CARBON AND ITS COMPOUNDS

Ionic bonds	Covalent bonds
~~Weak bonds~~	~~Strong~~
• Contains ions (hard solids)	Contains molecules (gas, liquid, soft solid)
• Non-volatile	Volatile
• High melting/boiling points	Low melting/boiling points
• Good conductors only in molten state (not solid)	Poor conductors in any state
• Soluble in water (not in organic solvents)	Soluble in organic solvents (not in water)

CARBON

» Carbon is the 3rd most imp. element (after oxygen and hydrogen)

» 'Carbo' (Latin) $\xrightarrow{\text{meaning}}$ Coal

» Belongs to Group 14 - Carbon family

- Group 1 — Alkali metals
  - form strong alkalis (bases) with water
  (H, Li, Na, K, Rb, Cs, Fr)
- Group 2 — Alkaline Earth Metals
  - Form weaker alkalis
  (Be, Mg, Ca, Sr, Ba, Ra)
- Group 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
  - Transition elements
  - Having 2 outermost incomplete shells

- Group 13 - Boron family
- Group 14 - Carbon family
- Group 15 - Nitrogen family
- Group 16 - Oxygen family

- Group 17 - Halogens (very reactive)
  (F, Cl, Br, I, At)
  gas liq. solid

- Group 18 - Zero group (0 valency)
  - Noble / Inert gases
  (He, Ne, Ar, Kr, Xe, Rn)

» Carbon belongs to group 14.
» Hence, it shows +4/-4 [C^{4+}] and [C^{4-}] in different forms.

» It contains 4 electrons in the atermost shell.
» It can neither donate (to form C^{+4}) nor gain (to form C^{-4}).

⇓

REASON:

1. Carbon cannot form C^{4+} because it has 6 protons (in nucleus) and 6 electrons (revolving). To remove 4 electrons, it requires large amount of energy.

2. It cannot form C^{4-} because 6 protons are incapable of holding 10 electrons.

COVALENT BONDS IN CARBON

»» Sharing of an electron pair between the atoms, either same or different, are called covalent bonds.

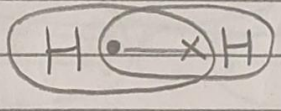
»» This sharing takes place to attain noble gas configuration.

»» C_{Z} ⇒ C_6 = K 2, L 4
Z = atomic no.

Examples

① Formation of H_2 molecule

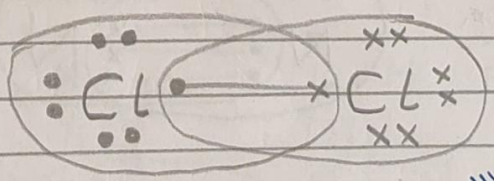
H_1 = K 1



H — H
»» single covalent bond.

② Cl_2 molecule

Cl_{17} = K 2, L 8, M 7

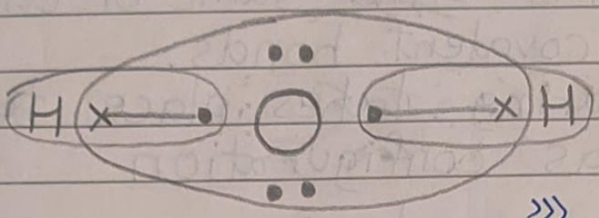


Cl — Cl
»» single covalent bond

>>>

③ **H_2O molecule**

	K	L
H_1 =	1	
O_8 =	2	6

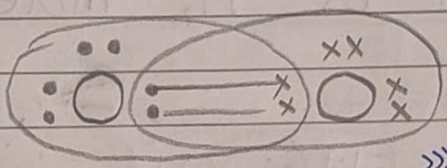


H – O – H

»» 2 single covalent bonds

④ **O_2 molecule**

	K	L
O_8 =	2	6

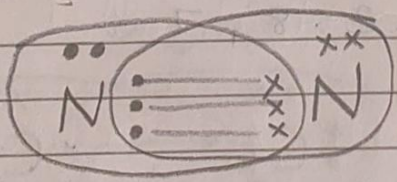


O = O

»» double covalent bond

⑤ **Nitrogen molecule** - N_2

	K	L
N_7 =	2	5

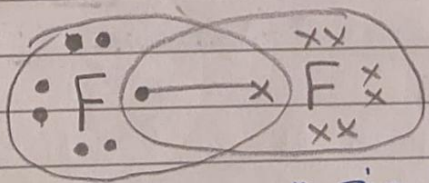


N ≡ N

»» triple covalent bond

⑥ **F_2 molecule**

	K	L
F_9 =	2	7



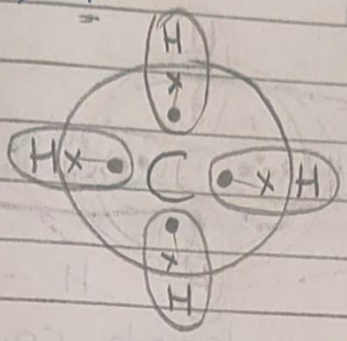
F – F

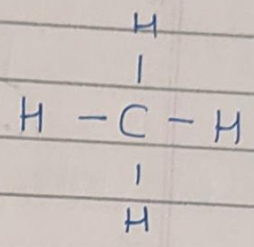
»» single covalent bond

⑦ **CH_4 (Methane)**

C_6 = 2, 4 (K, L)

H_1 = 1 (K)



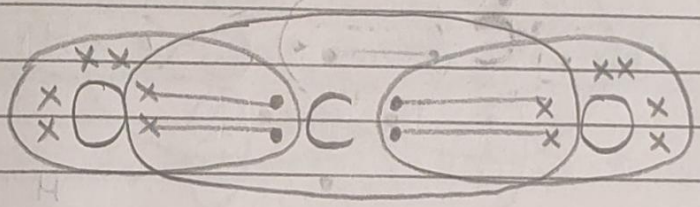


»» 4 single covalent bonds

⑧ **CO_2 molecule**

C_6 = 2, 4 (K, L)

O_8 = 2, 6 (K, L)



