THE RADIANT EDUCATION POINT

(MRITUNJAY MISHRA)

H.N. 1256, 33-FEET ROAD, S.G.M. NAGAR

FARIDABAD

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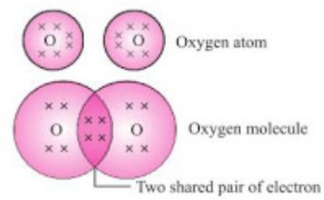
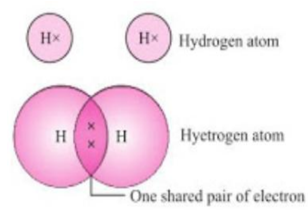
Introduction

→ Compounds are of two types:
(i) Organic Compounds
(ii) Inorganic Compounds
→ Organic Compounds are made up of Carbons and form the basis of all living organisms.

Organic Chemistry

Organic chemistry is that branch of chemistry that deals with the study of carbon and its compounds. Carbon is so versatile in nature that organic chemistry forms a separate branch of chemistry which deals mainly with carbon and its compounds.





Properties of Carbon

1. **Atomic Number**: 6
2. **Electronic configuration**: 2, 4.
3. **Valency of Carbon**:
• To complete the octet, either carbon can gain 4 electrons or lose 4 electrons.
• But if carbon gains electrons. it would be difficult for nucleus to hold 4 extra electrons as carbon atom is very small in size.
• If carbon loses its electron, it would require a large amount of energy to remove 4 electrons as attraction force of nucleus is more in carbon atom.
• Thus it is difficult for an atom of carbon to either gain or lose electrons.
→ Carbon makes four covalent bonds and attains the noble gas configuration by sharing its valence electrons.
→ The atoms of other elements like hydrogen, oxygen and nitrogen, chlorine also form bonds by sharing of electrons.
4. **Self - combination (Catenation):**
• Due to small size of carbon, it has a unique ability to combine with other carbon atoms to form long chains,
• This ability of carbon is known as "Catenation.
For example,
→ The atoms of other elements like hydrogen, oxygen and nitrogen, chlorine also form bonds by sharing of electrons.

Physical Properties of Covalent Compounds

→ Covalent compounds have low melting and boiling points as they have weak intermolecular force.
→ They are generally poor conductor of electricity as electrons are shared between atoms and no charged particles are formed.

Versatile Nature of Carbon

The two characteristic properties of carbon element which lead to the formation of large number of compounds:

• **Catenation**: Carbon can link with carbon atoms by means of covalent bonds to form long chains, branched chains and closed ring. Compound
Carbon atoms may be linked by single, double or triple bonds.

• **Tetravalency**: Carbon has 4 valence electrons. Carbon can bond with four carbon atoms, monovalent atoms, oxygen, nitrogen and sulphur.

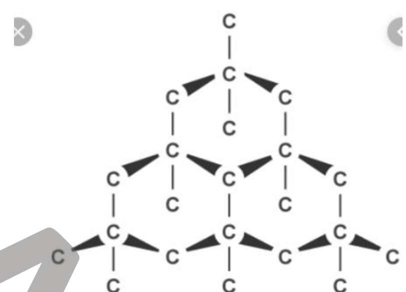
Occurrence of Carbon

Carbon occurs in two forms in nature.
Free State: Graphite, Diamond, Fullerene.
Combined State: Carbon combines with other elements to form compounds such as carbon dioxide ($C0_2$), glucose ($C_6H_{12}0_6$), etc.

Allotropes of Carbon

Different forms of an element which has different physical appearance and properties but their chemical properties are same are called allotropes.
There are three allotropes of carbon:
a. Diamond **b. Graphite** **c. Fullerene**

Diamond



Diamond is a three dimensional network of strong carbon — carbon covalent bonds.

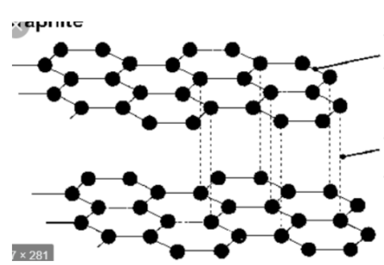
Properties of Diamond:

• Due to the presence of this large 3-D network of C - C covalent bonds, diamonds is very hard and have high melting point (around 4827°).
• As all the 4 electrons are utilized in making covalent bonds, no free electron is available for conduct electricity and therefore, diamond is a bad conductor of electricity.
• Diamond is transparent and shines in presence of light.

Uses of Diamonds:

• Due to its high hardness it is used in making cutting and drilling tools (for cutting glasses).
• Due to its brilliant shine it is used in making jewellery.
• Diamond is used in surgical instruments to remove cataract from eyes.

