• CARBON AND ITS COMPOUNDS •

• Carbon is an element. The symbol of carbon is C. It is a non-metal. The name carbon is derived from the Latin word 'carbo' which means 'coal'.

• Carbon is the main constituent of coal

For ex – • **Earth crust** – only 0.02% carbon in form of minerals (like carbonates, coal and petroleum)

• **Atmosphere** – only 0.03% of carbon dioxide gas.

• Organic compounds – All the living thing, plant and animals are made up of carbon based compound.

• A large number of things which we use in our day life are made of carbon compounds.

• Ex – Food, wood, silk, nylon, LPG, CNG gas, drugs, plastics.

• It plays an important role in our daily life.

• We can test the presence of carbon in a material on the basis of the fact that carbon and its compound burn in air to give carbon dioxide gas which turns lime water milky.

• This test can be performed as follows –

• Burn the given material in air. Pass the gas formed through lime water

• If the lime water turns milky, then the given material contain carbon.

• Carbon always forms covalent Bonds –

• The atomic number of carbon is 6. Electronic configuration K 2, L 4

• Carbon has 4 electrons in the outermost shell.

• It is not possible to remove 4 electrons from a carbon atom to give it the inert gas electron arrangement.

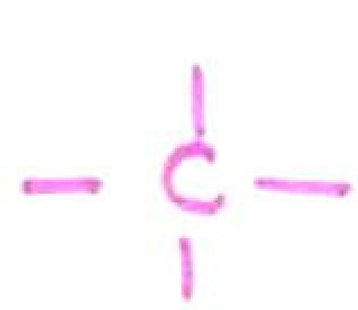
• It is also not possible to add as many as 4 electrons to carbon atom due to energy consideration and acquire inert gas configuration.

• They achieve stability by sharing of electrons, carbon always forms covalent bond.

• Carbon is Tetravalent –

• A carbon atom requires 4 electrons to achieve the eight-electron inert gas structure. Therefore valency of carbon is 4. That is carbon is tetravalent.

symbol –



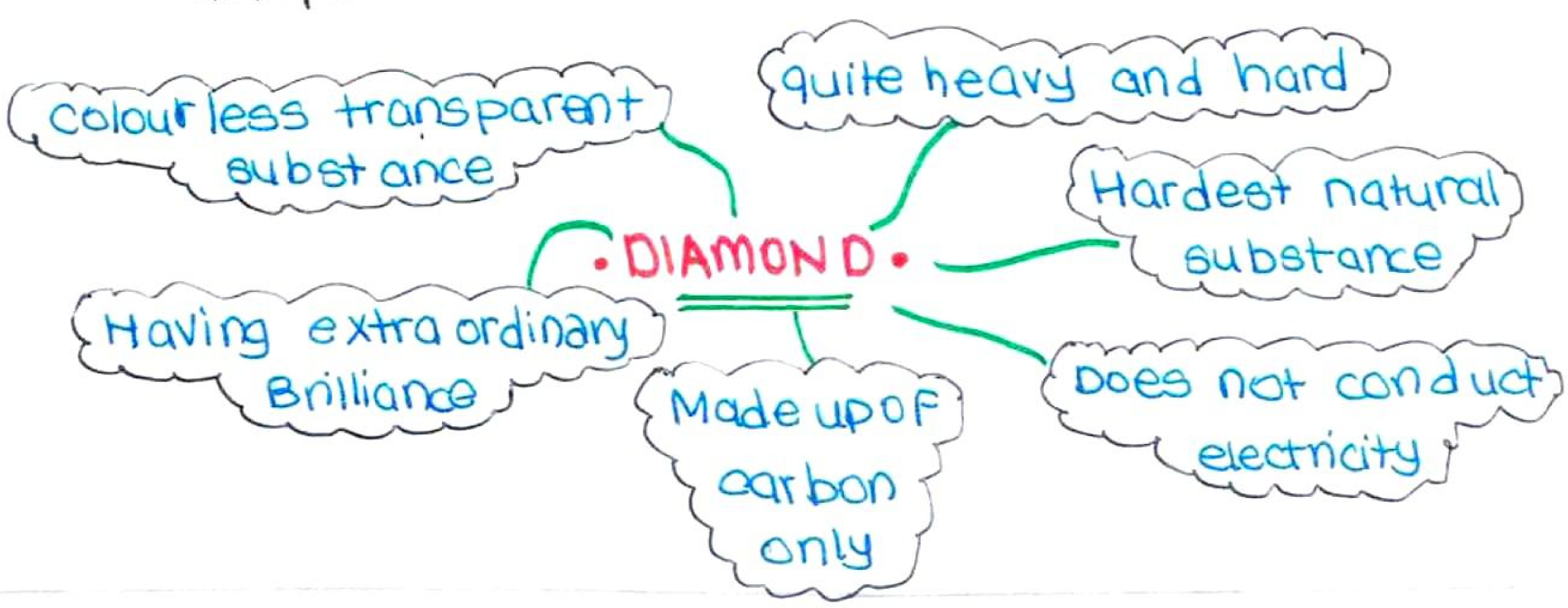
(By putting 4 lines)

- Self combination-
- The property of self combination of carbon atoms to form long chains is useful to us because it give rise to an extremly large number of carbon compound because a long chain of carbon atom act as a backbone.
- The formation of strong bonds by carbon atoms among themselves and with other element makes the carbon compounds exceptionally stable.
- The property of self combination known as- catenation.
- Silicon show some catenation property due to which it form compounds with hydrogen having chains of up to seven or eight silicon atoms. But due to weak bonds, these compounds are unstable.

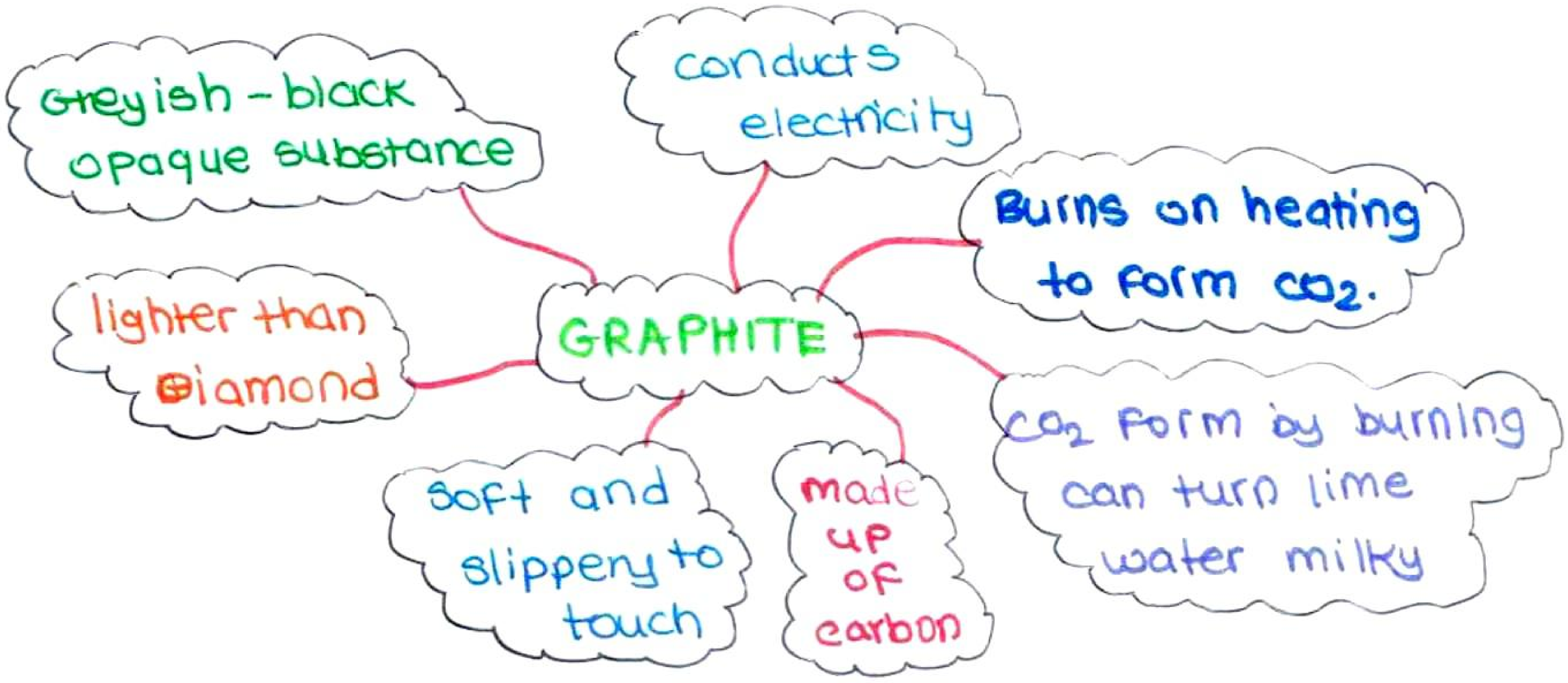
- **Occurrence of carbon-**
- carbon occurs in nature in "Free state" as well as in "combined state".
- Free state- carbon occurs in nature mainly in two forms-
- Diamond • Graphite
- Naturally occuring form of carbon is- Buckminster fullerene.
- combined state-
- carbon dioxide gas in air.
- carbonates (limestone, marble, chalk)
- Fossil Fuels (coal, petroleum)
- organic compound (protein, Fats, carbohydrate)

- **Allotropes of carbon-**
- The physical forms in which an element can exist are called allotropes of carbon.
- Three allotropes-
- Diamond • Graphite • Buckminster Fullerence (new)

  ↳ • olds alltrope ← (Diamond, Graphite) • allotropes (Buckminster Fullerence)



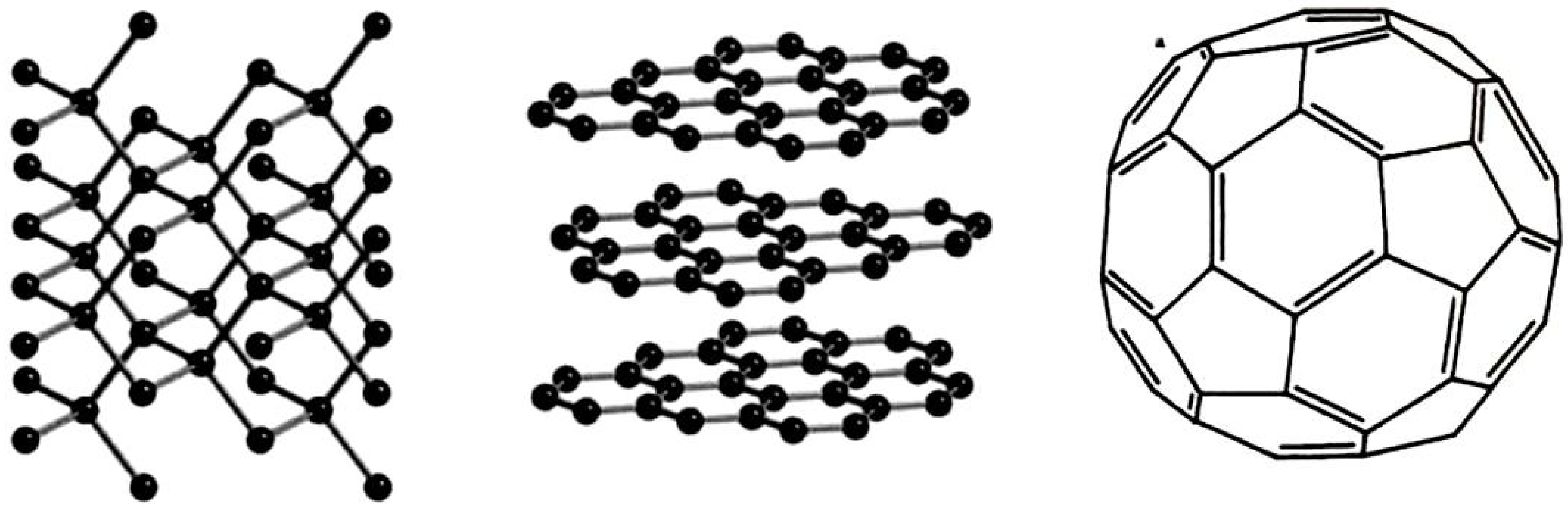
- Diamond burns on strong heating to form carbon dioxide if we burn diamond in oxygen, then CO_2 is left behind.
- The CO_2 formed by burning diamond can turn lime water milky.



- Structure of Diamond-
- A Diamond crystal is a gaint molecule of carbon atoms.
- Each carbon atom in the diamond crystal is linked to four other carbon atom by strong covalent bond.
- The four surrounding carbon atoms are at the four vertices of a regular tetrahedron.
- The diamond crystal, is therefore, made up of carbon atoms which are powerfully bonded to one another by network of covalent bonds. due to this diamond is very rigid.
- Diamond crystal has a tetrahedral arrangement of c atoms. due to 3D arrangement it gives it a high density.
- Diamond does not conduct electricity - bcoz of no free electron in a diamond crystal.

- STRUCTURE OF GRAPHITE-
- Each carbon atom in a graphite layer is joined to three other carbon atoms by strong covalent bonds to form flat of hexagonal rings.
- The various layer of carbon atom in graphite are held by weak van der Waals forces. due to weak forces, the sheet like structure, graphite is comparatively soft substance, which makes useful as dry lubricant for machine parts.
- Graphite is a good conductor of electricity due to presence of free electron in graphite crystal.

A New Form of Carbon



Diamond   Graphite C_{60} Buckyball

Uses of Diamond

- Used in cutting instruement like glass cutters → For cutting marble
- sharp edge diamond use for eye surgeon as tool to remove cataract from eye
- Manucfature of fine wire those used in toaster
- Diamond 'dies' are used for drawing thin wire like tungsten filament of Bulb.
- Used for making jewellery due to brilliance

Uses of Graphite

- Used as lubricant for fast moving parts of machinery — used as graphite powder
- Due to property of black substance
  - Used in making pencil leads
  - Graphite is usually mixed with clay
- carbon brushes of electric motor
- The black electrode in the dry cell is made of graphite as it is a good conductor of electricity

- Buckminster Fullerence -
- An allotrope of carbon containing cluster of 60 carbon atom joined together to form spherical molecules.
- The formula - C_{60} - 60 carbon atoms.
- Football - shaped spherical molecule in which 60 carbon atoms are interlocked hexagonal and pentagonal rings.
- 20 hexagon, 12 pentagon of carbon atoms. in one molecule of Buckminster Fullerence.
- Named after the American archiet Buckminister Fuller because its structure resembled the frame work of dome shaped halls designed by Fuller for large international exhibition.
- Buckminster Fullerene is a dark solid at room temperature.
- It neither very hard nor soft.

- ORGANIC COMPOUNDS-
- The compounds of carbon known as organic compound.
- Most of the organic compound are hydrocarbon - only hydrogen and carbon.
- Examples - Methane - CH_4 Ethane - C_2H_6 Ethene - C_2H_4 Ethanol - C_2H_5OH CH_3COOH - Ethanoic acid.
- The low melting point and boiling point of the above carbon compound show that the forces of attraction between their molecules are not very strong. so they are covalent compound.
- carbon compound are non-conductor of electricity as they do not contain ions.
- organic compounds occurs in living things likes plant and animals.
- Theory of organic compound was disproved by - Freidrich wohler in 1828.
- urea is an organic compound which was thought to be made inside the body of living being only.
- Wohler proposed the organic compound urea ($CO(NH_2)_2$) in the labratory from inorganic compound 'ammonium cynate' (NH_4CNO).
- This lead to the rejection of vital force theory for synthesis of organic compound.

- The study of carbon compounds is called - ORGANIC CHEMISTRY
- Though oxides of carbon, carbonate and carbides are also carbon compound but they are not considered to be organic compound.

• Reason for the large amount or number of organic compounds -

• Two characteristics -

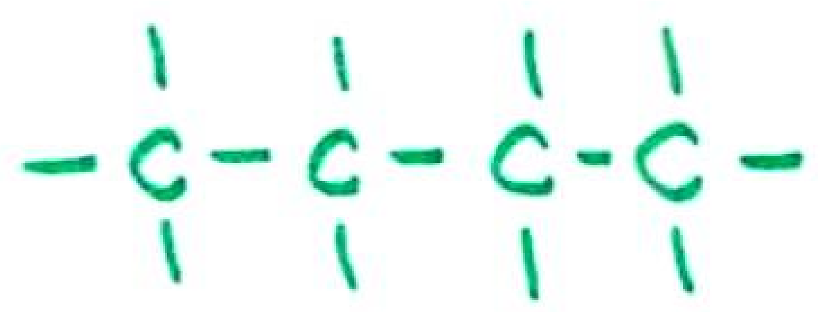
• Catenation (self linking) • Tetravalency (four valency).

