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Chapter no: 4

Carbon and its compounds

- Earth crust has only 0.02% carbon in the form of minerals like carbonates and hydrogen carbonates coal and petroleum.

- its presence in atmosphere is only 0.03% in the form of carbon-dioxide.

* Ionic compound:

Ionic compound are form by exchanging of ions between two metals

Na (11) → 2, 8, 1 — loose 1 e⁻ → gain

Cl (17) → 2, 8, 7

⇒ $Na^+ Cl^-$

* Bonding in carbon:

- We know the reactivity of element is explained a their tendancy to attain complete filled outer sh
- Element forming ionic compound acheive thi by either gaining or loosing electrons from the outermost shell

- carbon (C)

atomic no - 6

valency - 4

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- carbon cant gain four electrone Because if it does like this their will be 10 electron and 6 proton and it will make carbon atom highly unstable hence it can't gain 4 electrone

- carbon cant ~~gain~~ loose four e- beacouse it will need high amount of energy to do so. therefore it cant loose foure e-

* So how carbon become stable?

↓

By sharing

↓

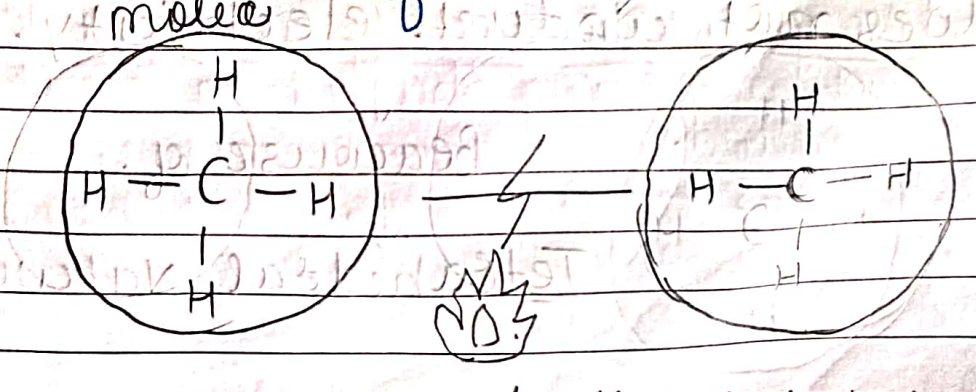
Type of Bond made by sharing of electrone

↓

covalent Bond.

* properties of covalent bonds.

- low boiling and melting points
- poor condictor of heat and electricity
- covalently bonded molecule are seen to have steong writhing the molecules but intermolecular forces are weak.



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* Occurance of ~~Metal~~ carbon:

carbon occurs in

free state

- diamond
- graphite
- Buckminsterfullerance

combine state

- carbon dioxide
- carbonate
- coal, petroleum
- carbohydrates

Allotropes of carbon

The element which has same chemical composition and property but different physical property → This property is call

Allotropy

- diamond.
  - hardest natural occurring substance
  - colourless and Transperent
  - High melting point
  - does not conduct electricity.

↓

Because of.

↓

Tetrahedral Nature

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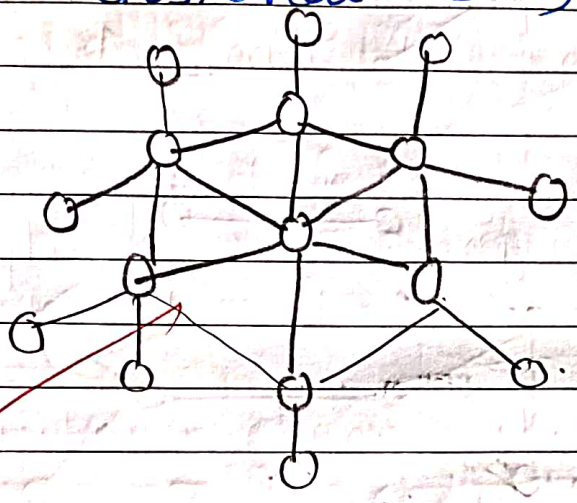
In diamond, each carbon atom is combined with each other and their is no single bond which is free ; and hence it does not contain electricity.