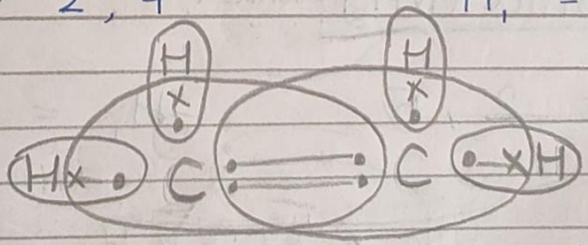
O = C = O

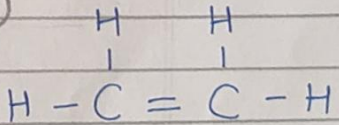
»» 2 double covalent bonds

⑨ **C_2H_4 (Ethene)**

C_6 = 2, 4

H_1 = 1

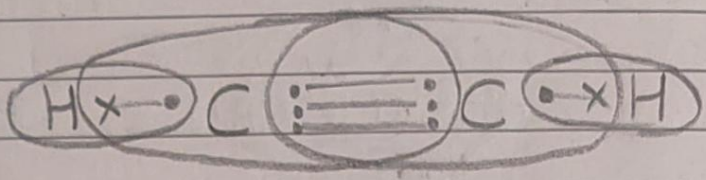




»» double covalent bond

(10) **C_2H_2 (Ethyne)**

$C_6 = 2, 4$ $\quad H = 1$

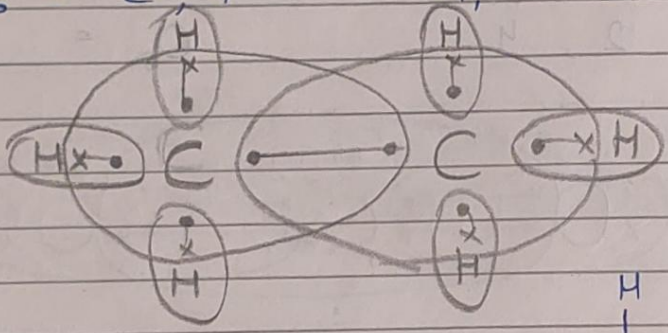


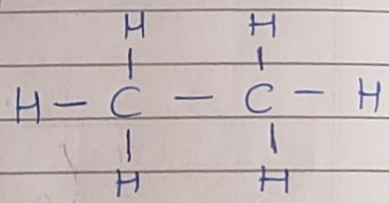
$H - C \equiv C - H$

⟩⟩⟩ triple covalent bond
(2 single covalent bonds)

(11) **C_2H_6 (Ethane)**

$C_6 = 2, 4$ $\quad H_1 = 1$

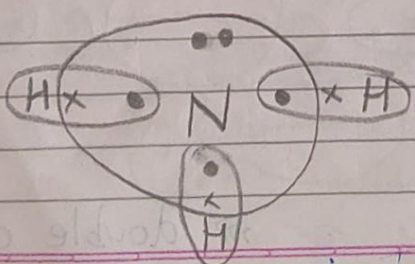


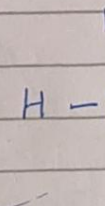


⟩⟩⟩ Single covalent bonds

(12) **Ammonia (NH_3)**

$N_7 = 2, 5$ $\quad H_1 = 1$



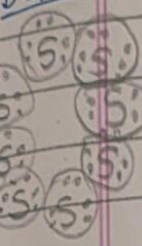


⟩⟩⟩ single covalent bonds

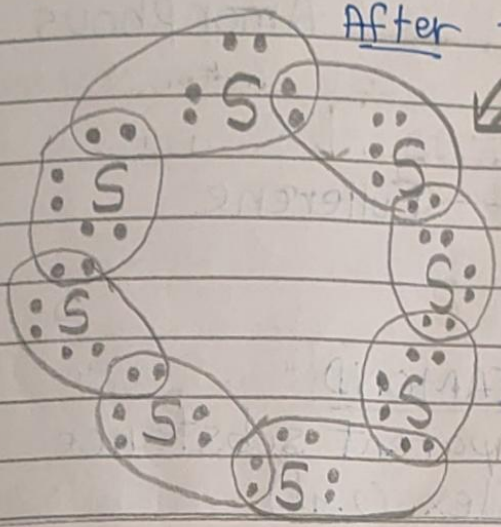
(13) Sulphur molecule (S_8)

$S_{16} = 2, 8, 6$

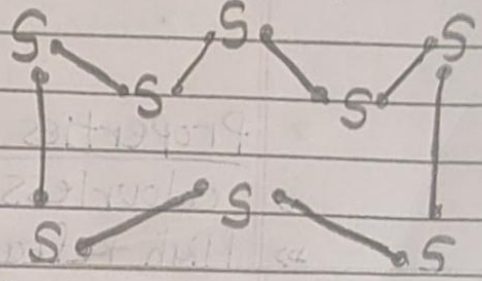
Before



After - Bond in ring formation



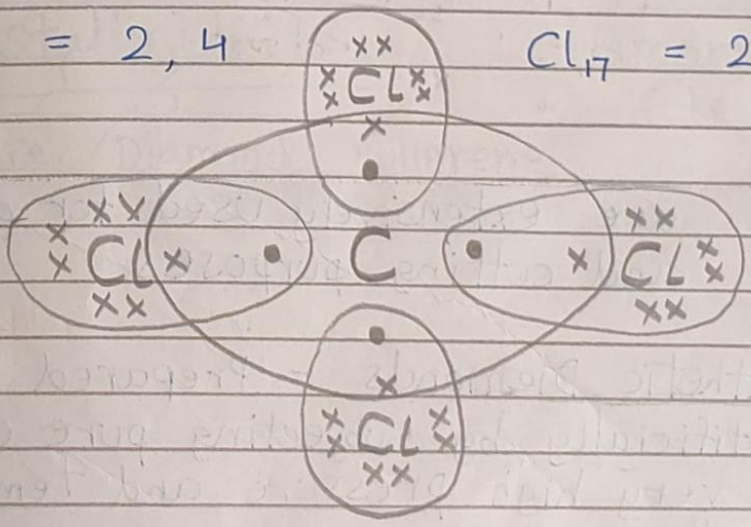
Crown Shape



⋙ 8 single covalent bonds

(14) CCl_4 (Carbon tetra-chloride)

$C_6 = 2, 4$ $\quad Cl_{17} = 2, 8, 7$



Diff. Phy. prop but same chem. prop.

Page

ALLOTROPES OF CARBON

- Crystalline (definite shape)
  - Graphite
  - Diamond
  - Fullerene
- Amorphous (indefinite shapes) (coke, charcoal, etc.)

• Properties of DIAMOND

- Colourless, transparent substance
- High refractive index (2.42)
- Hardest Known substance, heavy
- Does not conduct electricity due to absence of free electrons since all 4 valencies are firmly held in C-C single bond
- High melting point (3930°C)
- High thermal conductivity

↓

Diamond tools do not overheat and are extensively used for drilling and cutting purposes

Synthetic Diamonds - Prepared artificially by subjecting pure carbon to very high pressure and temperature

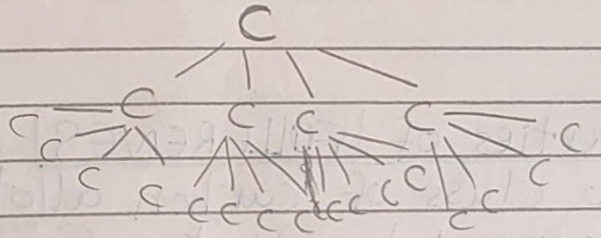
⇓

Uses:

- precious stones and gems
- Knives (for cutting marble, granite, glass and for surgery)

Structure:

1. Giant molecule of carbon atom in which each carbon atom is linked to 4 other carbon atoms by network of strong covalent bonds.
2. Form a rigid 3-D structure
3. Responsible for hardness
4. Lots of energy required to break the network of strong covalent bonds of diamond crystal.
   ∴ Melting point is high.
5. Bad conductor of electricity.