Graphite



• In graphite each carbon atom is bonded with three other carbon atoms to form hexagonal rings.
• These hexagonal rings join together to form layers.
• These layers containing hexagonal rings are hold together by weak Vander Waal Forces.
• Due to weak Vander WaaI forces, these layers can slide over each other and therefore graphite can be used as a dry lubricant for machine parts at high temperature.

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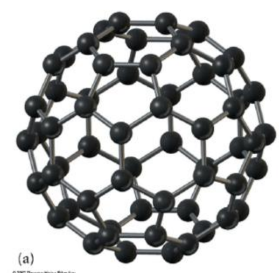
Properties of Graphite:
• Due to its layered structure, graphite is soft and has soapy touch.
• As the layers are bonded through weak Vander Waal forces it can act as a lubricant.
• Due to presence of one free electron, it is a good conductor of electricity and heat.

Use of Graphite:
Use of Graphite:
• It is used in lead pencils as it is soft and leaves black mark on the paper.
• Powered graphite is used as dry lubricant for machine parts which operate at high temperature where oil can't be used because graphite is non-volatile.
• It is used in making electrode in the cells.

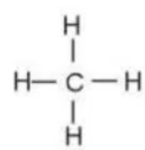
Fullerene
• Fullerene is a closed hollow cage in the form of sphere, tube and ellipsoid or of many other form
• Structure of fullerene is same as graphite.
• It is composed of a sheet of linked hexagonal rings (each carbon atom is bonded with three other carbon atoms). But they also contain pentagonal or sometimes heptagonal rings that prevent the sheet from being planer.
• Spherical fullerenes are usually called Bucky balls, while cylindrical fullerenes are called Bucky tubes or Nanotubes.

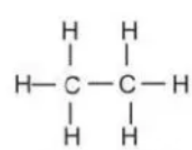


• C_{60} Is the smallest fullerene molecule that forms the shape of a football.
• Since it looks like the geodesic dome designed by the US architect Buckminster Fuller, it was called Buckminster fullerene/ fullerene.
Properties of Fullerene:
• Fullerenes are stable, but not totally unreactive.
• Fullerenes are soluble in many solvents like CO2 etc.
• Fullerenes are the only known allotrope of carbon that can be dissolved in common solvents at room temperature like C_{28}, C_{36} etc.
Uses of Fullerene:
• Artificial photosynthesis
• In cosmetics
• In surface coating

Hydrocarbon
→ Compounds made up of hydrogen and carbon are called hydrocarbon.
→ There are two types of Hydrocarbons. (i) Saturated Hydrocarbons (ii) Unsaturated Hydrocarbons

• **Saturated Hydrocarbons**
→ Single bond between carbon atoms.
→ —C—C—
→ Alkanes are saturated hydrocarbons.
General Formula: C_nH_{2n+2}


Methane (CH_4)


Ethane (C_2H_6)

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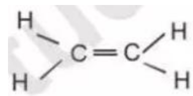
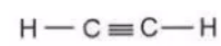
• **Unsaturated Hydrocarbons**
→ Double or triple bond between carbon atoms.
→ Alkenes and Alkynes are unsaturated hydrocarbons.
→ Alkenes: ─C═C─
General formula: C_nH_{2n}
→ Alkynes: ─C≡C─
General Formula: C_nH_{2n-2}


Ethene (C_2H_4)


Ethyne (C_2H_2)

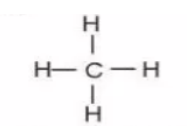
<u>*Naming and Structure of Saturated Hydrocarbons / Alkanes*</u>

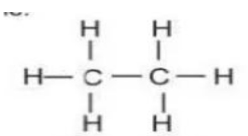
The name of an ***alkane*** is made up of two parts:
a) a prefix (first part of the name, ***alk)***
b) a suffix (last part of the name, ane)
The prefix is dependent on the number of carbon atoms in the chain of carbon atoms

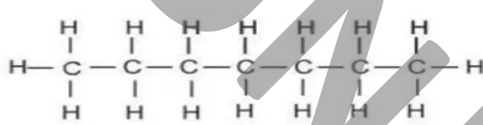
Number of carbon atoms:	1	2	3	4	5	6	7	8	9	10
Prefix:	meth	Eth	prop	but	pent	hex	hept	oct	non	dec
Suffix:	ane	Ane	ane	ane	ane	ane	ane	ane	ane	ane

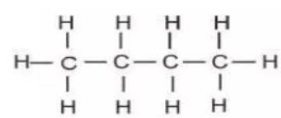
- CH_4 methane
- C_2H_6 ethane
- C_3H_8 propane
- C_4H_{10} butane
- C_5H_{12} pentane
- C_6H_{14} hexane
- C_7H_{16} heptane
- C_8H_{18} octane
- C_9H_{20} nonane
- $C_{10}H_{22}$ decane

General Formula: C_nH_{2n+2}
Here n is no. of carbon atoms
Structure:


Methane (CH_4)

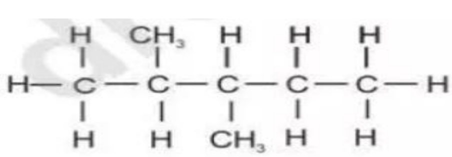

Ethane (C_2H_6)

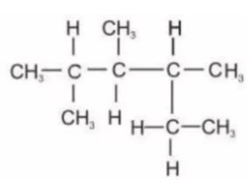

Heptane (C_7H_{16})


Butane (C_4H_{10})

<u>Straight Chain Alkanes:</u>
In the straight-chain alkanes, there are only single covalent bonds joining one carbon atom to another carbon atom in straight line. For examples, methane, ethane, propane, butane, heptane etc. The prefix n- is used before each straight chain hydrocarbon. For example, n-hexane, n-heptane, n-octane, n-nonane etc.

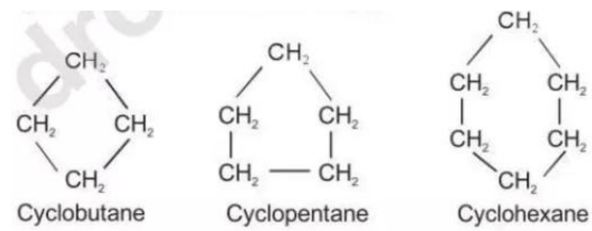
<u>Branched Chain Alkanes:</u>
Branched chain alkanes are derived from the straight-chain alkanes system by removing one of the hydrogen atoms from a methylene group (-CH2-) and replacing it with an alkyl group.





The straight chain joining all carbon atoms is called parent chain and branches of branched chain alkanes are called substitute groups.

Cyclic chain



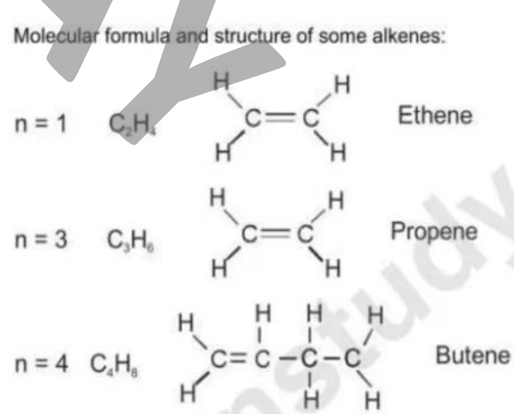
• When a series of atoms is connected to form a loop or ring, it is called cyclic structure.
• When carbon atoms are connected in ring form, such hydrocarbon atoms are called cyclic hydrocarbon.
• A cycloalkane is a cyclic hydrocarbon in which all of the carbon-carbon bonds are single bonds.
• If a simple straight alkane is converted to a cycloalkane. Two hydrogen atoms, one from each end of the chain, must be lost hence the general formula for a cycloalkane composed of n carbons is C_nH_{2n}.
Note: Butene, and cyclobutane have same molecular formula C_4H_8, but different structural formulae so they are called structural isomers.

Naming and Structure of Unsaturated Hydrocarbons

For naming of branched chain alkanes, we have to follow certain rules:
1.**Longest Chain Rule**
• Select longest possible chain containing C atoms.
• This will give you the parent name of the alkane.
2. **Numbering of Chain**
• Numbering of chain is done from the end from which the substituent is closer.
• The carbon number where the substitute group is attached appears in the name of the compound.
3. **Naming the substituent group**
• The hydrocarbon groups attached to the parent chain are called alkyl groups, such as methyl, ethyl, propyl, etc.
• Name the substituent as an alkyl group based on the number of carbons in this chain.
• Place the name of the branched substituent, preceded by a number indicating the carbon of the parent - chain carbon to which it joins.

Naming and Structure of Unsaturated Hydrocarbons

Alkene: Alkenes are hydrocarbons with at least one double bond.
The name of an alkene is made up of two parts:
a) a prefix (first part of the name, alk)
b) a suffix (last part of the name, ene)
The prefix is dependent on the number of carbon atoms in the chain of carbon atoms.
General formula: C_nH_{2n}



Number of carbon atoms:	1	2	3	4	5	6	7	8	9	10
Prefix:	meth	eth	prop	but	pent	hex	hept	oct	non	dec
Suffix:	ene	ene	ene	ene	ene	ene	ene	ene	ene	ene