- its three dimensional (3-D) rigid structure

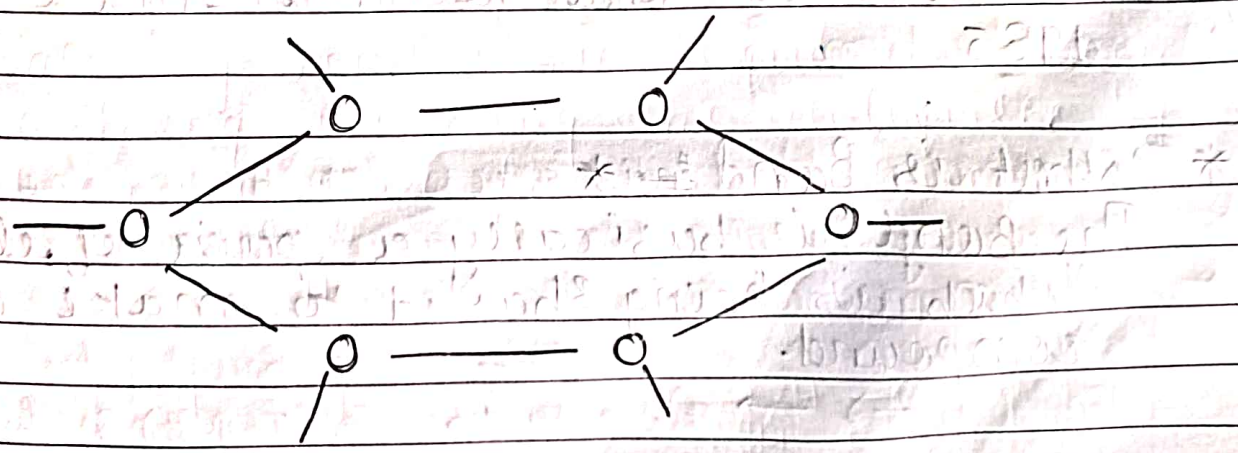
Structure:



- Graphite
- graphite is greying black substance
- graphite is smooth and slippery
- high melting points
- good conductor of electricity

Beacouse

Here one carbon atom is bonded with three other carbon leaving one bond empty for conduction of electricity.



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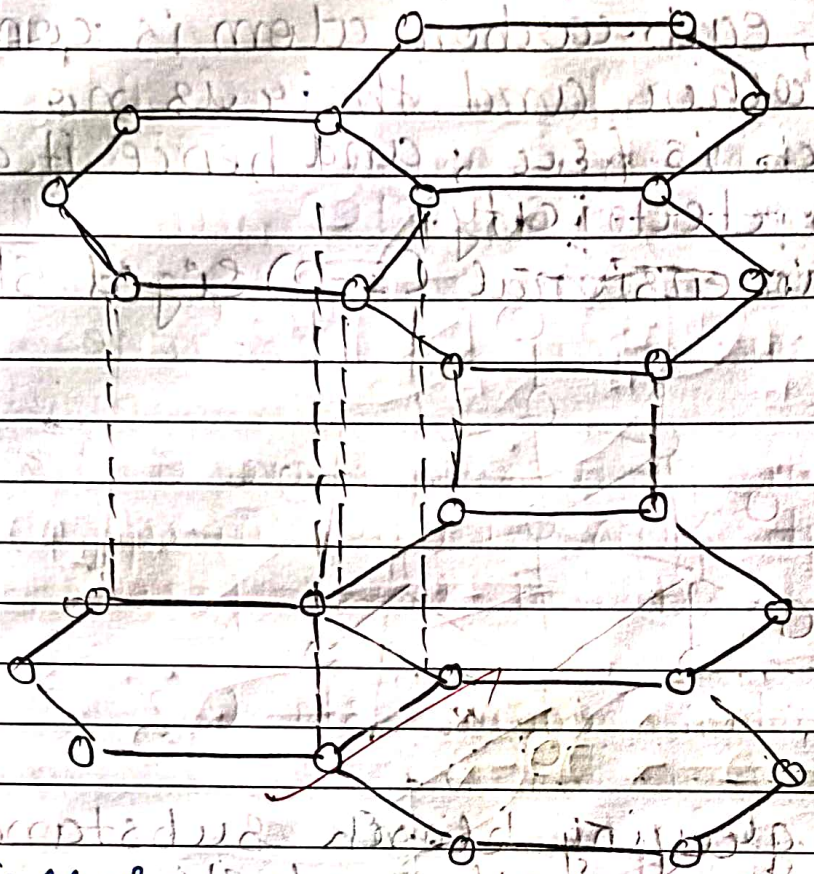