- Properties of GRAPHITE

Physical properties

» Low density - layers of graphite are less closely packed.

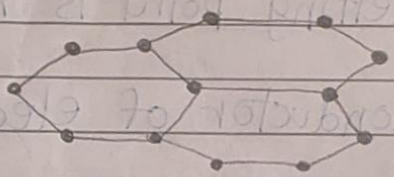
» Soft - held together by weak forces of attraction ∴ one layer can easily slide over other.

» Smooth, slippery – used as lubricants

» Solid – used in pencils

» Electrical and thermal conductivity

- Each carbon atom is joined to 3 other carbon atoms
- Forms hexagonal rings
- Only 3 valence electrons are used in single bond formation, 4th electron is delocalised (free to move)
- Thus, electrons are mobile.
- As a result, graphite is a good conductor of heat and electricity



Hexagonal structure, one layer over another

- Properties of FULLERENES

» new class of carbon allotropes

» Discovered by Harold Kroto, Richard Smalley and Robert Curl – by action of laser beam on vapours of graphite

» The first discovered fullerene was C-60 which contains 60 carbon atoms.

» C-60 is most stable

» C-60 is known as Buckminster fullerene as it has structure similar to geodesic dome designed by him. (soccer ball)

» New class of fullerenes has carbon atoms ranging from 60 to 350 or above.
» Has both pentagon and hexagon shape.

Physical properties
» Dark, solid at room temperature
» Giant molecule containing thousands of carbon atoms
» C-60 is very small molecule containing only 60 carbon atoms.

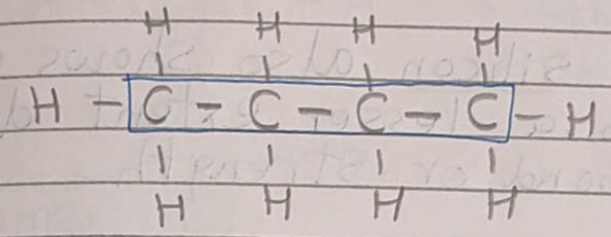
Uses
» Nanotechnology
» Medicine
» Acts as insulators in pure state
» Helps in improving antiwear and anti-friction properties of lubricating oils.

VERSATILE NATURE OF CARBON

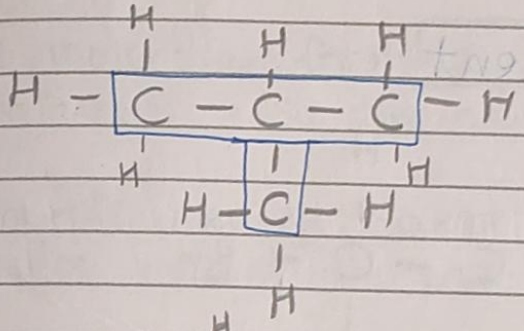
»» Carbon forms compounds by covalent bonding. (approx. 3 million)

⇓ How?

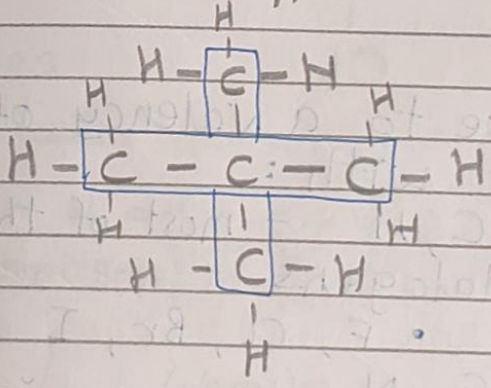
① **CATENATION** (Self-linking)



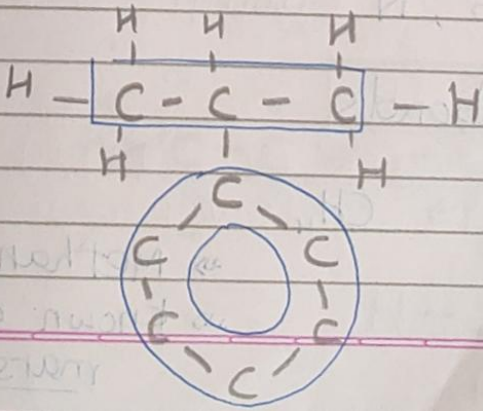
straight chain



Branched chain (1)



Branched chain (2)



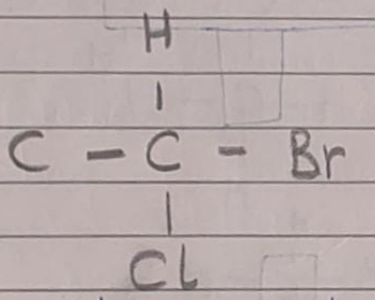
Cyclic chain (rings)

» Carbon can also link with simple, double or triple bonds.

» Self linking property of carbon atoms to form long chains - straight, branched, or rings - is called catenation.

» Next, silicon also shows catenation but to a lesser extent due to less bond or strength.

② Tetravalent



» Carbon, due to a valency of 4, connects with:

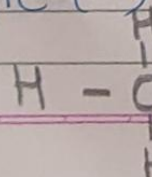
(i) C, H - most of the time

(ii) Halogens (sometimes)
- F, Cl, Br, I

(iii) S, N (rarely)

③ Multiple bonds

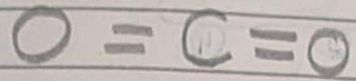
- Single (–) → CH_4



» Methane

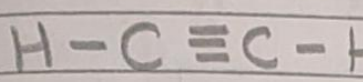
» known as marsh gas.

- Double (=) → CO_2



» Carbon dioxide (double bond)

- Triple (≡) → ~~Ethyne~~ C_2H_2



» Ethyne (triple bond)

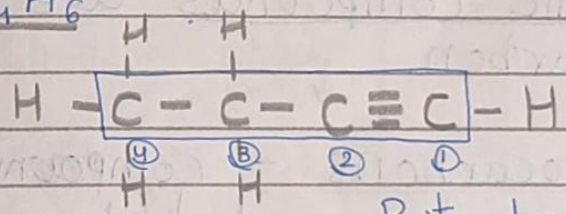
(4) Isomerism

Same molecular formula but different structures → so, the name also changes.

» Compounds having same molecular formula but different structural formula.

