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CARBON

Atomic Number :- 6 (6p and 6e)
Neutrons :- 6
Mass Number :- 12 (6p + 6n)
Electronic Configuration :- 2,4
Valency :- 4 (Tetravalent)

Importance of Carbon

- Main element present in all living organisms
- Almost all fuel that we use are made of carbon.
- Other organic substance like carbohydrate, protein, fats, alcohol, vinegar, glucose etc contain carbon.
- Plastics have Carbon.

Uniqueness in Carbon

- Carbon can form huge number of compounds.
- Number of carbon compounds are greater than all non-carbon compounds.
- Carbon based organic chemistry is studied as a separate branch of chemistry.

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Why CARBON is Unique?

- Catenation
- Tetra-Covalency
- Polymerisation
- Isomerism

1. Tetra-Covalency

Valency of Carbon is 4 and it form compounds only by sharing electrons.

Covalent Bond: The atomic number of carbon is 6. Its electronic configuration is 2,4. It requires, 4 electrons to achieve the inert gas electronic configuration. But Carbon cannot form an ionic bond because:

- It could gain four electrons forming C^{4-} cation. But it would be difficult for nucleus with six protons to hold on to ten electrons.
- It could lose four electrons forming C^{4+} cations. But it requires a large amount of energy to remove four electrons.

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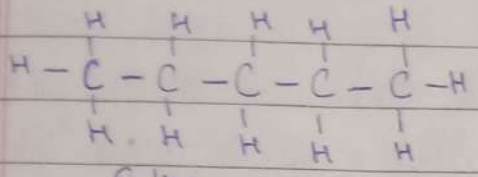
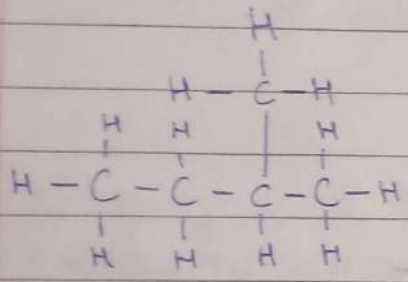
2 Catenation

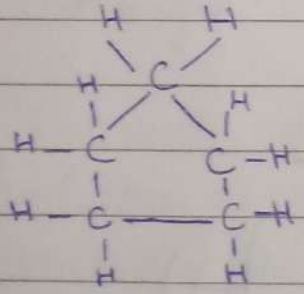
It is a property which is present in Carbon which leds to direct bonding between atoms of same element to form long chains, branches or ring structures.



Straight Chain
(Normal Pentane)



Branched Chain
(Iso-Pentane)



Closed Chain (ring)
(Cyclo Pentane)
C_5H_{10}

3 Polymerisation

The chemical process that combines several monomers to form a polymer or polymeric compound.

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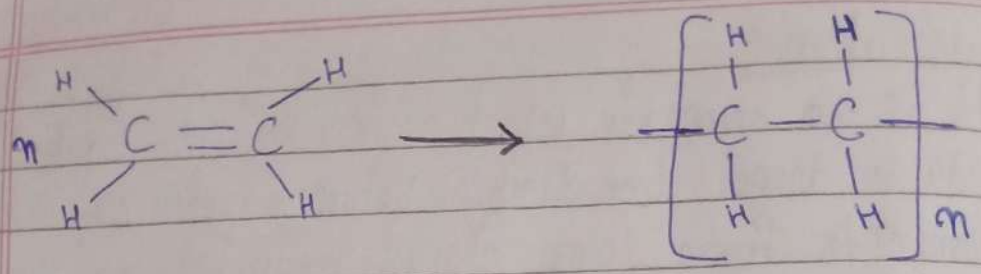


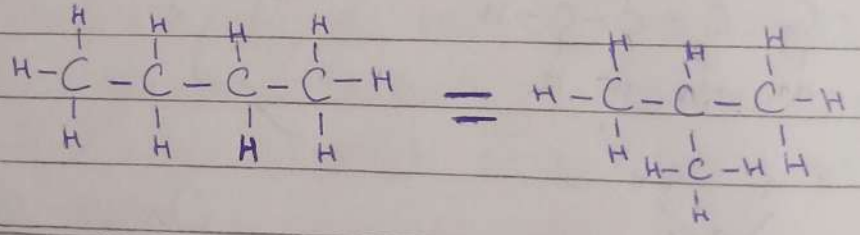
Ethene

Poly(ethene)

4 Isomerism

Compounds having same molecular formula, but different structures called isomers and this property is called isomerism.