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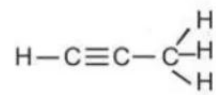
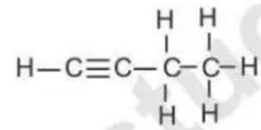
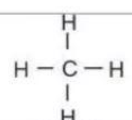
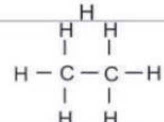
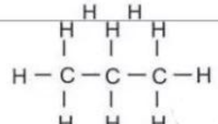
Alkyne: Alkynes are hydrocarbons with at least one triple bond.
The name of an alkynes is made up of two parts
a) a prefix (first part of the name, alk)
b) a suffix (last part of the name, yne)
The prefix is dependent on the number of carbon atoms in the chain of carbon atoms
General formula: C_nH_{2n-2}

Number of carbon atoms:	1	2	3	4	5	6	7	8	9	10
Prefix:	meth	eth	Prop	but	pent	hex	hept	oct	non	dec
Suffix:	yne	yne	yne	yne	yne	yne	yne	yne	yne	yne

n = 2	C_2H_2	$H-C\equiv C-H$	Ethyne
n = 3	C_3H_4		Proyne
n = 4	C_4H_6		Butyne

Isomers

The organic compounds which have same molecular formula but different structures are called isomers.
Note: At least 4 carbon atoms are required for hydrocarbons to show Isomerism.

Compound	Structures	Number of Isomers
Methane (CH_4)		–
Ethane (C_2H_6)		–
Propane (C_3H_8)		–
Butane (C_4H_{10})	⇨ $CH_3-CH_2-CH_2-CH_3$ ⇨ $CH_3-CH(CH_3)-CH_3$	2
Pentane (C_5H_{12})	⇨ $CH_3-CH_2-CH_2-CH_2-CH_3$ n - pentane ⇨ $CH_3-CH_2-CH(CH_3)-CH_3$ 2 methyl butane ⇨ $CH_3-C(CH_3)_2-CH_3$ 2, 2 dimethyl propane	3

Hexane (C_6H_{14})	⇨ $CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$ n - hexane ⇨ $CH_3-CH(CH_3)-CH_2-CH_2-CH_3$ 2 methyl pentane ⇨ $CH_3-CH_2-CH(CH_3)-CH_2-CH_3$ 3 methyl pentane ⇨ $CH_3-CH(CH_3)-CH(CH_3)-CH_3$ 2, 3 dimethyl butane ⇨ $CH_3-C(CH_3)_2-CH_2-CH_3$ 2, 2 dimethyl butane	5

Compound	Structures	Number of Isomers
Ethene (C_2H_4)	$CH_2=CH_2$	0
Propene (C_3H_6)	$CH_2=C(H)-CH_3$	0
Butene (C_4H_8)	⇨ $CH_2=CH-CH_2-CH_3$ But-1-ene ⇨ $CH_3-CH=CH-CH_3$ But-2-ene ⇨ $H_2C=C(CH_3)-CH_3$ 2- methyl prop-1-ene	3

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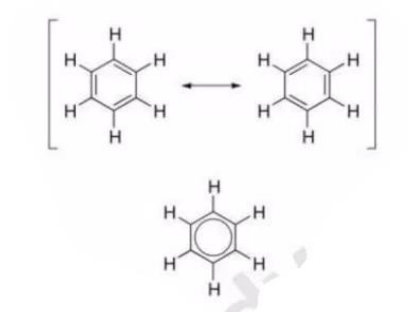
Benzene (C_6H_6)



• Benzene is an organic compound with the molecular formula C_6H_6.
• It is a six carbon ring hydrocarbon in which carbon atoms are joined by alternating double and single bonds.
• Sometimes a circle is used inside the hexagon as an alternative to represent the six pi electrons.

Homologous Series

A series of organic compounds having similar properties in which the successive members differ by a CH_2 group is called a Homologous series.

Homologous Series of different Hydrocarbons

Homologous series of Alkanes	Homologous series of Alkenes	Homologous series of Alkynes
CH_4 (Methane)	$CH_2 = CH_2$ (Methene)	$H - C \equiv C - H$ (Methyne)
$CH_3 - CH_3$ (Ethane)	$CH_3 - CH = CH_2$ (Ethene)	$CH_3 - C \equiv C - H$ (Ethyne)
$CH_3 - CH_2 - CH_3$ (Propane)	$CH_3 - CH_2 - CH = CH_2$ (Propene)	$CH_3 - CH_2 - C \equiv C - H$ (Propyne)
$CH_3 - CH_2 - CH_2 - CH_3$ (Butane)	$CH_3 - CH_2 - CH_2 - CH = CH_2$ (Butene)	$CH_3 - CH_2 - CH_2 - C \equiv C - H$ (Butyne)

Characteristics of Homologous Series

•Two successive members of a series differ by a CH2 group.
•All the members of a homologous series show similar chemical properties.
• In a Homologous series, the molecular mass of members increases with increasing number of carbon atoms and the molecular mass differ by 14 between two successive members.
•Members of a homologous series show gradual change in their physical properties like boiling point, melting point, solubility etc.
•Melting point / boiling point is directly proportional to Molecular Mass
• Solubility is inversely proportional to Molecular Mass

Functional Group

Atoms or group of atoms which provide certain specific properties when attached to a carbon chain is called a functional group.