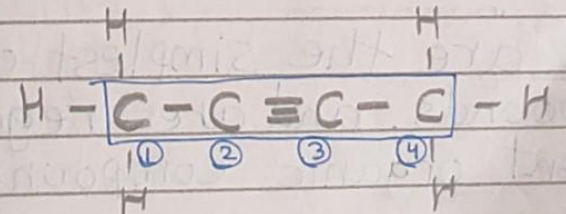
» Examples:

① C_4H_6



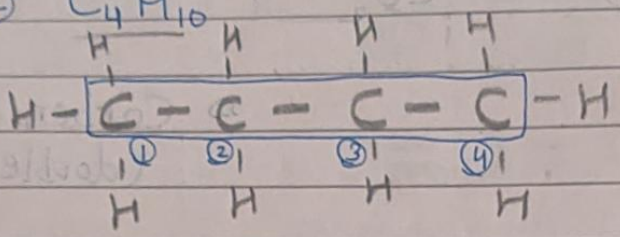
But-1-yne

OR



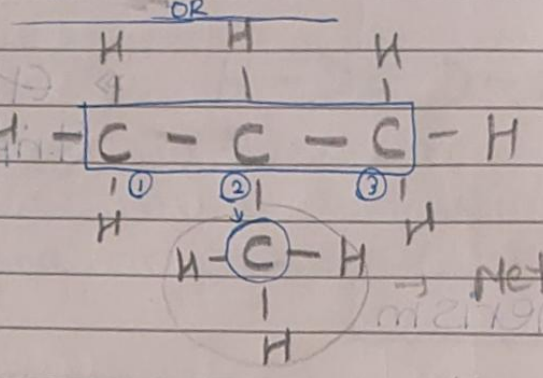
But-2-yne

② C_4H_{10}



Butane

OR



→ Methyle (CH_3)

2-Methyle Propane

ORGANIC CHEMISTRY

Chemistry of hydrocarbons and their derivations.

↓

Organic compounds are the compounds of carbon.

↓

Hydrocarbons - compounds containing only carbon and hydrogen

Eg - CH_4, C_2H_6, C_3H_4, C_2H_2

These are the simplest organic compounds, and are regarded as parent organic compounds.

Hydrocarbons

Saturated hydrocarbons

- Alkanes (Paraffins)
- single bonds (–)
- C_nH_{2n+2}

Unsaturated hydrocarbons

- Alkenes (Olefins)
- double bonds (=)
- C_nH_{2n}

- Alkynes
- triple bonds (≡)
- C_nH_{2n-2}

Saturated	Unsaturated
» All 4 valencies of C are satisfied with single covalent bonds.	» The valency of at least 2 C atoms are not fully satisfied
» Joined with single bond (–)	» Joined with double/triple bonds (=/≡)
» Less reactive due to non-availability of electrons so they undergo substitution reaction.	» More reactive, undergo addition reaction.
» Chemically inert, burns with blue and	» More reactive burns with yellow flame

non-smoky flame due to complete combustion.	along with soot / smoke due to incomplete combustion.

NOMENCLATURE

» Naming compounds according to IUPAC (Intl. Union of Pure & Applied Chem)

No. of carbon atoms	Root word
1	Meth
2	Eth
3	Prop
4	But
5	Pent
6	Hex
7	Hept
8	Oct
9	Non
10	Dec

Suffix

» The root word is followed by an appropriate suffix, which represents the nature of the bond in C-C- atom.

C–C	Single bond	Alkane
C=C	double bond	Alkene
C≡C	triple bond	Alkyne

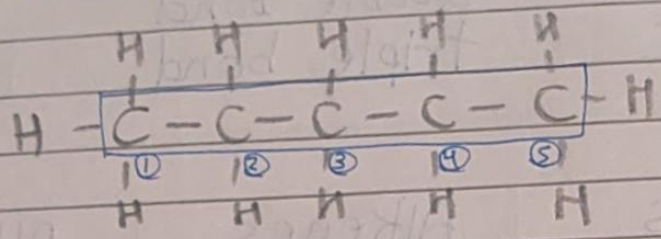
	Alkanes	Alkenes	Alkynes
	C_nH_{2n+2}	C_nH_{2n}	C_nH_{2n-2}
		double bonds don't occur in single C-atoms	
1-C	CH_4 – Methane		
2-C	C_2H_6 – Ethane	C_2H_4 – Ethene	C_2H_2 – Ethyne
3-C	C_3H_8 – Propane	C_3H_6 – Propene	C_3H_4 – Propyne
4-C	C_4H_{10} – Butane	C_4H_8 – Butene	C_4H_6 – Butyne
5-C	C_5H_{12} – Pentane	C_5H_{10} – Pentene	C_5H_8 – Pentyne
6-C	C_6H_{14} – Hexane	C_6H_{12} – Hexene	C_6H_{10} – Hexyne
7-C	C_7H_{16} – Heptane	C_7H_{14} – Heptene	C_7H_{12} – Heptyne
8-C	C_8H_{18} – Octane	C_8H_{16} – Octene	C_8H_{14} – Octyne
9-C	C_9H_{20} – Nonane	C_9H_{18} – Nonene	C_9H_{16} – Nonyne
10-C	$C_{10}H_{22}$ – Decane	$C_{10}H_{20}$ – Decene	$C_{10}H_{18}$ – Decyne

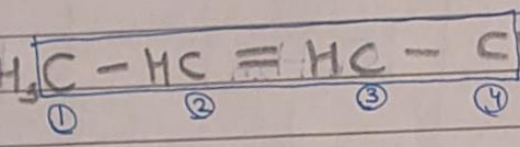
Alkyle group → C_nH_{2n+1}

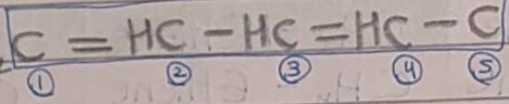
Methyle – CH_3
Ethyle – C_2H_5
Propyle – C_3H_7
Butyle – C_4H_9
Pentyle – C_5H_{11}
Hexyle – C_6H_{13}
Heptyle – C_7H_{15}
Octyle – C_8H_{17}
Nonyle – C_9H_{19}
Decyle – $C_{10}H_{21}$

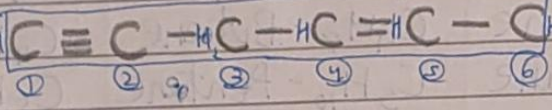
Derived from alkanes by removing one hydrogen atom

Equations

① 
C_5H_{12}
Pentane

② 
But-2-ene

③ 
Pent-1,3-diene

④ 
Hex-1-yne, 4-ene

Characteristics of Homologous Series

»» All members are represented by same general formula.

»» Any 2 adjacent homologues differ by 1 carbon atom and 2 hydrogen atoms in molecular formula.

»» All compounds of homologous series show similar chemical properties.

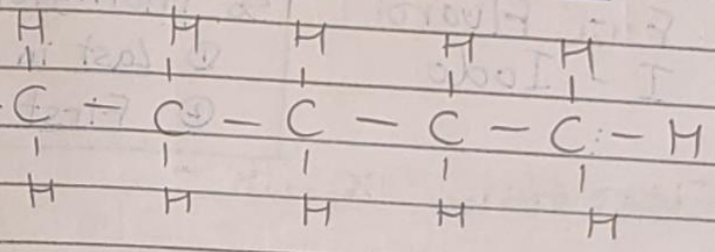
»» With increase in molecular mass, the gradual change in physical properties occurs.

- Example – With increased molecular mass,

the melting points and boiling points also increase.

» The difference in molecular masses of any 2 adjacent homologues is 14 u.