C_4H_{10}

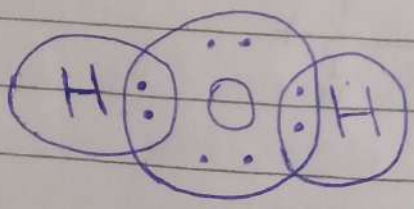


TYPES OF COVALENT BOND

Single Bonds

H_2O : H-O-H

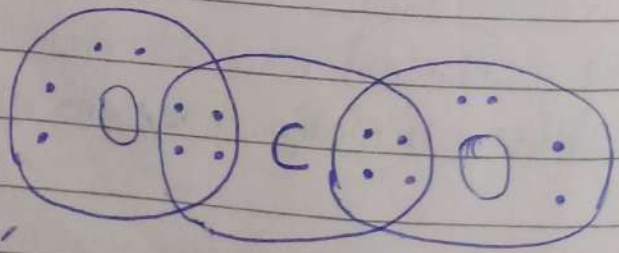
Share 1 pair of e⁻



Double Bonds

CO_2 : O=C=O

Share 2 pair of e⁻



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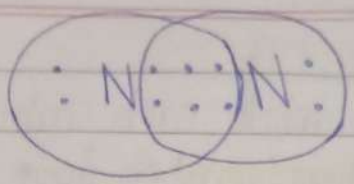
Triple Bonds

N_2 : N ≡ N

Share 3 pairs of e⁻



Allotropes of Carbon

~~Allo tro~~ Different forms of an element that has same ~~physical~~ chemical property but different physical properties are known as allotropes.

There are three allotropes of Carbon – Diamond, Graphite and Fullurence.

DIAMOND

It exists as a three-dimensional network with ~~carbon~~ strong carbon-carbon covalent bonds.

Diamond is hard in nature with high melting points.

It shines in presence ~~of~~ ~~of~~ light and it is a bad conductor of electricity. The most common use of diamond is in making jewellery. It is also used in cutting and drilling tools.

* Each Carbon atom is bonded ~~to~~ to four other carbon atoms to form a regular tetrahedron shape.
* No free e⁻.
* Melting point: 3,550 °C (6,422 °F) Boiling point: 4,830 °C

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GRAPHITE

- In Graphite each Carbon atom is bonded with other three carbon atoms in order to form hexagonal rings.
- It serves as good conductor of heat and electricity.
- It is used as dry lubricant for machines parts as well as it is used in lead pencils.

FULLERENCE

- Fullerence is the hollow cage which exists in the form of sphere. It resembles the structure of fullerence.
- But along with hexagonal rings, sometimes pentagonal or heptagonal rings are also present.
- Its structure looks like a Football.