Some Important Functional Groups

S. No.	Functional Group	Structure	Prefix	Suffix
1.	Halogen (X)	X = F,Cl,Br, I	Halo – Fluoro, Chloro, Bromo, Iodo	-
2.	Alcohol (- OH)	$-O-H$	—	"ol"
3.	Aldehyde	$-\overset{\overset{O}{\parallel}}{C}-H$	—	"al"
4.	Ketone	$-\overset{\overset{O}{\parallel}}{C}-C-$	—	"one"
5	Carboxylic Acid	$-\overset{\overset{O}{\parallel}}{C}-O-H$	—	"oic acid"

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1. Halogen Group (X = F, Cl, Br, I):

- When any halogen group is attached with alkanes, they form **Haloalkanes**.

  $C_2H_{2n+2} + \bullet X \longrightarrow C_2H_{2n+1}X$ (General formula)

For example:

$CH_3 - Cl$ Chloromethane
$CH_3 - CH_2 - Br$ Bromoethane
$CH_3 - CH_2 - CH_2 - I$ Iodopropane

2. Alcohol (– OH):

–OH is called Hydroxyl group. When a hydroxyl group is attached with carbon backbone (like alkanes), they are named as alcohol.

$C_2H_{2n+2} + \bullet OH \longrightarrow C_2H_{2n+1}OH$ or $C_2H_{2n+2}O$
(General formula)

For example:

$CH_3 - OH$ Methanol
$CH_3 - CH_2 - OH$ Ethanol
$CH_3 - CH_2 - CH_2 - OH$ Propanol
$CH_3 - CH_2 - CH_2 - CH_2 - OH$ Butanol

3. Aldehyde (– CHO):

When an aldehyde group is attached with alkyl group, the compound is called an aldehyde.

$C_nH_{2n+2} + \bullet CHO \longrightarrow C_nH_{2n}O$ (General Formula)

4. Ketone (– CO):

- In a ketone, the carbonyl carbon is doubly-bonded to an oxygen, and single bonded to two alkyl groups.
- Both groups should be alkyl groups. If either of the group or both groups are "H", it becomes an aldehyde.
- $C_nH_{2n+2} + \bullet CO \longrightarrow C_nH_{2n}O$ (General Formula)

For example:

$CH_3 - \underset{\underset{O}{||}}{C} - CH_3$ Propanone or Acetone

$CH_3 - CH_2 - \underset{\underset{O}{||}}{C} - CH_3$ Butanone

$CH_3 - CH_2 - CH_2 - \underset{\underset{O}{||}}{C} - CH_3$ Pentanone

5. Carboxylic Acid (– COOH)

- In Carboxylic acid, a carbon (C) atom is attached to an oxygen (O) atom by a double bond and to a hydroxyl group (–OH) by a single bond.
- The forth bond links carbon atom with hydrogen atom or with any alkyl group.

For example:

$H - \underset{\underset{O}{||}}{C} - O - H$ Methanoic Acid / Formic Acid

$CH_3 - \underset{\underset{O}{||}}{C} - O - H$ Ethanoic Acid / Acetic Acid

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Characteristics Properties of Carbon & it's Compounds

1. Combustion

• Burning of carbon or its compounds in presence oxygen is called combustion.
• In combustion process, mainly two products are formed i.e. CO_2 and H_2O and energy is released in form of heat and light,

$$\underset{\text{(Methane)}}{CH_4} + 2O_2 \longrightarrow CO_2 + 2H_2O + \text{Energy}$$

$$\underset{\text{(Ethanol)}}{2CH_3CH_2OH} + 7O_2 \longrightarrow 4CO_2 + 6H_2O + \text{Energy}$$

Note: Most of the hydrocarbons are used as fuel as they release energy on burning In air.
For example:
a. Methane (CH_4) is used In **Compressed Natural Gas (CNG).**
b. Butane (C_4H_{10}) is used in Liquefied Petroleum Gas (LPG).
c. Octane (C_8H_{18}) is used In Petrol as the main compound.
• Saturated hydrocarbons bum in air giving a clean blue flame.
• Unsaturated hydrocarbons burn in air giving a sooty flame (with lot of smoke).
•If combustion of saturated hydrocarbons is complete they release clean blue flame.
• If combustion of saturated hydrocarbons is incomplete, they release sooty flame.
When the oxygen supply (or air supply) is sufficient, then the fuels burn completely producing a blue flame. When the oxygen supply is insufficient, then the fuels burn incompletely producing mainly a yellow flame.

Burning of Substance with and without Flame:

• The fuels which are vaporisable (can be converted to vapours) burns with flame. For example; candle, petrol, Naphthalene bum with flame.
• The fuels which do not vaporise Burn without flame. For example: coal bums without flame.