Example of homologous series



$CH_3 - CH_2 - CH_2 - CH_2 - CH_3$

(structural formula)

This is an example of pentane. There is an increase of CH_2 in each adjacent member of the series.

⇓

Alkane series example

Methane – CH_4 (CH_4)
Ethane – $CH_3 CH_3$ (C_2H_6)
Propane – $CH_3 CH_2 CH_3$ (C_3H_8)
Butane – $CH_3 CH_2 CH_2 CH_3$ (C_4H_{10})
Pentane – $CH_3 CH_2 CH_2 CH_2 CH_3$ (C_5H_{12})
⋮ and so on.

>>>

FUNCTIONAL GROUPS

Halogens

Halogens [Prefix]

Group 17 - very reactive

F.G. ✗ Substituents ✓ (branches)

Added in Functional groups, but in REALITY they are substituents (not a part of main C chain)

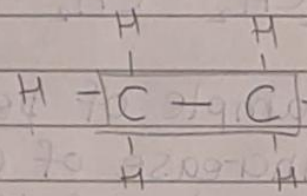
Cl - Chloro
Br - Bromo
F - Fluoro
I - Iodo
⋮

Priority (numbering) - ① F.G > =/≡ > ② Substituents ③

So, priority of halogens:
① Last in numbering (substituents)
② First in naming (Prefix)

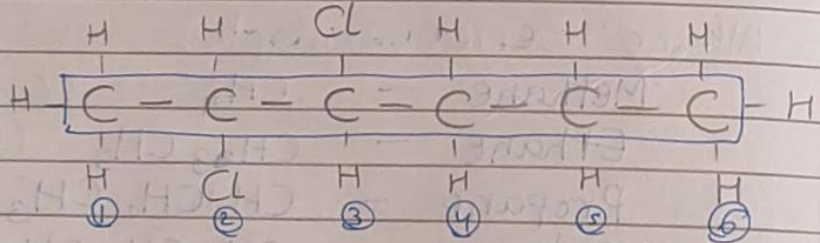
Examples:

① C_2H_6



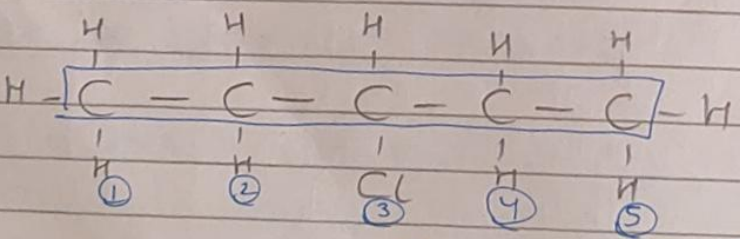
Ethane

②



2,3-di chloro Hexane

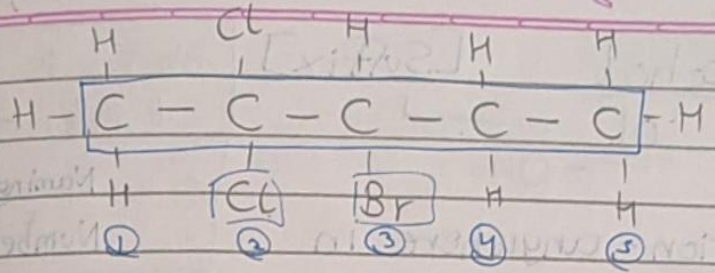
③



3 Chloro Pentane

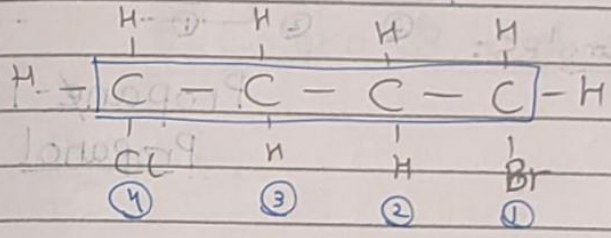
Date
Page

(4)



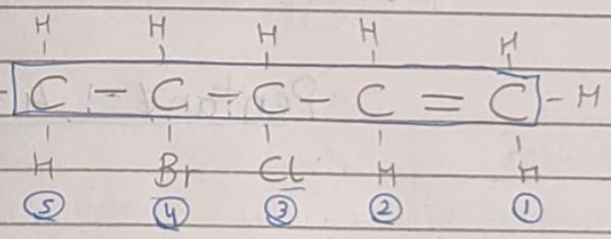
3-Bromo 2,2-di Chloro ~~3-Bromo 2,2-Chloro~~ Pentane

(5)



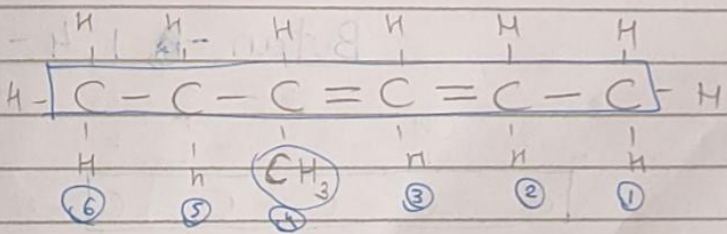
1-Bromo, 4-Chloro Butane

(6)



4-Bromo, 3-Chloro Pent-1-ene

(7)



4-Methyle, Hex-2,3-diene

1 Alcohol [Suffix]

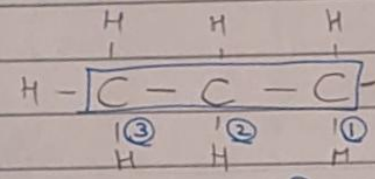
'ol' ⟵

$=-OH$

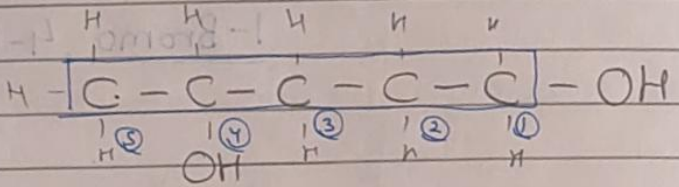
Position - anywhere in the C-C chain

Alcohol is functional group
- Priority:
  - Naming - Last (suffix)
  - Numbering - First (FG)

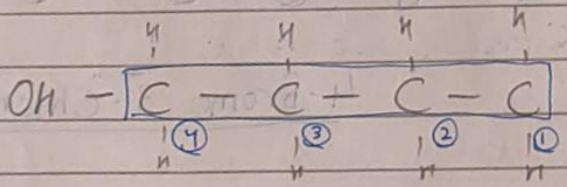
Examples:

① 

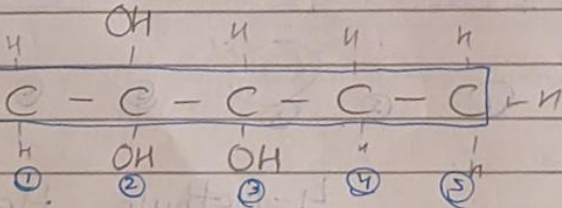
Propan-1-ol
Propanol

② 

Pentan-1,4-diol

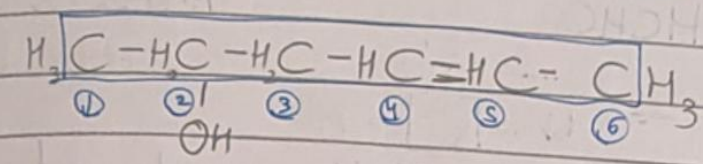
③ 

Butan-1,4-diol

④ 

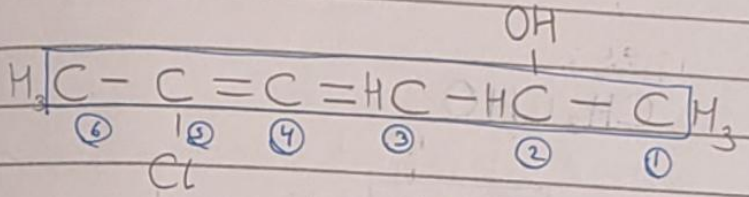
Pentan-2,2,3-triol

⑤



~~Hexan~~ Hex-4-ene-2-ol

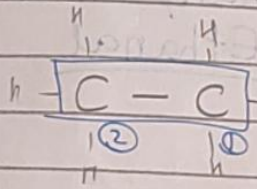
⑥



Hex-

5-Chloro^3,4-dien€ 2-ol

⑦



Ethan€-1-ol

Ethanol

② Aldehyde [Suffix]

'al' ⟵

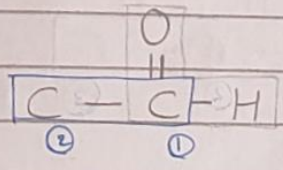
-CHO (O with = bond)

Priority :
Naming - Last (suffix)
Numbering - First (F.G.)

Position - only on terminal ends

Examples:

①



Ethan€-1-al

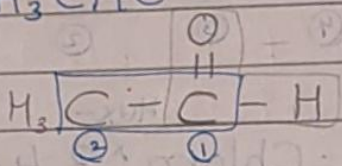
Ethanal

② $HCHO$

Methan**e**-1-al

Methanal

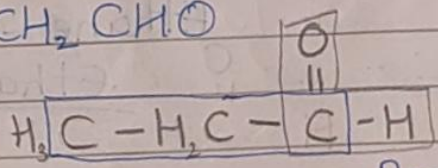
③ CH_3CHO



Ethan**e**-1-al

Ethanal

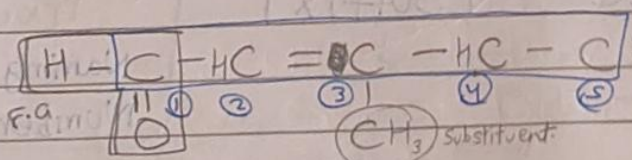
④ → CH_3CH_2CHO



Propan**e**-1-al

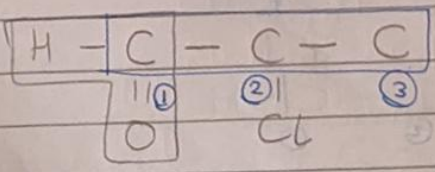
Propanal

⑤



3-Methyle Pent-2-en**e** 1-al

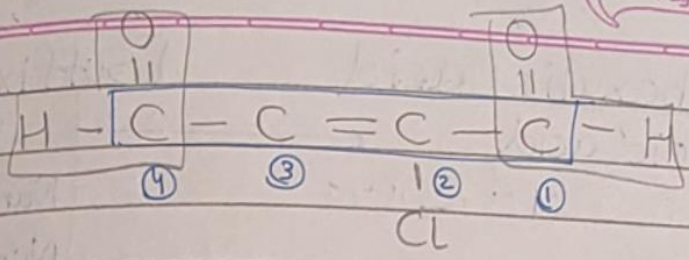
⑥



2-Chloro Propan**e**-1-al

2-Chloro Propanal

⑦



2-Chloro But-2-enk 1,4-dial

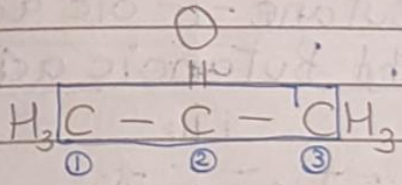
③ Ketone [Suffix]
'one' ⟵ =O

Priority:
Naming - Last [suffix]
Numbering - First [F.G.]

Position: Between the C-C chain (anywhere), not ends

Examples:

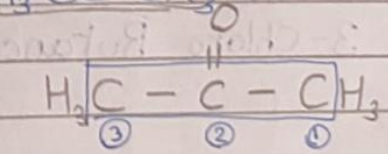
①



Propank-2-one

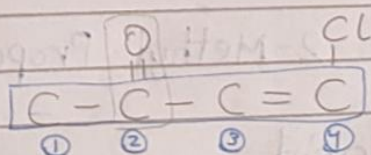
⇓

② $CH_3CO CH_3$



Propan-2-one

③



4-Chloro, But-3-ene-2-one

Date
Page

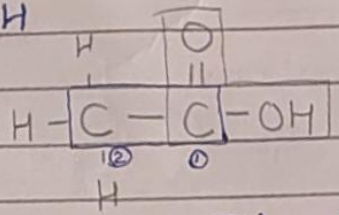
④ Carboxylic acid [Suffix]

'oic' acid ⟵ COOH

Priority:
Naming - Last (suffix)
Numbering - First (FG)

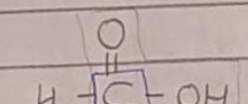
Position: Terminal ends

① CH_3COOH



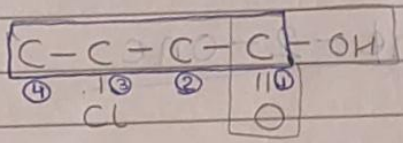
Ethan∅-1-oic acid
Ethanoic acid

②



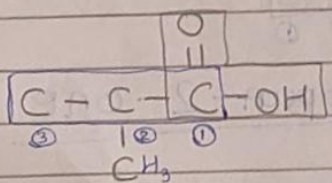
Methanoic acid

③



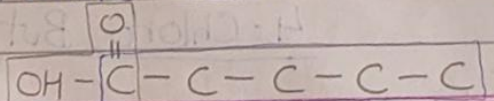
3-Chloro Butan∅-1-oic ~~ad~~ acid
3-Chloro Butanoic acid

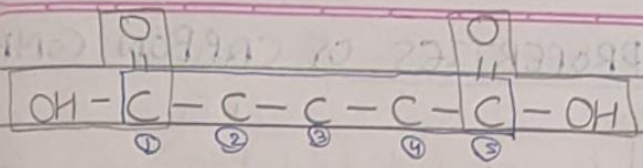
④



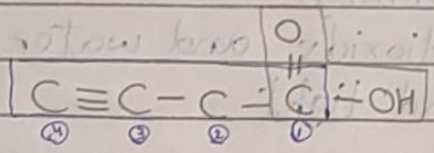
2-Methyl Propanoic acid

⑤ Pentanoic acid



⑥ 

Pentan - 1,5-dioic acid

⑦ 

But-3-yn-1-oic acid

But-3-ynoic acid

SUMMARY - FUNCTIONAL GROUPS

Sr. no.	Group	Affix (Prefix/Suffix)	& Structure		Position	Priority	
						Name	Number
	Halogens	Chloro/Bromo ~~Cl/Br/F/I~~	Prefix	-Cl/-Br/-F	Anywhere	First	Last
①	Alcohol	'ol'	Suffix	-OH	Anywhere	Last	First
②	Aldehyde	'al'	Suffix	-CHO	Ends	Last	First
③	Ketone	'one'	Suffix	=O	Between	Last	First
④	Carboxylic acid	'oic acid'	Suffix	-COOH	Ends	Last	First

* Detailed numbered priority is not in syllabus

↓

2 functional groups won't come together for nomenclature in Class 10.