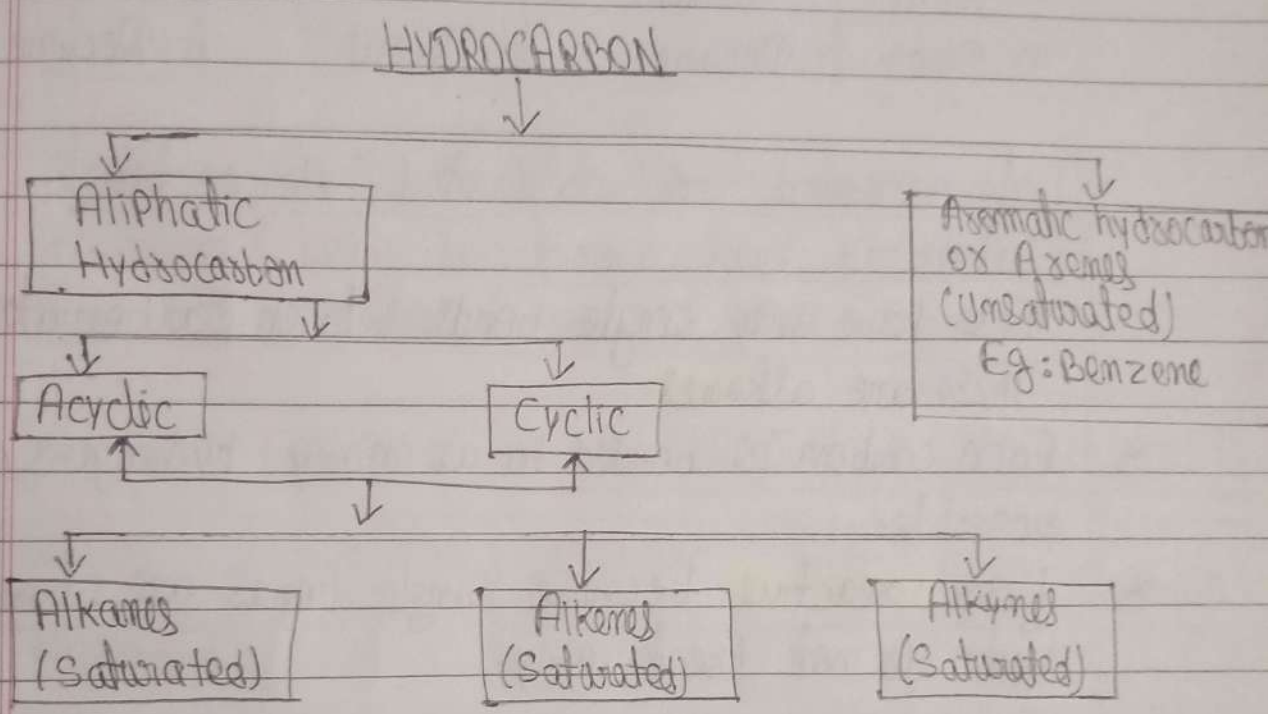
TYPES OF COMPOUNDS

CARBON COMPOUND – Compounds containing carbon.

ORGANIC COMPOUND – Compounds containing carbon

and nitrogen.

HYDRO CARBON — Compounds containing carbon and hydrogen only.



Aliphatic Hydrocarbons : (Open Chain)

No. of C atoms	Alkane (–)	Alkene (=)	Alkyne (≡)
1 (Meth)	Methane	X	X
2 (Eth)	Ethane	Ethene	Ethyne
3 (Prop)	Propane	Propene	Propyne
4 (But)	Butane	Butene	Butyne

5 (Pent)	Pentane	Pentene	Pentyne
6 (Hex)	Hexane	Hexene	Hexyne
7 (Hept)	Heptane	Heptene	Heptyne
8 (Oct)	Octane	Octene	Octyne
9 (Non)	Nonane	Nonene	Nonyne
10 (Dec)	Decane	Decene	Decyne

Saturated and Unsaturated hydrocarbons

Saturated Hydrocarbons

These have only single bonds between carbon atoms. These are **alkanes**.

* Each carbon is bonded to as many hydrogens as possible.
* **Less reactive** because single bonds are strong and do not break easily.

Unsaturated Hydrocarbons

These hydrocarbons contain one or more double or triple bonds between carbon atoms.
These are **alkenes** and **alkynes**.

* The carbon atoms aren't fully bonded to Hydrogen; They have **space to bond more** hydrogens if the double or triple bonds are broken.
* **Double** and **triple bonds are weaker** than single bonds. so they break easily in chemical reactions. When the

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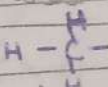
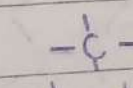
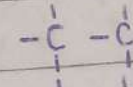
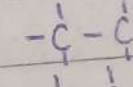
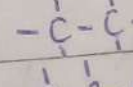
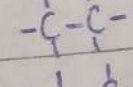
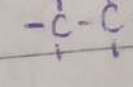
double or triple bonds breaks, new atoms (like hydrogen) can join, making them more reactive.

Differences

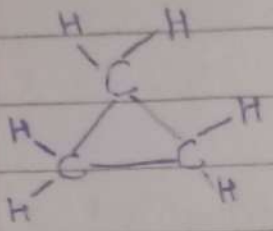
Property	Saturated	Unsaturated
Bond type	Single bonds only	Double or triple bonds
Activity	Less reactive	More reactive
Examples	Methane, Ethane	Ethene, Ethyne

