10th Class

Carbon and its Compounds

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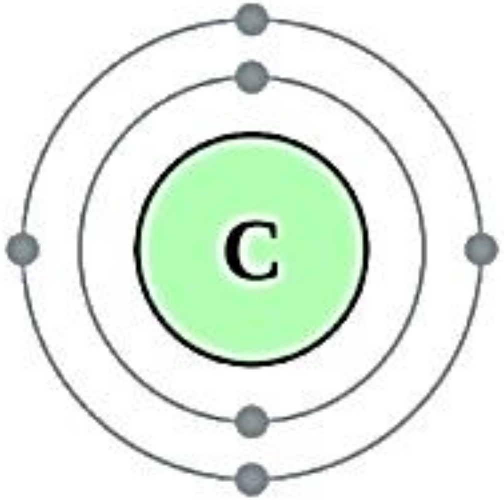
- Most of the things are made up of **compounds of carbon.**
- All living structures and non-living structures such as food, clothes, medicines, books etc. are carbon based.
- When a carbon compound is burnt, **CO_2 & water** is produced. Presence of CO_2 can be confirmed by passing it through **lime water** which turns milky.
- **Earth's crust** has only **0.02% carbon** (as minerals like carbonates, hydrogen carbonates, petroleum, coal etc.). The **atmosphere** has **0.03% CO_2.** But carbon has immense importance.

BONDING IN CARBON – THE COVALENT BOND

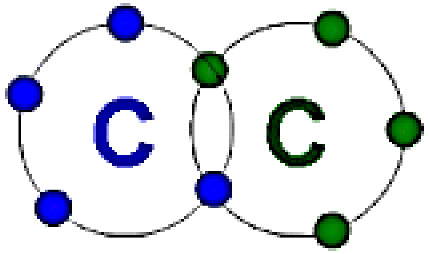
- Carbon compounds are **poor conductors** of electricity. So the bonding does not form ions. They have **low melting & boiling points** as compared to ionic compounds.
- **Atomic number (Z) of Carbon= 6.**
- **Electronic configuration= 2, 4 ($1s^2$ $2s^2$ $2p^2$).**
- Carbon has **4 electrons** in outermost shell.
- Gaining or losing 4 electrons is not possible to attain **noble gas configuration** because:
  - ✓ **Gaining 4 electrons (C^{4-} anion)** makes it difficult to hold 6 protons and 10 electrons.
  - ✓ **Losing 4 electrons (C^{4+} cation)** needs high energy to leave 6 protons and two electrons.

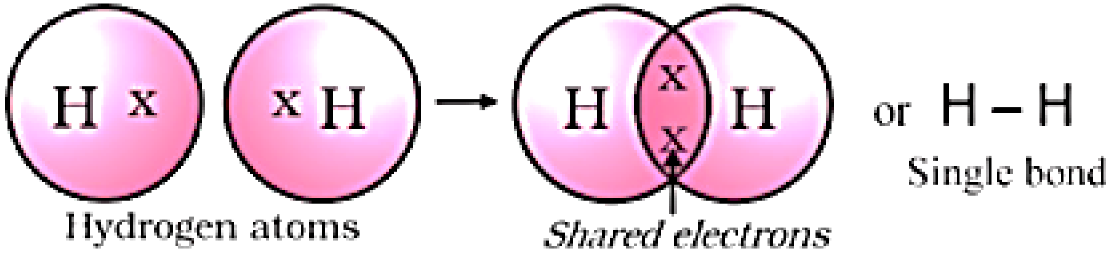
Carbon Compounds	Melting point (K)	Boiling point (K)
Acetic acid (CH_3COOH)	290	391
Chloroform ($CHCl_3$)	209	334
Ethanol (CH_3CH_2OH)	156	351
Methane (CH_4)	90	111



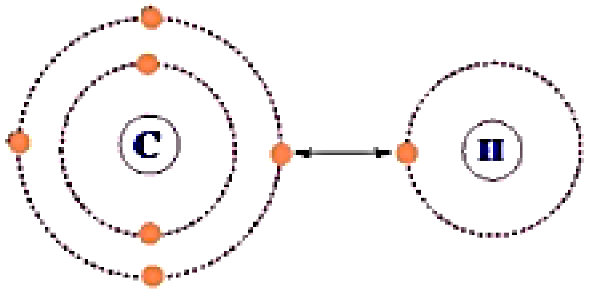
BONDING IN CARBON – THE COVALENT BOND

- This problem is overcome by **sharing valence electrons** with other atoms of carbon or other elements. Thus both atoms attain noble gas configuration.
- The simplest molecule formed by the sharing of valence electrons is that of **hydrogen (Z= 1).** It has one electron in K shell and needs one more electron to fill the K shell. So two hydrogen atoms share their electrons to form a **hydrogen molecule (H_2)** and attain nearest noble gas (**helium-** 2 electrons in K shell) configuration.
- To represent valence electrons, dots or crosses are used.
- The shared pair of electrons constitute a covalent bond between 2 hydrogen atoms. It is represented by a line.





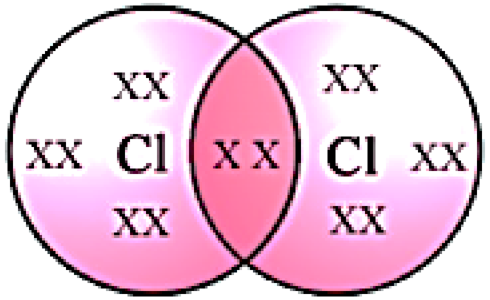
A molecule of Hydrogen



BONDING IN CARBON – THE COVALENT BOND

Electron dot structure of Chlorine

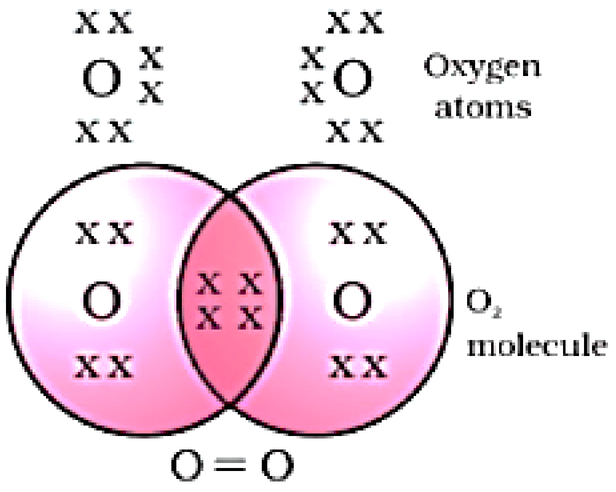
- Atomic number = 17.
- Electronic configuration= 2, 8, 7 (7 electrons in valence shell). It forms a diatomic molecule (Cl_2).



Cl - Cl or Cl_2 molecule

Electron dot structure of Oxygen

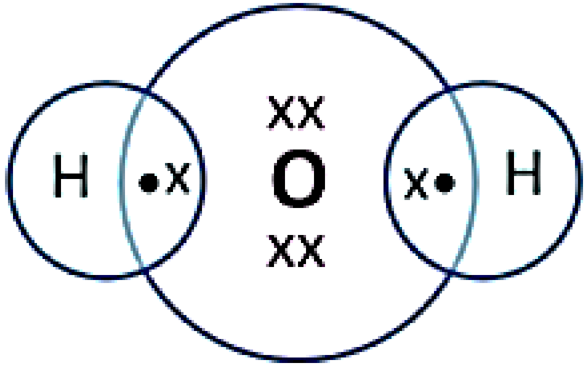
- Atomic number = 8. It has 6 electrons in L shell.
- It requires two more electrons to complete its octet.
- So the oxygen atom shares 2 electrons with another oxygen atom forming **double bond.**



Double bond between two oxygen atoms

BONDING IN CARBON – THE COVALENT BOND

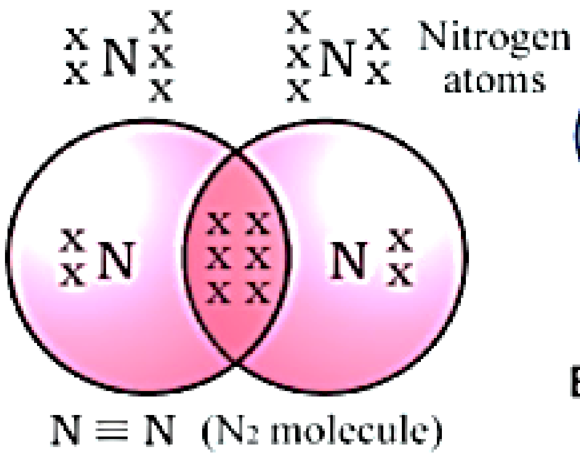
Electron dot structure of water (H_2O)

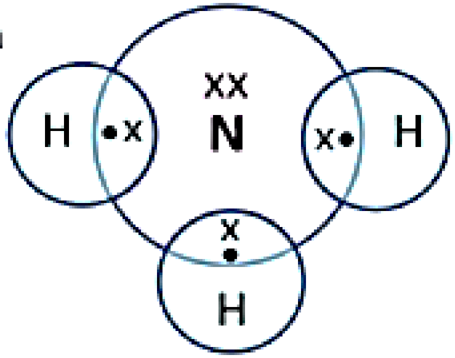


H – O – H

Electron dot structure of Nitrogen

- Atomic number = 7.
- Electronic configuration= 2, 5.
- It forms a diatomic molecule (N_2).
- To attain an octet, each nitrogen atom in a nitrogen molecule contributes 3 electrons forming **triple bond.**



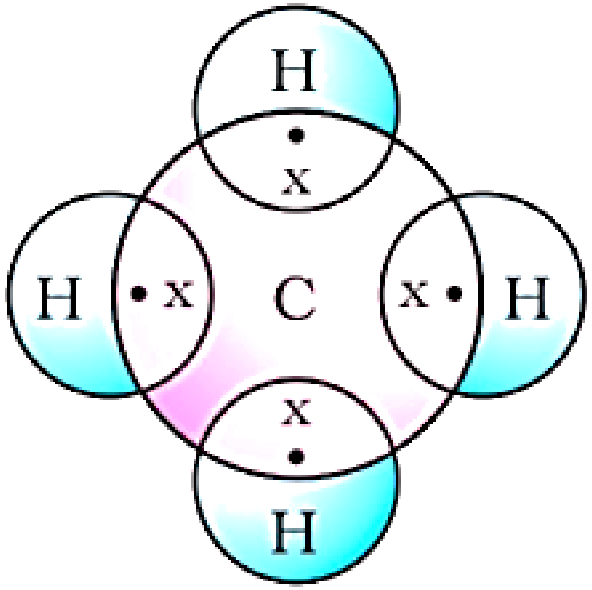


Electron dot structure of Ammonia (NH_3)