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

① **Combustion** (uncontrolled oxidation)

» Organic compounds are oxidised under high heat (burning).

» Gives carbon dioxide and water along with heat and light

Examples:

$CH_4 + 2O_2 \xrightarrow{\Delta} CO_2 + 2H_2O$ + heat + light

$C_3H_8 + 5O_2 \xrightarrow{\Delta} 3CO_2 + 4H_2O$ + heat + light

$CH_3CH_2OH + 2O_2 \longrightarrow 2CO_2 + 3H_2O$ + heat + light

$CH_3COOH + O_2 \longrightarrow 2CO_2 + 2H_2O$ + heat + light

Saturated (–)	Unsaturated (=/≡)
Clean, blue flame due to complete combustion ↓ But undergo incomple combustion in limited supply of air to give Sooty flame (sometimes) Eg - Vessels turn black on stove due to insufficient O_2	Yellow sooty flame, black smoke due to incomplete combustion

② **Oxidation** (controlled)

» Addition of O_2 or removal of H_2

» Alcohols can be oxidised by heating them in the presence of oxidising agents like

alkaline $KMnO_4$ (potassium permanganate) or acidified $K_2Cr_2O_7$ (potassium dichromate)

Eg- $CH_3CH_2OH + [O] \xrightarrow[\text{or aci. } K_2Cr_2O_7 + \Delta]{\text{alk. } KMnO_4 + \Delta}$ CH_3COOH

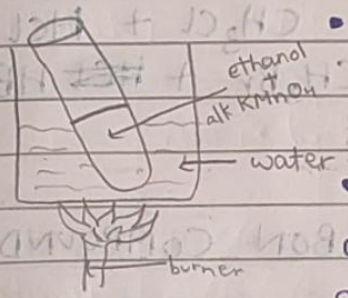
Ethanol — oxidising agents — Ethanoic acid

Alcohols convert into carboxylic acids only under COMPLETE oxidation. [Alcohol $\xrightarrow{[O]\text{ complete}}$ Acid]

↓

In PARTIAL oxidation,

Alcohol $\xrightarrow{[O]}$ Aldehyde $\xrightarrow{[O]}$ Acid



- Initially – The pink/purple colour of $KMnO_4$ fades as it oxidises ethanol to ethanoic acid
- Later – When excess $KMnO_4$ is added, pink/purple colour persists as there is no more ethanol left to be oxidised.

③ **Addition** (catalytic hydrogenation)

» Reaction in which a reagent is completely added to a reactant without removal of small molecules.

Adding of hydrogen to unsaturated compound in the presence of a catalyst (Ni/Pt/Pd) gives saturated hydrocarbon.

$C_2H_4 + H_2 \xrightarrow{Pt/Ni/Pd} C_2H_6$

[Ethene] — [Ethane]

» Burning of substances :
- With flame – candle, LPG
- Without flame – coal (glows, no flame)

(gas vaporises and substances burn themselves)

④ **Substitution**

» One reagent substitutes a subtrate

$$AB + C \longrightarrow AC + B$$

Examples:

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

$$CH_4 + Br_2 \xrightarrow{\text{sunlight}} CH_3Br + HBr$$

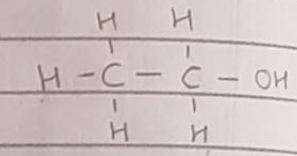
SOME IMPORTANT CARBON COMPOUNDS

1. **Ethanol** [C_2H_5OH]

» Commercially important

» Pleasant smell

» No action on litmus



CH_3CH_2OH (functional group)

Preparation:
- Fermentation of MOLASSES obtained from Sugarcane

(most efficient synlight to chemical energy converter)

Physical Properties:
- Liquid at room temperature
- Good solvent
- Soluble in water in all proportions

- Melting point – 156 K
  Boiling point – 351 K

Uses:

- Active ingredient of all alcoholic drinks
- Medications (tincture of iodine, cough syrup, etc.)
- Additive in petrol (Power fuel – 80% petrol 20% Ethanol since it is cleaner, no harmful gas liberated) and gives rise to CO_2 and H_2O when burnt in sufficient air.

Chemical Properties:

① **Reaction with Sodium**

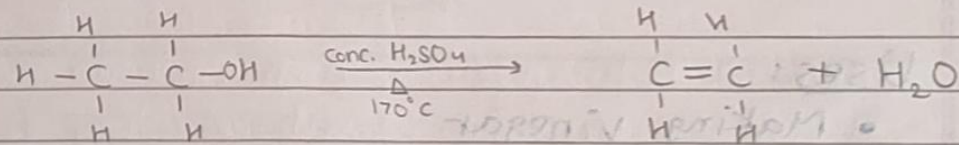
» Evolution of hydrogen gas

$$2\,CH_3CH_2OH + 2Na \longrightarrow 2CH_3CH_2ONa + H_2\uparrow$$

(Also reacts with potassium to form potassium ethoxide and H_2)

② **Dehydration**

» Concentrated H_2SO_4 is a good dehydrating agent and helps in removal of water.



Ethanol ⟶ Ethene

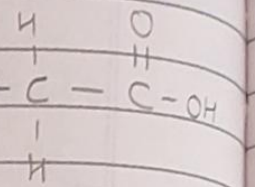
$[C_2H_5OH \xrightarrow{H_2SO_4} C_2H_4 + H_2O]$

Effects on living beings:

- Slows metabolic process
- Depresses the central nervous system (lack of coordination, drowsiness, lack of muscular judgements, etc.)

- Affects optic nerves → cause blindness
- To avoid misuse, it is made unfit for drinking by adding Methanol (poisonous), $CuSO_4$, Pyridine or coloured dye, forming DENATURED ALCOHOL.