SATURATED AND UNSATURATED HYDROCARBONS

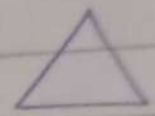
Name	Molecular Formula	Condensed Formula	Structural Formula
Methane	CH_4	CH_4	
Ethane	C_2H_6	H_3CCH_3	
Propane	C_3H_8	$H_3CCH_2CH_3$	
Butane	C_4H_{10}	$H_3C(CH_2)_2CH_3$	
Pentane	C_5H_{12}	$H_3C(CH_2)_3CH_3$	
Hexane	C_6H_{14}	$H_3C(CH_2)_4CH_3$	
Heptane	C_7H_{16}	$H_3C(CH_2)_5CH_3$	

CYCLOALKANE

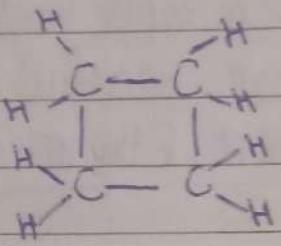
Foxomula : C_nH_{2n}



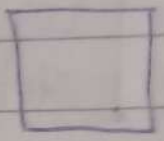
CYCLO PROPANE



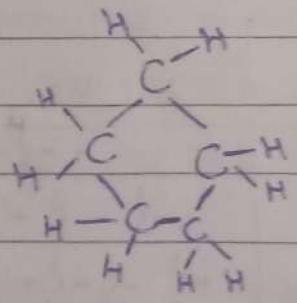
C_3H_6



CYCLO BUTANE

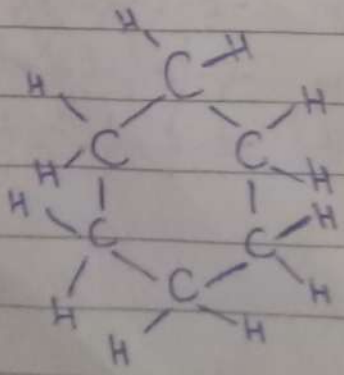


C_4H_8



CYCLO PENTANE

C_5H_{10}

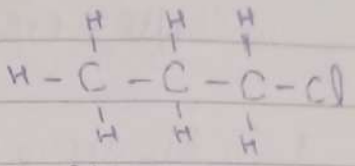


CYCLO HEXANE

C_6H_{12}

FUNCTIONAL GROUPS

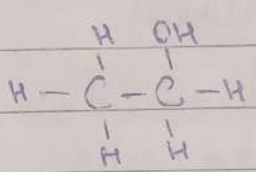
* Halogen
  - Cl — Chloro
  - Br — Bromo
  - I — Iodo



Chloropropane

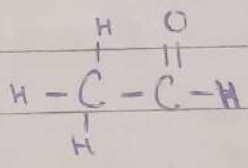
Substituted on the place of Hydrogen

* Alcohol
  Suffix - ol



Ethanol

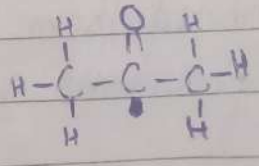
* Aldehyde
  Suffix - al



Ethanal

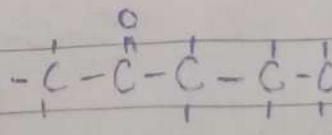
* This group (=O) comes either in the last or the first carbon.

* Ketone
  Suffix - one



Propanone

* This group (=O) should not come in the first or last. If it comes then it will be aldehyde.



Pentanone

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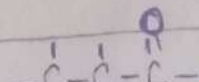
* Carboxylic acid

Suffix - oic acid

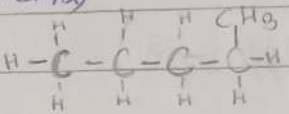


Propanoic acid

* In this group both alcohol and aldehyde are present.

* ALKYL GROUP

CH_4 (Methane) → CH_3 (Methyl) [Removal of 1 hydrogen] ane → yl



Methylbutane

Methyl — CH_3

Ethyl — C_2H_5

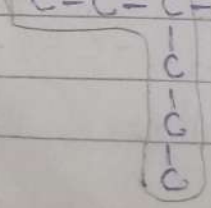
Propyl — C_3H_7

Butyl — C_4H_9

Formula : C_nH_{2n+1}

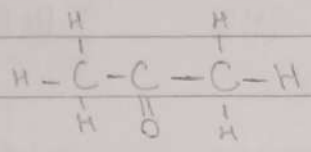
RULES FOR IUPAC NOMENCLATURE

1. Longest continuous carbon chain which include the functional group is selected; then the carbon chain is numbered from the end nearer to the functional group. Functional group get the least number.