BONDING IN CARBON – THE COVALENT BOND

Electron dot structure for Methane (CH_4)

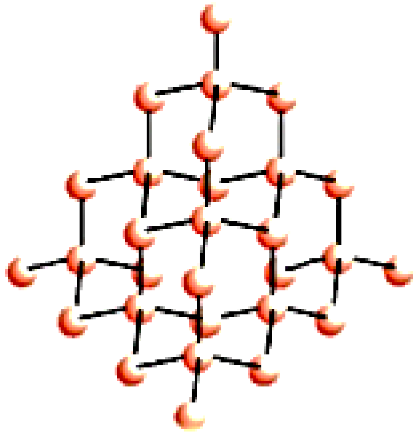
- **Methane** is one of the simplest compounds of carbon.
- It is used as a fuel and is a major component of **biogas** and **Compressed Natural Gas (CNG).**
- **Valency of Hydrogen= 1. Valency of Carbon= 4.**
- Carbon shares these electrons with 4 hydrogen atoms to get noble gas configuration.
- The bonds formed by sharing of an electron pair between two atoms are called **covalent bonds.**
- Covalently bonded molecules have **strong bonds** within the molecule, but **intermolecular forces** are **weak.** This gives rise to the **low melting & boiling points.**
- Since the electrons are shared between atoms and no charged particles are formed, covalent compounds are generally **poor conductors of electricity.**



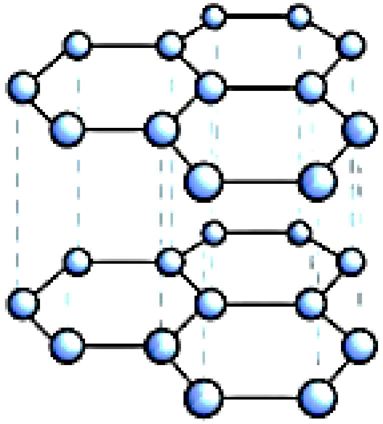
BONDING IN CARBON – THE COVALENT BOND

Allotropes (different forms) of carbon

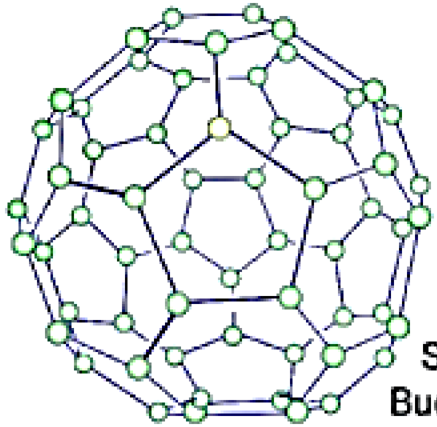
- E.g. **Diamond, Graphite & Fullerenes.**
- **Diamond:** In this, each carbon atom is bonded to **four other carbon atoms** forming rigid **three-dimensional structure.**
- **Graphite:** In this, each carbon atom is bonded to **three other carbon atoms** in the same plane giving a **hexagonal array.** One bond is double-bond to satisfy valency. Hexagonal arrays are placed in layers one above the other.

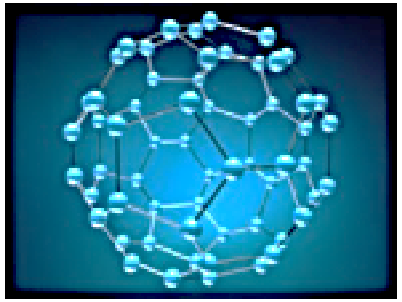


Structure of diamond



Structure of graphite





Structure of C-60 Buckminsterfullerene

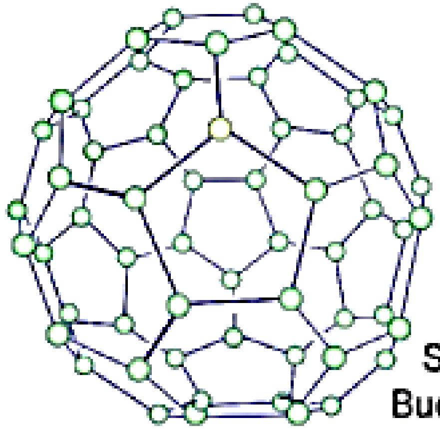
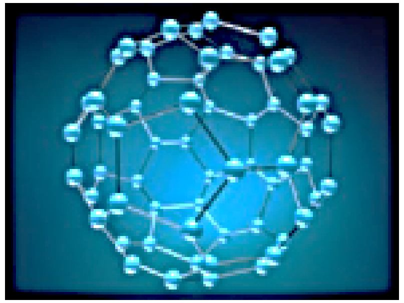
BONDING IN CARBON – THE COVALENT BOND

Allotropes (different forms) of carbon

- Diamond & Graphite have different physical properties but same chemical properties.
- **Diamond** is the **hardest** substance. **Graphite** is **smooth** and slippery and a very good conductor of electricity.
- **Synthetic diamonds** can be produced by subjecting pure carbon to very high pressure and temperature. These are small but indistinguishable from natural diamonds.
- **Fullerenes:** The first identified one was **C-60** which has carbon atoms arranged as a football. This looked like the geodesic dome designed by US architect **Buckminster Fuller.** So it was named fullerene.

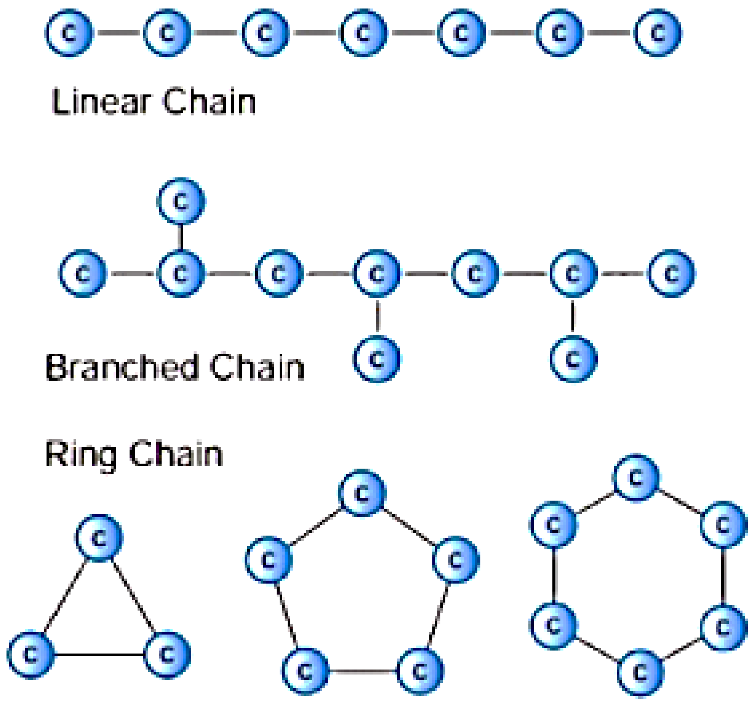

Diamond


Graphite

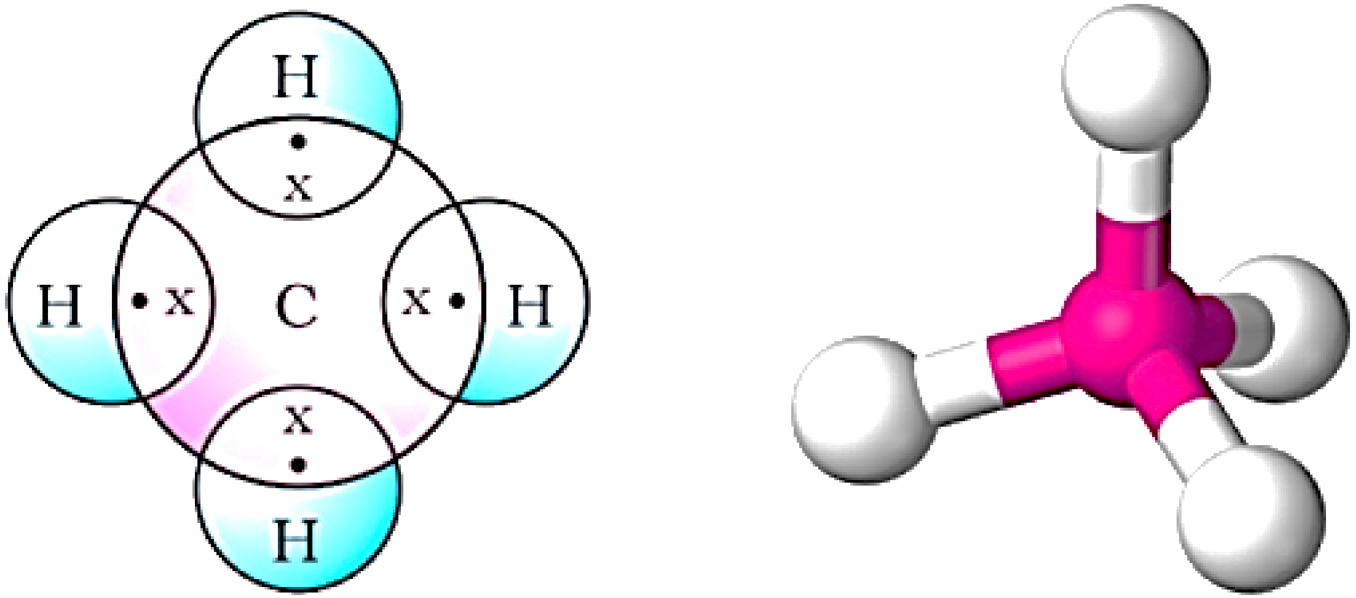


Structure of C-60 Buckminsterfullerene

VERSATILE NATURE OF CARBON

- Carbon has two unique properties called **Catenation** & **Tetravalency.** So it can form millions of compounds.
- This outnumbers the compounds formed by all the other elements put together.