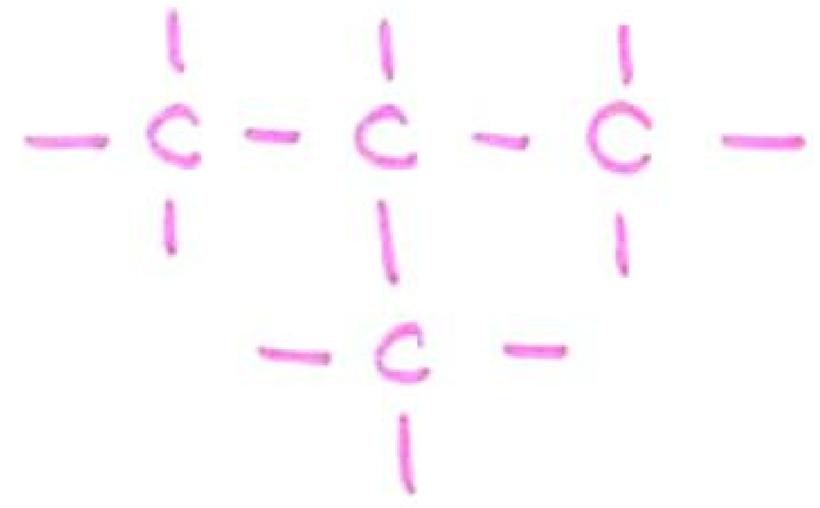
• carbon atoms linked with one another by means of covalent bond to form long chain of carbon atoms -

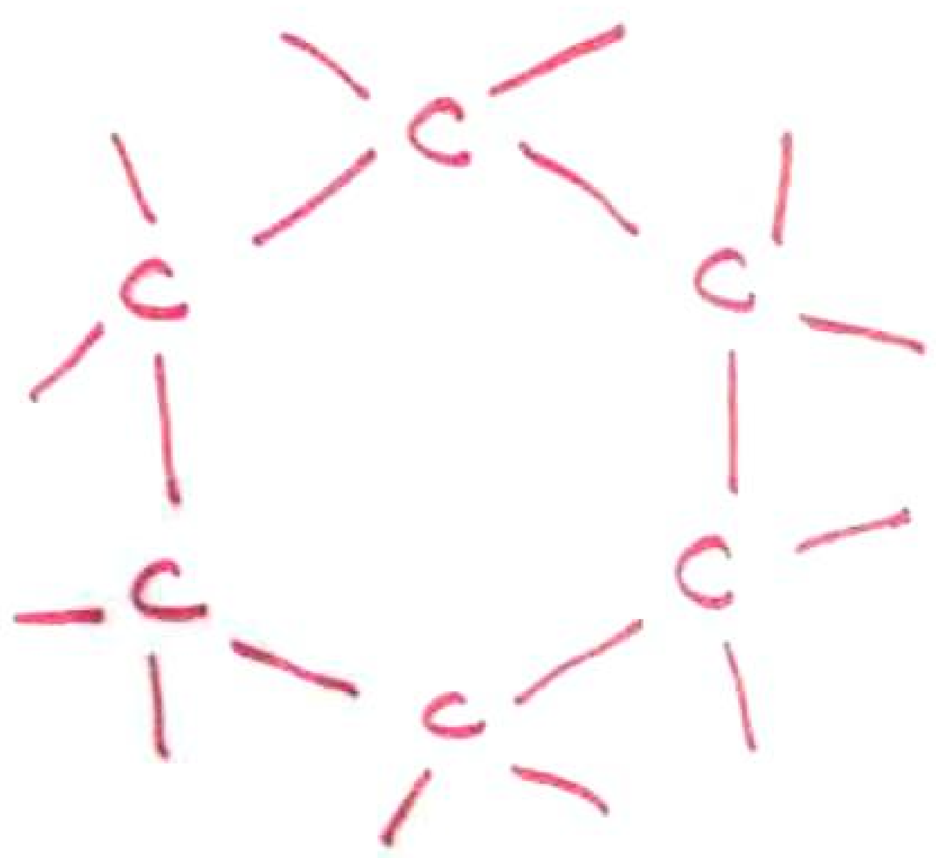
• The property of carbon element due to which atoms can join with one another to form long carbon chains - called catenation.

• three types of chains formed -

• straight chain • branched chain • ring type chain.







• Tetravalency -

The existence of large number of organic compounds is that the valency of carbon is 4 (which is quite large). Due to its large valency of 4, a carbon atoms form covalent bond.

• TYPES OF ORGANIC COMPOUNDS -

• common types -

• Hydrocarbon • Haloalkane • Alcohol • Aldehyde

• Ketone • carboxylic acids

• HYDROCARBON - (Hydrogen + carbon = Hydrocarbon)

• A compound made up of hydrogen and carbon is called Hydrocarbon.

• The most important natural source of hydrocarbon is petroleum or (crude oil), which is obtained from underground oil deposits by drilling oil wells.

• TYPES OF HYDROCARBON -

• saturated hydrocarbon • unsaturated hydrocarbon.

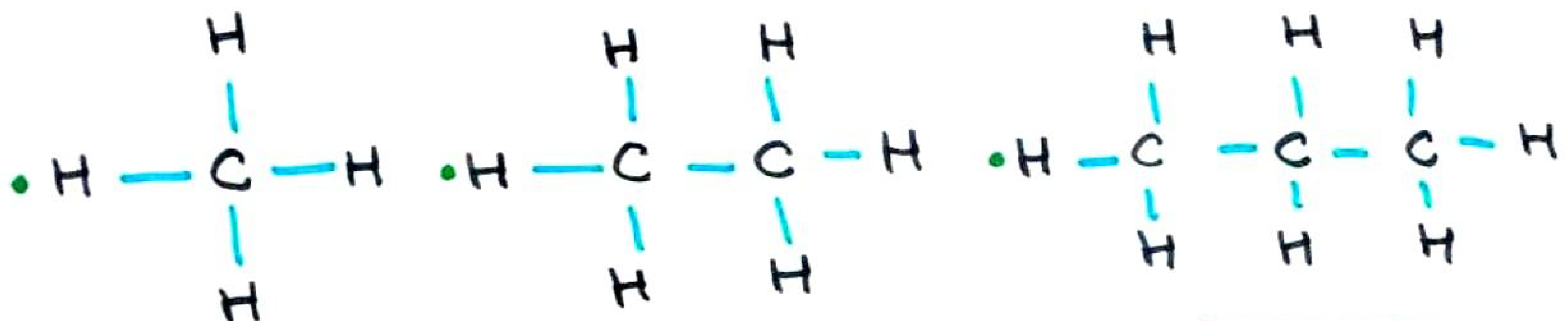
• Saturated hydrocarbon - (Alkanes)

• A hydrocarbon in which the carbon atoms are connected by only single bonds.

- An alkane is a hydrocarbon in which the carbon atom are connected by only single covalent bond (there are no double or triple bond in an alkane).
- Ex- The hydrocarbons methane, ethane, propane formed a series of compound known as alkane.
- The suffix at end of alkane is - 'one'
- The general formula of alkane is - C_nH_{2n+2}
- Where n is the number of carbon atoms in one molecule of the alkane.
- If an alkane has 1 carbon atom in its molecule, then n=1 and its molecular formula will be - $C_1H_{2\times1+2}$ = CH_4 (methane)
- If an alkane has 2 carbon atom in its molecule, then n= 2 and its molecular formula will be - $C_2H_{2\times2+2}$ or C_2H_6

• Name of alkane	• No. of carbon atoms	• Molecular formula
• Methane	• 1	• CH_4
• Ethane	• 2	• C_2H_6
• Propane	• 3	• C_3H_8
• Butane	• 4	• C_4H_{10}
• Pentane	• 5	• C_5H_{12}

- Structural formula-



• Methane • Ethane • Propane

- The saturated hydrocarbon are chemically not very reactive. They are quite un reactive.
- Unsaturated Hydrocarbon (Alkenes and Alkynes) -
- A hydrocarbon in which the two carbon atoms are connected by a double and triple bond is called unsaturated hydrocarbon.

• $CH_2 = CH_2$ • Ethene

• $CH \equiv CH$ • Ethyne

- Bcoz ethene contains double bond and ethyne contains triple bond.
- The unsaturated hydrocarbon are obtained mostly from petroleum by process called cracking.

Alkenes-

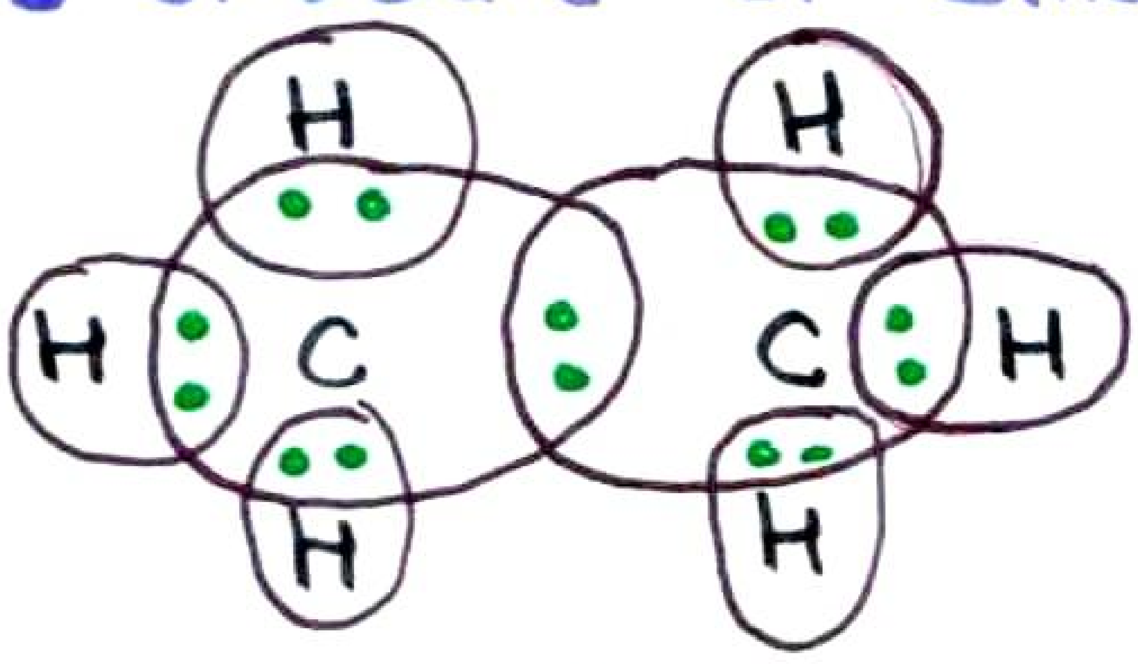
- An unsaturated hydrocarbon in which the two carbon atoms are connected by a double bond.
- Alkene contains - $>C=C<$ group.
- Ethene and propene are two alkene because they contain double bond between two carbon atoms.
- There can be no alkene having only one carbon.
- **The general formula of alkene is C_nH_{2n}.**
- The common name of ethene is Ethylene

Name of alkene	No. of C atoms	Molecular for.
Ethene	2	C_2H_4
Propene	3	C_3H_6
Butene	4	C_4H_8

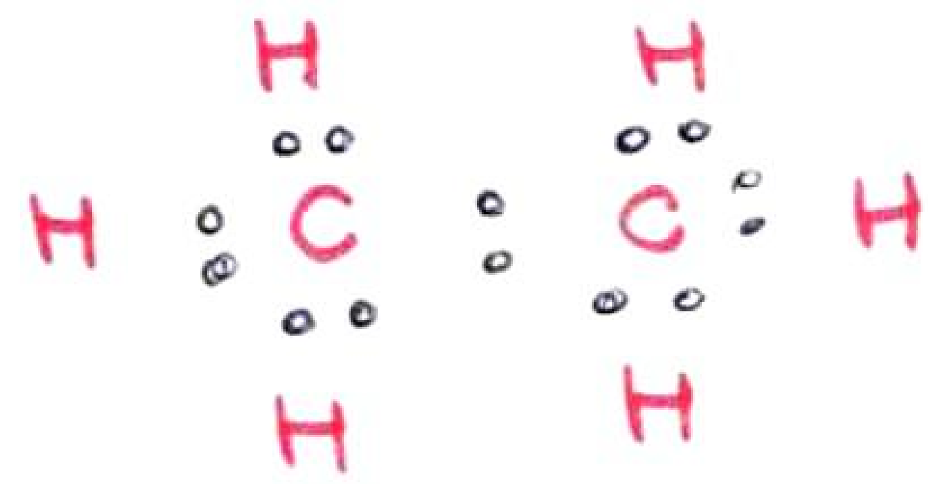
Alkynes-

- An unsaturated hydrocarbon in which the two carbon atoms are connected by triple bond.
- Alkynes contains —— $C\equiv C$ ——
- Ethyne, propyne and Butyne are alkynes because they contain triple bond between two carbon atoms.
- There is no alkyne having only one carbon atom.
- General formula of allkynes is - C_nH_{2n-2}.
- The common name of alkynes is - Acetylene.
- unsaturated hydrocarbons are more reactive than saturated hydrocarbons.
  - Unsaturated hydrocarbon > Saturated hydrocarbon
- Alkene and Alkynes are chemically more reactive than Alkane.
  - Alkene, Alkynes > Alkane

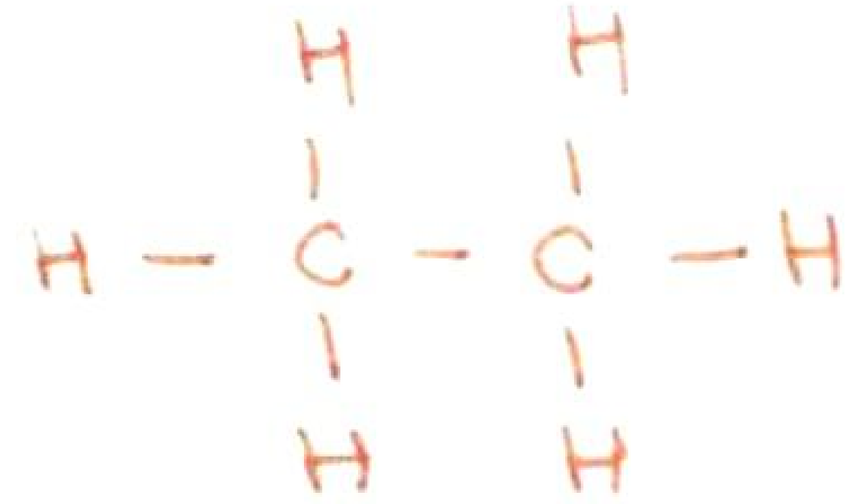
- Ethane, ethene, ethyne are covalent molecules which are formed by sharing of electrons between various atom.
- structure of ethane molecule - C_2H_6



C_2H_6

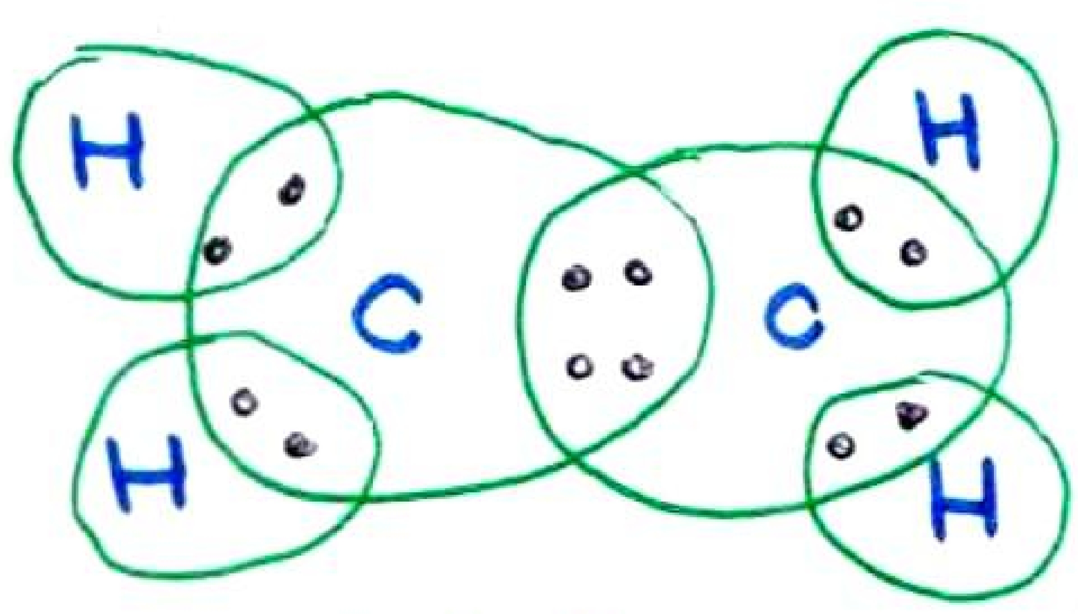


- Electron dot structure



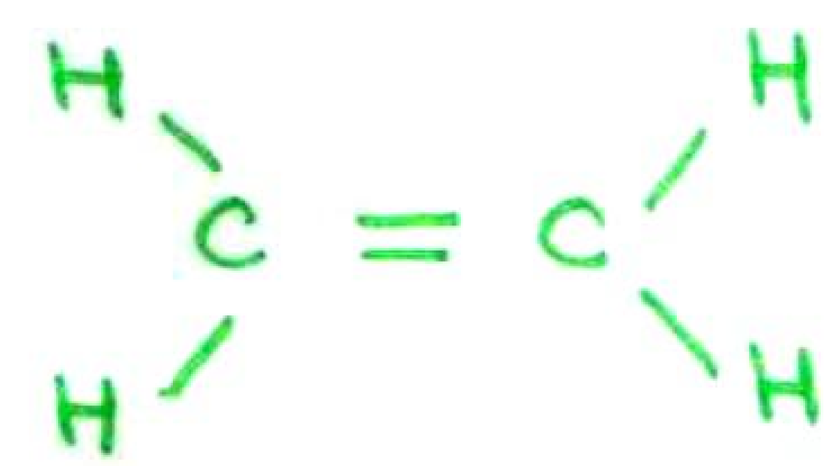
structural Formula

- In ethane → 1 carbon - carbon single bond and 6 carbon-hydrogen single covalent bonds so- number of covalent bond in ethane molecule is - $1 + 6 = 7$
- Structure of ethene molecule - C_2H_4



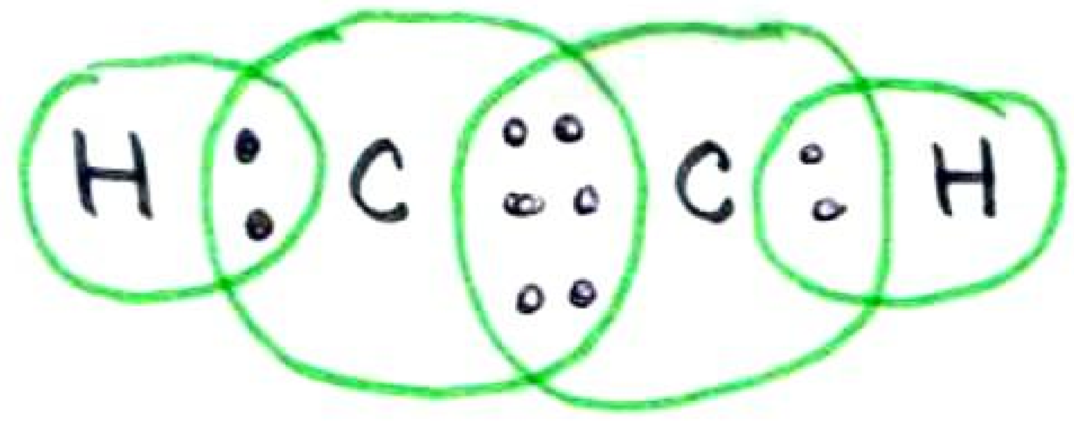
- C_2H_4

- Electron dot structure



- structural formula.