3 ethyl Hexane

2. If the name of functional group is to be given as suffix, the name of carbon chain is modified by deleting final 'e' and adding the appreciate suffix.



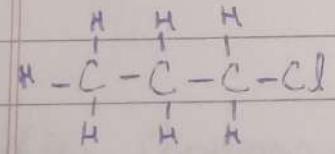
~~Propanone - e = propan~~

Propane - e = propan + one = propanone

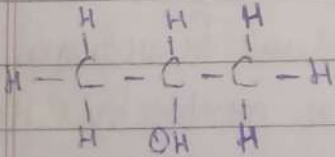
3. If the carbon chain is unsaturated then the final 'ane' in the name of the carbon chain is substituted by one oxyne.
*Unsaturated: Double / Triple bond

4. Functional group. 5. Alphabetic order.

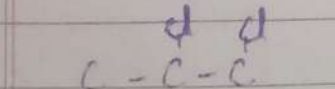
~~Examples~~ EXAMPLES



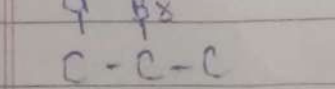
Chloro Propane



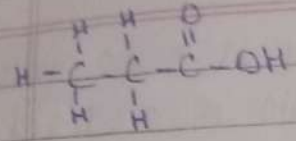
2 propanol / Propan-2-ol



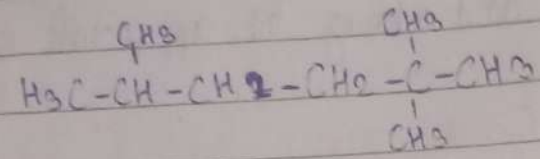
1,2, dichloro Propane



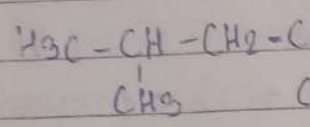
~~1, Chloro, 2 Bromo~~
2 Bromo, 1 Chloro Propane



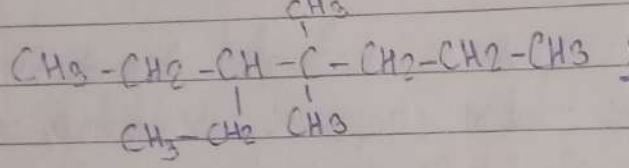
Propanoic acid



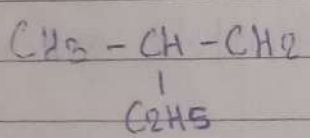
2-dieMethyl, 5Methyl Hexa



2,4-dieMethyl Pentane



3ethyl,4-diemethyl Heptane



2,4-diethyl Pentane

HOMOLOGOUS SERIES

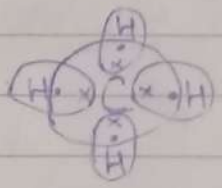
Homologous series is a series of compounds with similar chemical properties and same functional group differing from the successive member by CH_2.

Homologous Series

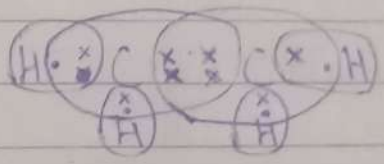
Alkanes	Alkynes	Alcohols
CH_4	C_2H_2	CH_3OH
C_2H_6	C_3H_4	C_2H_5OH
C_3H_8	C_4H_6	C_3H_7OH
C_4H_{10}	C_5H_8	C_4H_9OH
CH_2	CH_2	CH_2