Catenation property of carbon



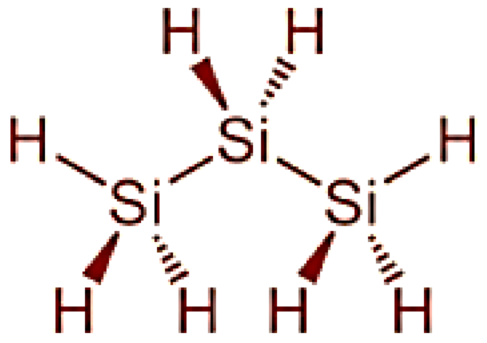
Tetravalency of carbon

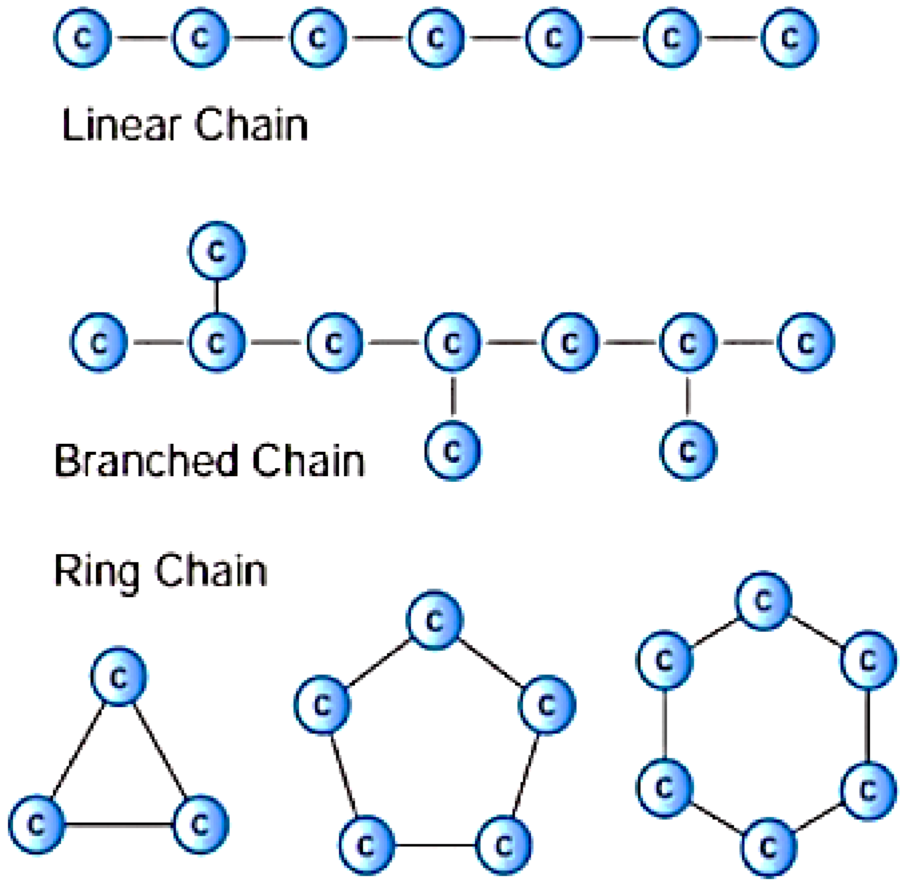
VERSATILE NATURE OF CARBON

1. Catenation

- It is ability of carbon to form **bonds with other atoms of carbon,** giving rise to large molecules.
- They may be **long chains, branched chains** or **ring forms.**
- No other element exhibits catenation like carbon.

Silicon forms compounds with hydrogen which have chains of up to 7 or 8 atoms, but these are very reactive. **Carbon-carbon bond is very strong & stable.** This gives large number of compounds.

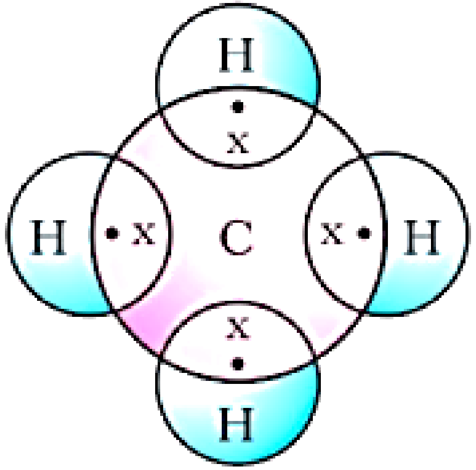


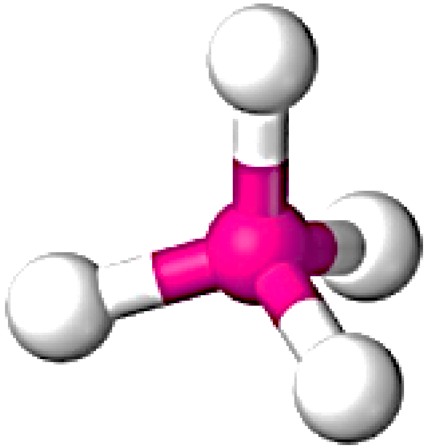


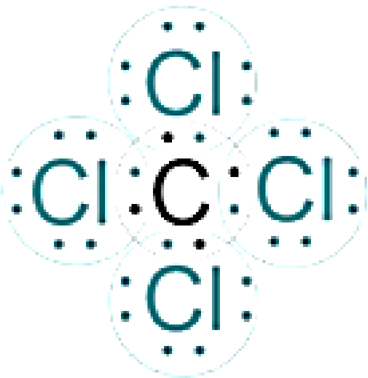
VERSATILE NATURE OF CARBON

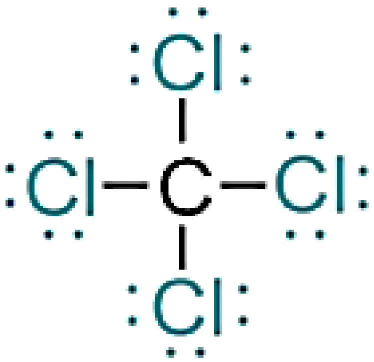
2. Tetravalency

- **Carbon** can bond with four other atoms of carbon or some other monovalent elements.
- Carbon compounds are formed with **oxygen, hydrogen, nitrogen, sulphur, chlorine** etc. giving specific properties.
- Carbon atom is small sized. So the nucleus can hold the shared pairs of electrons strongly. So carbon can make very stable compounds with other elements. The bonds formed by elements having bigger atoms are weaker.





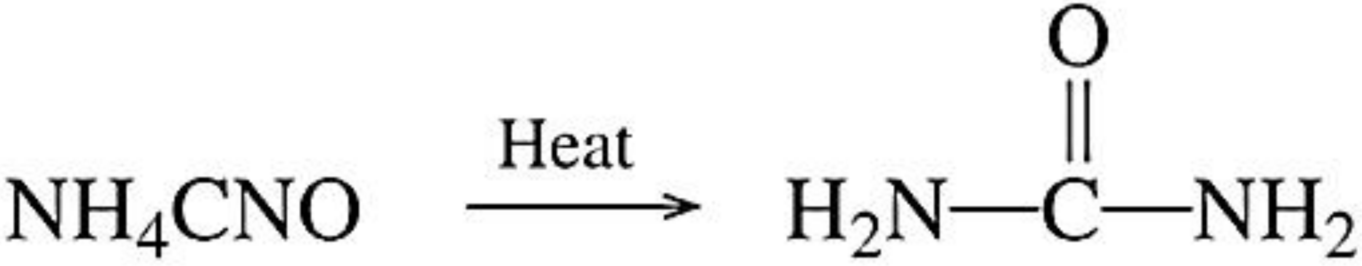




VERSATILE NATURE OF CARBON

- It was thought that organic or carbon compounds could only be formed with the help of a **vital force** (i.e., a living system is needed).
- **Friedrich Wöhler** (1828) disproved this by preparing **urea** from **ammonium cyanate.**
- But carbon compounds, except for carbides, oxides of carbon, carbonate and hydrogencarbonate salts are studied under **organic chemistry.**

Friedrich Wöhler



Ammonium cyanate (inorganic)

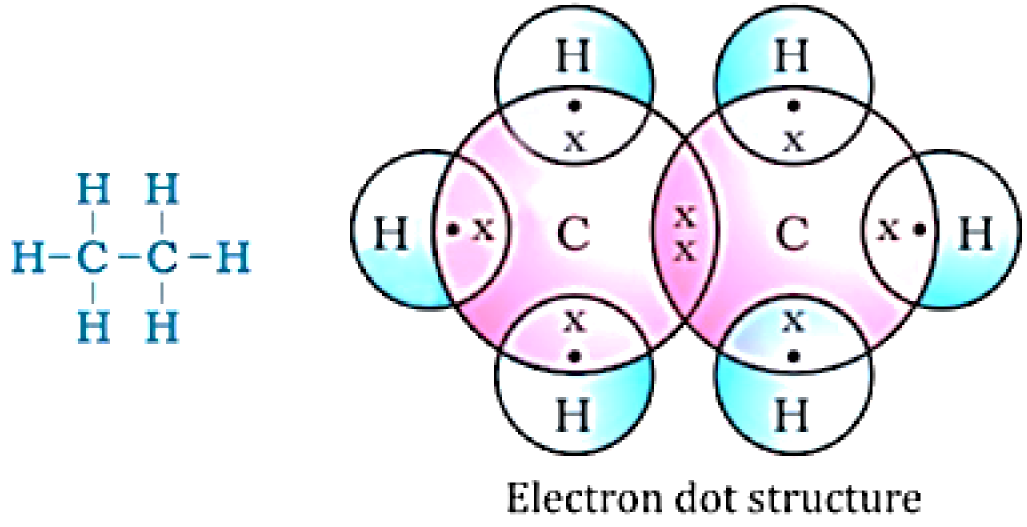
Urea (organic)