2. Oxidation Reactions

• Oxidation is addition of oxygen. Carbon compounds get easily oxidized on combustion.

$$CH_4 + O_2 \longrightarrow \underset{\text{(addition of Oxygen)}}{CO_2} + H_2O$$

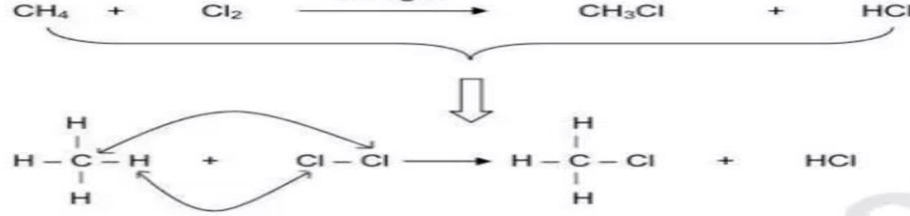
• Alcohols undergo oxidation in presence of **oxidizing agents** like alkaline potassium permanganate ($KMnO_4$) to form carboxylic acid.

$$CH_3-CH_2-OH \xrightarrow[\Delta]{\text{Alkaline } KMnO4} \underset{\text{(Ethanoic Acid)}}{CH_3-\overset{\overset{O}{\|}}{C}-OH}$$

3. Substitution Reactions

• The reactions in which one or more hydrogen atoms of a hydrocarbon ar replaced by some other atoms are called substitution reactions.

$$\Rightarrow CH_4 + Cl_2 \xrightarrow{\text{Sunlight}} CH_3Cl + HCl$$



$$\Rightarrow CH_4 + Cl_2 \xrightarrow{\text{Sunlight}} \underset{\text{(Chloromethane)}}{CH_3Cl} + HCl$$

$$\Rightarrow CH_3Cl + Cl_2 \xrightarrow{\text{Sunlight}} CH_2Cl_2 + HCl$$

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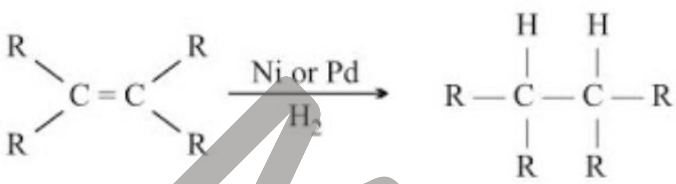
4. Addition Reaction

Unsaturated hydrocarbon adds hydrogen in the presence of catalyst palladium or nickel. Vegetable oils are converted into vegetable ghee using this process.
It is also called hydrogenation of vegetable oils.



Commercially Important Compounds of Carbon

1. **Ethanol (C_2H_5OH)**

Physical Properties:

a. **Physical State**: Ethanol is a colorless liquid having a pleasant smell.
b. **Boiling Point**: Ethanol is volatile liquid having boding 78°C.
c. **Solubility in Water**: Ethanol is soluble in water In all proportions. that's why It is the main component of alcoholic drinks and known as Alcohol.

Harmful Effects of Ethanol:

• Consumption of alcohol is not good for human health. It slows down the metabolic process.
• It depresses the central nervous system.
• It causes lack of coordination, metal confusion and drowsiness.
• It affects kidney and liver function.

Note: Pure ethanol (known as absolute alcohol) is very health hazardous.

2. Methanol (CH_3OH)

It is too a type of alcohol which is poisonous in nature. Methanol is colourless, volatile, with a distinctive odour similar to ethanol.

Poisonous Nature of Methanol:

• Methanol (CH_3OH) is poisonous as it is oxidized to Methanal (CH_3CHO) in liver, which rapidly reacts with the protoplasm (liquid present in cells) arid coagulates it, like egg is coagulated on boiling.

$$\underset{\text{(Methanol)}}{CH_3OH} \xrightarrow{\text{Liver}} \underset{\text{(Methanal)}}{CH_3CHO}$$

• Methanol damages optic nerve causing permanent blindness in a person.

3. Denatured alcohol

Physical Properties:

• It is the ethyl alcohol which is made unfit for drinking by adding small amounts of poisonous methanol, copper sulphate etc.
• Sometimes a dye is also added to give it a blue colour.

Chemical Properties:

a. Combustion:

Ethanol undergoes combustion giving CO_2 and H_20 along with release of energy.

$2C_2H_50H + 70_2 \longrightarrow 4C0_2 + 6H_20 + \text{Energy}$

As ethanol gives only carbon dioxide ($C0_2$) and water on combustion with no other gas it Is a cleaner fuel.

b. Reaction with Metals:

Reaction of ethanol with metals shows its acidic nature.