LEWIS DOT STRUCTURE

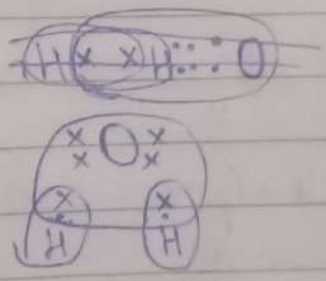
CH_4 (Methane) $\longrightarrow$



C_2H_4 (Ethene) $\longrightarrow$



H_2O $\longrightarrow$



Chemical properties of carbon compounds

1. Combustion Reaction

(i) $C + O_2 \longrightarrow CO_2 + \text{heat and light}$

(ii) $CH_4 + O_2 \longrightarrow CO_2 + H_2O + \text{heat and light}$

(iii) $CH_3CH_2OH + O_2 \longrightarrow CO_2 + H_2O + \text{heat and light}$

2. Oxidation Reaction

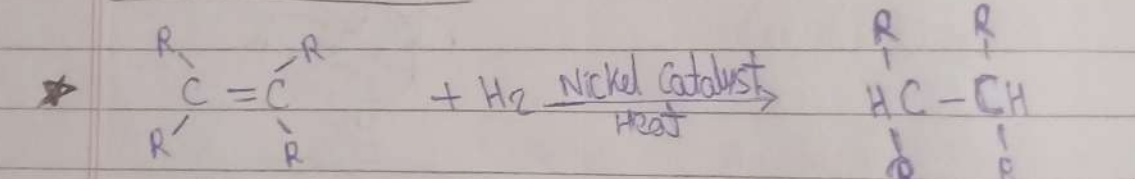
$$CH_3CH_2OH \xrightarrow[K_2Cr_2O_7]{KMnO_4} CH_3-\overset{O}{\overset{\|}{C}}-OH$$

(Ethanol)

$KMnO_4$ → Potassium Permanganate

$K_2Cr_2O_7$ → Potassium dichromate

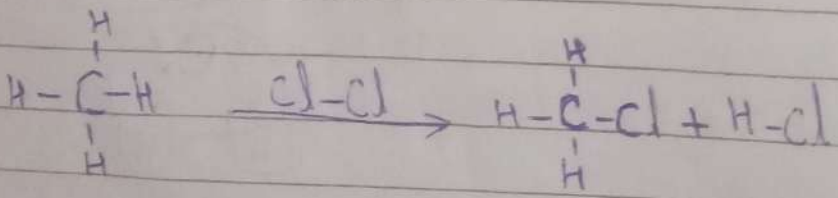
3. Addition Reaction



(Vegetable oil)
Unsaturated

(Vegetable ghee)
Saturated

4. Substitution Reaction



Ethanol

GROUP	Alcohol Family
MOLECULAR FORMULA	C_2H_5OH
NATURE	Neutral

* $C_2H_5-CH_2OH \xrightarrow{H_2SO_4} CH_2=CH_2 + H_2O$
(Ethanol) (Ethene)

$2Na + 2CH_3CH_2OH \longrightarrow 2CH_3CH_2O^-Na^+ + H_2$
Salt

ETHANOIC ACID

GROUP	Carboxylic Acid Family
MOLECULAR FORMULA	CH_3COOH
NATURE	Acidic

* Reaction of Ethanol with Ethanoic acid

$C_2H_5OH + CH_3COOH \underset{}{\overset{H_2SO_4}{\rightleftharpoons}} CH_3-\overset{O}{\overset{\|}{C}}-O-C_2H_5 + H_2O$
(Ethanol) (Ethanoic acid) (Ester)

* About reaction is also called Esterification reaction.
* Esters — Sweet smelling substances
* Ester = Ethyl Acetate

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Saponification Reaction

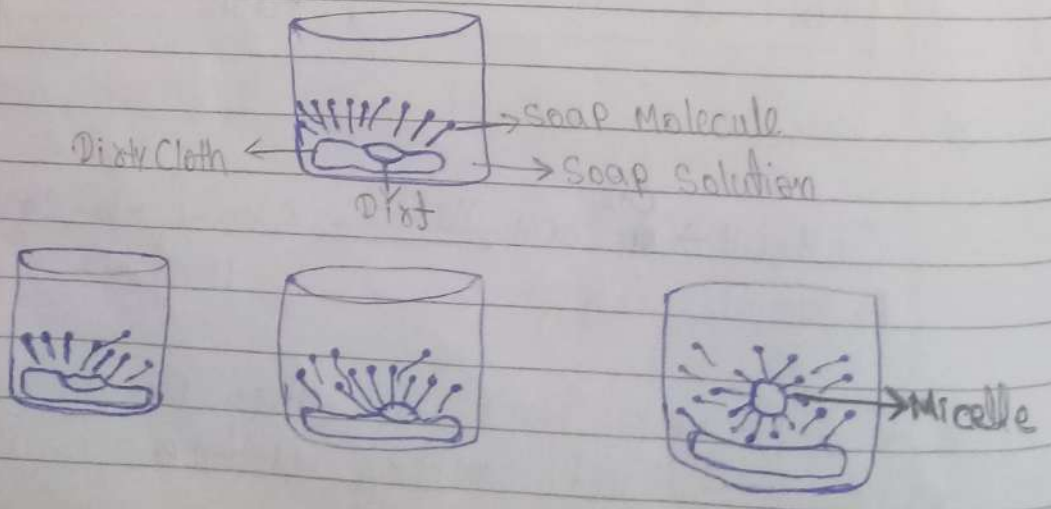
$CH_3COCH_2CH_3 + NaOH(aq) \rightarrow CH_3-C(=O)-ONa(aq) + C_2H_5OH$

