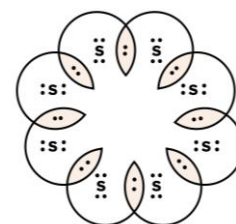


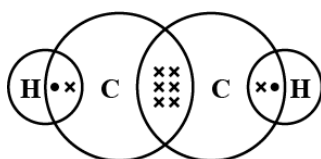
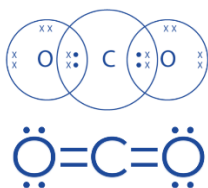
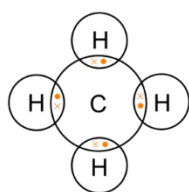
4.1 BONDING IN CARBON – THE COVALENT BOND

Reactivity of elements is explained as their tendency to attain a **completely filled outer shell**, that is, attain noble gas configuration. In elements forming **ionic compounds** **Stability achieved this by either gaining or losing electrons** from the outermost shell. If carbon follows this:

- To gain four electrons forming C^{4-} anion. (difficult for the nucleus with six protons to hold on to ten electrons)
- To lose four electrons forming C^{4+} cation. (Require a large amount of energy to remove four electrons leaving behind a carbon cation with six protons in its nucleus holding on to just two electrons.)

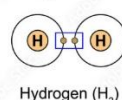


Carbon solves problem by **SHARING of ELECTRON** or **COVALENCY**.

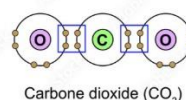


Covalent Bond Types

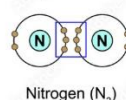
Single Bond



Double Bond



Triple Bond

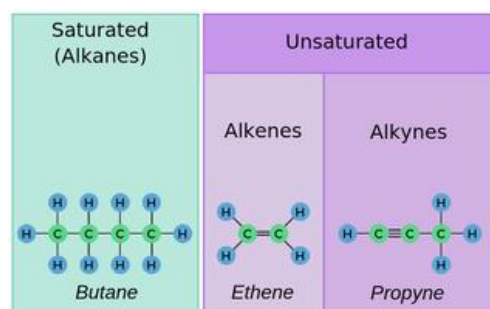


properties of Covalently bonded Molecules :

- Strong intramolecular bonding but weak intermolecular bonding. So Low Melting and Boiling point.
- Poor conductor of electricity as electrons are shared between atoms and no charged particles are formed

4.2 VERSATILE NATURE OF CARBON

- Catenation** : Carbon has the unique ability to form bonds with other atoms of carbon, giving rise to large molecules. This property is called catenation.
- Tetravalency** : carbon has a valency of four, it is capable of bonding with four other atoms of carbon or atoms of some other mono-valent element. Compounds of carbon are formed with oxygen, hydrogen, nitrogen, sulphur, chlorine and many other elements giving rise to compounds with specific properties
- Small Size** : enables the nucleus to hold on to the shared pairs of electrons strongly. The bonds formed by elements having bigger atoms are much weaker.



4.2.1 Saturated and Unsaturated Carbon Compounds

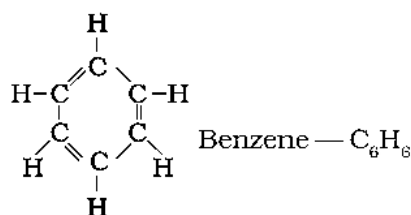
Alkane		Alkene		Alkyne	
C_nH_{2n+2}		C_nH_{2n}		C_nH_{2n-2}	
Homologous series		Homologous series		Homologous series	
Name	Formula	Name	Formula	Name	Formula
Methane	CH_4	–	–	–	–
Ethane	C_2H_6	Ethene	C_2H_4	Ethyne	C_2H_2
Propane	C_3H_8	Propene	C_3H_6	Propyne	C_3H_4
Butane	C_4H_{10}	Butene	C_4H_8	Butyne	C_4H_6
Pentane	C_5H_{12}	Pentene	C_5H_{10}	Pentyne	C_5H_8
Hexane	C_6H_{14}	Hexene	C_6H_{12}	Hexyne	C_6H_{10}

Saturated Hydrocarbon	Unsaturated Hydrocarbon
1. In these compounds, there is a single bond between carbon atoms.	In these compounds, there is a double or triple bond between carbon atoms.
2. They give a clean flame on heating.	They give yellow flame with a lot of black smoke on burning.
3. On burning, saturated hydrocarbons give a clean flame.	On burning, unsaturated hydrocarbons give yellow flame with lots of black smoke.