- In ethene, the total number of carbon - hydrogen single bonds in ethene is - $2 + 2 = 4$
- structure of ethyne molecule - C_2H_2



C_2H_2

H:C⋮⋮C:H

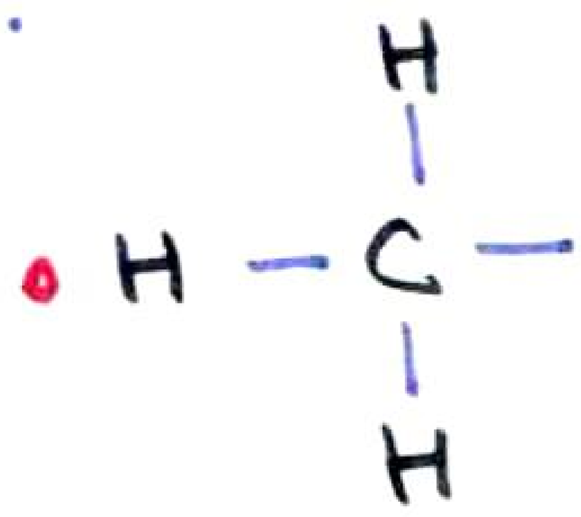
- Electron dot structure

$H - C \equiv C - H$

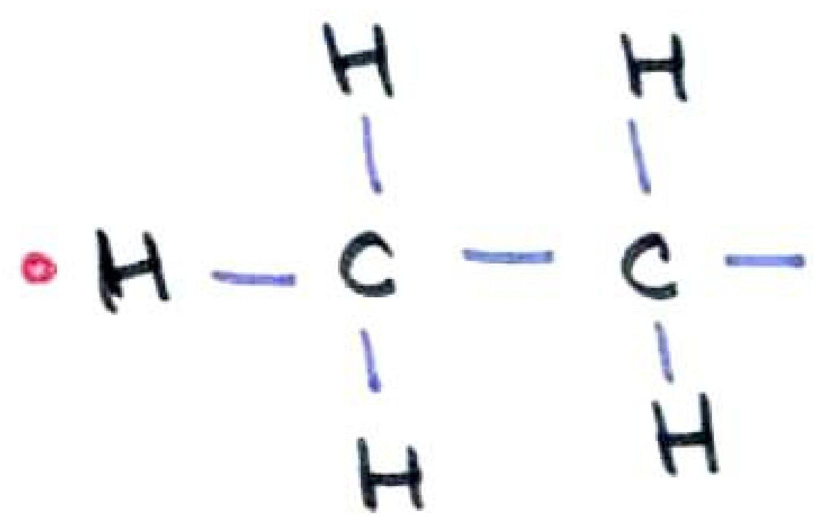
- structural Formula

- single bond - 2 dots
- Double bond - 4 dots
- Triple bond - 6 dots.
- **Alkyl Groups-**
- The group formed by the removal of one hydrogen atom from an alkane molecule.
- Ex - Methyl group (CH_3-) and ethyl group (C_2H_5-)
- Methyl group (CH_3-) is formed by the removal of one H atom from methane (CH_4).

- Ethyl group (C_2H_5-) is formed by the removal of one H atom from ethane (C_2H_6).
- The structural formula of the methyl and ethyl group are given on right hand side.
- Free line (—) show on the carbon atom of an alkyl group means that the one valency of carbon atom is free in an alkyl group.
- The general formula of an alkyl group - C_nH_{2n+1}, denoted by letter R.



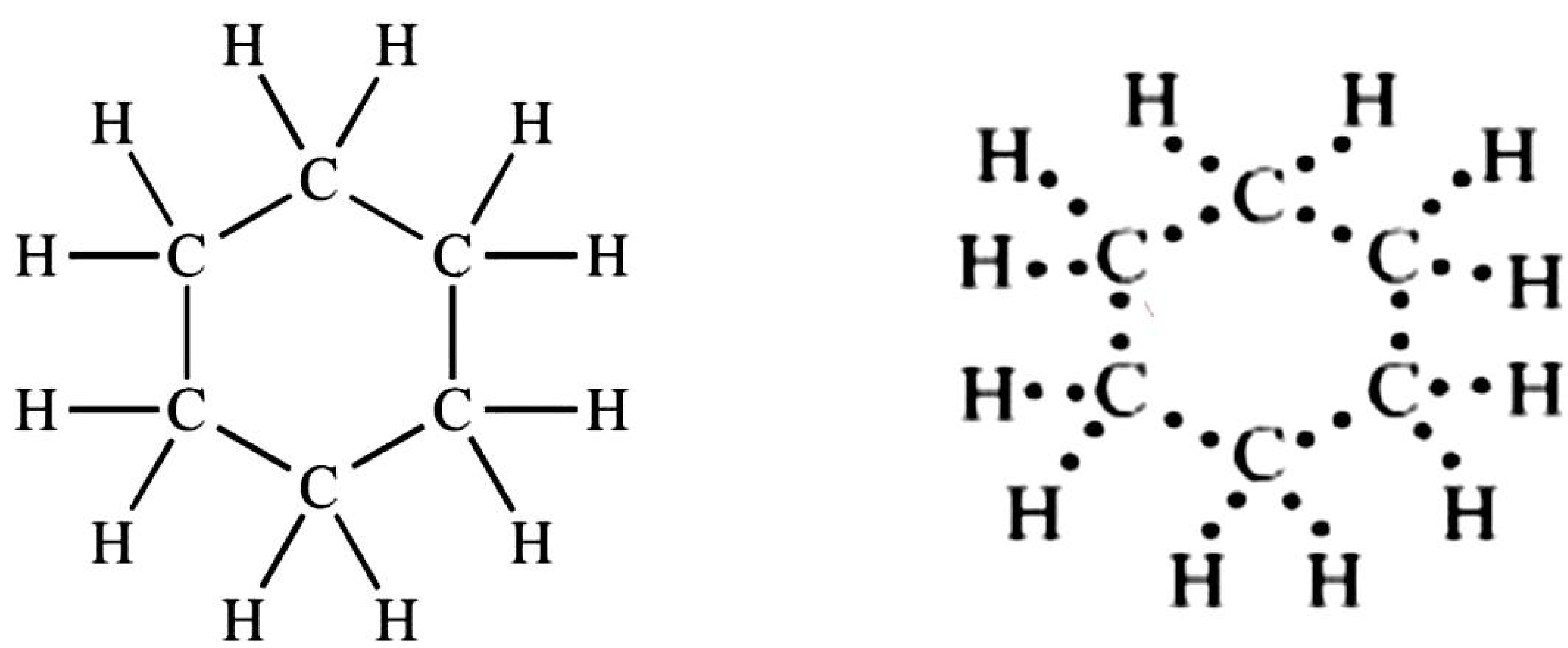
- Methyl group



- Ethyl group

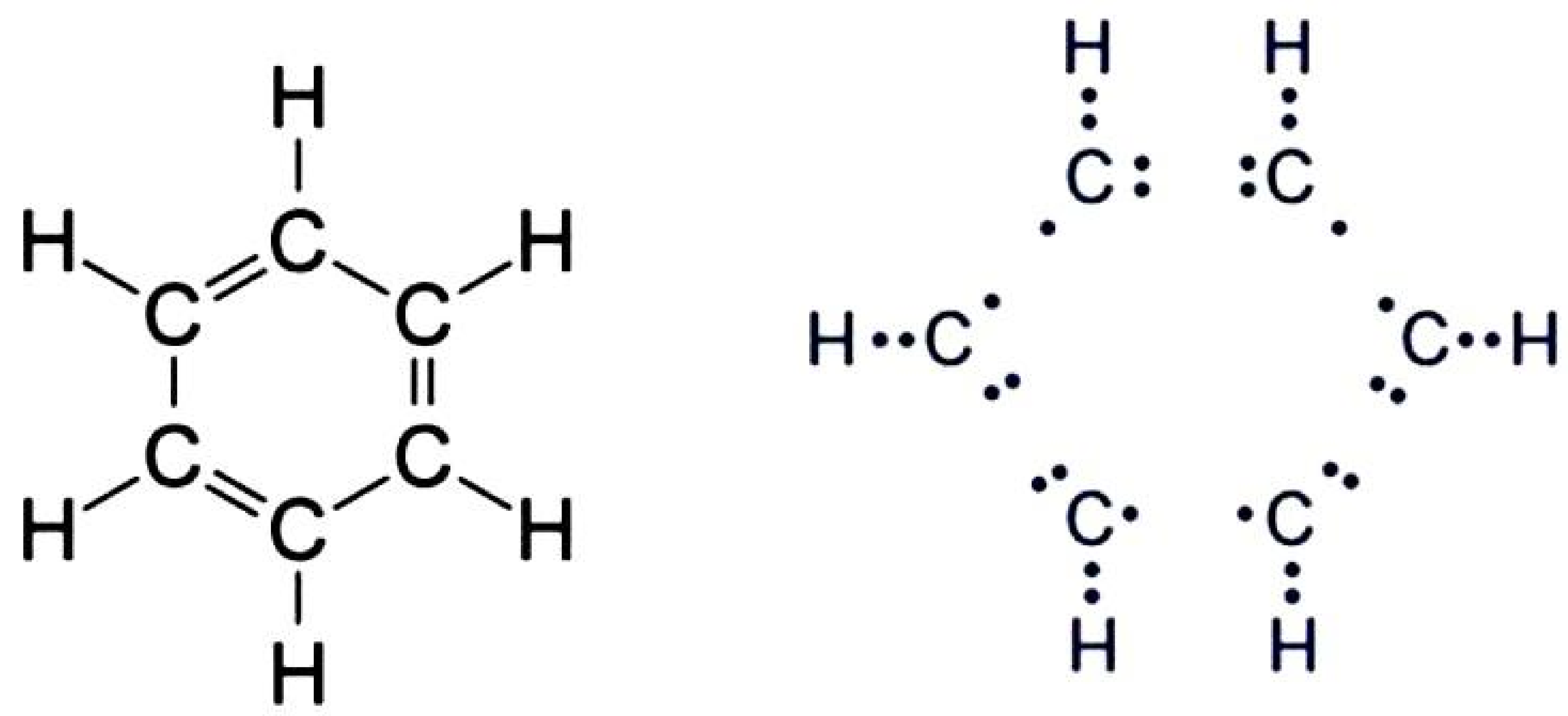
• CYCLIC HYDROCARBON -

- The hydrocarbon in which the carbon atom are arranged in form of a ring. such hydrocarbon is called cyclic hydrocarbon.
- It can be saturated or unsaturated.
- A saturated cyclic hydrocarbon is 'cyclohexane'.
- Formula of cyclohexane - C_6H_{12}.
- The electron dot structure of cyclohexane has been obtained by putting two electron dots in place of every single bond this is because every single bond consist of two shared electron.
- The saturated cyclic hydrocarbon are called - 'cycloalkane'
- cycloalkane having 3 carbon atom in ring - cyclopropane (C_3H_6)
- cycloalkane having 4 carbon atom in ring - cyclobutane (C_4H_8)
- The general formula of cycloalkane is - C_nH_{2n}.



STRUCTURAL FORMULA OF CYCLOHEXANE & ELECTRON DOT STRUCTURE

- An unsaturated cyclic hydrocarbon is benzene-
- Formula is benzene - C_6H_6
- A molecule of benzene is made up of 6 carbon atoms and 6 hydrogen atom.
- 3 carbon - carbon double bond. and 3 - carbon - carbon single bond and. 6 carbon - hydrogen single bonds.
- The unsaturated cyclic compounds like benzene are called - Aromatic compound.



Benzene (C_6H_6)

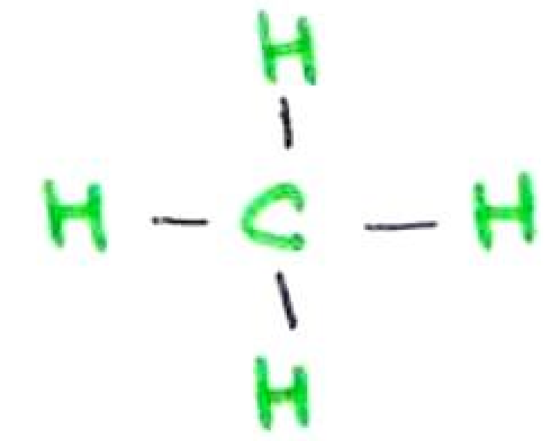
- Naming of Hydrocarbon-
- The official name or systematic name of organic compound were given by - **IUPAC- International unioun of pure and Applied chemistry.** in 1958, so they are called IUPAC nomenclature. and common name.
- The number of carbon atom in a hydrocarbon is indicated by using the following stems-
- one carbon atom is indicating by writing - 'Meth'
- Two carbon atom is indicating by writing - 'Eth'
- Three carbon atom is indicating by writing - 'Prop'
- four carbon atom is indicating by writing - 'But'
- Five carbon atom is indicating by writing - 'Pent'
- six carbon atom is indicating by writing - 'Hex'
- Seven carbon atom is indicating by writing - 'Hept'
- Eight carbon atom is indicating by writing - 'oct'
- Nine carbon atom are indicating by writing - 'Non'
- Ten carbon atom is indicating by writing - 'Dec'
- Prefix of alkane (single bond) - 'ane'
- Prefix of alkene (double bond) - 'ene'
- Prefix of alkyne (triple bond) - 'yne'

• Naming of saturated hydrocarbon -

1. Naming of CH_4 -

- 1 carbon atom indicate - meth, all single bond so, it is saturated
- The compound hydrocarbon is indicated by ending - ane.
- on joining 'meth' and 'ane' - meth + ane - methane.

CH_4
Methane

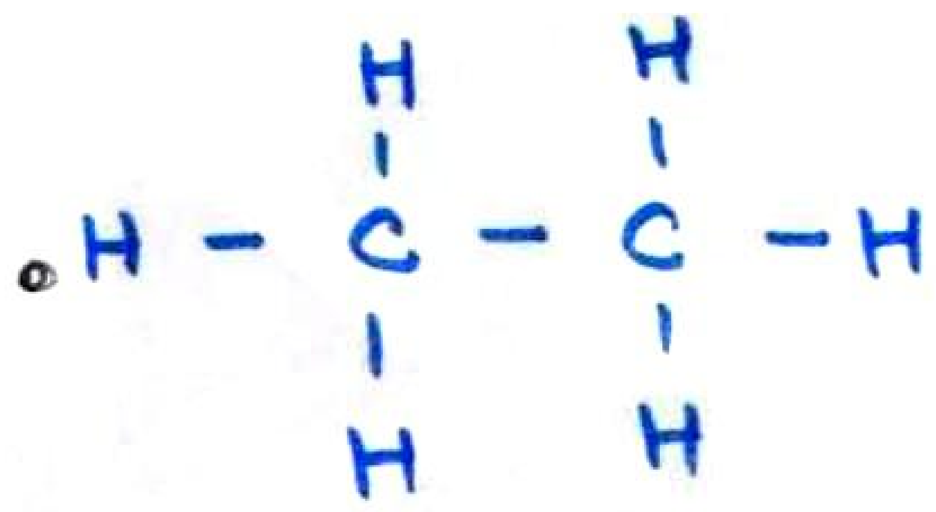


IUPAC - Methane
common name - Methane

2. Naming of C_2H_6 -

- 2 carbon atom indicate - eth
- The saturated hydrocarbon is indicated by using the suffix or ending 'ane'.
- Now joining 'eth' and 'ane' - ethane
- IUPAC name - Ethane   common name - Ethane.

C_2H_6
Ethane

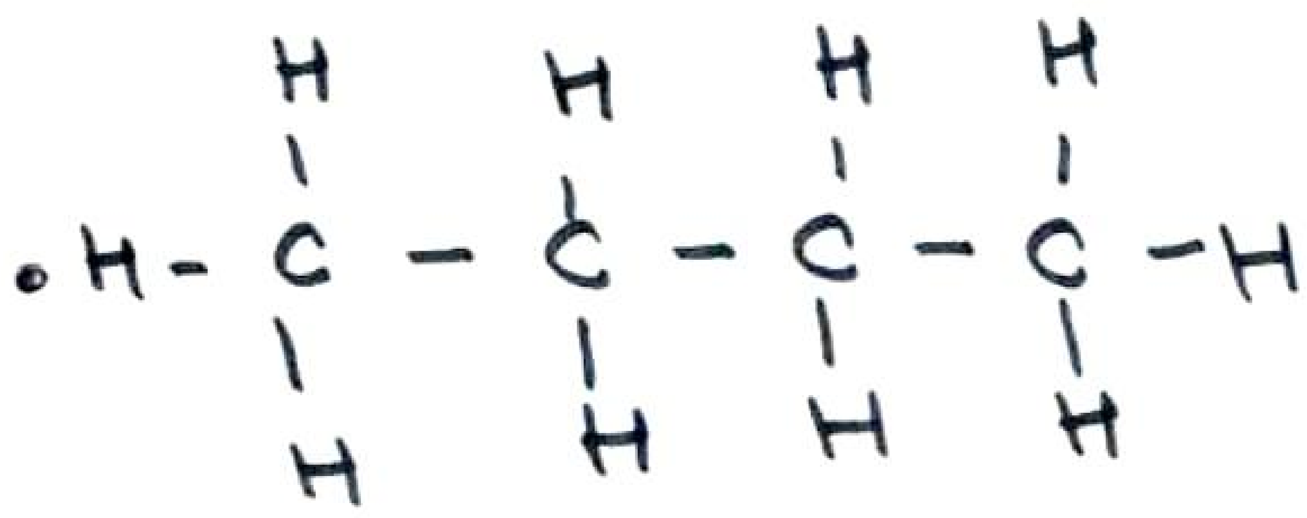


or $CH_3 - CH_3$
• condensed Formula.