(Ethyl Acetate) (Sodium Hydroxide) (Sodium Acetate) (Soap)

Distinguish between Soap and Detergent

Soap	Detergent
• Soaps works well in soft water.	Detergents works well both in soft and hard water.
• Biodegradable.	Non-biodegradable.
• They have relatively weak cleansing action.	They have strong cleansing action.

CLEANSING ACTION OF SOAP



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Saponification Reaction

$CH_3COCH_2CH_3 + NaOH(aq) \longrightarrow CH_3-C(=O)-ONa(aq) + C_2H_5OH$

(Ethyl Acetate) (Sodium Hydroxide) (Soap: Sodium Acetate)

Distinguish between Soap and Detergent

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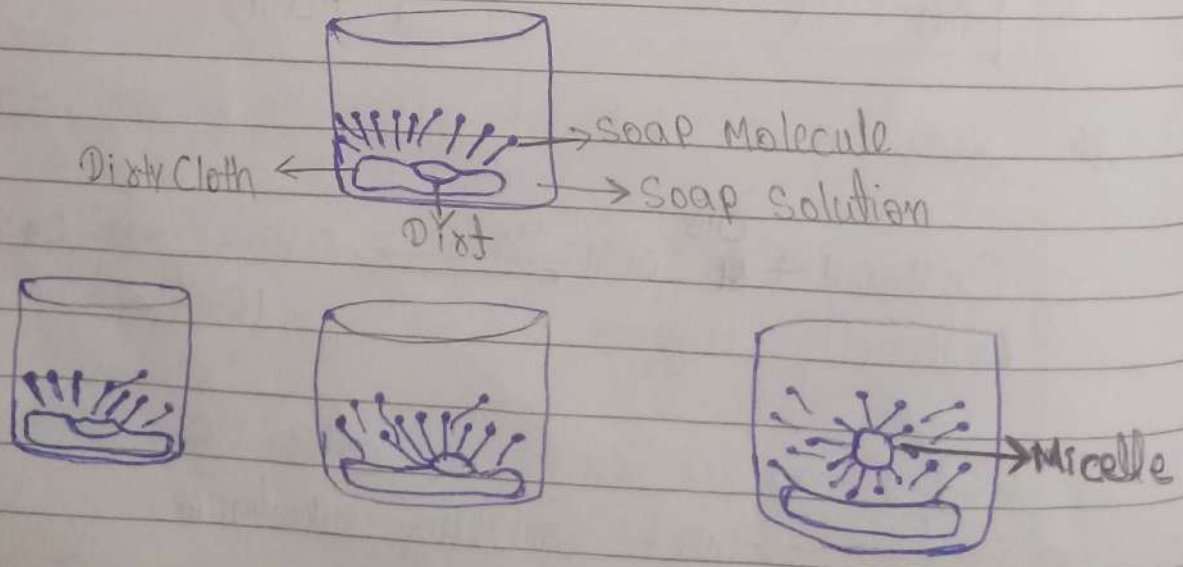
CLEANSING ACTION OF SOAP



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The cleansing action of soaps works as follows:

1. Soap has two parts:
   - Hydrophillic head (water-loving): sticks to water.
   - Hydrophobic tail (water-hating): sticks to oil or grease.
2. When soap is applied, the hydrophobic tails attatch to the grease or dirt, while the hydrophillic head stays in water.
3. This forms tiny structures called micelles, where the dirt gets trapped inside.
4. Rinsing with water washes away the micelles, removing the dirt and grease.

Why Soap doesn't work in hard water?

Soap doesn't work well in hard water because the minerals in hard water react with the soap to form an insoluble substance called soap scum.

Denatured Alcohol

Denatured alcohol is ethyl alcohol (ethanol) that has been made unfit for drinking by adding poisonous substances.