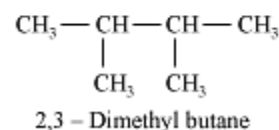
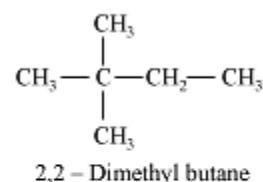
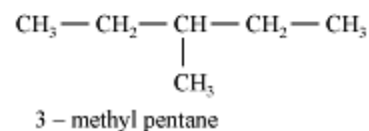
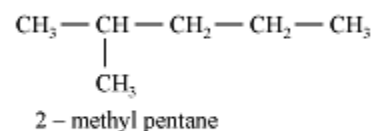
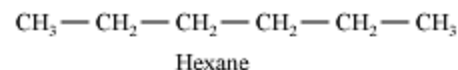
HOMOLOGOUS SERIES

Number of Carbons	Prefix	Suffix	Structural Formula	Molecular Formula
1	Meth-	ane	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	CH_4
2	Eth-	ane	$\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C}- & \text{C}-\text{H} \\ & \\ \text{H} & \text{H} \end{array}$	C_2H_6
3	Prop-	ane	$\begin{array}{c} \text{H} & \text{H} & \text{H} \\ & & \\ \text{H}-\text{C}- & \text{C}- & \text{C}-\text{H} \\ & & \\ \text{H} & \text{H} & \text{H} \end{array}$	C_3H_8
4	But-	ane	$\begin{array}{c} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C}- & \text{C}- & \text{C}- & \text{C}-\text{H} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$	C_4H_{10}
5	Pent-	ane	$\begin{array}{c} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & \\ \text{H}-\text{C}- & \text{C}- & \text{C}- & \text{C}- & \text{C}-\text{H} \\ & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$	C_5H_{12}
6	Hex-	ane	$\begin{array}{c} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & \\ \text{H}-\text{C}- & \text{C}- & \text{C}- & \text{C}- & \text{C}- & \text{C}-\text{H} \\ & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$	C_6H_{14}
7	Hept-	ane	$\begin{array}{c} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & \\ \text{H}-\text{C}- & \text{C}- & \text{C}- & \text{C}- & \text{C}- & \text{C}- & \text{C}-\text{H} \\ & & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$	C_7H_{16}
8	Oct-	ane	$\begin{array}{c} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & & \\ \text{H}-\text{C}- & \text{C}- & \text{C}- & \text{C}- & \text{C}- & \text{C}- & \text{C}- & \text{C}-\text{H} \\ & & & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$	C_8H_{18}

A homologous series is a group of organic compounds that have similar structural features and chemical properties. These compounds share the **same functional group** and **differs in**



Class	Functional Group	General Formula	Prefix	Suffix	IUPAC Name
Carboxylic acid	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{OH} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{OH} \\ (\text{R}=\text{C}_n\text{H}_{2n+1}) \end{array}$	Carboxy	-oic acid	Alkanoic acid
Ester	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{OR} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{O}-\text{R}' \\ (\text{R} \neq \text{R}') \end{array}$	Carbalkoxy	Alkyl (r) - oate	Alkyl alkanoate
Aldehyde	-CHO	$\text{R}-\text{CHO}$	Formyl or oxo	-al	Alkanal
Ketone	$\begin{array}{c} -\text{C}- \\ \\ \text{O} \end{array}$	$\begin{array}{c} \text{R}-\text{C}-\text{R} \\ \\ \text{O} \end{array}$	oxo	-one	Alkanal
Alcohol	-OH	$\text{R}-\text{OH}$	Hydroxy	-ol	Alkanol
Alkenes	$\text{C}=\text{C}$	C_nH_{2n}	-	-ene	Alkene
Alkynes	$\text{C}\equiv\text{C}$	$\text{C}_n\text{H}_{2n-2}$	-	-yne	Alkyne
Halides	-X (X = F, Cl, Br, I)	$\text{R}-\text{X}$	Halo	-	Haloalkane