VERSATILE NATURE OF CARBON

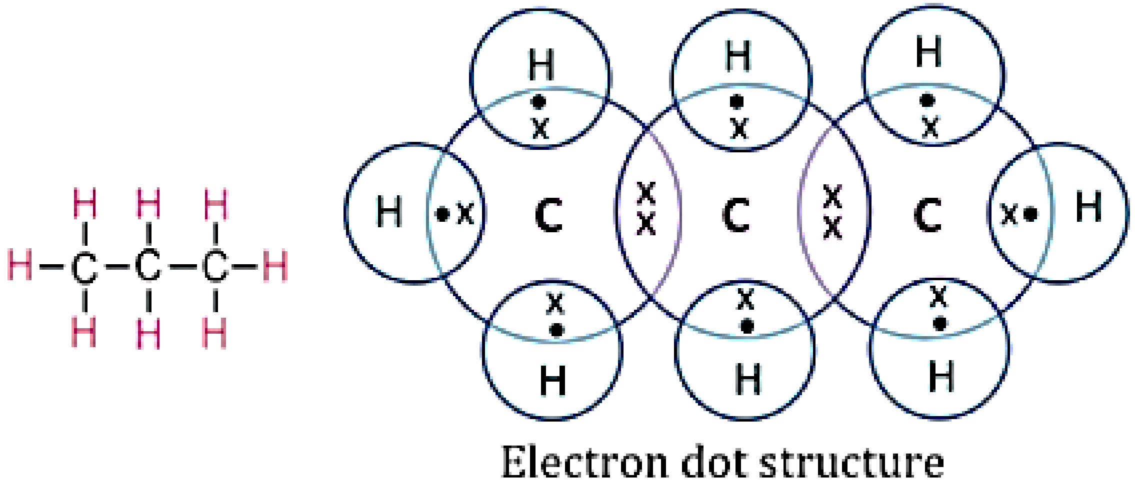
Saturated and Unsaturated Carbon Compounds

Saturated compounds

- They are linked by only single bonds between the carbon atoms.
- These are not very reactive. E.g. **Ethane (C_2H_6).**



Structure of ethane



Structure of propane (C_3H_8)

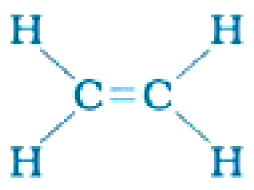
VERSATILE NATURE OF CARBON

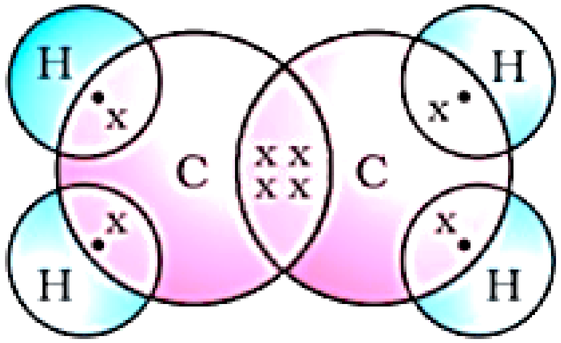
Saturated and Unsaturated Carbon Compounds

Unsaturated compounds

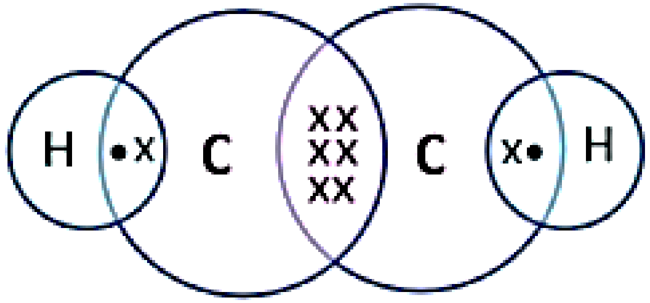
- They have double or triple bonds between carbon atoms.
- They are more reactive. E.g.
  - **Ethene (C_2H_4):** It needs double bond to satisfy the valency.
  - **Ethyne (C_2H_2):** It has triple bond between carbon atoms to satisfy the valency ($H - C \equiv C - H$).

Structure of ethene





Electron dot structure

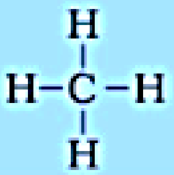
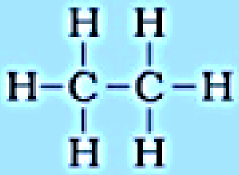
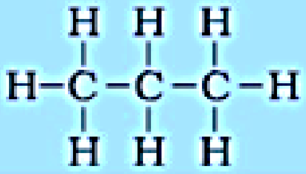


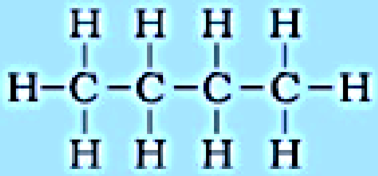
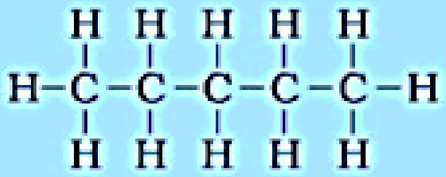
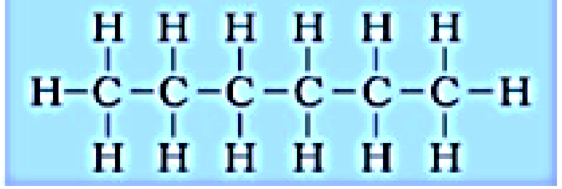
Electron dot structure for ethyne

VERSATILE NATURE OF CARBON

Chains, Branches and Rings

There are number of chains of carbon atoms. E.g.

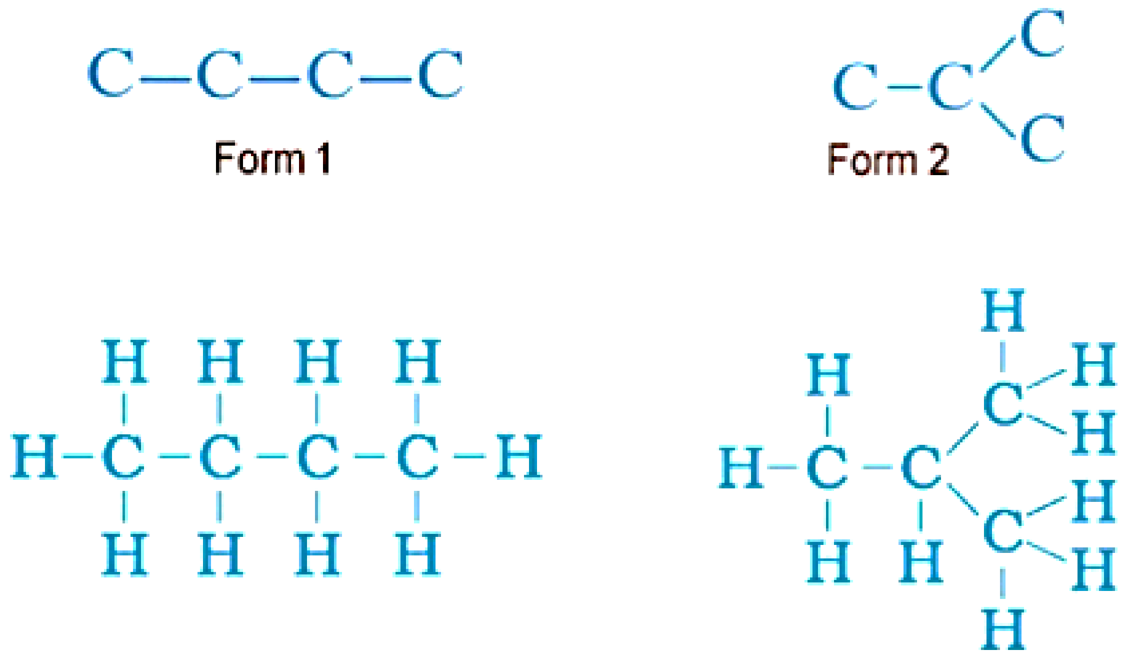
No. of C atoms	Name	Formula	Structure
1	Methane	CH_4	
2	Ethane	C_2H_6	
3	Propane	C_3H_8	

No. of C atoms	Name	Formula	Structure
4	Butane	C_4H_{10}	
5	Pentane	C_5H_{12}	
6	Hexane	C_6H_{14}	

VERSATILE NATURE OF CARBON

Chains, Branches and Rings

- Carbon 'skeleton' of 4 carbon atoms has two forms:



These structures have same formula C_4H_{10}. Such compounds with identical molecular formula but different structures are called **structural isomers.**

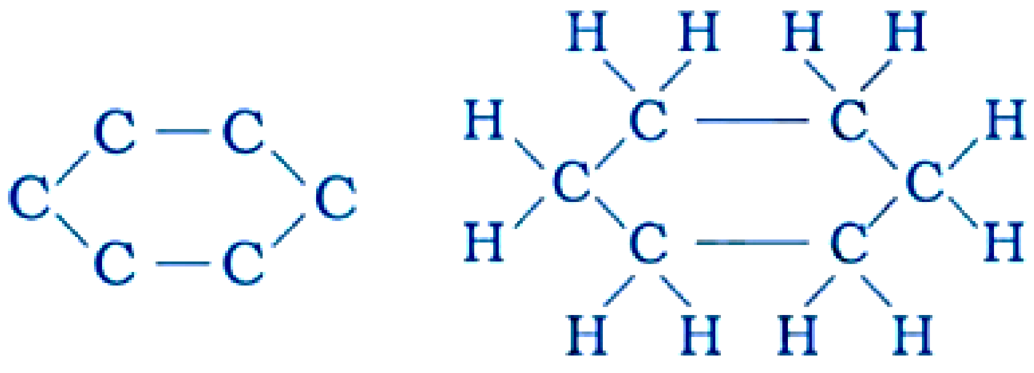
Complete molecules for two structures with formula C_4H_{10}