• Naming of C_4H_{10} -

- 4 carbon atoms indicate - but
- Now joining 'but' and 'ane' - butane
- IUPAC name - Butane   • common name - n-butane

• C_4H_{10}
• Pentane



or • $CH_3-CH_2-CH_2-CH_2-CH_3$
• condensed Formula

• n-pentane

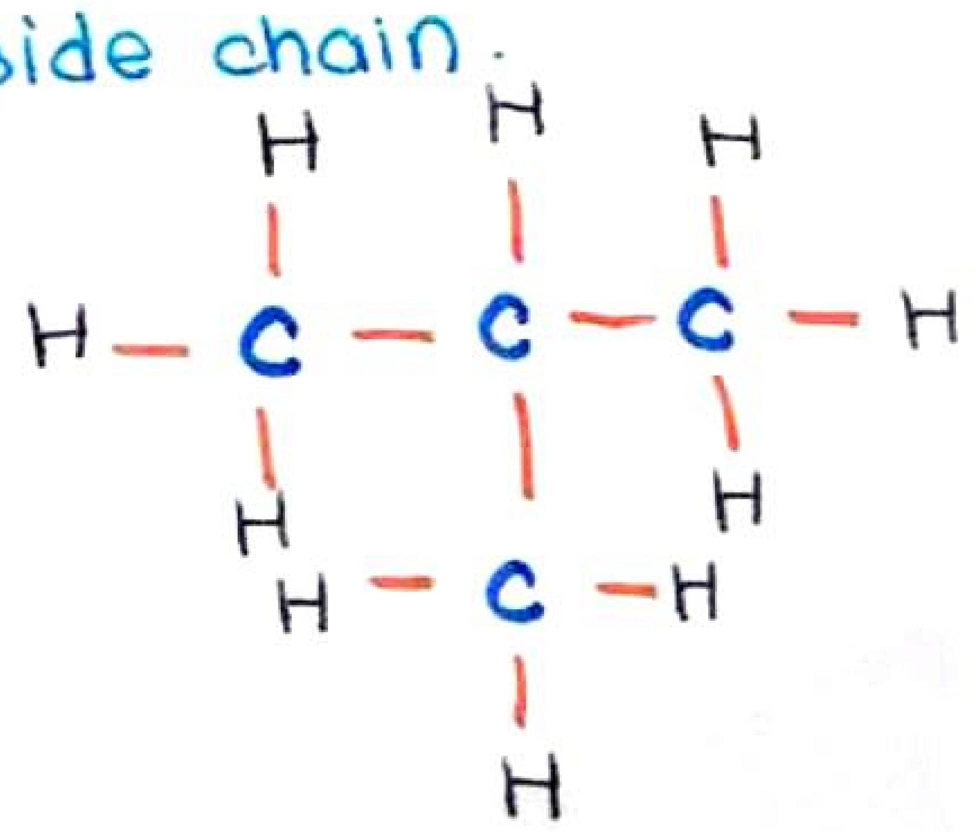
• IUPAC nomenclature For Branched - chain saturated hydrocarbon -

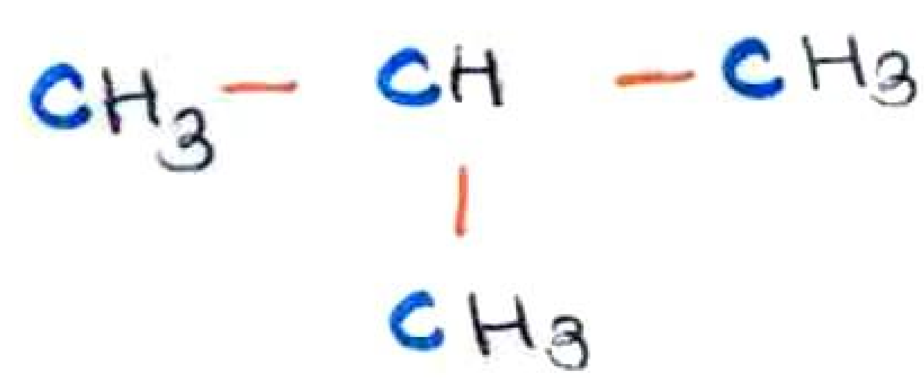
• Result -

• The longest chain of carbon atoms in the structure of the compound is found first. The compound is the named as derative of the alkane hydrocarbon which corresponds to the longest chain of carbon atoms. (Parent hydrocarbon).

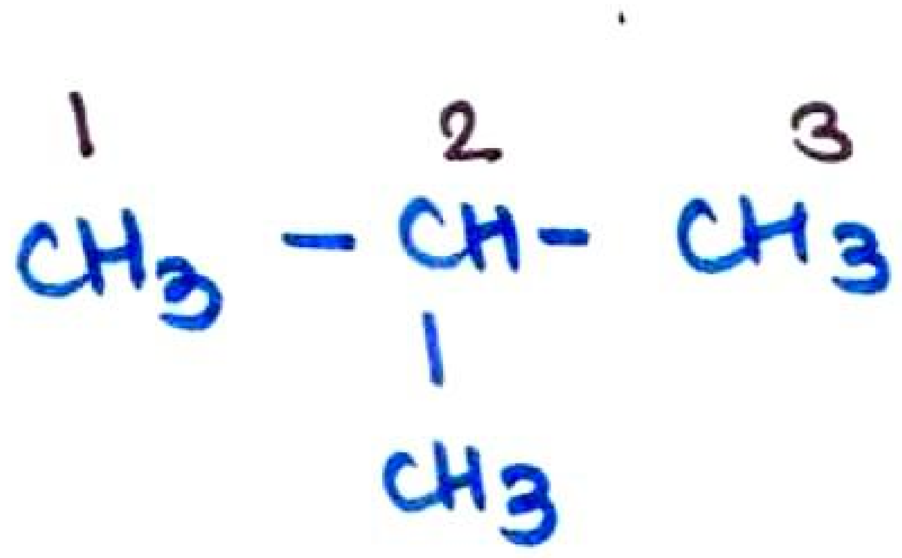
- The alkyl groups present as side chains are considered as substituents and named seperately as methyl (CH_3-) or ethyl (C_2H_5-) groups
- The carbon atoms of the longest carbon chain are numbered in a such way that the alkyl group get the lowest possible number (smallest possible number).
- The position of alkyl group is indicated by writing the number of carbon atom to which it is attached.
- The IUPAC name of the compound is obtained by writing the position and name of alkyl group just before the name of parent hydrocarbon.

- **C_4H_{10} - Butane -**
- Three atoms in the straight chain and the fourth carbon atom in the side chain.



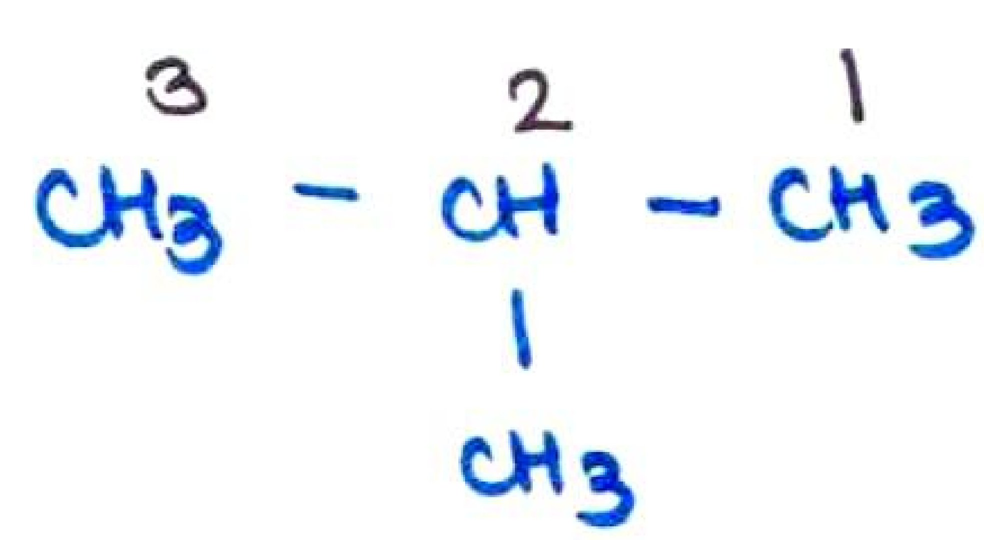


- There are 3 carbon in straight chain so, it is propane. so it is compound is to be named as derivative of propane.
- one methyl group (CH_3) is present in the side chain of propane so, the above compound is - **methyl derivative of propane.**
- The carbon chain in such a way that the methyl group gets the lowest possible number.
- Here we number the chain from left to right or right to left the position of methyl group remain the same.
- The methyl group falls on carbon number 2, so it is actually as '2 methyl group.
- If we join '2 methyl' and 'propane' - The IUPAC name becomes - **2 methyl propane**. The common name isobutane.



left to right

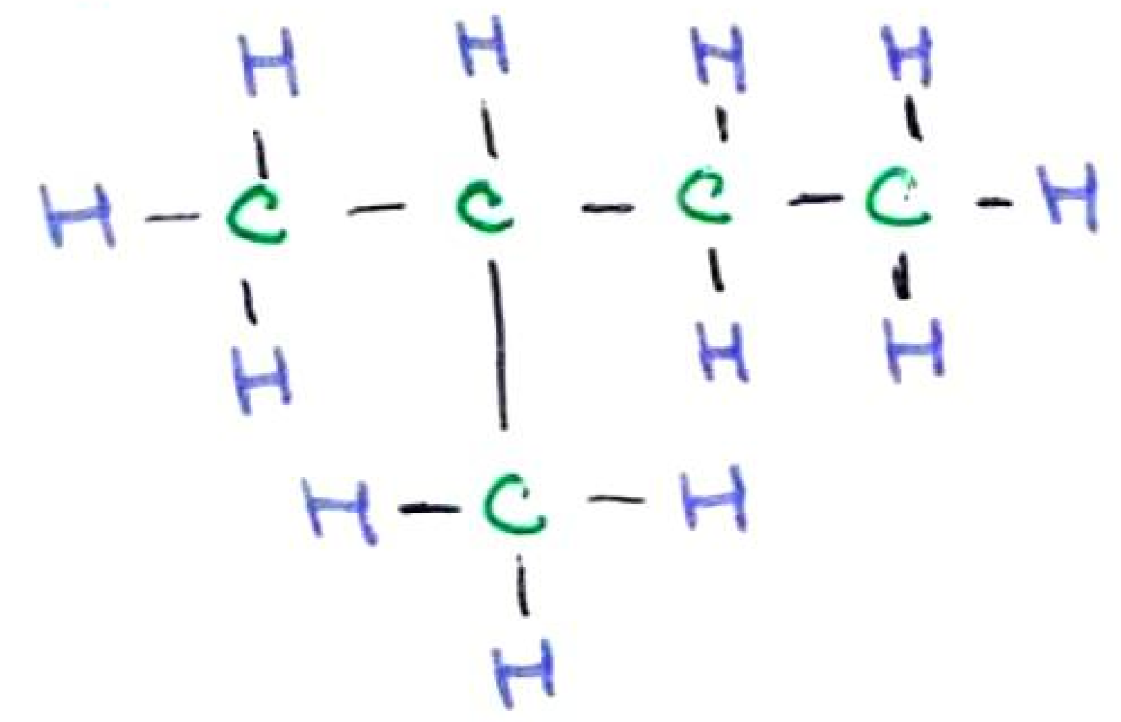
2methyl propane



right to left.

2 methyl propane

Example 2 - C_5H_{12}

- 

or $CH_3 - CH(CH_3) - CH_2 - CH_3$

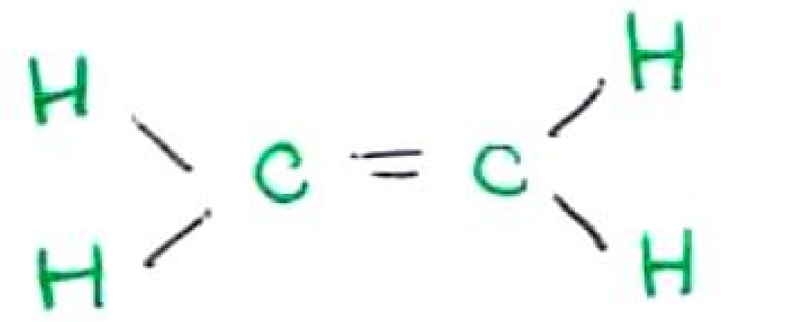
- If we number the carbon chains from left hand side to right hand side, then the methyl group comes on carbon number 2.
- Above compound is butane having methyl group. IUPAC name will be - 2 methyl butane.
- As we number the carbon chains from right hand to left hand then methyl group falls on - carbon number 3 and hence the name becomes 3 methyl butane.

- $\overset{1}{C}H_3 - \overset{2}{C}H(CH_3) - \overset{3}{C}H_2 - \overset{4}{C}H_3$
  - 2 methyl butane (correct name)
- $\overset{4}{C}H_3 - \overset{3}{C}H(CH_3) - \overset{2}{C}H_2 - \overset{1}{C}H_3$
  - 3 methyl butane (wrong name)

- IUPAC name - 2 methyl butane.
- Common name - Iso pentane.

- Naming of unsaturated Hydrocarbon containing an double bond -
- The presence of double bond is indicated by using the ending 'ene'.

- Naming of C_2H_4 - The hydrocarbon contains 2 carbon atoms which are indicated by writing 'eth'. and double bond indicated by using the ending - 'ene'.
- IUPAC name - eth + ene = ethene
- common name - ethylene ($CH_2 = CH_2$)

- C_2H_4  or $H_2C = CH_2$
- IUPAC - Ethene
- common name - Ethylene

- **Naming of unsaturated hydrocarbon containing triple bond -**
- The presence of triple bond is indicated that word 'yne' after the stem.
- **Naming of C_2H_2 -**
- Hydrocarbon contains 2 carbon atoms which are indicated by writing 'eth'.
- Triple bond suffix - yne
- Now joining 'eth' with yne we get ethyne eth + yne = ethyne
- IUPAC name - ethyne
- common name - acetylene.

- C_2H_2
- $H - C \equiv C - H$
- $CH \equiv CH$

- Acetylene
- Ethyne

- **Naming of C_3H_4 -**

Hydrocarbon contains 3 atoms which are indicated by writing 'prop'.

- Triple bon suffix - yne
- Now join with yne we get - prop + yne = propyne
- IUPAC name - Propyne
- common name - methyl acetylene

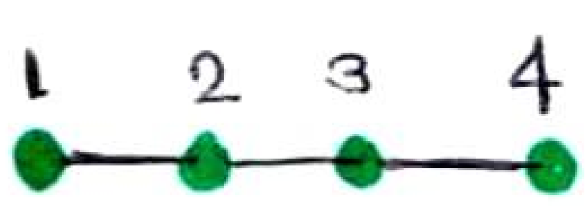
C_3H_4

$H - \overset{H}{\underset{H}{C}} - C \equiv C - H$ or $CH_3 - C \equiv CH$

- Propyne
- Methyl acetylene

- **ISOMERS -**
- The organic compound having the same molecular formula but different structure.
- Ex - Normal butane and isobutane are example of isomer bcoz they same molecular formula but different structure.
- Normal butane - straight chain.
- Isobutane - Branched chain.
- IUPAC name is -
- n butane - Butane
- isobutane - 2 methyl propane.
- Isomerism - The existence of two or different organic compound having the same molecular formula but different structure is called Isomerism.

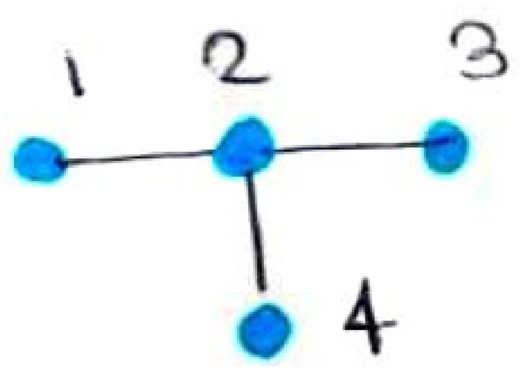
- Isomerism is possible only with hydrocarbon having 4 or more carbon atoms because only then we can have two or more different arrangement of carbon atoms is possible.
- No isomerism is possible in hydrocarbon containing 1, 2 or 3 carbon atoms per molecule because then only one arrangement of carbon atom is possible.
- No isomerism is possible in methane, ethane and propane becoz they contain only one, two or three carbon atoms.
- Butane (C_4H_{10}) - Two isomers are possible
- Pentane (C_5H_{12}) - three isomers are possible.
- Hexane (C_6H_{14}) - Five isomers are possible.
- **As the no. of carbon atoms in an alkane molecule increases, the no. of possible isomer increases rapidly.**
- First, all the four carbon atoms are joined in a continous straight chain to give the following structure -



$\overset{1}{CH_3} - \overset{2}{CH_2} - \overset{3}{CH_2} - \overset{4}{CH_3}$ (n-butane)

This structure represents the compound normal butane.

- Second, all the three carbons atoms can be put in straight chain and fouth carbon atom can be joined in the side chain -



$\overset{1}{CH_3} - \overset{2}{CH} - \overset{3}{CH_3}$ (Iso-butane)
$\quad\quad\;|$
$\quad\;\; CH_3$ 4

- The compound having this structure is called isobutane.