- Fullerance
- Fullerance is an allotrope of carbon in which 60 carbon are joined to form a Spherical shape like foot ball
- one ~~molecule~~ molecule of fullerance has 20 hexagonal rings and 12 pentagonal rings
- it was recently discover by Robert Curl, Herald Kroto and Richard Smalley in 1985

* What is Bond ~~Bo~~ *

The Bond is basically a pair of electron which is being shared to make a compound.

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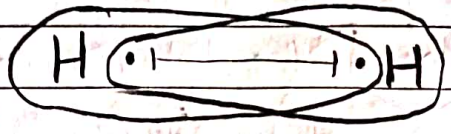
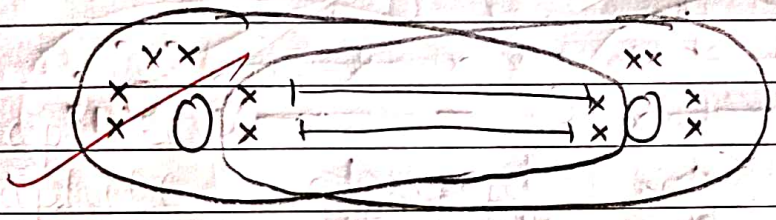
1) H_2



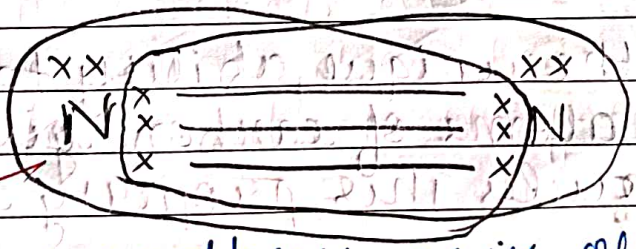
here as one pair of electrons is shared hence its is single bond.

2) O_2



here as two pair of electrons is shared hence it is double bond.

3) N_2



here as three pair of electron is shared hence it is triple bond.

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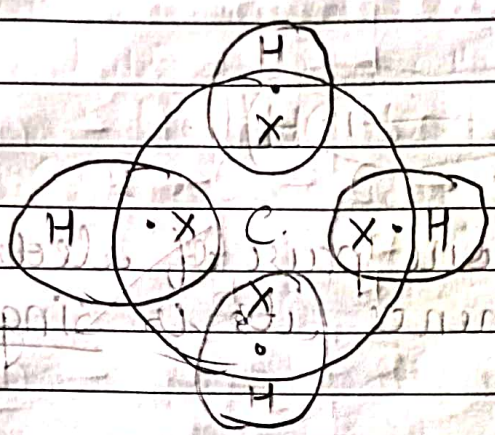
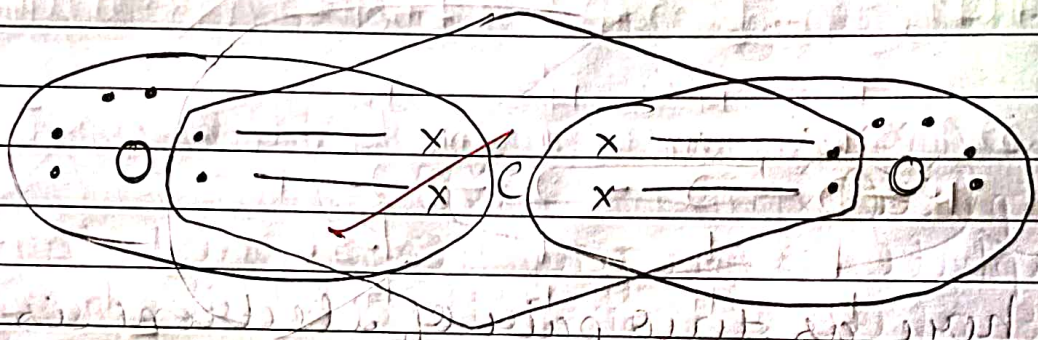
4) CH_4