VERSATILE NATURE OF CARBON

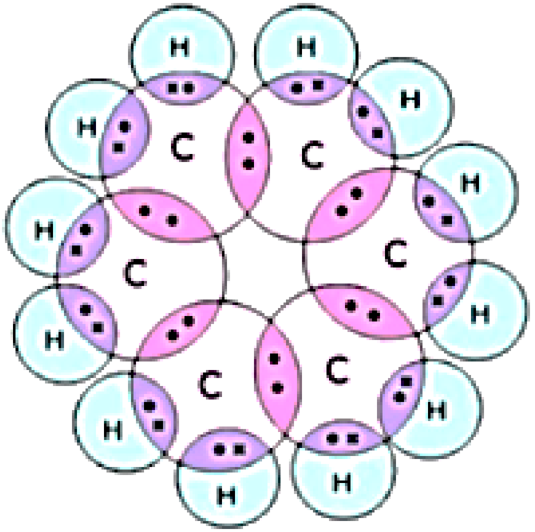
Chains, Branches and Rings

- Some compounds have carbon atoms arranged in the form of a **ring.** E.g., **cyclohexane (C_6H_{12}).**

Structure of Cyclohexane



(a) carbon skeleton (b) complete molecule

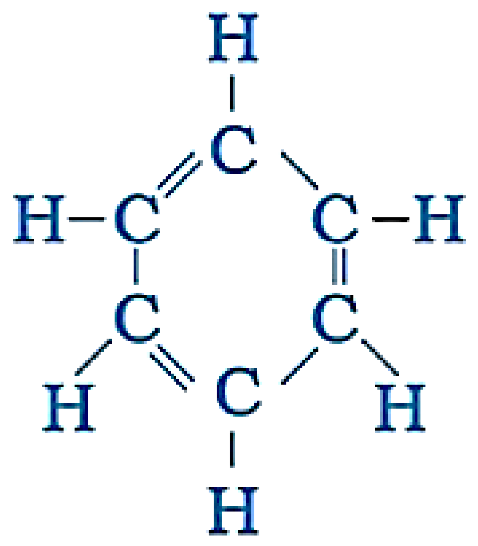


(c) electron dot structure

VERSATILE NATURE OF CARBON

Chains, Branches and Rings

- Straight chain, branched chain & cyclic compounds may be **saturated** or **unsaturated.** E.g. **benzene (C_6H_6).**
- All carbon compounds that contain only carbon and hydrogen are called **hydrocarbons.**
- **Saturated hydrocarbons** are called **alkanes.**
- The unsaturated hydrocarbons which contain one or more double bonds are called **alkenes.** Those containing one or more triple bonds are called **alkynes.**

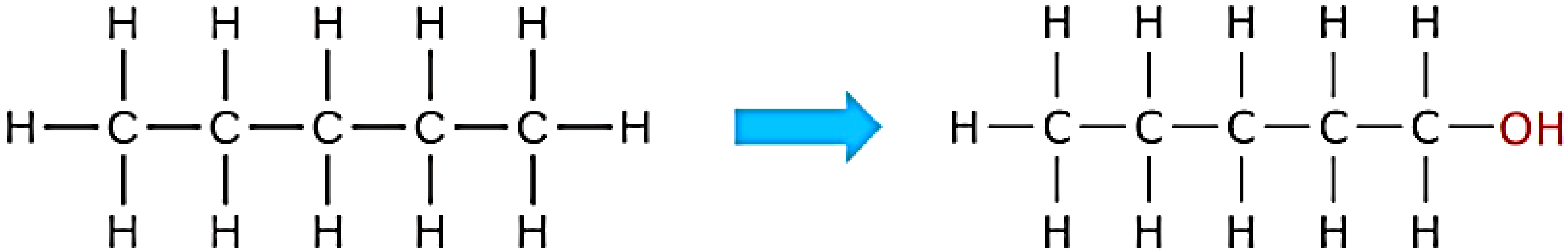


Benzene (C6H6)

VERSATILE NATURE OF CARBON

Will you be my Friend?

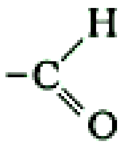
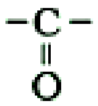
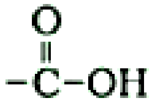
- Carbon also bonds with other elements such as **halogens, oxygen, nitrogen & sulphur.**
- In a **hydrocarbon chain,** one or more hydrogens are replaced by these elements. The element replacing hydrogen is called a **heteroatom.**
- Heteroatoms and the group containing these give specific properties to the compound, regardless of the length and nature of the chain. So they are called **functional groups.**



VERSATILE NATURE OF CARBON

Will you be my Friend?

Some functional groups in carbon compounds

Hetero atom	*Class of compounds*	*Formula of functional group*
Cl/Br	Halo- (Chloro/bromo) alkane	—Cl, —Br (substitutes for hydrogen atom)
Oxygen	1. Alcohol	—OH
	2. Aldehyde	
	3. Ketone	
	4. Carboxylic acid	

Free valency or valencies of the group are shown by the **single line.** The functional group is attached to the carbon chain through this valency.

VERSATILE NATURE OF CARBON

Homologous Series

- A functional group such as **alcohol** decides the properties of the carbon compound. E.g. chemical properties of **CH_3OH, C_2H_5OH, C_3H_7OH** and **C_4H_9OH** are very similar.
- Such a series of compounds in which the same functional group substitutes for hydrogen in a carbon chain is called a **homologous series.**

Homologous series for alkanes

Succeeding members differ by a **$-CH_2$ unit.** E.g.

- **CH_4** and **C_2H_6** differ by a $-CH_2$ unit
- **C_2H_6** and **C_3H_8** differ by a $-CH_2$ unit
- **C_3H_8** and **C_4H_{10}** differ by a $-CH_2$ unit

CH_4
CH_2
C_2H_6
CH_2
C_3H_8
CH_2
C_4H_{10}

- They show a difference of **14 U** in molecular masses b/w the pairs (atomic mass of carbon = 12 u, hydrogen = 1 u).

VERSATILE NATURE OF CARBON

Homologous Series

Homologous series for alkenes

- They also differ by a $-CH_2$ unit.
- First member is **ethene (C_2H_4).**
- Succeeding members are **C_3H_6, C_4H_8, C_5H_{10}** etc.

C_2H_4] CH_2
C_3H_6] CH_2
C_4H_8] CH_2
C_5H_{10}

- General formula for **alkenes** is **C_nH_{2n}** [n = 2, 3, 4].
- General formula for **alkanes** is **C_nH_{2n+2}**
- General formula for **alkynes** is **C_nH_{2n-2}**

As the **molecular mass increases,** physical properties such as **melting & boiling points, solubility in solvent** etc. also **increase.** But **chemical properties** remain **similar.**

VERSATILE NATURE OF CARBON

Homologous Series

Homologous series of Alcohols

Compounds	Difference in formula	Difference in molecular mass
CH_3OH & C_2H_5OH	$-CH_2-$	14 U
C_2H_5OH & C_3H_7OH	$-CH_2-$	14 U
C_3H_7OH & C_4H_9OH	$-CH_2-$	14 U
C_4H_9OH & $C_5H_{11}OH$	$-CH_2-$	14 U

VERSATILE NATURE OF CARBON

Nomenclature of Carbon Compounds

Method of naming a carbon compound:

1. Identify **number of carbon atoms.** E.g. three-carbon compound is named as **propane.**
2. Presence of functional group is indicated by a **prefix** or a **suffix.**
3. If the suffix of the functional group begins with a vowel, the final letter 'e' is deleted from the name of the carbon chain. E.g., **Propane** with a **ketone group** is named as

   Propane – 'e' = propan + 'one' = propanone
4. For **unsaturated carbon chain,** the final 'ane' is substituted by 'ene' or 'yne'. E.g., **propene** (double bond), **propyne** (triple bond) etc.

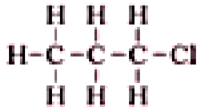
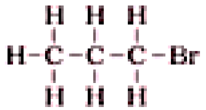
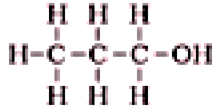
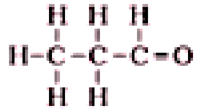
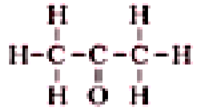
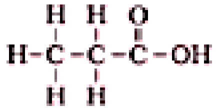
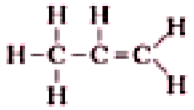
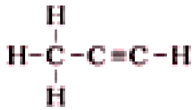
Functional Group	Prefix	Suffix
Carboxylic Acid	carboxy-	-oic acid
Ester	alkoxycarbonyl-	-oate
Acyl Halide	halocarbonyl-	-oyl halide
Amide	amido-	-amide
Nitrile	cyano-	-nitrile
Aldehyde	oxo-	-al
Ketone	keto/oxo	-one
Alcohol	hydroxy-	-ol
Amine	amino-	-amine
Ether	alkoxy-	-ether

Functional group	Prefix/suffix	example
alkane	-ane	 propane
alkene	-ene or -en-	 propene
alkyne	-yne	 propyne

VERSATILE NATURE OF CARBON

Nomenclature of Carbon Compounds

Nomenclature of organic compounds

Class of compounds	Prefix/Suffix	Example
1. Halo alkane	Prefix-chloro, bromo, etc.	 Chloropropane  Bromopropane
2. Alcohol	Suffix - ol	 Propanol
3. Aldehyde	Suffix - al	 Propanal
4. Ketone	Suffix - one	 Propanone
5. Carboxylic acid	Suffix - oic acid	 Propanoic acid
6. Alkenes	Suffix - ene	 Propene
7. Alkynes	Suffix - yne	 Propyne