- **Homologous series -**
- A homologous series is a group of organic compound having similar structure and similar chemical properties in which the successive compounds differ by CH_2 group.
- It is clear that the two adjacent homologus differe by 1 carbon atom and 2 hydrogen atom - CH_2 group.

- **Homologous series of alkane -**

Alkane	Molecular formula
Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}

- General formula of the homologous series of alkane -
- C_nH_{2n+2}

- Characteristic of a homologous series-
- All the members of homologous series can be represented by the general formula- C_nH_{2n+2}.
- Any two adjacent homologues differ by 1 carbon atom and 2 hydrogen atoms in their molecular formulae. two adjacent homologues differ by $-CH_2$ group. The difference between CH_4 and C_2H_6 is CH_2.
- The difference in the molecular masses of any two adjacent homologues is 14u.
- molecular mass of CH_4 (methane) is 16u, ethane (C_2H_6) is 30u.
- Difference in molecular masses of ethane and methane is- 30 − 16 = 14u.
- All the compounds of homologous series show similar chemical properties. All compound of alkane undergo subsitution rxn with chlorine.
- The members of homologous series show a graudal change in physical properties with increase in molecular mass
  - No. of carbon atom increase, the melting, boiling point and density of its members increase gradually.

- Homologous series of Alkenes-
- General Formula- C_nH_{2n}.

Alkene	Molecular Formula
Ethene	C_2H_4
Propene	C_3H_6
Butene	C_4H_8
Pentene	C_5H_{10}

- Ethene is used as- ripening new raw fruits Bananas and other fruits have been ripened.

- Homologous series of Alkynes-
- General formula- C_nH_{2n-2}

Alkynes	Molecular formula
Ethyne	C_2H_2
Propyne	C_3H_4
Butyne	C_4H_6
Pentyne	C_5H_8

- The organic compounds such as halo alkane, alcohol, Ketone, aldehyde, and carboxylic acids also form the homologous series.
- **Heteroatom** - Any atom other than carbon and hydrogen. (hetero - other or different)
- Some of the common heteroatom are halogen atoms - chlorine (Cl), bromine (Br) and iodine (I), oxygen (O) atom.
- The functional groups of organic compound containing two types of heteroatom - Halogen atom, oxygen atom.

FUNCTIONAL GROUPS -

- An atom or group of atoms which makes a carbon compound reactive and decides its properties (or function) is called functional group.
- Ex- Alcohol group, –OH present in ethanol, C_2H_5OH is an example of functional group.
- **Halo group – X (X can be Cl, Br or I).**
- Halo group can be chloro –Cl, bromo –Br, iodo– –I depending upon whether a chlorine, bromine is linked to carbon atom of the compound.
- Chloromethane - CH_3Cl - chloro group is present.
- Bromomethane - CH_3Br - Bromo group is present.
- Bromine, chlorine and Iodine are collectively called Halogen.
- **Represented by** - symbol X. It is written as R–X (where R is an alkyl group and X is halogen atom).

- **Alcohol group :- –OH.**
- Made up of one oxygen and one hydrogen atom joined together.
- The alcohol group is also known as alcoholic group or OH group.
- Ex - CH_3OH - Methanol C_2H_5-OH - Ethanol
- General Formula - R–OH. (R - alkyl group, OH - alcohol group). (R is CH_3, C_2H_5).
- **carboxylic group** - –COOH or $-\overset{\overset{O}{\|}}{C}-OH$
- Methanoic acid - H–COOH
- Ethanoic acid - CH_3–COOH
- The organic compound containing -COOH group are called organic acid or carboxylic acid.

- Aldehyde group - $-CHO$ or $-\overset{O}{\overset{\|}{C}}-H$ or $-\overset{H}{\overset{|}{C}}=O$
- Also called aldehydic group.
- Example - Methanal $HCHO$, Ethanal CH_3CHO. The aldehyde group always occurs at end of a carbon chain.
- General Formula - $R-CHO$ (R is an alkyl group).

- Ketone - $>C=O$ or $-\underset{\underset{O}{\|}}{C}-$ or $-CO-$

- consist of one carbon and oxygen atom. attached to two alkyl groups. The ketone group is called ketonic group.
- Examples - Propanone - CH_3COCH_3, Butanone - $CH_3COCH_2CH_3$
- Ketone group can occur only in middle of carbon chain. A ketone group can never occur at end of a carbon chain.

- Alkene group - $>C=C<$ - it is carbon - carbon double bond.
- Ethene - $CH_2=CH_2$ • propene - $CH_3-CH=CH_2$.

- Alkyne group - $-C\equiv C-$ carbon - carbon triple bond.
- Ethyne - $CH\equiv CH$, propyne - $CH_3-C\equiv CH$
- compound containing alkyne group are known as alkyne.
- All the organic compound having an functional group show similar chemical property.

— HALOALKANE —

- When one hydrogen atom of an alkane is replaced by a halogen atom we get haloalkane.

Ex - when one hydrogen atom of methane is replaced by a chlorine atom we get chloromethane.

$$\underset{\text{Methane}}{CH_4} \xrightarrow[\text{by Cl}]{\text{Replace H}} \underset{\text{chloromethane}}{CH_3Cl}$$

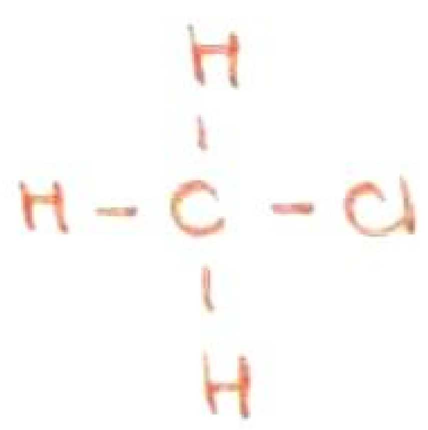
- General formula - $C_nH_{2n+1}-X$, where X represent Cl, Br, I.

IUPAC name of Haloalkane	Formula
chloromethane	CH_3Cl
chloroethane	C_2H_5Cl
chloropropane	C_3H_7Cl

• Naming of Haloalkane -

• In the IUPAC method, Haloalkane are named after the parent alkane by using prefix or suffixes to show the presence of halo group such as chloro (–Cl), Bromo (– Br).

• CH_3Cl by IUPAC method -

• CH_3Cl or CH_3-Cl or 

• Parent alkane - Methane (CH_4)

• compound contains - chloro group (–cl group).

• chloro + methane = chloromethane – IUPAC name

• common name = methyl chloride

• CH_3Br will be – Bromo methane • common - name - methyl bromide

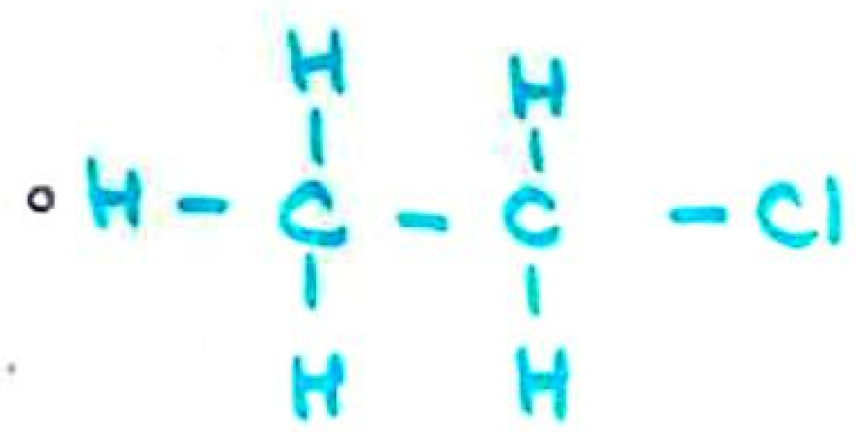
• C_2H_5Cl by IUPAC method -

• parent alkane - ethane

• chloro group present - IUPAC name - Chloroethane

• common name - Ethyl chloride

• C_2H_5Br will be - Bromoethane • common name – Ethyl bromide.

• C_2H_5Cl • CH_3-CH_2-Cl 

chloroethane

• ALCOHOLS -

• Alcohol are the organic compounds containing hydroxyl group (–OH group) attached to carbon atom.

• –OH group is the functional group of alcohol.

• Two simple alcohol - • CH_3OH - methyl alcohol also known as methanol.

• C_2H_5OH - ethyl alcohol also known as ethanol.

• Ex - By replacing one hydrogen atom of methane by a hydroxyl group we get an alcohol called methyl alcohol or methanol.

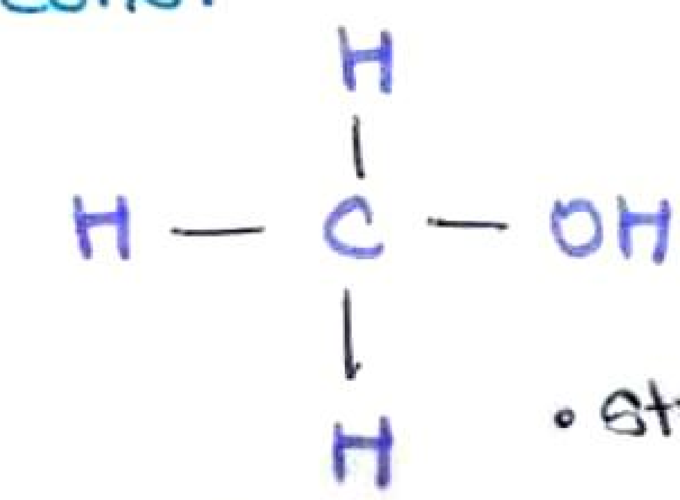
$$CH_4 \xrightarrow[\text{by OH}]{\text{Replace H}} CH_3-OH$$

• General Formula - $C_nH_{2n+1}-OH$

• IUPAC name of alcohol	• Formula
Methanol	CH_3OH.
Ethanol	C_2H_5OH.
Propanol	C_3H_7OH.

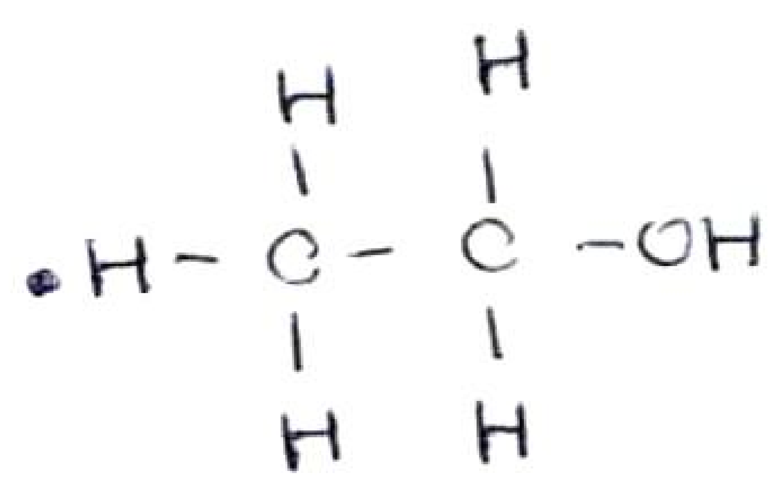
• Naming of Alcohols-

- All alcohol compound contain alcohol group –OH at end of the parent alkane.
- 'ol' is used as suffix to show the presence of alcohol group in an organic compound.
- The last word of parent 'alkane', e is replaced by 'ol' to indicate the presence of OH group.
- The compound CH_3OH by IUPAC method-
- 1 carbon atom - so it is parent alkane is methane.
- Methane, here e is replaced by 'ol' - Methanol.
- Methan + ol = Methanol.
- IUPAC name of CH_3OH - Methanol
- common name - methyl alcohol

CH_3OH or 

• Methanol • structure

- The compound C_2H_5OH by IUPAC method.
- compound 2 atom - So it is parent alkane is ethane.
- Ethane, here e is replaced by 'ol' - Ethanol.
- Ethan + ol = Ethanol
- common name - ethyl alcohol.

• C_2H_5OH or • CH_3-CH_2-OH or • 

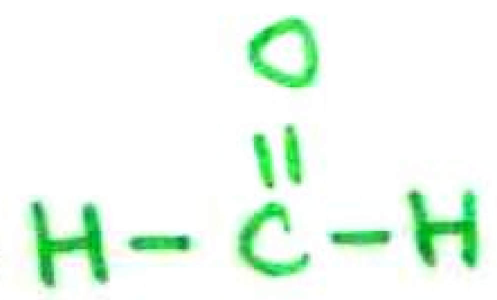
• Ethanol

— ALDEHYDES —

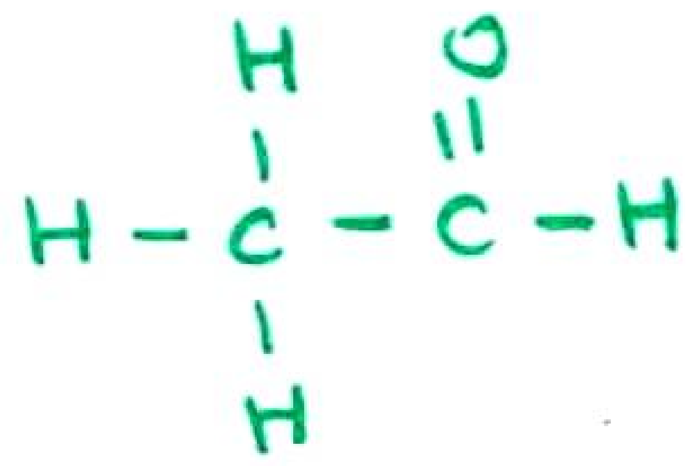
- Aldehydes are the carbon compounds containing an aldehydes group –CHO attach to a carbon atom.
- Ex- Formaldehyde - HCHO also called as methanal.
  Acetaldehyde - CH_3CHO also called as ethanal.
- General formula - $C_nH_{2n}O$. - $C_1H_{2\times1}O$ - CH_2O - CHOH

IUPAC name	Formula
• Methanal	HCHO
• Ethanal	CH_3CHO
• Propanal	CH_3CH_2CHO

- Naming of Aldehydes-
- Aldehydes are the compound containing –CHO group.
- The name 'aldehyde' the first two letters make 'al'.
- The last 'e' of the parent alkane is replaced by 'al' to indicate the presence of aldehyde group.
- HCHO by IUPAC method -
- HCHO contains 1 carbon atom so its parent alkane is methane.
- The replacing the last 'e' of the methane by 'al' we get the name - methanal - methan + al = Methanal. (IUPAC).
- common name - HCHO - Formaldehyde.
- CH_3CHO by IUPAC method -
- CH_3CHO contains 2 carbon, so its parent is - Ethane
- CH_3CHO also contains an aldehyde group which is indicated by using 'al' as ending
- IUPAC - Ethan + al - Ethanal (IUPAC)
- common name - acetaldehyde. - CH_3CHO

- HCHO or - H - CHO or - 

- Methanal

- CH_3CHO or CH_3 - CHO or 

- Ethanal

• KETONE •

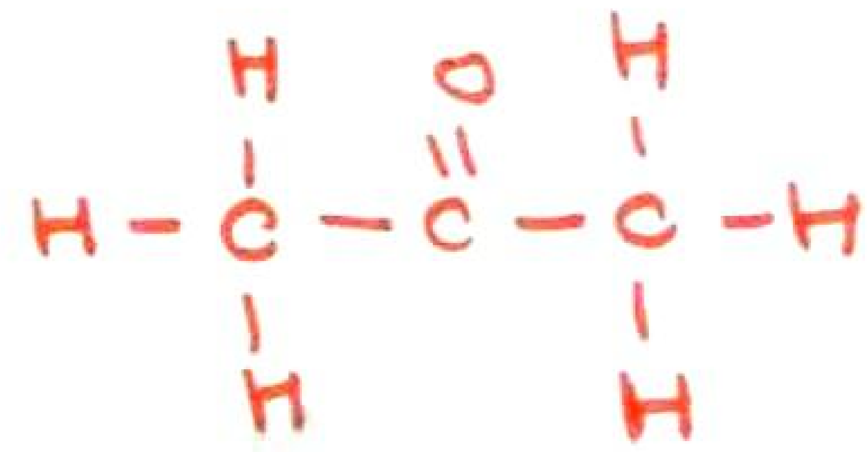
- Ketone are the carbon compound containing the ketone group – CO – group.
- It always occurs in the middle of a carbon chain, it must be least three carbon atoms in its molecule.
- Molecular Formula - $C_nH_{2n}O$

• IUPAC name	• Formula of ketone
• Propanone	CH_3COCH_3
• Butanone	$CH_3COCH_2CH_3$
• Pentanone	$CH_3COCH_2CH_2CH_3$
• Hexanone	$CH_3COCH_2CH_2CH_2CH_3$

Naming of ketones-

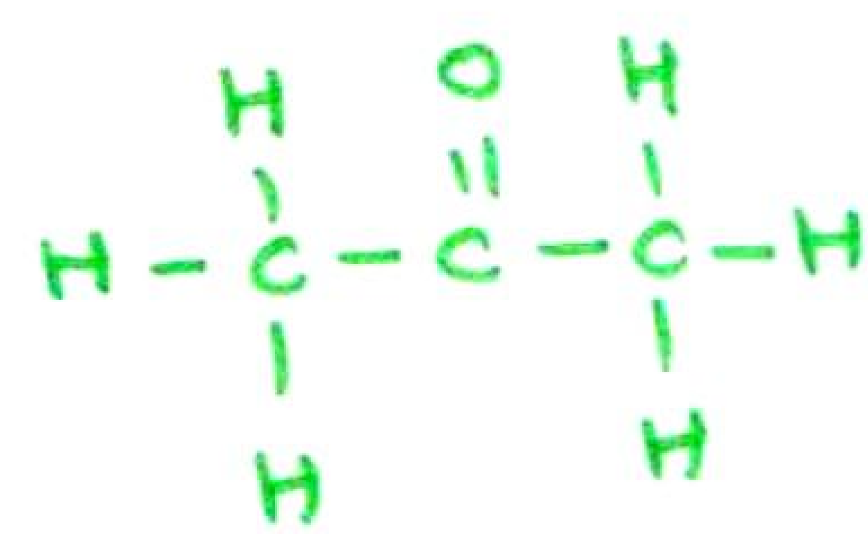
- Ketone are compound containing the ketone group- —CO— group.
- 'one' is used as a preffix, suffix to show the presence of ketone group.
- 'Here' e is replaced by 'one' to indicate the presence of a ketone group.

