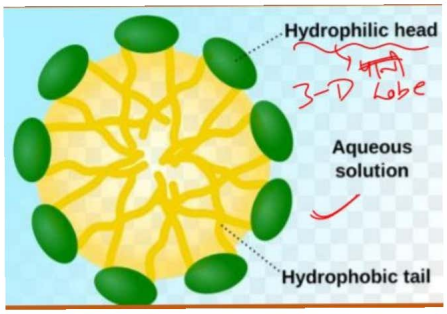


- Most of the dirt is oil.
- Oil does not dissolve in water.

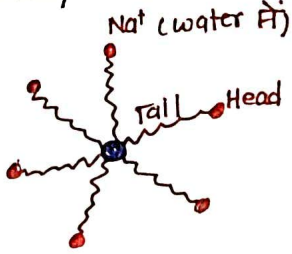




Head → Towards water
Tail → Towards water



The oil dirt is trapped inside micelle. washed away with water rinsing.



Hard water :-

water that contains salts of calcium and magnesium, bicarbonates, chlorides, sulphates.
(salts)

foam with soft water
foam formed easily

Foam with Hard water
foam not formed.

✡ Soap reacts with salts of 'ca' and 'mg' to form insoluble Ca and Mg salts ppt. (No foaming)

Detergents (effective in hard water) → Hard water → No ppt → forms foam

✡ Sodium salts of sulphonic acid or Ammonium salts with chlorides or bromides.

→ Do not form insoluble precipitate with Ca and Mg salts of hard water.
→ Used to make shampoo and cleaning clothes.