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

Combustion

- Carbon (all allotropic forms) & most carbon compounds burn in oxygen to give CO_2 releasing heat and light. These are **oxidation reactions.**

$$C + O_2 \rightarrow CO_2 + \text{heat \& light}$$

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{heat \& light}$$

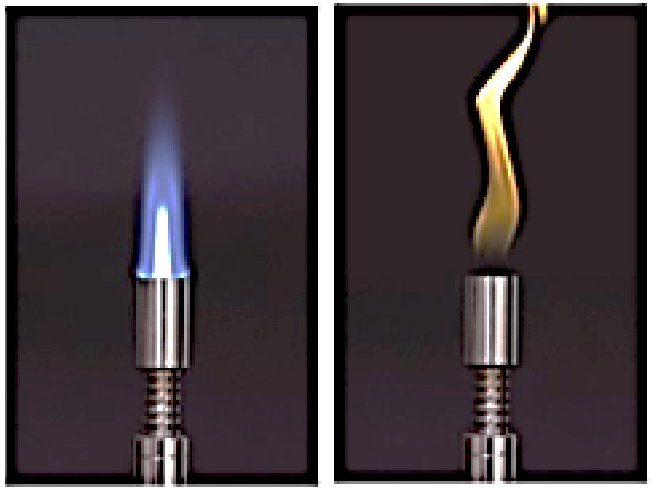
$$CH_3CH_2OH + 3O_2 \rightarrow 2CO_2 + 3H_2O + \text{heat \& light}$$

- **Saturated hydrocarbons** generally give a **clean flame.**
- **Unsaturated carbon compounds** give a yellow flame with black smoke or sooty deposit (carbon). E.g. **Camphor** & **Naphthalene** (unsaturated hydrocarbons) burn with **yellow flame** and leave residues.
- **Alcohol** is **saturated** and burns with clean **blue flame.**

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

Combustion

- Light a Bunsen burner and adjust the air hole at the base to get different types of flames/presence of smoke.
- If there is no sufficient supply of air, it results in **incomplete combustion** of even saturated hydrocarbons giving a **yellow, sooty flame.** In presence of sufficient air with oxygen, it gives **blue flame.**
- The gas/kerosene stove has inlets for sufficient supply of air, the fuel is burnt to give a clean blue flame.
- Blackening of the bottom of cooking vessel indicates that the air holes are blocked and fuel is getting wasted.
- **Coal** and **petroleum** have some **nitrogen & sulphur.** Their combustion forms oxides of sulphur & nitrogen. They are major air **pollutants.**



Air Hole Open

Air Hole Closed

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

Combustion

Why do substances burn with or without a flame?

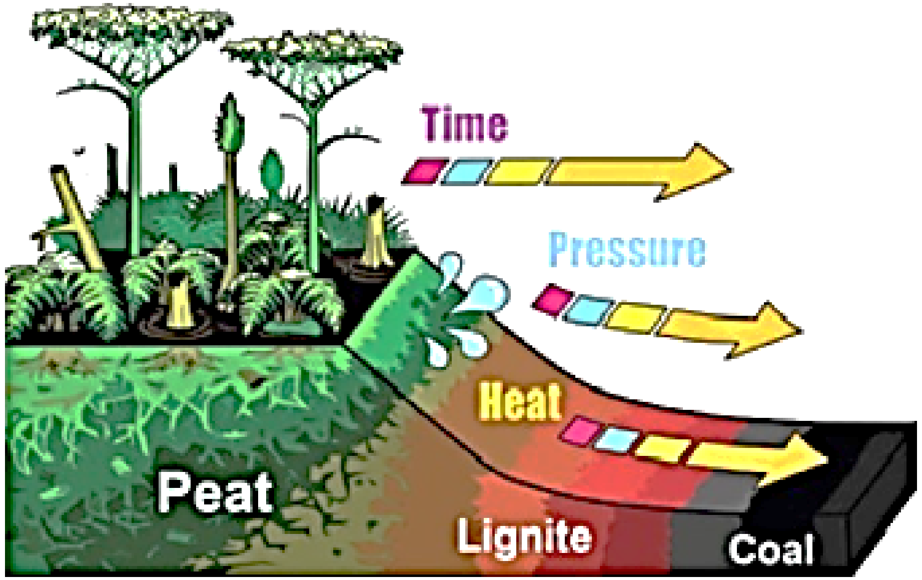
- A flame is produced only when gaseous substances burn. So a candle or LPG burns with a flame.
- **Wood, coal** or **charcoal** burn with a flame at first due to the volatile substances in them. After that they just **glow red** and gives out heat.
- Atoms of gas substance are heated and glow to produce flame. Each element produces characteristic colour. E.g. heating a **copper** wire in flame gives **bluish green flame.**
- **Yellow colour** of a **candle flame** is due to incomplete combustion of carbon particles. When light falls on them, they scatter yellow colour.

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

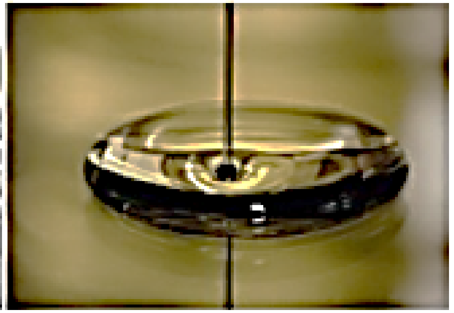
Combustion

Formation of coal and petroleum (fossil fuels)

- **Fossil fuels** were formed from **biomass** by biological and geological processes.
- Millions of years ago, **trees, ferns** and **other plants** were crushed into the earth due to earthquakes or volcanic eruptions. They were pressed down by layers of earth and rock. They slowly decayed into **coal.**
- **Dead marine tiny plants** and **animals** sank to the sea bed and were covered by silt. Due to bacterial action, they turned into **oil & gas** under high pressure. The silt was compressed into rock. The oil & gas seeped into porous rock parts, and got trapped like water in a sponge.




Coal


Petroleum

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

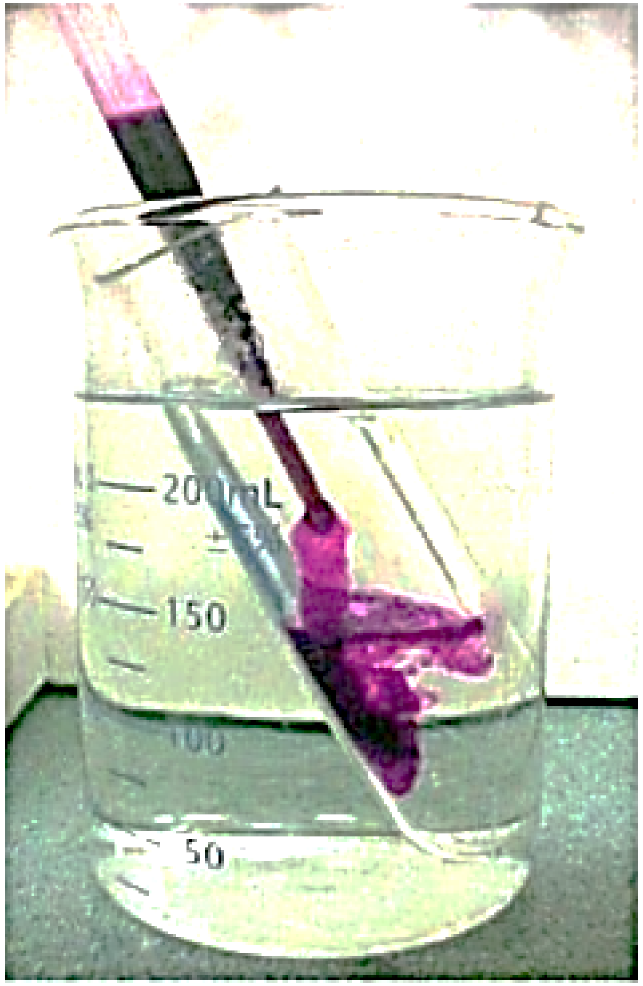
Oxidation

- Carbon compounds are easily oxidised on combustion.
- **Alcohols** can be oxidised to **carboxylic acids.** Here, oxidising agents like alkaline **potassium permanganate ($KMnO_4$)** or acidified **potassium dichromate ($K_2Cr_2O_7$)** are used.

  (***Oxidising agents:*** *The substances that can add oxygen to others*).

- E.g. Take 3 mL **ethanol** in a test tube and warm gently in a water bath. Add a 5% solution of alkaline **$KMnO_4$** drop by drop. **Purple** colour of $KMnO_4$ **disappears** initially.
- When more $KMnO_4$ is added, the colour persists because all the alcohol gets consumed and the reaction stops.

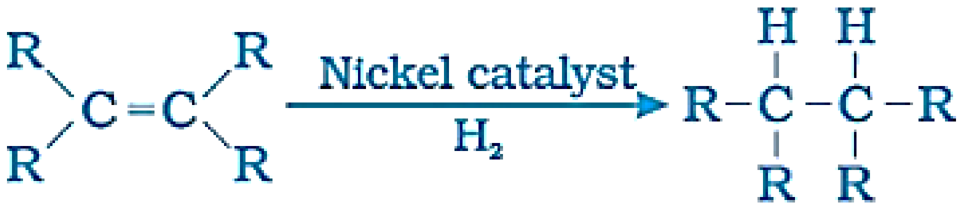
$$CH_3-CH_2OH \xrightarrow[\textit{Or acidified } K_2Cr_2O_7 + \textit{Heat}]{\textit{Alkaline } KMnO_4 + \textit{Heat}} CH_3COOH$$

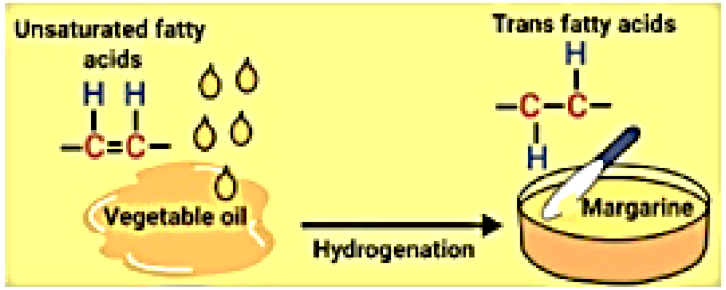


CHEMICAL PROPERTIES OF CARBON COMPOUNDS

Addition Reaction

- **Unsaturated hydrocarbons** add hydrogen in the presence of **catalysts** such as **palladium** or **nickel** to give **saturated hydrocarbons.** (***Catalysts:*** *The substances that influences the rate of a reaction without changing itself*).
- This reaction is commonly used in the **hydrogenation** of vegetable oils using a **nickel catalyst.**