Ethanol + Metals $\longrightarrow$ Hydrogen + Metal salt

$2C_2H_50H + 2Na \longrightarrow C_2H_5ONa + H_2$

(Ethanol) (Sodium ethoxide)

c. Reaction with conc. H_2S0_4

When ethanol is heated with concentrated sulphuric acid, ethene is collected over water. This is called dehydration of Alcohol.

$$C_2H_5OH \xrightarrow[443K]{\text{Conc. } H_2S0_4} CH_2{=}CH_2 + H_20$$

Here concentrated H_2S0_4 is acting as a dehydrating agent.

uses of ethanol

- **Used as a solvent:** Many organic compounds which are insoluble in water and soluble in ethanol.
- It is used as a fuel in cars along with petrol. This mixture of alcohol and petrol is known as power alcohol.
- It is used in alcoholic drinks like whisky, beer etc.
- It is used as an antiseptic to sterilize wounds and syringes in hospitals.

4. Ethanoic acid

- It is also called acetic acid.
- Vinegar is 5—8% aqueous solution of acetic acid making acetic acid the main component of vinegar apart from water.

Physical Properties

a. It is a sour, colourless liquid having smell of vinegar.

b. Its boiling point is 118°C.

c. When pure ethanol is cooled, it freezes to give a solid which looks like a glacier, due to which it is known as glacial acetic acid.

Chemical Properties:

a. Action on Litmus:

- It converts blue litmus paper into red.
- Acetic acid is organic acid. That’s why it is always weak in nature. Whereas hydrochloric acid (HCI) is a strong acid.

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b. Reaction with Alcohol (Esterification):

• When acetic acid reacts with ethanol in the presence of an acid as a catalyst, ester (ethyl ethanoate) is produced.

$$CH_3COOH + C_2H_5OH \xrightarrow{Acid} CH_3COOC_2H_5 + H_20$$

• Since ester is formed in this process, the reaction is also known as Esterification
• If ester again reacts with H_20 in presence of acid, acetic acid and ethanol is produced.
• Esters are sweet smelling compounds. Therefore, these are used in making perfumes.

c. Reaction with Base:

Acetic acid (CH_3COOH) when reacts with sodium hydroxide (a base), sodium acetate (CH_3COONa) a salt and H_20 are formed.

$$\underset{\text{(acetic acid)}}{CH_3COOH} + \underset{\text{(Base)}}{NaOH} \longrightarrow \underset{\text{(Sodium acetate)}}{CH_3COONa} + H_20$$

This is an example of an acid-base neutralization reaction in which an acid and a base react to produce water plus a salt i.e. CH_3COONa.

d. Reaction with Sodium Carbonate & Bicarbonate

• When sodium carbonate / sodium bicarbonate react with acetic acid, sodium acetate (CH_3COONa), H_20 and CO_2 is released.

$$Na_2CO_3 + 2CH_3COOH \longrightarrow 2CH_3COONa + CO_2 + H_20$$

$$NaHCO_3 + CH_3COOH \longrightarrow CH_3COONa + CO + HO$$

• CO_2 is the main product of reaction; it is released with brisk effervescence.

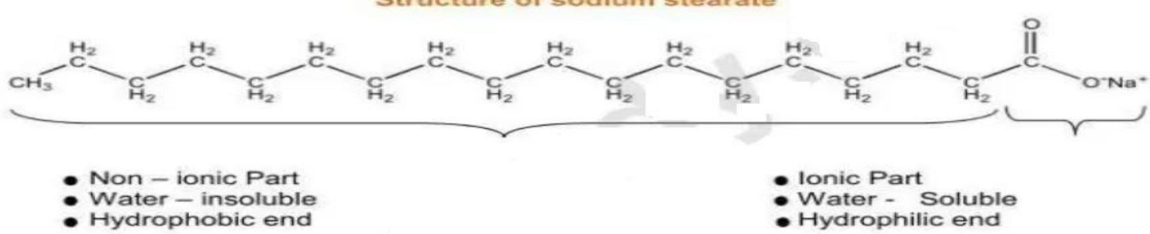
Use of CH_3COOH:
• It is used in form of vinegar as a preservative for food & pickels.
• Used to form esters which are used in perfumes and scents.

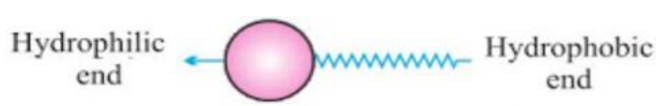
Soaps & Detergents

Soap:

• A soap is the sodium or potassium salt of a long chain carboxylic acid, which has cleansing property in water.
Sodium stearate ($C_{17}H_{35}C00^-Na^+$) is the most common soap used in domestic purpose

Structure of sodium stearate





Structure of soap molecule

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Detergent:

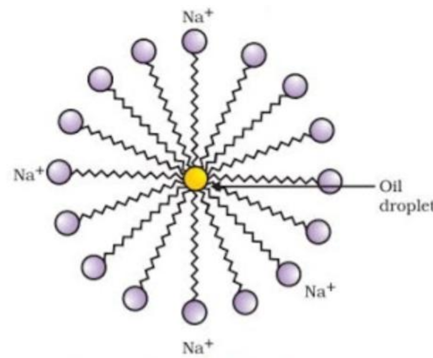
Any substance which has cleansing action in water is called detergent.