Nomenclature of Carbon Compounds

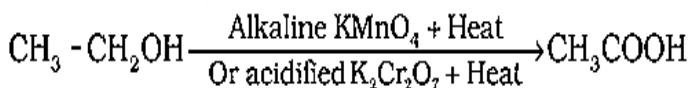
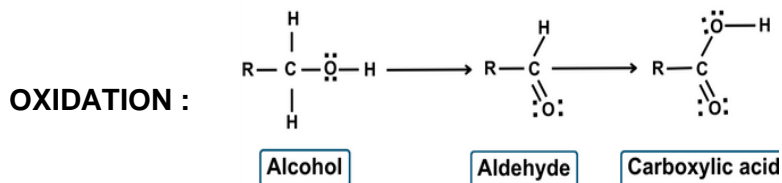
1. Identify the Parent chain
2. Low Count to carbon containing Functional Group.
3. Give appropriate Prefix and Suffix .

4.3 CHEMICAL PROPERTIES OF CARBON COMPOUNDS

COMBUSTION

Carbon compounds can burn in the presence of oxygen to produce carbon dioxide (CO_2) and water vapour (H_2O), along with the release of energy in the form of heat and sometimes light.

- (i) $\text{C} + \text{O}_2 \rightarrow \text{CO}_2 + \text{heat and light}$
- (ii) $\text{CH}_4 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{heat and light}$
- (iii) $\text{CH}_3\text{CH}_2\text{OH} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{heat and light}$

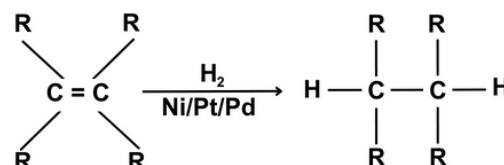


We see that some substances are capable of adding oxygen to others. These substances are known as oxidizing agents.

Alkaline potassium permanganate or **acidified potassium dichromate** are oxidizing alcohols to acids, that is, adding oxygen to the starting material. Hence they are known as oxidizing agents.

ADDITION REACTIONS

Unsaturated carbon compounds, such as alkenes and alkynes, can participate in addition reactions. These reactions involve the addition of atoms or groups of atoms to the carbon-carbon double or triple bonds.



SUBSTITUTION REACTIONS

In substitution reactions, one or more hydrogen atoms in a molecule are replaced by different atoms or groups of atoms. **Saturated hydrocarbons (alkanes)** are known for their **substitution reactions**. For instance, when **methane (CH₄)** reacts with **chlorine (Cl₂)** in the presence of sunlight, it undergoes a substitution reaction to form chloromethane (CH₃Cl) and hydrogen chloride (HCl).



SOME IMPORTANT COMPOUNDS

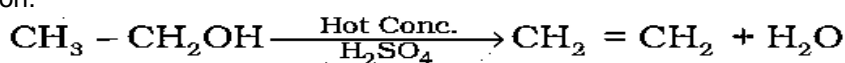
Ethanol (Physical properties)	Ethanoic acid (Physical properties)
(i) It has very low melting point (156 K) and low boiling point (351 K).	(i) It has moderate melting point (290 K) and boiling point (391 K).
(ii) It has a burning taste.	(ii) It has a sour taste.
(iii) It has a distinct smell.	(iii) It has a pungent smell.
Chemical properties	Chemical properties
(i) It is neutral in nature and thus, it does not turn blue litmus to red or vice-versa.	(i) It is acidic in nature and turns blue litmus to red.
(ii) Ethanol does not react with Na ₂ CO ₃ or NaHCO ₃ . $\text{C}_2\text{H}_5\text{OH} + \text{Na}_2\text{CO}_3 \rightarrow \text{No reaction}$	(ii) Ethanoic acid reacts with Na ₂ CO ₃ or NaHCO ₃ to give brisk effervescence of CO ₂ gas. $2\text{CH}_3\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{CH}_3\text{COONa} + \text{CO}_2\uparrow + \text{H}_2\text{O}$

ETHANOL : Physical State: Ethanol is a clear, colourless, and volatile liquid at room temperature. relatively low melting point and boiling point, which allows it to exist as a liquid under normal conditions.