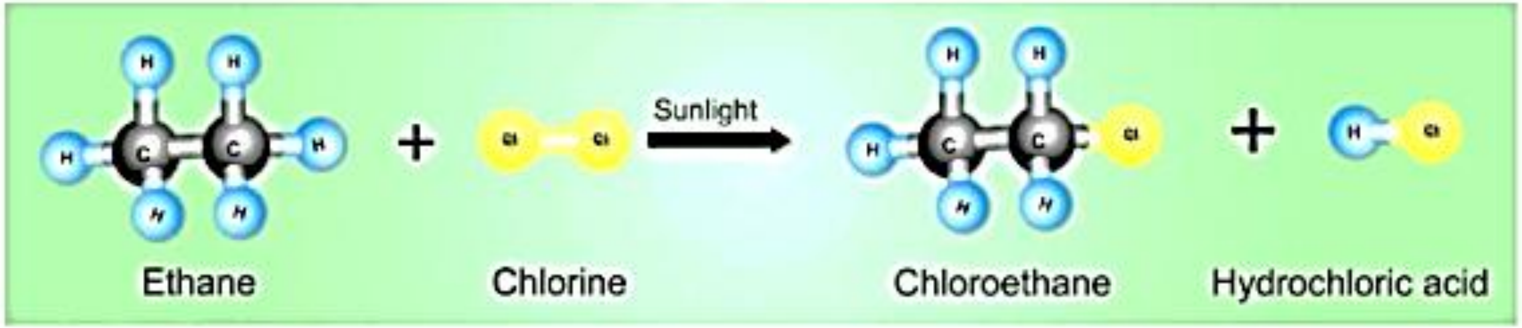
- **Vegetable oils** generally have long **unsaturated carbon chains (fatty acids).** So they are healthy.
- **Animal fats** generally contain **saturated fatty acids** which are harmful to health.

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

Substitution Reaction

- **Saturated hydrocarbons** are **unreactive** and **inert** in the presence of most reagents.
- However, in presence of sunlight, hydrocarbons undergo **substitution reaction** very fast. E.g.

$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ (in the presence of sunlight)



- Here, **chlorine** replaces the **hydrogen** atoms one by one.
- Higher homologues of alkanes can form many products.

SOME IMPORTANT CARBON COMPOUNDS: ETHANOL & ETHANOIC ACID

Properties of Ethanol

- **Ethanol** is liquid at room temperature.
- It is commonly called **alcohol** and is the active ingredient of all alcoholic drinks.
- It is a **good solvent.** So it is used in medicines such as **tincture iodine, cough syrups,** and **tonics.**
- Ethanol is soluble in water in all proportions.

SOME IMPORTANT CARBON COMPOUNDS: ETHANOL & ETHANOIC ACID

Properties of Ethanol

- Consumption of small quantities of dilute ethanol causes **drunkenness.** Intake of even a small quantity of **pure ethanol (absolute alcohol)** is lethal. Long-term intake leads to many health problems.
- Ethanol for industrial use is made unfit for drinking by adding methanol. It is called **denatured alcohol. Blue dyes** are added to alcohol to identify easily.
- Some countries use alcohol as an additive in petrol since it is a cleaner fuel. It releases only CO_2 & water.

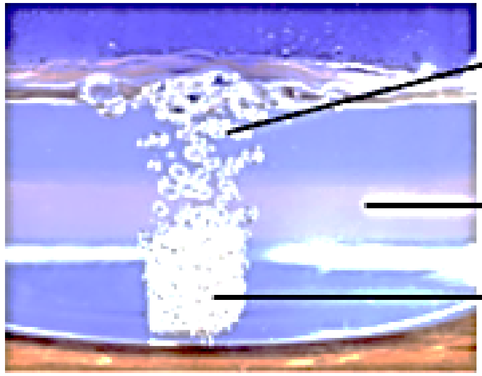
SOME IMPORTANT CARBON COMPOUNDS: ETHANOL & ETHANOIC ACID

Properties of Ethanol: Reactions of Ethanol

a. Reaction with sodium

- Alcohols react with sodium evolving **hydrogen.**
- E.g. Drop a small piece of sodium into pure ethanol. It produces **sodium ethoxide ($2CH_3CH_2O{-}Na^+$)** and **H_2.**

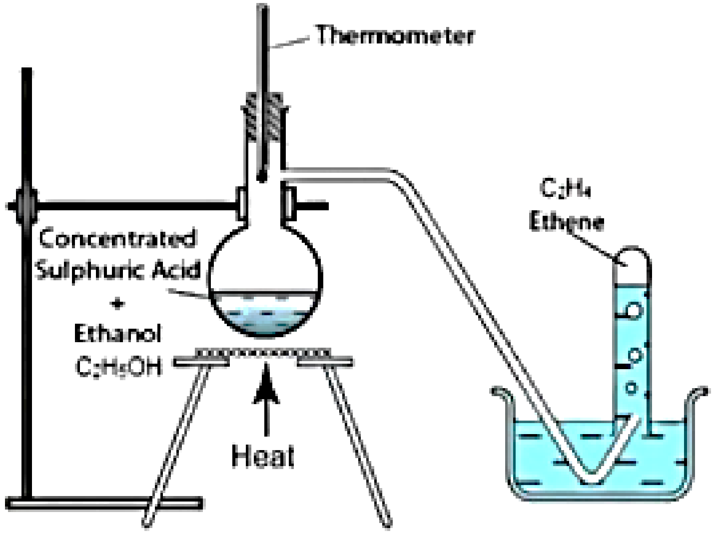
$$2Na + 2CH_3CH_2OH \rightarrow 2CH_3CH_2O{-}Na^+ + H_2$$



b. Reaction to give unsaturated hydrocarbon

- Heating ethanol at 443 K with excess **conc. H_2SO_4** results in **dehydration of ethanol** to give **ethene.** Conc. H_2SO_4 is a **dehydrating agent** (removes water from ethanol).

$$CH_3-CH_2OH \xrightarrow{Hot\ Conc.H2SO4} CH_2 = CH_2 + H_2O$$



SOME IMPORTANT CARBON COMPOUNDS: ETHANOL & ETHANOIC ACID

Properties of Ethanoic acid (Acetic acid)

- It belongs to **carboxylic acids (weak acids).**
- 5-8% solution of acetic acid in water is called **vinegar.** It is used as a **preservative** in pickles.


- The melting point of pure ethanoic acid is **290 K** and hence it often freezes during winter. So it is known as **glacial acetic acid.**
- Acetic acid is weak acid and HCl is strong acid.

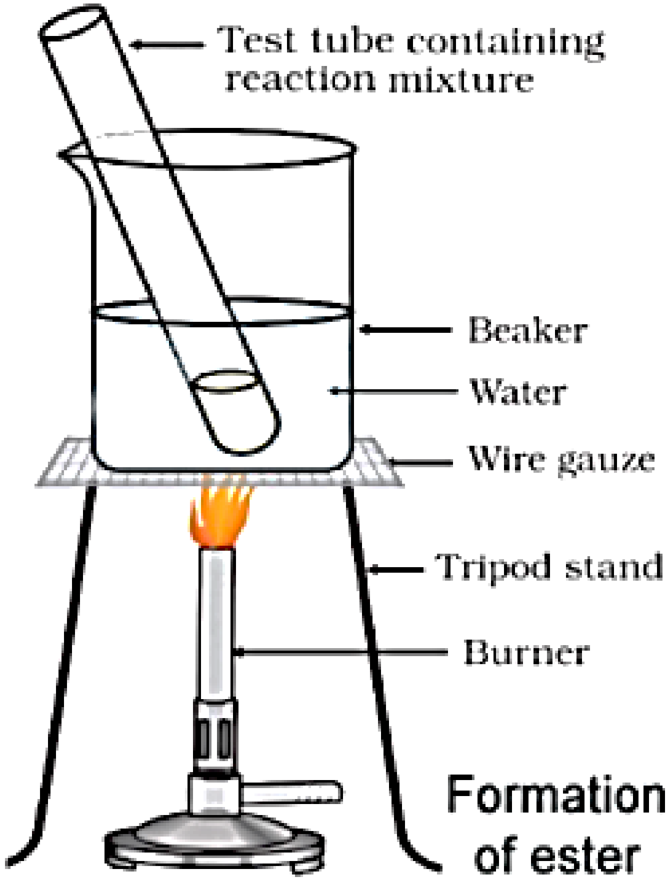

SOME IMPORTANT CARBON COMPOUNDS: ETHANOL & ETHANOIC ACID

Properties of Ethanoic acid (Acetic acid): Reactions of ethanoic acid

a. Esterification reaction

It is the formation of **esters** by reaction of an **acid** & an **alcohol.** E.g.

- Take 1 mL **absolute ethanol** + 1 mL **glacial acetic acid (ethanoic acid)** + few drops of **conc. H_2SO_4** (acid catalyst) in a test tube.
- Warm in a water-bath for 5 minutes.
- Pour into a beaker containing 20-50 mL of **water.** The resulting mixture is an **ester.**



Formation of ester

$$\underset{\text{(Ethanoic acid)}}{CH_3-COOH} + \underset{\text{(Ethanol)}}{CH_3-CH_2OH} \xrightleftharpoons{\text{Acid}} \underset{\text{(Ester)}}{CH_3-C-\underset{\underset{O}{||}}{C}-CH_2-CH_3} + H_2O$$

