11/11/22 Module-2

The compounds which have same molecular formula but different physical and chemical properties are known as isomers and this phenomena is know as isomerism.

Isomerism may be classified into two types
1. Structural isomerism
2. Stereoisomerism

1. Structural isomers are the compounds that have same molecular formula but different structural formula.

for example: Dimethyl ether and ethanol

CH_3OCH_3 C_2H_5OH

molecular formula C_2H_6O C_2H_6O

Structural isomerism is of following types
1. Chain isomerism
2. Position isomerism
3. functional isomerism
4. Metamerism
5. Tautomerism

1. Chain isomerism: in chain isomerism the isomers have same molecular formula but differ ~~in~~ the order in which they are bonded with each other.

Example: C_4H_{10}

$CH_3-CH_2-CH_2-CH_3$

n-butane

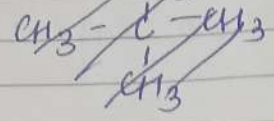
$CH_3-CH(CH_3)-CH_3$

iso butane / 2 methyl propane

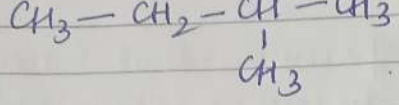
• C_5H_{12}

$CH_3-CH_2-CH_2-CH_2-CH_3$

n-pentane



2,2-Dimethyl propane



2 methyl butane

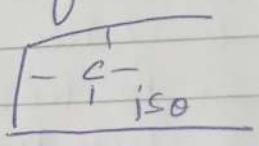
2. Position isomerism : in position isomerism, the isomers have the same molecular formula but differ in the position of a functional group on the carbon atom.

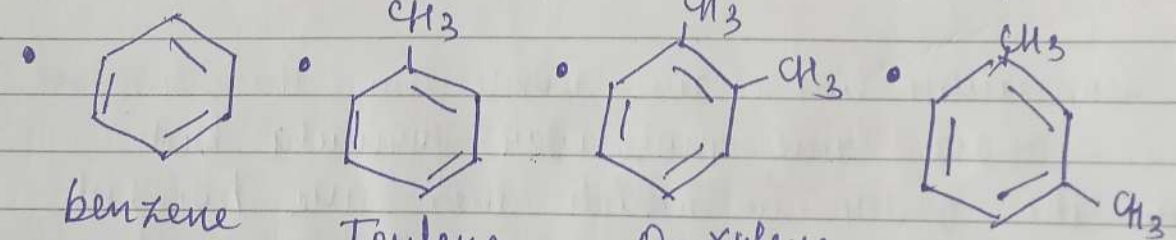
for example: with the molecular formula of C_3H_8O the following two isomers are :-

$CH_3-CH_2-CH_2-OH$ propan-1-ol

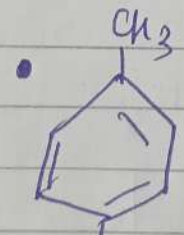
$CH_3-CH(OH)-CH_3$ propan-2-ol

Isopropyl alcohol / Isopropanol





benzene Toulene O-xylene m-xylene



p-xylene

3. Functional Isomerism : in functional isomerism, isomers have same molecular formula but different functional group.
for example : with the molecular formula of C_2H_6O
- CH_3OCH_3 ⇒ methoxy methane / Dimethyl ether
- C_2H_5OH ⇒ Ethanol / ethyl alcohol

$C_2H_4O_2$ $CH_3-\overset{O}{\overset{\|}{C}}-OH$ Acetic acid

$H-\overset{O}{\overset{\|}{C}}-OCH_3$ Methyl formate

4. Metamerism : in metamerism the isomers are called as metamers they have same molecular formula but differ in the nature of the alkali groups attached to same functional group.
$C_2H_5OC_2H_5$ function group ether.

~~$CH_3OCH_2CH_3$~~
$CH_3CH_2OCH_2CH_3$ Diethyl ether
$CH_3OCH_2CH_2-CH_3$ Methyl propylether

5. Tautomerism : in tautomerism isomers are in dynamic equilibrium with each other.
Example : Ethyl Aceto Acetate it is the equilibrium mixture of the following two forms.