5) CO_2



* Versatile Nature of carbon.
  - Catenation
  - Tetravalency

1) Catenation
   - Carbon has the unique ability to form bonds with other atoms of carbon giving rise to large molecules This property is called catenation
   - Compound which are linked ~~to ghe~~ to gether by only single bond are called saturated hydro carbons

(—> → Alkanes → (ane) suffix

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- Compounds of carbon having double or triple bonds between their carbon atoms are called unsaturated hydrocarbons

(=) → Alkene → (ene) → suffix
(≡) → Alkyne → (yne) → suffix

2. Tetravalency.
Since carbon has a valency of four. it is capable of bonding with four other atom of carbon or atoms of some other mono-valent element.

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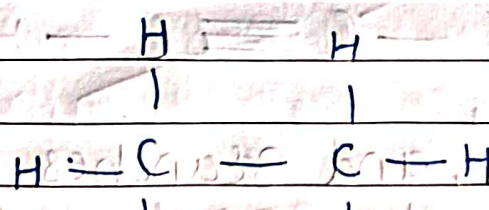
* How to Make the carbon compounds.

(i) C_2H_6

Step-1: write the carbon ~~ain~~ single chain with single bond

C — C

Step:2: complete the valency.



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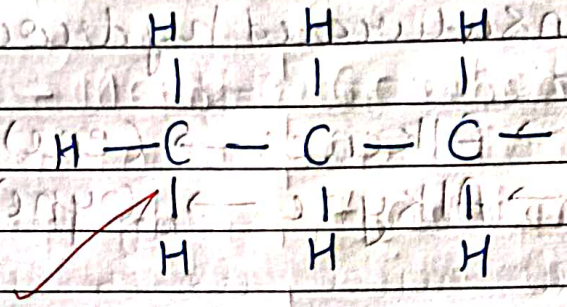
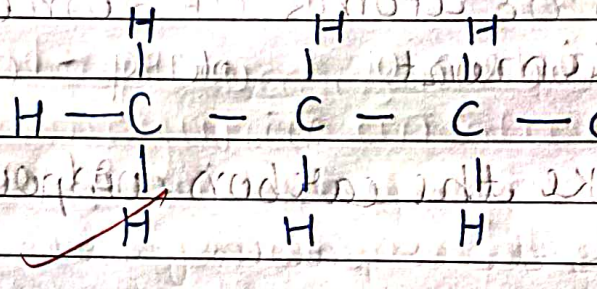
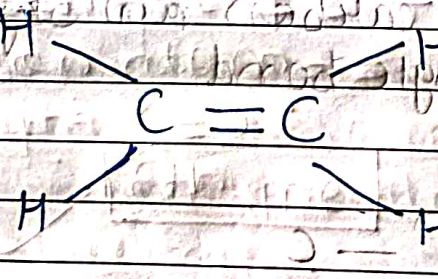
(iii) C_3H_8



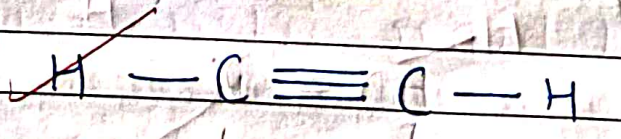
(iii) C_4H_{10}



iv) C_2H_4



v) C_2H_2



* Rings, chains, and Branches:
Carbon has bought the capacity to make bond with a number of carbon atom by which it can make chain, Branches & Ring

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Did you know.

like carbon, silicon also makes the chain and rings and Brandhes But it can make bond only with seven to eight Silicon atom at a time Beacouse carbon is small in size as compare to silicon

* Saturated and unsaturated ~~by~~ carbon compounds.