2. Ethanoic acid



» Acetic acid

»» Vinegar = 5-8% of ethanoic acid in water

Physical Properties:

- Colourless liquid
- Pungent smell
- 290 K melting point
- In winter, it freezes to form ice like flakes ∴ called Glacial Acetic Acid (water-free / anhydrous acetic acid)
- Weaker than HCl, but stronger than alcohol
  1. Turns blue litmus red
  2. Higher pH than HCl or lemon juice

Uses:

- Making Vinegar
- Preservatives in pickles
- Synthesis of compounds like Ester

Preparation – (Refer "Oxidation")

$$CH_3CH_2OH \xrightarrow[\text{or aci. } K_2Cr_2O_7]{\text{alk. } KMnO_4} CH_3COOH$$

Ethanol → Ethanoic acid

Chemical Properties:

(i) Acidity

HCl
Acetic acid
Alcohol

high ↓ low — ionisation

$2CH_3COOH + 2Na \longrightarrow 2CH_3COO^-Na^+ + H_2\uparrow$
(Sodium acetate)

[Metal + Acid → Salt + Water]

(ii) Reaction with Base

Reacts with Base to give salt and water

$CH_3COOH + NaOH \longrightarrow CH_3COO^-Na^+ + H_2O$
Ethanoic acid — Sodium hydroxide — Sodium acetate — Water

[Acid + Base → Salt + Water]

(iii) Reaction with carbonates and hydrogen carbonates

Reacts and forms Sodium acetate, H_2O and CO_2.

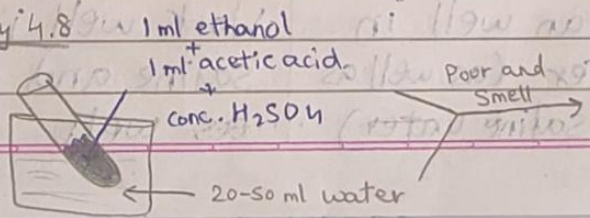
$2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COO^-Na^+ + CO_2 + H_2O$
(Sodium carbonate)

$CH_3COOH + NaHCO_3 \longrightarrow CH_3COO^-Na^+ + CO_2 + H_2O$
(Sodium bicarbonate)

(iv) ESTERIFICATION [Ester = Acid + Alcohol]

Ethanoic acid reacts with Ethanol in the presence of an acid catalyst to give ester.

Activity 4.8



Sweet-smelling compound [ESTER]

$CH_3COOH + C_2H_5OH \xrightarrow[\Delta]{conc.\ H_2SO_4} CH_3COOC_2H_5 + H_2O$

Carboxylic acid — Alcohol — Ester — Water

[Ethanol + Ethanoic acid ⟶ Ethyl acetate + water]

$CH_3COOC_2H_5 = R'COOR$

CH_3: Alkyl group; C_2H_5: Alkyl group

(v) Saponification

Converting ester back to Alcohol and Sodium salt by treating it with NaOH (alkali)

Used in preparation of soap

$CH_3COOC_2H_5 \xrightarrow{NaOH} CH_3COO^-Na^+ + C_2H_5OH$

(backward reaction)

SOAPS AND DETERGENTS

Soaps	Detergents
Sodium or Potassium salts of a long chain of carboxylic acids	Ammonium or sulfonate salts of long chains of carboxylic acids
Mostly Biodegradable	Mostly non-biodegradable
Do not clean well in hard water (as well as acidic and saline water)	Work well in hard, saline and acidic water as well

Soaps	Detergents
Form Scum with hardwater as they contain Mg^{2+} and Ca^{2+} impurities which become precipitates with carboxylic acids	Form lather with hard water as the sulphonic salts are soluble in water
More dissolution time	Less dissolution time
Prepared from natural compounds like fatty acids or plant and animals fats through saponification	Derived synthetically from petrochemicals

Soaps

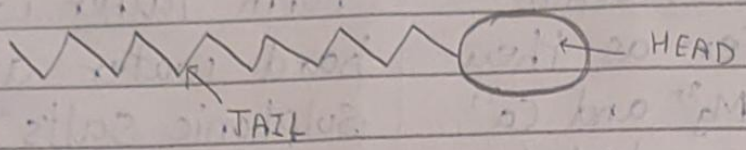
[Saponification]

$$\text{Fat/oil (Ester)} + \text{NaOH (Alkali)} \xrightarrow{\Delta} \text{Sodium salt of fatty acid (Soap)} + \text{Glycerol (Alcohol)}$$

Structure

- ~~Amphilic~~ Amphiphilic [both polar and non-polar]

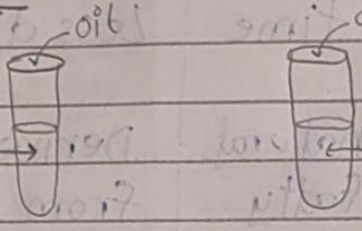
Tail (non-polar)	Head (polar)
• long chain	• short part
• non-ionic	• ionic
• Hydrophobic (fear of H_2O)	• Hydrophilic (water loving)
∴ Insoluble in water but soluble in oil (lipophilic)	∴ Soluble in water but insoluble in oil (lipophobic)



Cleansing action of Soaps

Micelle Formation

Activity 4.10



A

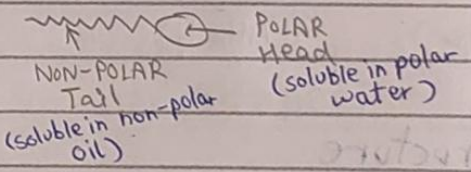
oil and water seperates in layers

B

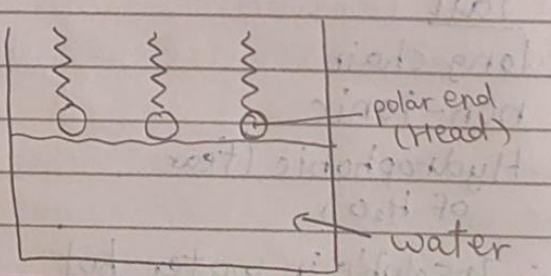
No seperate layers, disperses the oil from water

Universal law of solubility – "Like Dissolves Like"

∴ Polar dissolves in Polar and Non-polar dissolves in non-polar



At the Surface of water



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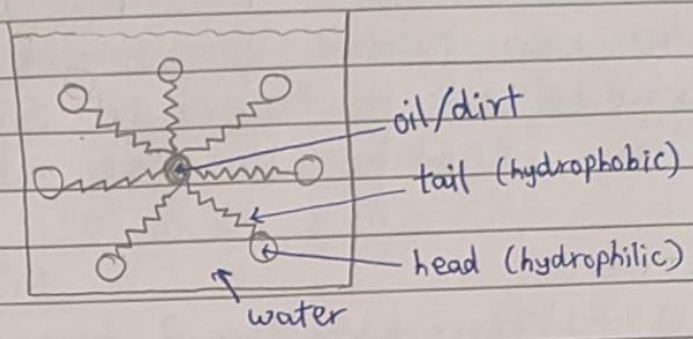
Inside the water



This formation is called MICELLES
(Tails at the interior and heads on the surface of the cluster)

↓

- The soap solution is able to clean as the oily dirt is being collected at the centre of micelles.
- The hydrophobic tails surround the oily dirt, while the hydrophilic heads face outward into the water.
- These heads create a colloidal suspension that traps the dirt and allows it to be rinsed away.