- CH_3COCH_3 by IUPAC name -
- The 3 carbon atoms, so its parent alkane is propane.
- By replacing the last 'e' of propane by one - propan + one = propanone. (IUPAC) - simplest ketone.
- common name - Acetone

- CH_3COCH_3 or $CH_3-\overset{O}{\overset{||}{C}}-CH_3$ or 

- Propanone
- Acetone

- $CH_3COCH_2CH_3$ by IUPAC name-
- The 4 carbon atoms, so its parent alkane is Butane.
- By replacing the last 'e' of butane by one - Butan + one = Butanone. (IUPAC name)
- common name - Ethyl methyl ketone

$CH_3COCH_2CH_3$ or $CH_3-\overset{O}{\overset{||}{C}}-CH_2-CH_3$ or 

- Butanone

— CARBOXYLIC ACIDS —

- The compounds containing carboxylic acids (—COOH) are called carboxylic acids. commonly known as organic acids.
- Name for —COOH for carboxylic acids is - alkanoic acids.
- made up of three atoms - carbon, oxygen, hydrogen.
- General formula of homologous series - is R-COOH, where R is an alkyl group.

IUPAC name	Formula of acid.
• Methanoic acid	$HCOOH$
• Ethanoic acid	CH_3COOH
• Propanoic acid	CH_3CH_2COOH

- Naming of COOH group -
- IUPAC name obtain by replacing the last 'e' of the parent alkane by 'oic' acid.
- HCOOH by IUPAC name -
- The compound contains 1 carbon atom so, its parent alkane is methane.
- Methan + oic acid = Methanoic acid. (IUPAC)
- common name - Formic acid.

$$HCOOH \quad or \quad or \quad H-\overset{\overset{\large O}{||}}{C}-OH$$

- Methanoic acid.

- CH_3COOH by IUPAC name -
- The compound contains 2 carbon atoms, so its parent alkane is - Ethane.
- **Ethan + oic acid = Ethanoic acid** (IUPAC name).
- Common name - acetic acid

$$CH_3COOH \quad or \quad H-\overset{\overset{\large H}{|}}{\underset{\underset{\large H}{|}}{C}}-\overset{\overset{\large O}{||}}{C}-OH$$

Acetic acid

• COAL AND PETROLEUM •

- When fuel is burned, the energy is released mainly as heat. these energy used for many purpose such as cooking food, heating water. machines in factories.
- Most of the common fuels are either free compound or carbon compound
- For example - coke, coal and charcoal contain free carbon whereas the fuels such as kerosene, petrol, LPG and natural gas are all carbon compounds.
- When carbon in any form is burned in the oxygen in the oxygen it forms carbon dioxide gas and releases a large amount of heat and some light.

$$C + O_2 \longrightarrow CO_2 + Heat + light$$

carbon, oxygen, carbon dioxide

- Most of the fuels which we use today are obtained from coal, petrol and natural gas are known as Fossil Fuels.

- Fossils are the remains of the pre-historic animals or plant buried under the earth, million of years ago.
- Coal, petroleum and natural gas are known as fossil fuel bcoz they were formed by the decomposition of the remains of prehistoric plant and animals. (buried) under the earth, long, long ago.
- Coal is a complex mixture of compounds of carbon, hydrogen and oxygen and some free carbon. small amount of nitrogen and sulphur compounds are present in coal.

- **How coal was formed -**
- coal was formed by the decomposition of large land plants and trees buried under the earth million years ago.
- It is believed that million of years ago, due to earthquake and volcanoes the forest were buried under the surface of the earth and get covered with sand, clay and water.
- Due to high temp. and high pressure inside earth, and in the absence of air, wood was converted into coal.

- Petroleum is a dark viscous and foul smelling crude oil. The petroleum means rock oil. It is called petroleum bcoz it is found under the crust of earth trapped in the rocks.
- The crude oil petroleum is a complex mixture of several solids, liquid and gaseous hydrocarbon mixed with water, salt and earth particles.
- The fuel such as petrol, kerosene, diesel and LPG are obtained from petroleum.

- **How petroleum was formed -**
- Petroleum oil (and natural gas) were formed by the decomposition of remains of extremely small plants and animals buried under the sea millions year ago.
- It is believed that millions of years ago the microscopic plants and animals which lived in seas, died. Their bodies sank to the bottom of sea.
- The chemical effect of pressure and heat and bacteria converted the remains of microscopic plants and animals into petroleum oil and natural gas just converted forest into coal. conversion of these took place in absence of oxygen.
- The petroleum thus formed got trapped between two layers of impervious rocks forming an oil trap.
- When coal and petroleum fuels are burnt, they lead to the formation of oxides of nitrogen and sulphur which go into air.

- These oxides of nitrogen and sulphur are major pollutant in the air.
- Why do substance burn with a flame or without flame -
- A candle, LPG and kerosene oil, all burn with a flame.
- A flame is the region where combustion of gaseous substance takes place. Flame is produced only when gaseos substance burn.
- All the gaseous fuels burns with flame, but only those solid and liquid fuel which vaporise on heating.
- Flames are of two types - Blue flame and yellow flame.
- When the oxygen supply is sufficent, then fuels burns completely producing a blue flame -
- The blue flame does not produce much light, so it is said to be non-luminous flame. In gas stove, cooking gas (LPG) burns with a blue non-luminous flame.
- Explanation - The gas stove has holes for air to mix propenly with cooking gas. The cooking gas gets sufficent oxygen from this air and hence burns completely producing a blue flame. Thus, complete combustion of cooking gas takes place in a gas stove.

- When the oxygen supply is insufficent then the fuel burn incomplelely producing mainly yellow flame. due to incomplete combustion of fuel. this yellow flame produces light so it is to be luminous light flame. incomplete combustion of wax takes place in a candle.
- Those solid and liquid fuels which do not vaporise on heating, burn without producing a flame - coal and charcoal burn in 'angithi' without producing flame. They just glow and produce heat. coal and charcoal producing flame. The volatile substance present in them vaporise and they are ignited, the volatile substance present in them vaporise and they burn with a flame in the begining.

- CHEMICAL PROPERTIES OF CARBON COMPOOND -

- COMBUSTION - BURNING -
- The process of burning of a carbon compound in air to give CO_2 water, heat and light is known as combustion.
- Most of the carbon compound burns in air to produce a lot of heat
- Ex - Alkanes burn in air to produce a lot of heat due to which alkanes are excellent fuels.
- When methane burns in an sufficent supply of air, then CO_2 and water vapour are formed a lot of heat is also produced.

- $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ + Heat + light
  methane, oxygen, carbon dioxide, water

- Natural gas produces a lot of heat on burning, so it is used as fuels in homes, transport and in industry.
- The cooking gas (LPG) which we use in our homes is mainly an alkane called butane C_4H_{10}.
- When butane burns in air in the burner of a gas stove, then it forms carbon dioxide and water vapour with the evolution of a lot of heat. Due to this, butane is an excellent fuel.
- carbon and its compounds are used as fuels - bcoz they burns in air releasing a lot of energy.
- The saturated hydrocarbon generally burn in air with a blue, non-sooty flame - this is because the percentage of carbon in saturated hydrocarbon comparatively low which get oxidised completely by the oxygen present in air.
- The supply of air for burning is reduced then incomplete combustion of even saturated hydrocarbon will take place and they will burn producing a sooty flame.
- The gas stove used in our homes have tiny holes of air so that sufficient oxygen of air is available for the complete burning of fuel to produce a smokeless blue flame.
- If the bottom of the cooking utensils in our homes are getting blocked and fuel is not burning completely.
- The unsaturated hydrocarbon burn in air with yellow, sooty flame (producing black smoke).
- The unsaturated hydrocarbon burn with a sooty flame bcoz the % of carbon in unsaturated hydrocarbon is comparatively higher which does not get oxidised completely in the oxygen of air.
- If unsaturated hydrocarbon are burned in pure oxygen, then they will burn completely producing a blue flame (without any smoke at all).
- The oxygen - acetylene flame is extremely hot and produces a very high temperature which is used for welding metals.
- A mixture of acetylene and air is not used for welding bcoz they burning of acetylene in air produces a sooty flame which is not hot enough to melt metals for welding.

- The incomplete combustion of fuels has the disadvantages -
- Incomplete combustion in insufficient supply of air leads to unburnt carbon in the form of soot which pollutes the atmosphere, blackens cooking utensils and blocks chimney in factory.
- Incomplete combustion also leads to the formation of an extremely poisonous gas called carbon-monoxide.

- Substitution Reactions -
- saturated hydrocarbon undergo substitution reaction with Cl_2 in the presence of sunlight.
- The reaction in which one hydrogen atom of a hydrocarbon are replaced by some other atoms is called - substitution rnx.
- If the substitution of hydrogen atoms takes by chlorine it is also called - chlorination.
- substitution reaction are a characteristic property of saturated hydro carbon. , unsaturated hydrocarbon donot give substitution reaction with halogens (Alkenes and Alkynes).
- Substitution reaction of methane with chlorine -
- Methane reacts with chlorine in the presence of sunlight to form chloromethane and hydrogen chloride.

$$\underset{\text{Methane}}{CH_4} + \underset{\text{chlorine}}{Cl_2} \xrightarrow[\text{sunlight}]{} \underset{\text{chloromethane}}{CH_3Cl} + \underset{\text{Hydrogenchloride}}{HCl}$$

- Three compounds -
- Dichloromethane or methylene dichloride CH_2Cl_2, Trichloromethane $CHCl_3$, Tetrachloromethane CCl_4 are all saturated hydrocarbons. so, all these compound will give subsitution reaction.

- Addition Reactions -
- The reaction in which an unsaturated hydrocarbon combines with another substance to give a single product.
- Addition reaction are characteristic property of unsaturated hydro carbon. it contains double and triple bond. that is addition reaction are given by all the alkenes and alkynes.
- Addition reaction of Ethene with hydrogen -

Ethene reacts with hydrogen when heated in the presence of Ni (Nickel) catalyst. to form ethane.

$$\underset{\text{Ethene}}{CH_2=CH_2} + \underset{\text{Hydrogen}}{H_2} \xrightarrow[\Delta]{\text{Ni catalyst}} \underset{\text{ethane}}{CH_3-CH_3}$$

• **Hydrogenation of Oils-**

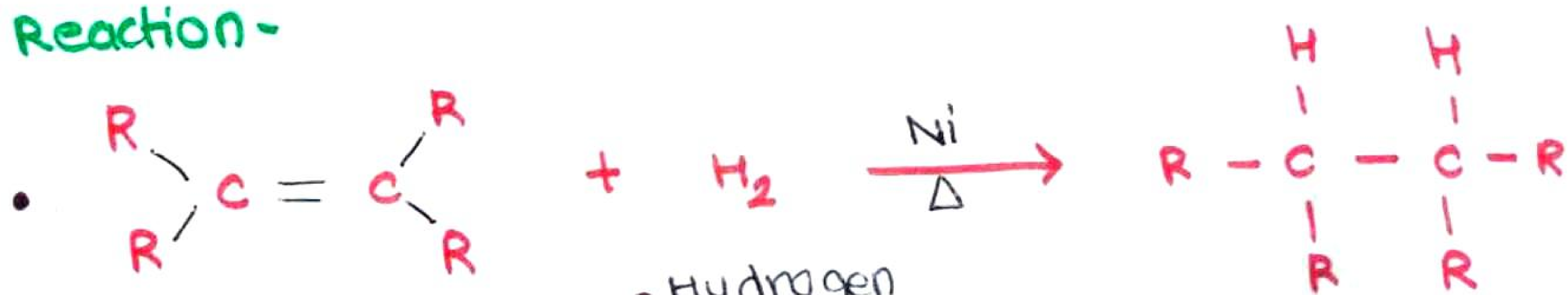
• The addition of hydrogen to an unsaturated hydrocarbon to obtain a saturated hydrocarbon. is called Hydrogenation.

• It takes place in the presence of nickel or palladium metal as a catalyst.

• It is used to prepare vegetable ghee from vegetable oils.

• The vegetable oils are unsaturated compounds containing double bond. they are in the liquid state at room temperature. **due to presence of double bond, vegetable ghee undergo additon of hydrogen to form saturated product called vansapti ghee.** which is solid at room temperature.

• **Reaction-**



• Hydrogen

(liquid) • Vegetable oil — unsaturated Fat

(solid) Vegetable ghee — saturated Fat

• Vegetable oils containing unsaturated Fatty acid are good for our health. The saturated ghee like vegetable ghee obtained by the hydrogenation of oils, are not good for health.

• Brand name - **Dalda, Rath and Panghat.**

• The addition of bromine is used in form of bromine water bromine water has red - brown colour due to presence of bromine in it. if an organic compound decolourises bromine water, then it will be an unsaturated compound.

• **All the unsaturated compound decolourisees bromine water but saturated compound do not decolourisees bromine water.**

• we will distinguish chemically between a cooking oil and butter taken in seperate test tube -

• **cooking oil** - decolourseies bromine water (showing that it's an unsaturated compound.

• **Butter** - does not decolourisees bromine water (showing that it is an saturated compound.

- some important carbon compounds-
- Ethanol - or ethyl alcohol
- Ethanol is the second member of homologous series of alcohol.
- Formula - C_2H_5OH , common name - ethylalcohol.

Physical Properties of Ethanol

- Colourless liquid having pleasant smell and burning taste
- Volatile liquid having a low boiling point
- No effect on litmus paper
- It is lighter than water.
- Ethanol contain 5% of water is called rectified spirit
- 100% pure ethanol is called absolute alcohol
- solubility of ethanol in water is due to presence of -OH group
- covalent compound
- It is neutral compound bcoz does not contain any H+ ions.

- CHEMICAL PROPETIES OF ALCOHOL -

• COMBUSTION

- It is the burning of an organic compound in the oxygen.
- The organic compound reacts rapidly with oxygen and breaks up completely to form CO_2 and water vapour and a lot of heat and light are also produced.

• OXIDATION

- It is a kind of controlled combustion.
- The organic compound combines with oxygen to form a new compound, Here, the organic compound does not break down completely. with low amount of heat and light.

- combustion - Ethanol is a highly inflammable liquid. It catches fire easily and starts burning. Ethanol burns readily in air to form CO_2 and water vapour and releasing a lot of heat and light.

- $$\underset{\text{ethanol}}{C_2H_5OH} + \underset{\text{oxygen}}{3O_2} \xrightarrow{\text{combustion}} \underset{\text{carbon dioxide}}{2CO_2} + 3H_2O + \text{Heat} + \text{light}$$

- **Ethanol as Fuel-**

- A material which is burnt to obtain heat is called a fuel. since, ethanol burns with a clear flame giving a lot of energy and heat, it is used as fuel.

- **Used as an additive in petrol.**

- It is a clean fuel because it gives harmless products carbon dioxide and water vapour on burning. does not produce any harmful gas like carbonmonoxide.

- Ethanol is produced on large scale from sugar cane crop the juice is used to obtain sugar by process of crystallisation

- **After the crystallisation of sugar from conc. sugar cane juice, a thick, dark brown liquid called - Molasses.**

- Molasses still contain about 30%. of sugar which could not be seprated by crystallisation.

- **Ethanol is produced by the fermentation of the cane sugar present in molasses.** Ethanol produced by the ferementation of sugar is mixed with petrol and used as fuel for running cars.

- Alkaline potassium permanganate and acidified potassium dichromate are **strong oxidising agent.** Nascent oxygen is freshly generated atomic oxygen which is very, very reactive.

- **Oxidation-** Oxidation means "controlled combustion"

When ethanol is heated with alkaline potassium permanganate solution, it gets oxidised to ethanoic acid.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} + \underset{\text{Nascent oxygen}}{2[O]} \xrightarrow[\cdot K_2Cr_2O_7]{\cdot KMnO_4} \underset{\text{ethanoic acid}}{CH_3COOH} + \underset{\text{water}}{H_2O}$$

- By adding 5%. aqueous solution of $KMnO_4$ in sodium hydroxide solution to ethanol dropwise till purple colour of $KMnO_4$ solution.

- Ethanoic acid is formed by oxidation of ethanol by using strong oxidising agent.

- The ethanoic acid formed by the oxidation of ethanol can turn blue litmus to red.

- Reaction with sodium metal-
- Ethanol reacts with sodium to form sodium ethoxide and hydrogen gas-

$$2C_2H_5OH + 2Na \longrightarrow 2C_2H_5O^-Na^+ + H_2$$

ethanol, sodium, sodium ethoxide, hydrogen

- This reaction is used as a test for ethanol.
- when a small piece of sodium metal is put into ethanol in dry test tube rapid effervescene due to the evolution of H_2 gas. The hydrogen gas produced can be tested by burning.
- When burning splinter is brought near the mouth of the test tube, the gas bums with 'pop' sound which is characteristics of hydrogen gas.
- **All the alcohol react with sodium metal to evolve hydrogen gas.**

- Dehydration-
- means removal of water molecule from it. when ethanol is heated with excess of conc. H_2SO_4 at 170°C, it gets dehydrated to form ethene.

$$CH_3-CH_2OH \xrightarrow{conc\ H_2SO_4} CH_2=CH_2 + H_2O$$

Ethanol, Ethene, water

- During dehydration of ethanol molecule, H from the CH_3 group and OH from CH_2OH group are removed in the form of a water molecule resulting in the formation of ethene molecule.