- Saturated carbon compounds are compound which has only single bond
- The carbon atom which are bonded to other atoms by single bond are called Alkanes
- Unsaturated carbon compounds are compound which has either a double or triple bond
- (=) Alkene
  (≡) Alkyne.

* General formulas *.

Alkane (–) $\longrightarrow C_nH_{2n+2}$

Alkene (=) $\longrightarrow C_nH_{2n}$

Alkyne (≡) $\longrightarrow C_nH_{2n-2}$ //

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* Preffix use for naming carbon compound *

1 carbon - Meth
2 carbon - Eth
3 carbon - Prop
4 carbon - But
5 carbon - Pent
6 carbon - Hex
7 carbon - Hept
8 carbon - Oct
9 carbon - Non
10 carbon - Dec

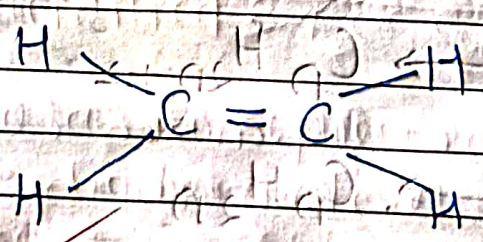
for example:

(i) C_2H_2

carbon atom = 2
bond = (≡)

Ethyne

(ii) C_2H_4



carbon atom = 2
type of bond = double.

Ethene

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* Nomenclature of orgnic compounds *

Hetro atoms	class of compound	Formula of functional group	Prefix/ Suffix.
1) Halogens	Chlorine	$-Cl$	Chloro
	Bromine	$-Br$	Bromo
2) Oxygen	• Alcohole	$-OH$	Suffix - ol
	• Aldehyde	$-\overset{\overset{O}{\|\|}}{C}-H$	Suffix-al
	• Ketone	$-\overset{\overset{O}{\|\|}}{C}-$	Suffix-one
	• Carboxylic acid.	$-\overset{\overset{O}{\|\|}}{C}-OH$	Suffix - oic acid.
	• Alkene	C_nH_{2n}	Suffix-ene
	• Alkyne.	C_nH_{2n-2}	Suffix-yne

* Nomenclature is a system where we name the organic compound. using functional group. as suffix & prefix to name parent compound.

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* Chemical properties of carbon compounds.

* Combustion Reaction

- Carbon, in all its allotropic forms burns with oxygen to carbon dioxide along with release of heat and light

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

ii) $CH_4 + O_2 \longrightarrow CO_2 + H_2O + heat\ and\ light$

(iii) $CH_3CH_2OH + O_2 \longrightarrow CO_2 + H_2O + Heat + light$

- Saturated hydrocarbon will generally give clean flame while unsaturated carbon compounds will give a yellow flame with lots of Black smoke.

* oxidation *

- Carbon compound can easily oxidised on combustion
- In addition to this complete oxidation we have reaction in which alcohols are converted to carboxylic acid.

$$CH_3-CH_2OH \xrightarrow[\text{or acidified } K_2Cr_2O_7 + Heat]{\text{Alkaline } KMnO_4 + Heat} CH_3COOH.$$

- Alkaline potassium permagnet or acidified potassium dichromate are oxidising Alcohol to acid that is adding oxygen to the starting material.