$CH_3-\overset{O}{\overset{\|}{C}}-\underset{H}{\underset{|}{CH}}COOC_2H_5 \rightleftharpoons CH_3-\overset{OH}{\overset{|}{C}}=CH-COOC_2H_5$

Keto form

Enol

14/11/22
Monday

Optical Isomerism

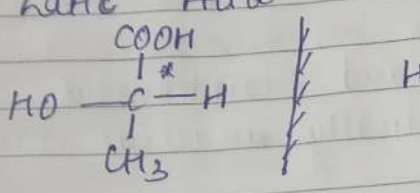
When the two compounds have same molecular formula and they have similar chemical and physical properties but differ in their action towards plane polarised light, then they are known as optical isomers and Enantiomers of each other and this phenomeon is know as optical Isomerism.
The isomerism which ppl towards the right or clockwise direction is also as dextrotary and is represented by symbol 'd' or '+'. And the isomers which rotate the ppl towards anticlockwise or towards the left is called as levorotatory and represented by symbol 'l' or '−'.
An equimolar mixture of (50:50) d and l isomers is know as Racemic mixture it is optically inactive and therefore, it will not rotated the ppl.
It is represented by dl or (±).

- Chiral Centre OR Asymetric carbon OR chairal carbon
A carbon atom which is bonded to four different groups of or atom asymetric.

- Conditions for optical Activity or optical Isomerism
1) The optically active compound must contains atleast one chiral carbon atom.
2) The enantiomers or optical isomers should be non superimposable mirror images of each other.
3) A compound can exists as an isomers if and it does not contain any element of symmetry.
a) Plane of symetry, b) centre of symetry, c) access of symmetry

- Optical isomers of Organic compound containing one chiral carbon atom.

Latic Acid



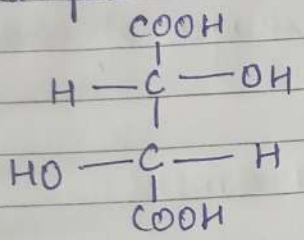
d(+) latic acid

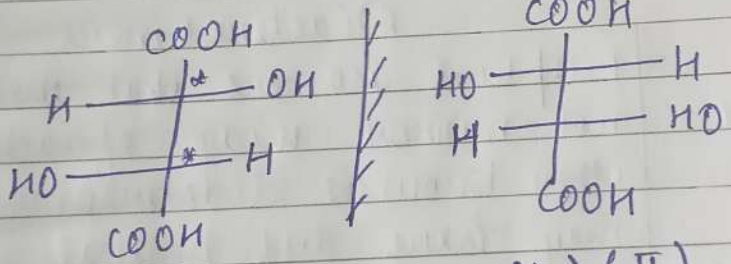
l(-) latic acid

50% d + 50% l
Racemic mixture
dl(±)

- Optical isomerism of organic compounds containing two chiral carbon atoms.

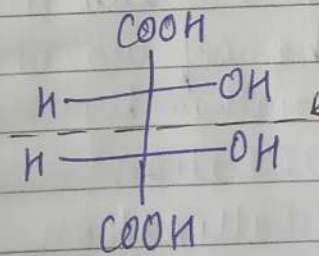
Example is tartaric acid





d(+) (I)

d(-) (II)



↙ Plane of symmetry

III Meso optically inactive

• Racemic Mixture

50% d + 50% l

(dl) (±)

IV

optically inactive

• I and II are optical isomerms and enantiomers

• III form meso tartaric acid optically inactive due to plane of symmetry.

• IV Racemic mixture which is equimolar mixture of d and l isomerms and therefore optically inactive.

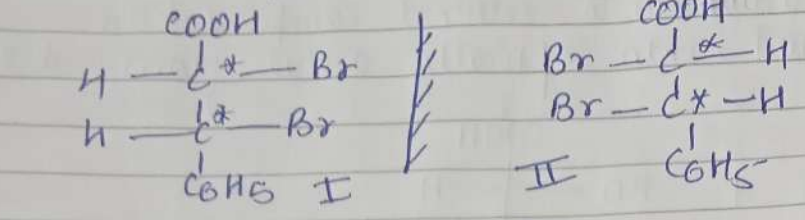
* Diastereomers

I and III are diastereomers, II and III are also diastereomers because they not the mirror images of each other.