"conc. H_2SO_4 act as a dehydrating agent"

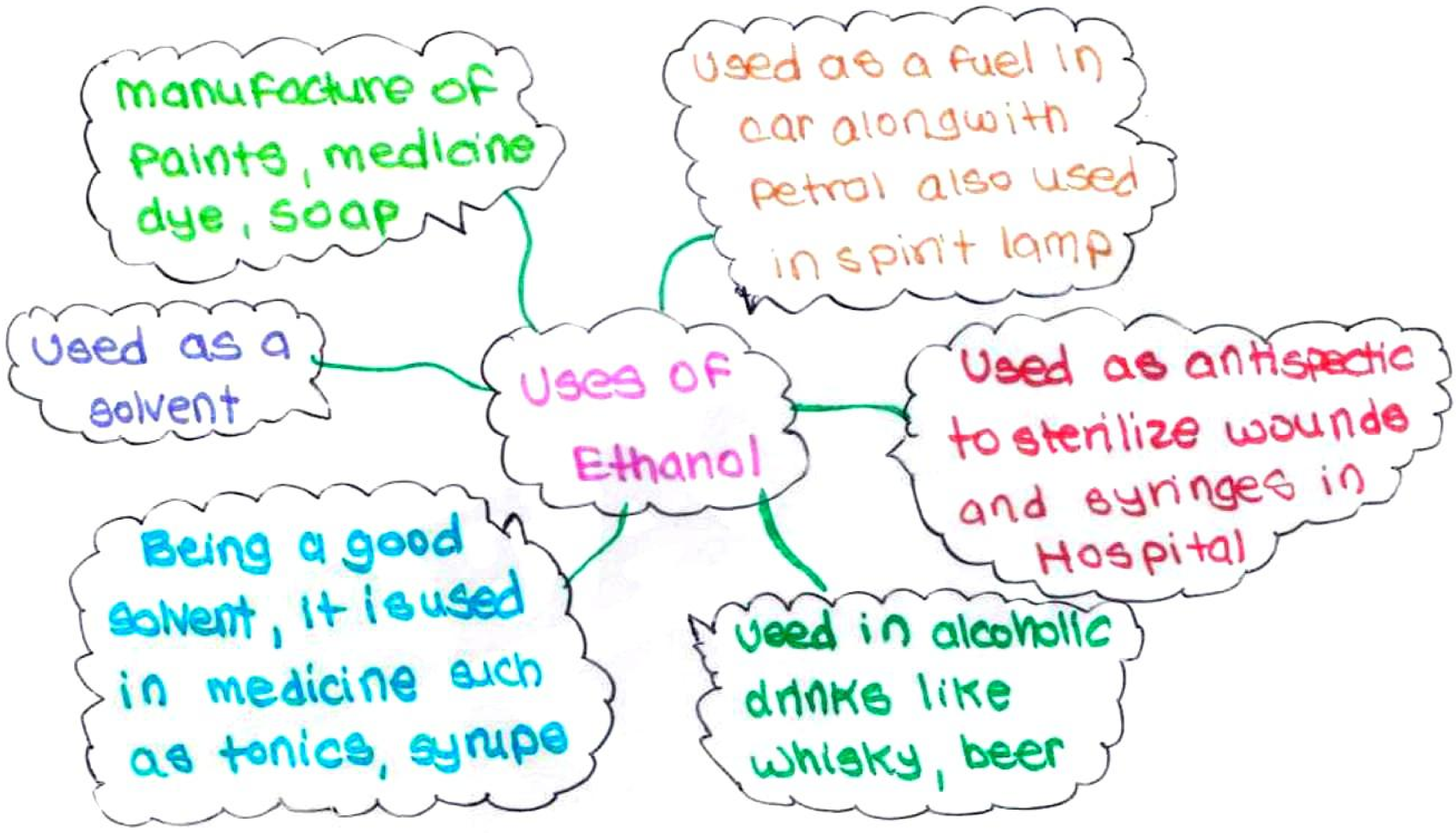
- Reaction with Ethanoic acid - Formation of Ester-
- Ethanol reacts with ethanoic acid on warming in the presence of a few drops of conc. H_2SO_4 acid to form sweet smelling ester, ethyl ethanoate.

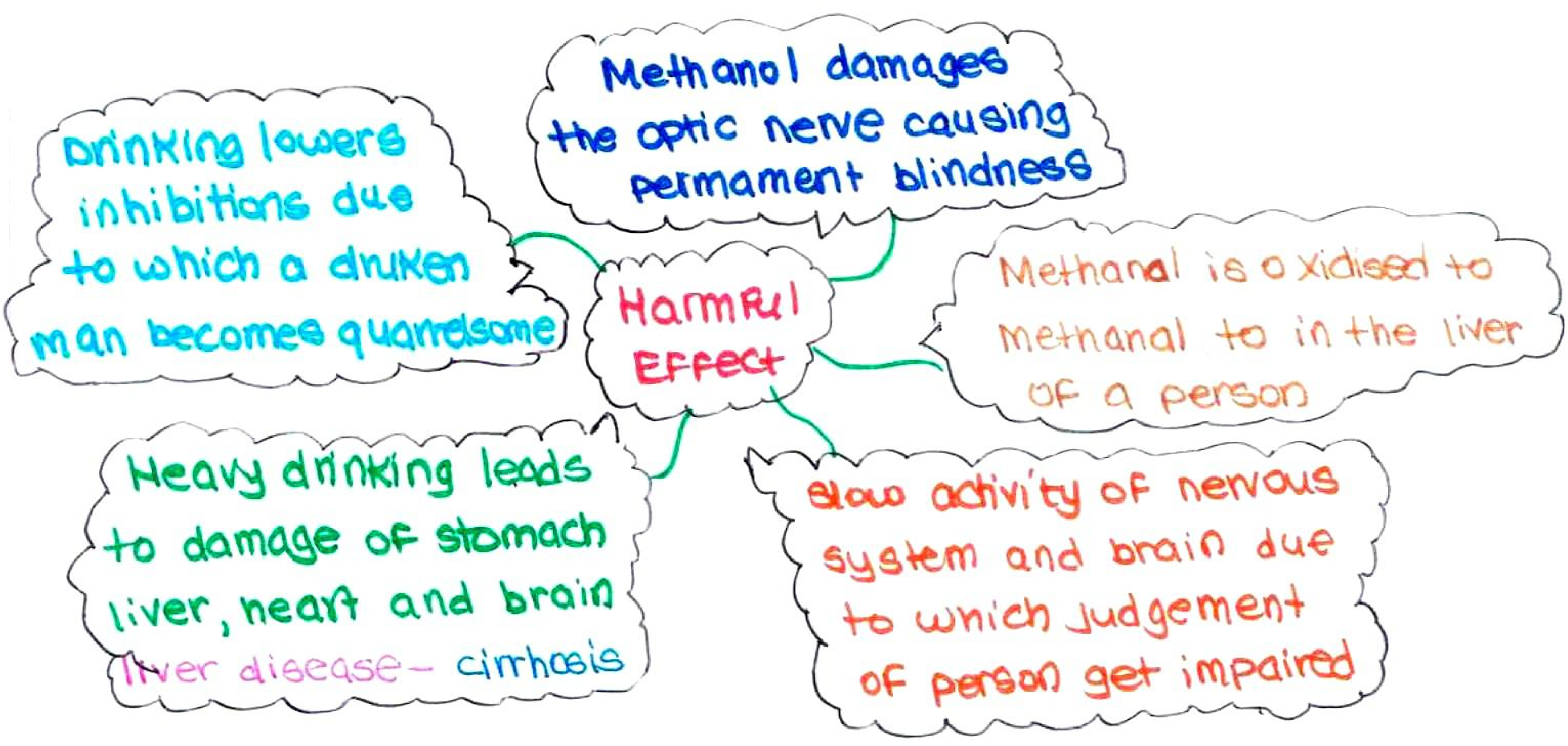
$$CH_3COOH + C_2H_5OH \xrightarrow{Conc.\ H_2SO_4} CH_3COOC_2H_5 + H_2O$$

ethanoic acid, ethanol, ethyl ethanoate (sweet smelling ester), water

- The reaction in which -COOH (carboxylic acid) combines with an alcohol to form an ester - called **esterification.**
- It takes place in the presence of a catalyst like H_2SO_4.

- we can carry out the reaction between ethanol and ethanoic acid to form an ester -
- Take 1ml of pure ethanol, in a test tube and add 1ml of glacial ethanoic acid to it. Then add 2 or 3 drops of conc. H_2SO_4 acid to the mixture.
- Warm the test tube containing above reaction mixture in hot water bath for about 5 minutes.
- Pour the content of the test tube in about 50ml of water taken in another beaker and smell it.
- sweet smell is obtained indicating the formation of an ester.





• ETHANOIC ACID - ACETIC ACID

• Ethanoic acid is the second member of homologous series of carboxylic acid.

• Formula- CH_3COOH , • common name – Acetic acid.

• Dilute solution of ethanoic acid in water is called - vinegar

• vinegar contains about 5 to 8 percent ethanoic acid. It is widely used as preservative in pickles.

PHYSICAL PROPERTIES

- Colourless liquid
- Sour taste and smell of vinegar
- Boiling point is 118°C.
- Pure ethanoic acid is called glacial ethanoic acid
- miscible with water in all properties
- Pure ethanoic acid is cooled it freeze to form colourless ice like solid.

• CHEMICAL PROPERTIES-

• Reaction with carbonates and Hydrogen carbonate -
Ethanoic acid reacts with carbonate and hydrogen carbonate to evolve carbon dioxide gas along with formation of salt and water.

• Reaction with sodium carbonate – Ethanoic acids reacts with sodium carbonate to form sodium ethanoate and CO_2 gas.

$$2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + CO_2 + H_2O$$

• ethanoic acid • Sodium carbonate Sodium ethanoate carbon dioxide water

• When sodium carbonate is added to solution of ethanoic acid, brisk effervescene of carbon dioxide given off. The salt formed in this reaction is sodium ethanoate.

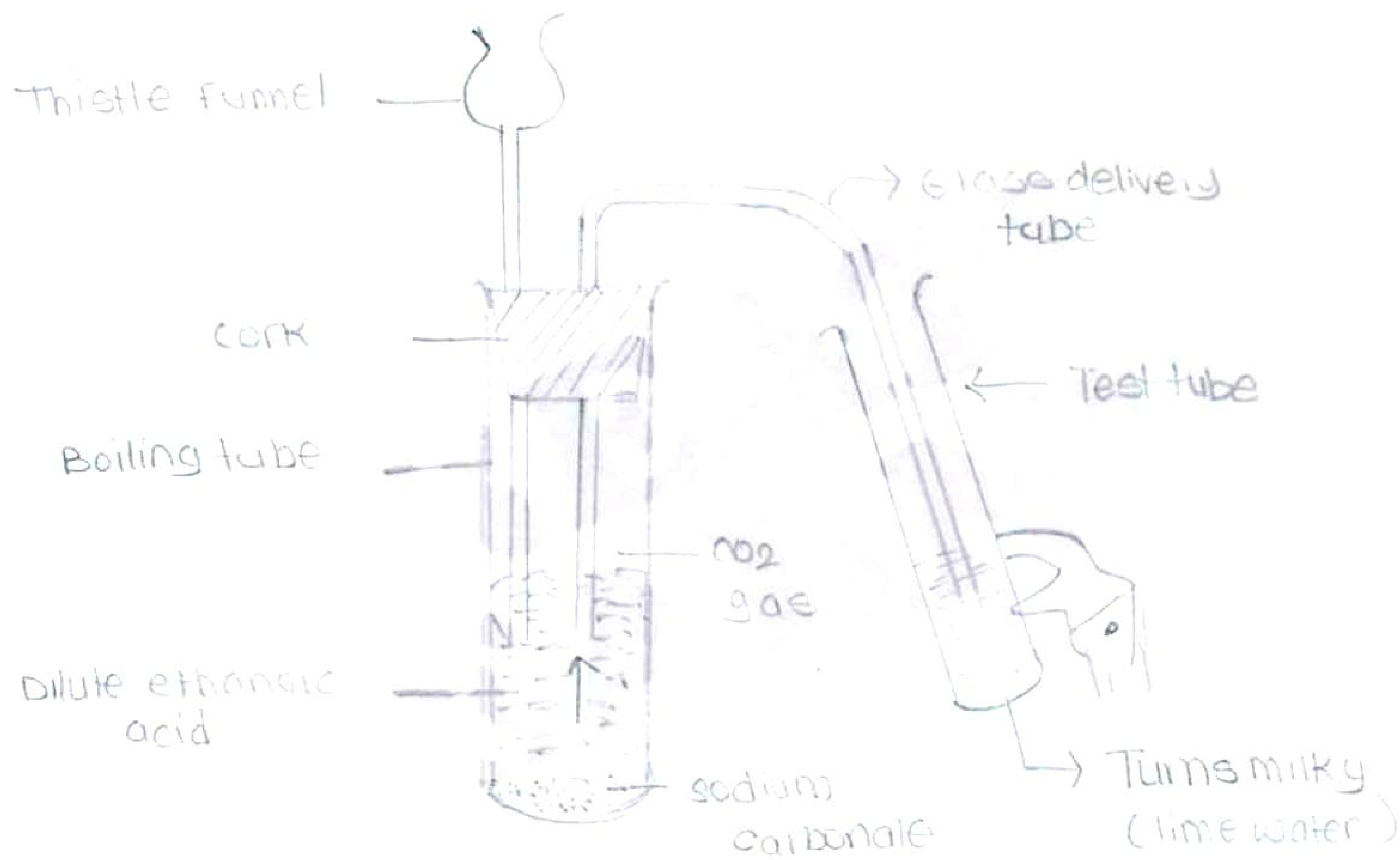
• Common name of sodium ethanoate - Sodium acetate

- Reaction with sodium hydrogen carbonate - Ethanoic acid react with sodium hydrogen carbonate to evolve brisk effervescene of CO_2 gas.

CH_3COOH + $NaHCO_3$ ⟶ CH_3COONa + CO_2 + H_2O

ethanoic acid, sodium hydrogen carbonate, sodium ethanoate, carbon dioxide, water

- Take a boiling tube and put about 0.5g of sodium carbonate in it.
- Add 2 ml of dilute ethanoic acid to the boiling tube.
- We will observe that brisk effervescene of CO_2 gas is produced.
- Pass this gas through lime water taken in a test tube.
- The lime water turns milky.
- conclusion - This experiment proves that when ethanoic acid react with sodium carbononate, then CO_2 gas is produced.



- Reaction with sodium hydroxide-
- Ethanoic acid reacts with bases to form salts and water.
- Ethanoic acids react with sodium hydroxide to form salt called sodium ethanoate and water.

CH_3COOH + $NaOH$ ⟶ CH_3COONa (salt) + H_2O

ethanoic acid, sodium hydroxide, sodium ethanoate, water

- Reaction with Alcohols - Formation of ester-
- Ethanoic acids react with presence of little conc. H_2SO_4 acid to form ester. when ethanoic acids is warmed with ethanol in the presence of few drops of conc. H_2SO_4, a sweet smelling ester is called ethyl ethanoate.

- CH_3COOH + C_2H_5OH ⟶ $CH_3COOC_2H_5$ + H_2O

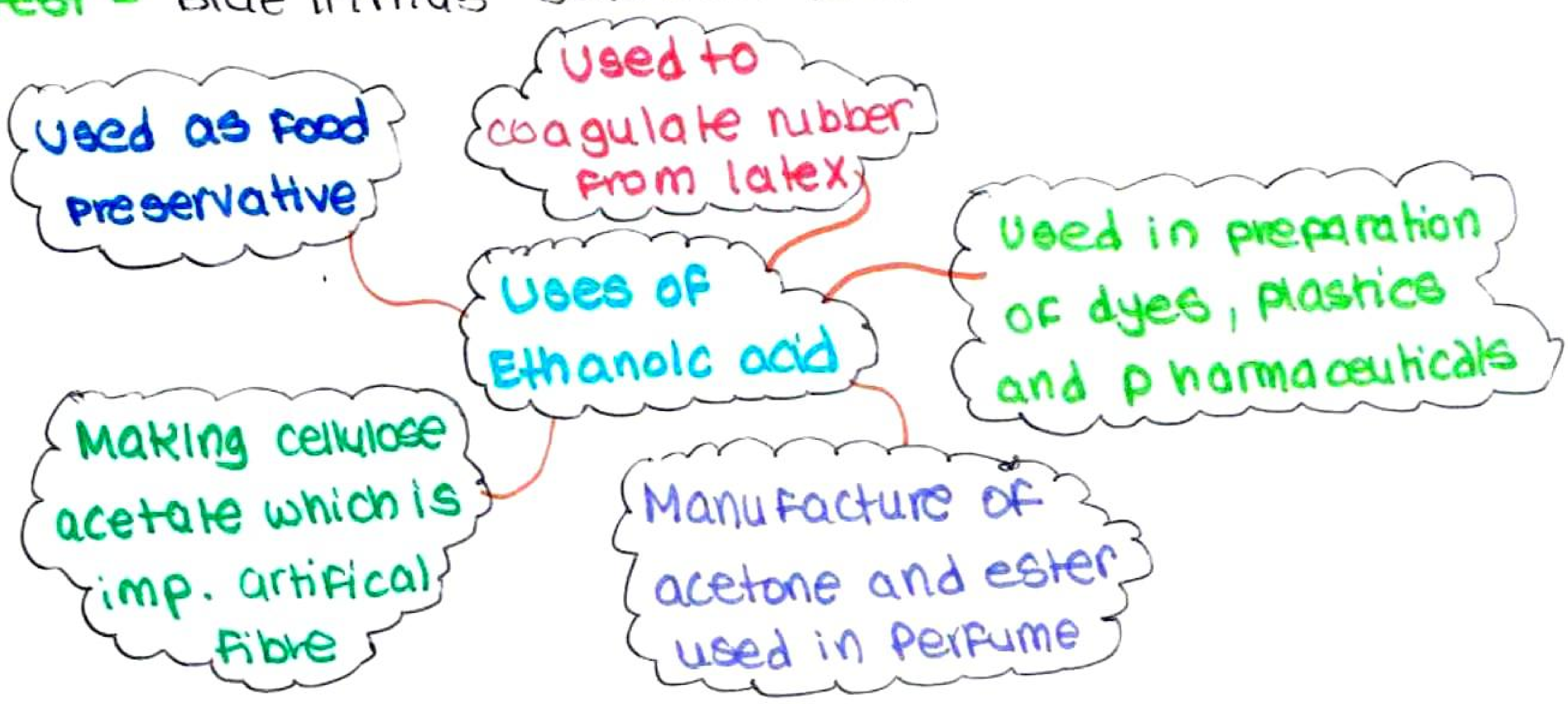
Ethanoic acid (Acetic acid) · ethanol · Ethyl ethanoate (sweet smell) · water

- The reaction in which a sweet smelling ester is formed is used as a test for ethanoic acid.
- Esterification- The reaction of a carboxylic acid with an alcohol to form an ester.
- Ester are usually volatile liquids having sweet smell and pleasant smell.
- Ester used as Flavouring agent. it used in icecream, sweets and cold brinks.
- **Hydrolysis of Ester-**
- when an ester is heated with sodium hydroxide solution then the ester get hydrolysed to form the parent alcohol and sodium salts of -COOH acid.
- Ex- when ethyl ethanoate ester is boiled with sodium ethanoate solution, then sodium ethanoate and ethanol are produce.