- **Solubility:** Ethanol is highly soluble in water, and it can mix with water in all proportions.
- **Medical Uses:** Ethanol is used in medicines such as tincture iodine, cough syrups, and tonics.
- **REACTIONS :**

☞ The evolution of hydrogen gas is a characteristic test for the presence of ethanol.
 $2\text{Na} + 2\text{CH}_3\text{CH}_2\text{OH} \rightarrow 2\text{CH}_3\text{CH}_2\text{ONa} + \text{H}_2$

☞ **Dehydration Reaction:** Heating ethanol at around 443 K with excess concentrated sulfuric acid (H₂SO₄) leads to the dehydration of ethanol, producing ethene (CH₂=CH₂) and water (H₂O). Concentrated sulfuric acid serves as a dehydrating agent, removing water from ethanol in this reaction.



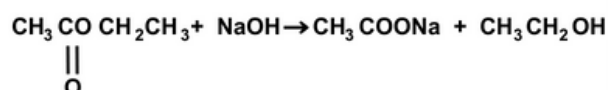
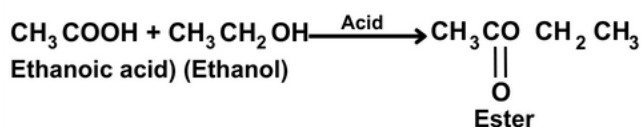
Ethanoic Acid (Acetic Acid) :Physical State: Ethanoic acid is a colourless liquid with a strong, pungent smell and a sour taste.

Solubility: soluble in water, and it can mix with water in all proportions. Vinegar-5-7% Solution of Etanoic acid in water.

- Pure ethanoic acid has a freezing point of 290 K, which can lead to it freezing during cold winters, giving rise to the name "glacial acetic acid."

REACTIONS :

Esterification Reaction: Ethanoic acid can undergo esterification reactions, where it reacts with an alcohol, such as absolute ethanol, in the presence of an acid catalyst to form an ester. Esters are often sweet-smelling substances and find use in perfumes and flavouring agents.

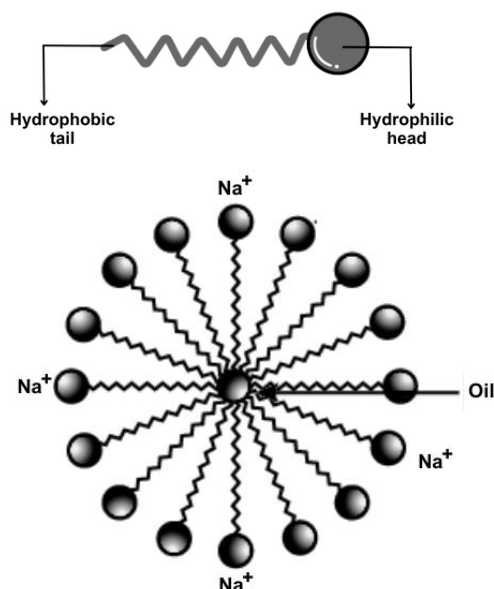


SAPONIFICATION : When treated with sodium hydroxide (NaOH), an alkali, esters can be converted back to alcohol and the sodium salt of the carboxylic acid. This process is known as saponification and is used in soap production.

- **For sodium carbonate:**
 $2\text{CH}_3\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{CH}_3\text{COONa} + \text{H}_2\text{O} + \text{CO}_2$
- **For sodium hydrogen carbonate:**
 $\text{CH}_3\text{COOH} + \text{NaHCO}_3 \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O} + \text{CO}_2$

Table 1: Comparison of Soap and Detergent

Soaps	Detergents
Are sodium salts of long chain carboxylic acids	Are sodium salts of long chain benzene sulphonic acids or alkyl sulfate
Obtain by natural resources from plants and animals (fats, oils)	Synthetic materials, hydrocarbon of petroleum or coal
Calcium and magnesium salts are insoluble in water	Calcium and magnesium salts are soluble in water
Produces scum in hard water which affects it's cleaning action	Hard water does not affect it's cleaning action
Biodegradable	Not too biodegradable



Cleansing action of SOAP

- Soaps work by forming structures called micelles in water.
- Micelles are spherical aggregates of soap molecules in which the hydrocarbon tails are directed inward and the ionic heads are directed outward, surrounded by water molecules.
- When you wash something with soap, the hydrophobic tails of soap molecules attach to oil and grease (dirt) on the surface, while the hydrophilic heads remain in contact with water.
- This allows the dirt to be lifted off the surface and rinsed away with water.