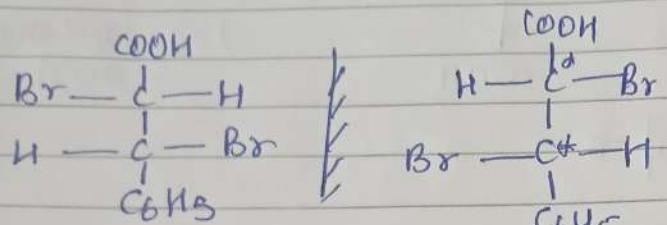
Difference b/w Enantiomers & Diastereomers

Enantiomers	Diastereomers
1. They are the mirror images of each other are know as enantiomers	1. Optical isomers that the not mirror image of each other know as diastereomer
2. They have identical physical property like boiling point, melting point density	2. They have diff physical properties like boiling, melting point, density etc.
3. The racemic mixture can be separated into d and l by the process of resolution.	3. They can be separated from one another by fraction distillation, fraction crystallization and chromatography.

OPTICAL ISOMERISM OF ORGANIC COMPOUNDS CONTAINIG Dissimilar chiral carbon atoms.



I II



III IV

for compound containing no of dissimilar chiral carbon. The no. of optical isomer possible is 2^n for Eg - Feramic Acid dibromide exist in the following four active form.

1) 1 & 2 are enatiomers } because they are mirror image
   3 & 4 are enatiomers } of each other

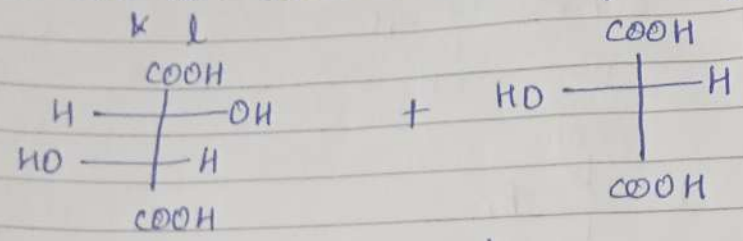
2) 1 & 3 and 1 & 4 are diastereomers and 2 & 4 are also diastereomers because they are not the mirror image of each other.

Que 1) what is optical isomerism state the condition necessary for showing optical Activity

Que 2) Write about the stereotartaric Acid

Que 3) Write the steriomers of 2,3 dichlorobutane

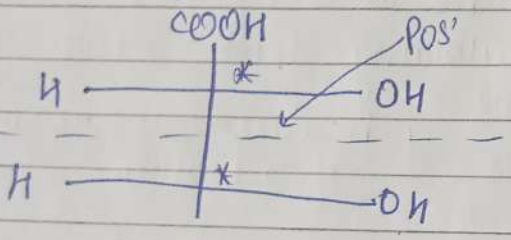
Racemi Mixture: a racemic mixture contain the two equimolar.
It is optically inactive due to external compensation
It can be resolved into optically active from d(+)



l(-) tartaric acid

d(+) tartaric acid 50/50

* Meso Compound: a meso compound has plain of symmetry although it contain two assymetric carbon atoms



① It is optically inactive due to internal compensation
② It cannot be resolved into optically active form
eg. Meso Tartaric Acid.

Que What is optical Activity & How will you measure optical activity. Explain optical inactivity racemix citre & Mesoforms.

R and S Nomenclature of optical Isomers

Absolute configuration the actual 3 dimensional arrangement of atoms or groups in an asym molecule is called as absolute configuration. This system is also called Cahn Ingold & Prelog named after it inventors. R is derived from latin word Rectus which means Right or clockwise. 'S' is derived from latin word Sinister which means left or anticlockwise.

CIP Rules / RRIORITY RULES / SERQUENCE RULES

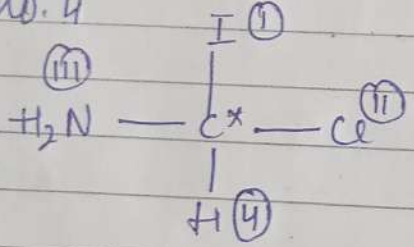
The configuration of the asymetric carbon atom is decided as follows

1. The four atoms attached to the asymmetric carbon ranked in order of periority i.e, in the order of decreasing atomic number.
2. Atom of higher atomic number get piroxity over atom of lower atomic no. for example:

$$\underline{I > Br > Cl > O > N > C > H}$$

Priority in decreasing order of atomic no.