Cleansing Action of Soap:

• When a cloth with dirt attached to It is immersed in water containing soap, then the hydrocarbon chain (hydrophobic end) is attached to the dirt particle whereas the Ionic end (hydrophilic end) points outward, towards water.

• So the dirt particles are surrounded by the soap molecules forming a micelle.

• This micelle gets attached with water molecules through the ionic end and is washed away along with the dirt particles.



Formation of micelles

Soft and Hard Water:

• Soft water easily generates lather/ foam with soap.

• But hard water contains salts of calcium and magnesium. When salts of calcium and magnesium react with soap molecules, they form a precipitate instead of lather.

$$C_{17}H_{35}Coo^-Na^+ + MgCl_2 \longrightarrow \underbrace{(C_{17}H_{35}C00)_2Mg}_{\text{Scum}} + NaCI$$

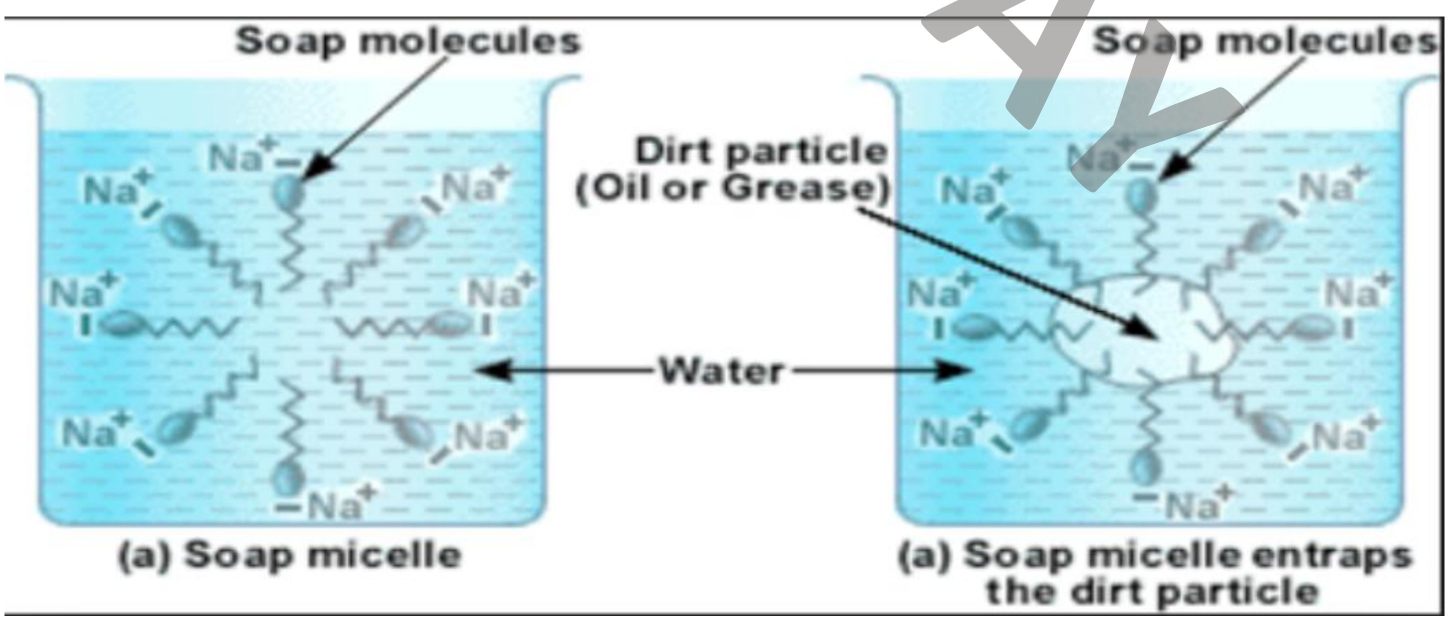
• The precipitate formed in this reaction is called scum.

• Since the scum is insoluble in water, soap cannot form lather in hard water.

• Detergents on the other hand are less likely to form these scum.

• Detergents are the sodium salts of long chain benzene sulphonic acids which has more cleansing property in water than soap.

Chemical formula of detergent: $CH_3- (CH_2)_{11} - C_6H_4 -S0_3^-Na^+$



(a) Soap micelle
(a) Soap micelle entraps the dirt particle