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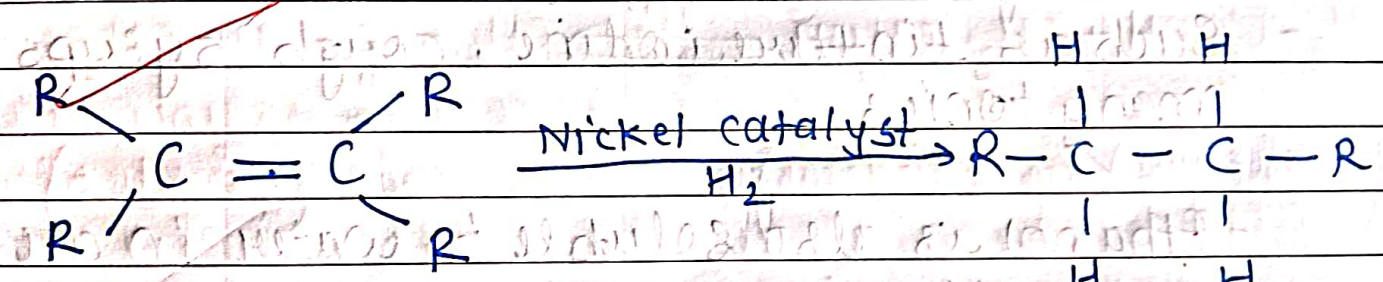
* Addition Reaction *.

- Unsaturated hydrocarbons add hydrogen in the presense of catalyst such as palladium or nickel to give saturated Hydrocarbons

- catalyst are substance that cause reaction more faster or more slower.



* Substitution Reaction

- Saturated Hydrocarbon are fairly unreactive and are inert in the presence of most reagents However in the presense sunlight, chlorine is added to hydrocarbon in a very fast reaction.
- chlorine can replace hydrogen atom one by one It is called substitution reaction because one type of atom or a group of atom take the place of another.

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* Some important carbon compound *

i) ethanol

ii) ethanoic acid.

i) - Ethanol is liquid at room temperature Ethanol is commonly called alcohol and is the active ingredient of all alcoholic drinks

- it is good solvent, it is used in medicines such as tincture iodine, cough syrups, and many tonics

- Ethanol is also soluble in water in all proportion. Consumption of small quantities of dilute ethanol causes drunkeness

* Reaction of Ethanol *

i) Reaction with Sodium :

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

(Sodium ethoxide)

Alcohole react with Sodium leading to the evolution of hydrogen with ethanol the other product is Sodium ethoxide

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ii) Reaction to given unsaturated hydrocarbon:

- Heating ethanol at 443k with excess concentrated sulphuric acid result in dehydration of ethanol to give ethene

$$CH_3-CH_2OH \xrightarrow[H_2SO_4]{\text{Hot conc.}} CH_2=CH_2 + H_2O$$

* Properties of Ethanoic acid *

- Ethanoic acid is commonly called ~~acid~~ acetic acid and belongs to group of acid called carboxylic acid. 5-8% solution of acetic acid in water is called vinegar is is used as preservative in pickles
- The melting point of pure ethanoic acid is 290k and hence it often freezes during winter
- The group of organic compound called carboxylic acid are obviously characterised by their acidic nature.
- Unlike mineral acid like HCl which are completly ionised carboxylic acid are weak acids.

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* Reaction of ethanoic acid

(i) Esterification reaction

- Esters are most commonly formed by reaction of an acids and an alcohole
- Ethanoic acid reacts with absolute ethanol in the presence of an catalyst to give an ester.

$$CH_3-COOH + CH_3-CH_2OH \xrightleftharpoons{Acid} CH_3-\underset{\underset{O}{\|}}{C}-O-CH_2-CH_3 + H_2O$$

(Ethanoic acid) (Ethanol) (Ester)

- generally ester are sweet smelling substance These are used in making perfumes and as flavoring agents
- On treating with sodium hydroxide which is an alkali the ester is converted back to alcohole and sodium salt of carboxylic acid

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

ii) Reaction with base:

like mineral acid ~~ethanoic~~ ethanoic acid reacts with a base such as sodium hydroxide to give a salt. Sodium ethanoate commonly called as "sodium acetate"

$$NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$$

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(iii) Reaction with carbonates and hydrogen carbonates:

Ethanoic acid reacts with carbonates and hydrogencarbonates to give rise to a salt, carbon dioxide and water. The salt produced is commanly called sodium acetate

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

$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + H_2O + CO_2.$$