SOME IMPORTANT CARBON COMPOUNDS: ETHANOL & ETHANOIC ACID

Properties of Ethanoic acid (Acetic acid): Reactions of ethanoic acid

- Esters have **sweet smell.**
- Uses of esters: To make **perfumes** & as **flavouring agents.**
- On treating with **NaOH** (an alkali), the **ester** is converted back to **alcohol** and **sodium salt of carboxylic acid.** This is called **saponification** because it is used to prepare **soap.**

$$CH_3COOC_2H_5 \xrightarrow{NaOH} C_2H_5OH + CH_3COONa$$

SOME IMPORTANT CARBON COMPOUNDS: ETHANOL & ETHANOIC ACID

Properties of Ethanoic acid (Acetic acid): Reactions of ethanoic acid

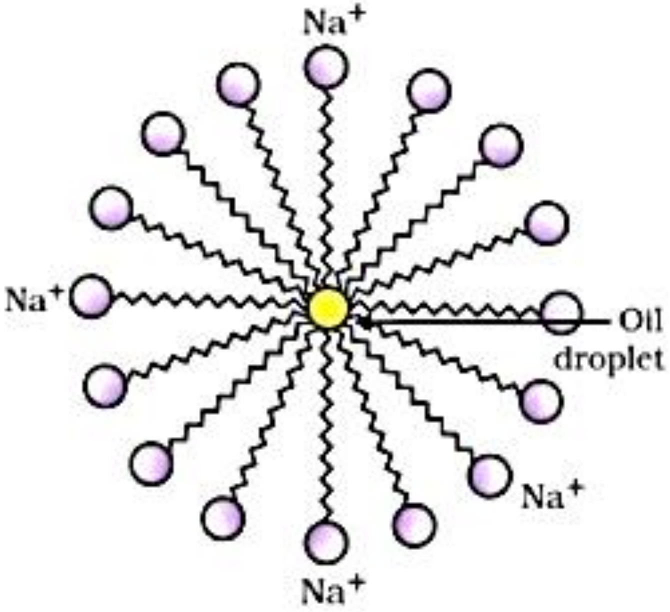
b. Reaction with a base	Ethanoic acid reacts with a base like **NaOH** to give a **salt (sodium ethanoate or sodium acetate)** and **water.** $NaOH + CH_3COOH \rightarrow CH_3COONa + H_2O$
c. Reaction with carbonates & hydrogen carbonates	• Take a spatula full of **sodium carbonate** in a test tube and add 2 mL **dilute ethanoic acid.** Following reaction occurs: $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + CO_2 + H_2O$ (Sodium acetate) Pass the gas produced through lime-water. It turns milky. i.e., the gas is **CO_2.** • **Reaction with sodium hydrogen carbonate:** $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$

SOAPS AND DETERGENTS

- Take 10 mL of **water** each in two test tubes A & B.
- Add a drop of **cooking oil** to both the test tubes.
- To the test tube B, add few drops of **soap solution.**
- Shake test tubes vigorously to get unclear mixtures.
- Leave the test tubes undisturbed for some time. **Oil layer separates** out in both test tubes. But this happens first in test tube A.
- This activity demonstrates the effect of soap in cleaning.
- Most dirt is oily and does not dissolve in water.

SOAPS AND DETERGENTS

- Soap molecules are **sodium / potassium salts** of long-chain **carboxylic acids.**
- **Ionic-end (hydrophilic)** of soap interacts with water while **carbon chain (hydrophobic tail)** interacts with oil. The soap molecules, thus form structures called **micelles.** In this, one end of the molecules is towards the oil droplet and the ionic-end faces outside. It forms an **emulsion** in water. The soap micelle thus helps in pulling out the dirt in water and clothes become clean.

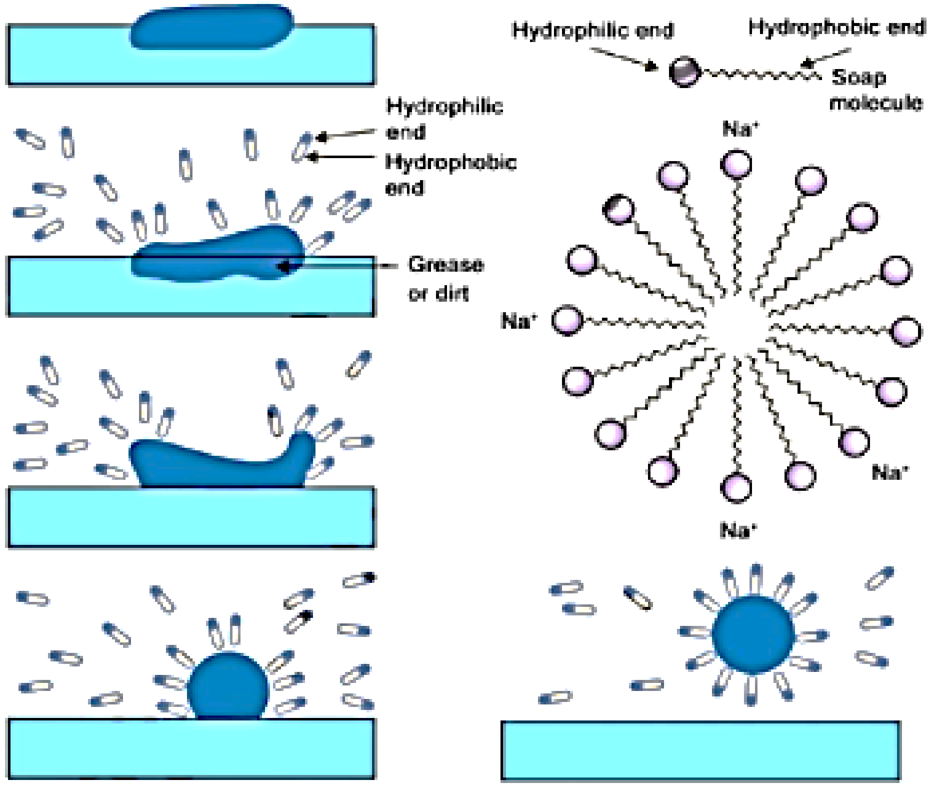


Formation of micelles

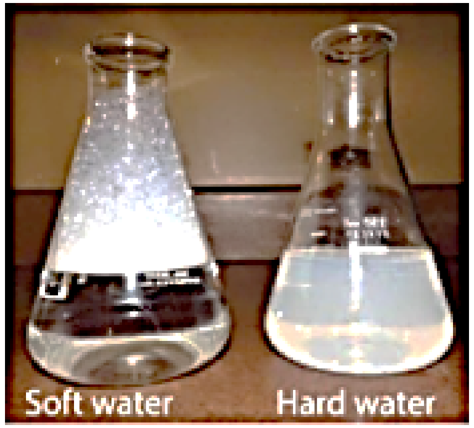
SOAPS AND DETERGENTS

Effect of soap in cleaning

- At the surface of water, soap aligns such that its ionic end is in water and hydrocarbon tail protrude out of water.
- Inside water, these molecules form clusters in which the hydrophobic tails are oriented towards interior and the ionic ends towards exterior. This cluster is called a **micelle.**
- The oily dirt is collected in the centre of micelle. The micelles stay as a colloid and will not come together to precipitate because of **ion-ion repulsion.** So, the dirt in micelles is easily rinsed away.
- The soap micelles are large enough to scatter light. Hence a soap solution appears cloudy.



SOAPS AND DETERGENTS

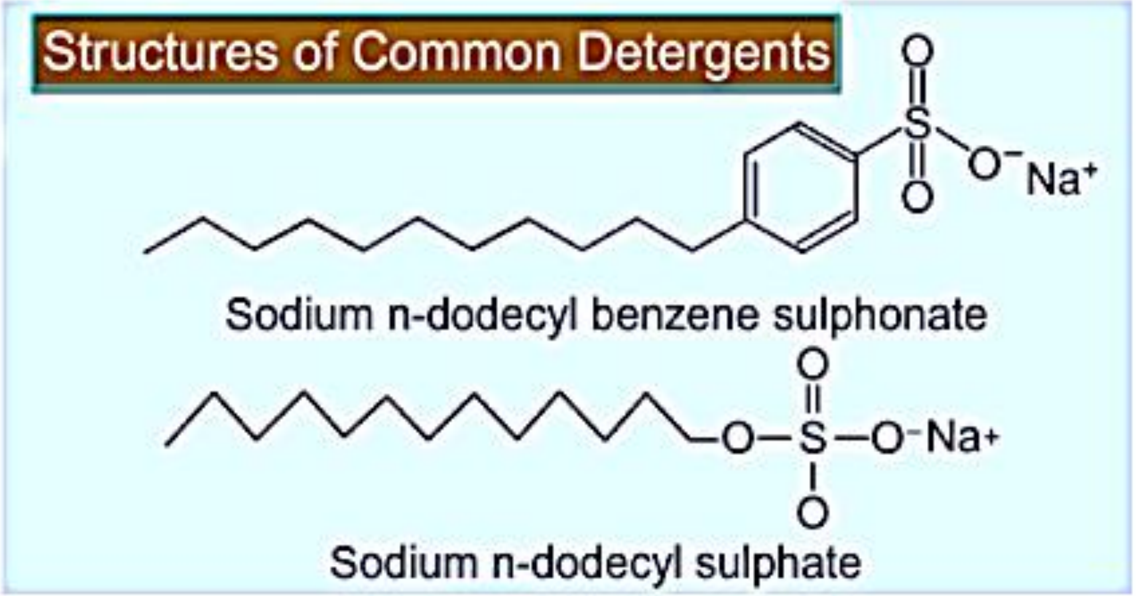


- The water containing **sulphates/ chlorides/ hydrogen carbonates** of **calcium** or **magnesium** is called **hard water.** E.g. Water from tube well or hand-pump.
- It is difficult to produce foam by soaps in hard water. So bathing and washing become difficult. After washing, an insoluble substance **(scum)** remains in hard water. It can be demonstrated by the following experiment:
  - Take 10 mL **distilled water (or rain water)** and 10 mL **hard water** in separate test tubes (hard water can be prepared by dissolving salts of Ca or Mg in water).
  - Add few drops of soap solution to both and shake well for same period.
  - Test tube with distilled water gets more foam.
  - Test tube with hard water gets white curdy precipitate.
- This **scum** or **precipitate** is caused by the reaction of soap with the calcium and magnesium salts.

SOAPS AND DETERGENTS

Detergents

- These are **sodium salts of sulphonic acids** or **ammonium salts** with **chlorides** or **bromides** ions, etc.
- Both have **long hydrocarbon chain.** Charged ends of these compounds do not form insoluble precipitates with Ca & Mg ions. Thus, they are also effective in hard water.



SOAPS AND DETERGENTS

Detergents

- It can be demonstrated by the following experiment:
  - Take two test tubes with 10 mL hard water in each.
  - Add five drops of soap solution to one and five drops of detergent solution to the other.
  - Shake both test tubes for the same period.
  - The test tube with detergent gets more foam.
  - In test tube with soap, curdy precipitate is formed.

Uses of Detergents

To make **shampoos** and products to **clean clothes.**


thank
you