- $CH_3COOC_2H_5$ + $NaOH$ ⟶ CH_3COONa + C_2H_5OH

Ethyl Ethanoate (Ethyl acetate) · sodium hydroxide · sodium ethanoate (sodium acetate) · ethanol (ethyl alcohol)

- Hydrolysis of Ester is known as - SAPONIFICATION (soap making). bcoz this reaction is used for preparation of soaps.
- when the esters of higher fatty acids with glycerol (oil and fats) are hydrolysed with sodium hydroxide solution, we get sodium salts of higher fatty acid which are called SOAPS.
- Litmus test - Blue litmus solution turns red litmus.



• SOAPS AND DETERGENTS -

• SOAP-

- Soap is the sodium salt of long chain carboxylic acid (fatty acid) which has cleaning properties in water.
- soap has a large non-ionic hydrocarbon group and ionic group COO^-Na^+.

• EX- Sodium stearate and sodium palmitate

- SODIUM STEARATE - $C_{17}H_{35}COO^-Na^+$
- sodium stearate 'soap' is the sodium salt of long chain saturated fatty acid called - stearic acid.
- long alkyl group - $C_{17}H_{35}$, • ionic carboxylate group - COO^-Na^+
- SODIUM PALMITATE - $C_{15}H_{31}COO^-Na^+$
- sodium palminate 'soap' is the sodium salt of a long chain saturated fatty acid called - Palmitic acid.
- solution of soap in water is basic in nature.
- A soap solution turns red litmus paper to blue.

• Manufacture of soap -

- soap is made from animal fat or vegetable oils.
- Fats and vegetable oil are naturally occurring esters of higher fatty acids. and an alcohol called - glycerol.
- when fats and oils are heated with sodium hydroxide solution, they split to form sodium salts of higher fatty acids and glycerol.
- Fat or oil (An ester) + sodium hydroxide (An alkali) $\xrightarrow{\text{Heat}}$ soap (Fatty acid) + Glycerol (An alcohol)
- The process of making soap by hydrolysis of fats and oils with an alkaline is called - SAPONIFICATION

• Preparation of soap in the laboratory -

- The main raw material required for preparing soap in a school laboratory or at home -
- vegetable oil • sodium hydroxide (caustic) • sodium chloride (common salt)

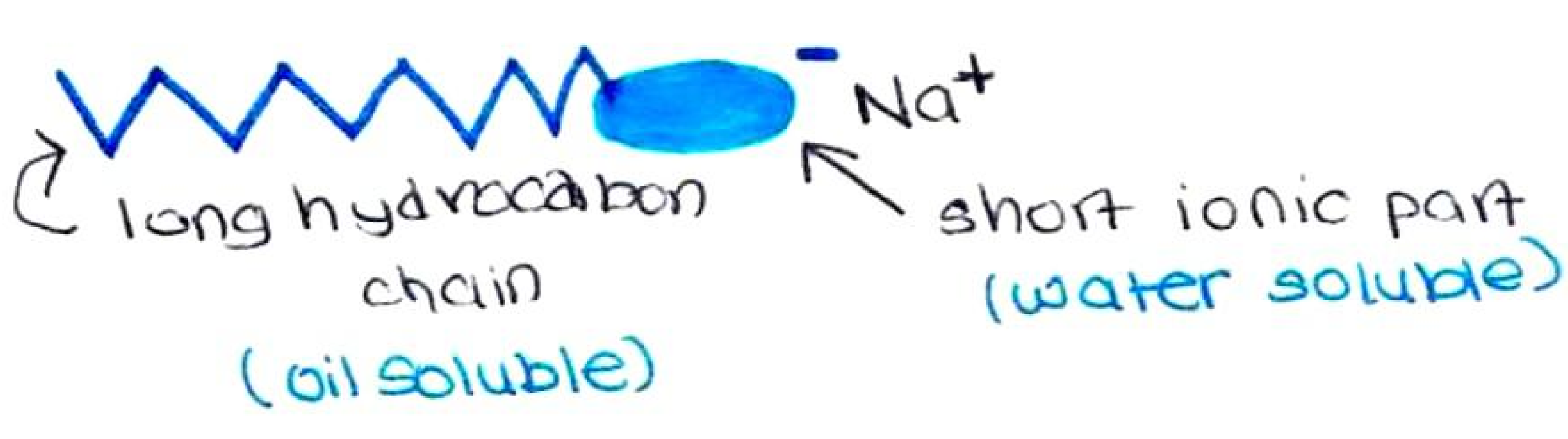
Procedure -

- Take about 20ml of castor oil in a beaker. Add 30ml of 20% NaOH solution to it.
- Heat the mixture with constant stirring till paste of soap is formed.

- Then add 5 to 10 grams of common salt -
- Stir the mixture well and allow it to cool. On cooling the solution, solid soap seprates out.
- When the soap sets, it can be cut into pieces called 'soap bars'
- Why common salt is added in soap making -
- Common salt is added to the mixture to make the soap come out of solution.
- Common salt is added to precipitate out all the soap from the aqueous solution, when we add common salt to the solution, then the solubility of soap present in it decreases.
- The soap which is used for washing clothes works by making the oil and grease particles dissolve in water.

- **STRUCTURE OF A SOAP MOLECULE -**

- A soap solution molecule is made up of two parts - a long hydrocarbo part and a short ionic part containing - $-COO^{-}Na^{+}$ group.
- The soap molecule is said to have a tadpole structure.
- The long hydrocarbon chains is - hydrophobic (water repelling) so part of soap molecule is insoluble in water but soluble in oil and grease.
- The ionic portion of the soap molecule is - hydrophilic (water- attracting due to polar nature of water molecule. It is soluble in water, but insoluble in oil and grease.
- The short ionic part of the soap molecule in soluble in water, so it can attach to the water particles.
- **Micelle** - A spherical aggregate of a soap molecule in the soap solution in water is called micelle. (soap solution is colloidal solution).



- structure of soap molecule

- Cleansing action of soap -
- When soap is dissolved in water, it forms a colloidal suspension in water in which the soap molecule cluster together to form spherical micelles.
- In a soap micelle - The soap molecule are radially arranged with hydrocarbon ends directed towards the center and ionic ends directed outwards.

• Micelle formation will not takes place when soap is added to organic solvents like ethanol because - the hydrocarbon chains of soap molecules are soluble in organic solvents like ethanol.

• When a dirty cloth is put in water containing dissolved soap, then the hydrocarbon ends of soap molecule in the micelle attach to the oil or grease particle by using its hydrocarbon ends.

• When the dirty cloth is agitated in the soap solution, the oily and greasy particles present on its surface and entrapped by soap micelles get dispersed in water due to which the soap water become dirty, but the cloth gets cleaned.

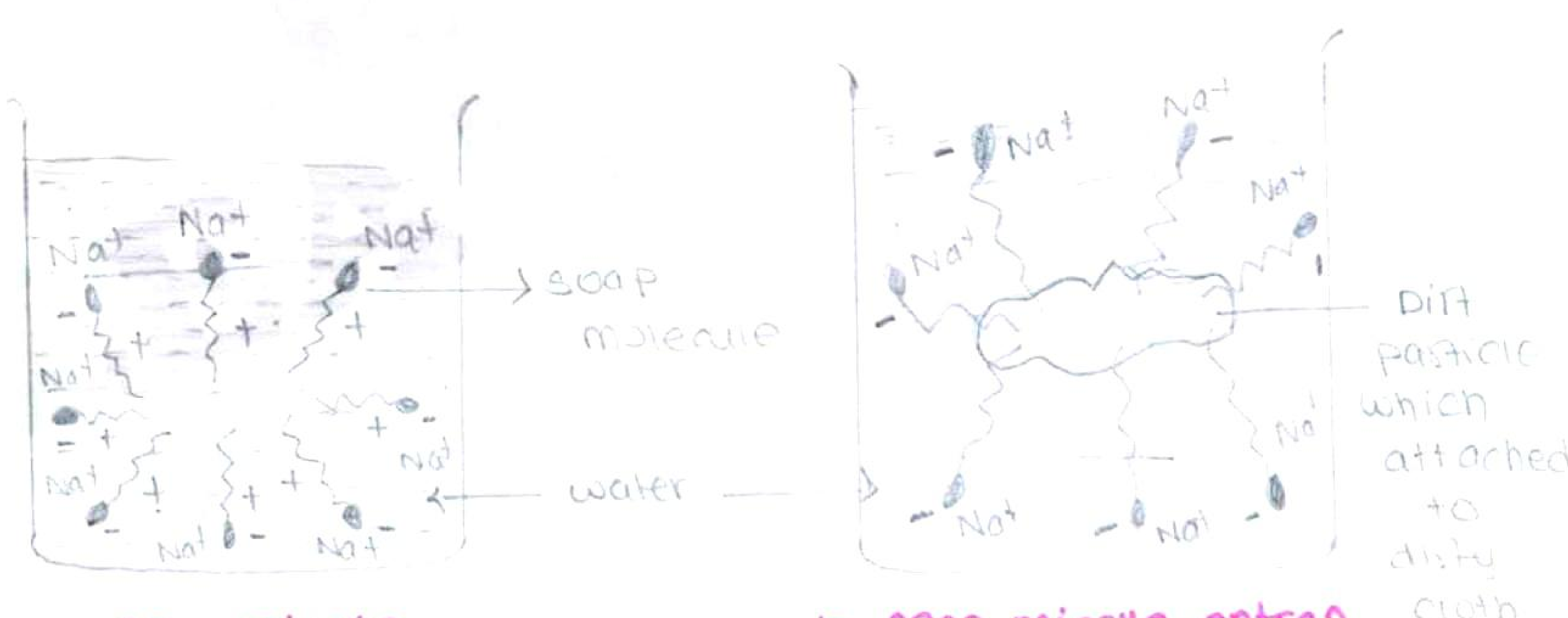
• The fact that soap acts by making oily and greasy particles mix with water can be demonstrated as follows -

• Take about 10 ml of water in a test tube and add a little cooking oil to it. The oil does not mix with water. It floats on water.

• Put a cork on the test tube and shake it well for few minutes. Even the oil floats on water and does not mix in it.

• Now add a little of soap and shake it again.

• This time the oil and water mix and form a milky emulsion, from this we conclude that soap has made the oil mix in water.



a. Soap micelle

b. soap micelle entrap the dirt particle

• limitation of soap -

• Hard water contains calcium and magnesium salts.

• why soap is not suitable for washing clothes with hard water bcoz -

• When soap is used for washing clothes with hard water, a large amount of soap is wasted in reacting with calcium and magnesium ions of hard water to form insoluble precipitate called scum. a large amount of soap is needed for washing clothes when the water is hard.

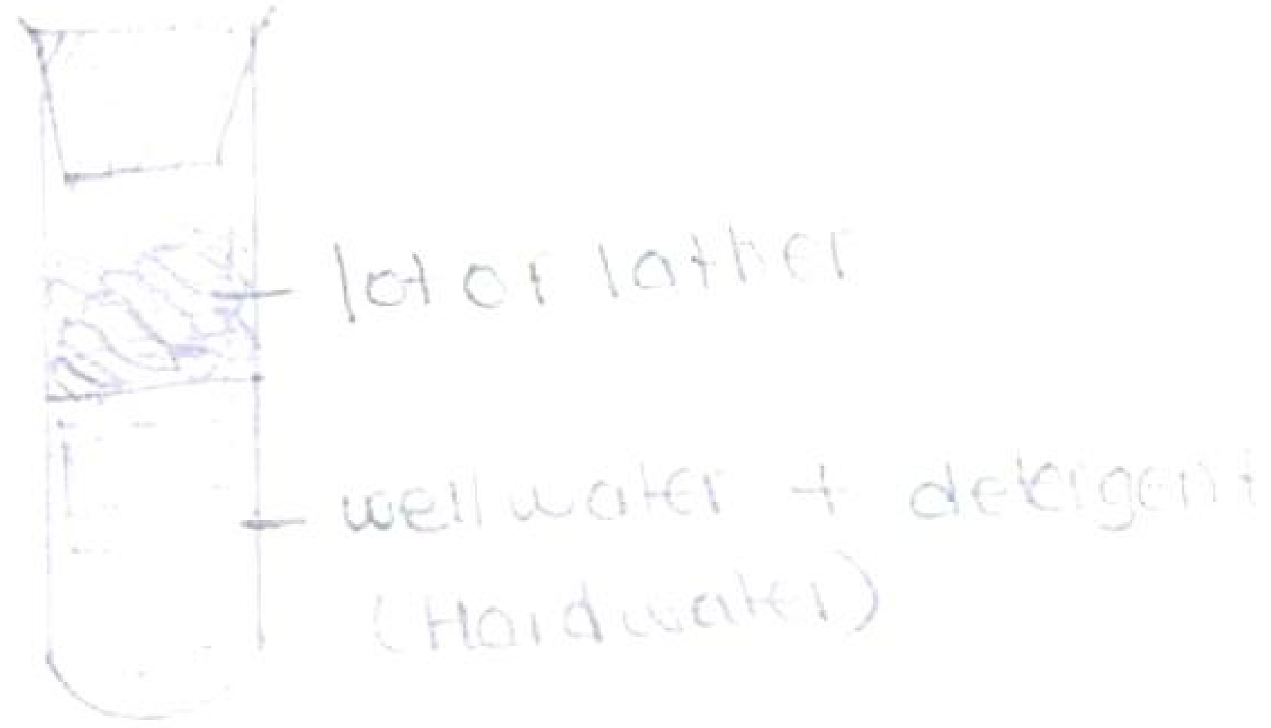
- The scum formed by the action of hard water on soap, sticks to the clothes being washed and infers with the cleaning ability to the additional soap. This makes the cleaning of clothes difficult.
- **Why soaps does not give lather easily with hard water?**
- Bcoz it first reacts with calcium ions and magnesium ions present in hard water to form insoluble precipitate of Ca^{++} and magnesium salts of fatty acids.

- **Why soaps does give lather easily with soft water?**
- Bcoz soft water does not contain calcium and magnesium ions then lather easily form when soap is added.
- The calcium and magnesium salts which can dissolve to obtain hard water are- calcium hydrogen carbonate, calcium sulphate, calcium chloride, magnesium hydrogen carbonate.

- **DETERGENTS-**
- The quite difficult to wash clothes with soap when the water is hard. These difficulty has been overcome by using another kind of cleansing agent called **Detergents.**
- Detergents are also called 'soapless soaps' bcoz though they act as like a soap in having the cleasning properties they do not contain the unusal 'soaps' like sodium stearate.
- **Detergents are better cleansing agents than soap** because they do not form insoluble calcium and magnesium salts with hard water and hence can be used for washing even with hard water.
- A detergent forms lather easily even in hard water.
- A detergent is the sodium salt of a long chain benzene sulphonic acid which has cleansing properties in water.
- A detergent has a large non-ionic hydrocarbon group and ionic group like sulphonate group- $SO_3^-Na^+$ or sulphate group- $SO_4^-Na^+$
- Examples- Sodium n- dodecyl benzene sulphonate and sodium n-dodecyl sulphate.

- $CH_3-(CH_2)_{11}-C_6H_4-SO_3^-Na^+$ — Sodium n-dodecyl benzene sulphonate
- $CH_3-(CH_2)_{10}-CH_2-SO_4^-Na^+$ — Sodium n-dodecyl sulphate

- The structure of a detergent is similar to that of soaps-
- Two parts - • A long hydrocarbon chain which is water repelling and a short long part which is water attracting (hydrophillic).
- Detergents are made from long chain hydrocarbons obtain from petroleum.
- The cleansing action of detergent is similar to that of a soap.
- Detergents are usually used to make washing powder and shampoos



- A detergent forms lather easily even with Hard water

• SOAPS	• DETERGENTS
• Soaps are the sodium salts of the long chain carboxylic acids	• Detergents are sodium salts of long chain benzene sulphonic acids.
• Ionic group - $-COO^-Na^+$	• Ionic group - $-SO_3^-Na^+$ and $-SO_4^-Na^+$.
• soaps are biodegradable	• some detergents are not bio-degradable.
• Soaps are relatively weak action of cleansing	• Detergent are strong cleansing action.

- Detergent have a number of advantages over soaps due to which they are replacing soaps as washing agents-
- Detergent can be used even with hard water whereas soaps are not suitable for use with hard water.
- Detergent are a strong cleansing action than soaps.
- Detergent are more soluble in water than soaps.
- Detergent cause water pollution as they cannot be decomposed by microorganism. whereas soaps can.