Atom of highest piroxity is assinged no. 1 followed by two and three an atom of three priority hydrogen is given no. 4

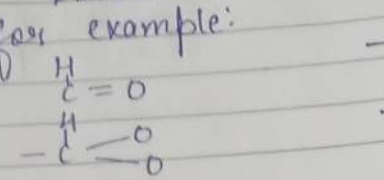


If the first atoms are same then 1 goes to the 2 atom to give the priority

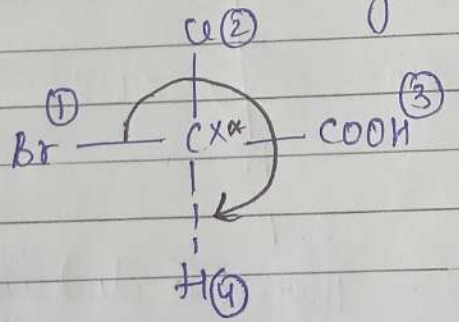
-CHO group preffered over -CN group.

$-\overset{O}{\overset{\|}{C}}-H$ > $-C \equiv N$

- In methyl and ethyl group ethyl group is given the higher priority over the methyl group.
- Multiple bonds are considered as separate single bond, for example:



- If the lowest priority is present vertically downward then no interchange of atoms or group.
- If the atoms of group are present in the horizontal line then two interchanges have to be done in order to locate the lowest priority group to the vertical downward position.
- Now the molecule is observed in such a way that the lowest priority group is away from the observer.
- Now the arrangement of remaining groups or atom is observed in the decreasing order of their priorities. if the moves in clockwise direction the configuration is assinged as R and if the eye moved in anticlockwise direction then the configuration is assinged as S.



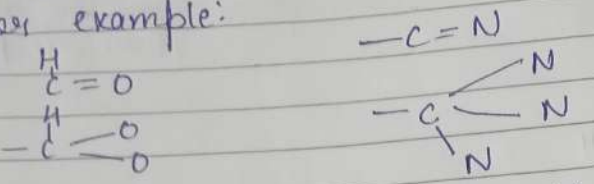
Priority order: Br > Cl > COOH > H

Clockwise or R Configuration

$-CHO$ group preffered over $-CN$ group.

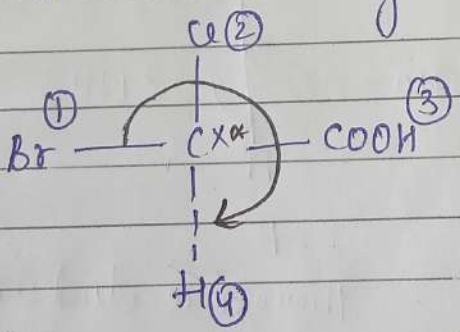
$-\overset{H}{\underset{|}{C}}-O$ > $-C \equiv N$

- In methyl and ethyl group ethyl group is given the higher priority over the methyl group.
- Multiple bonds are considered as separate single bond, for example:



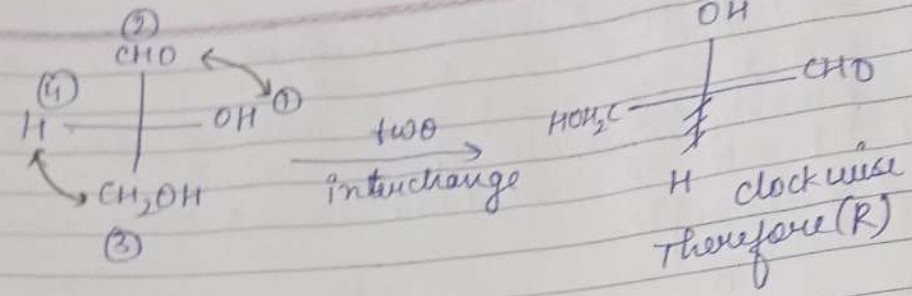
- If the lowest priority is present vertically downward then no interchange of atoms or group.
- If the atoms of group are present in the horizontal line then two interchanges have to be done in order to locate the lowest priority group to the vertical downward position.
- Now the molecule is observed in such a way that the lowest priority group is away from the observer.
- Now the arrangement of remaining groups or atom is observed in the decreasing order of their priorities.

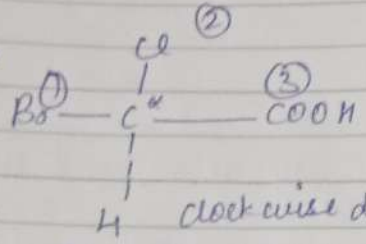
if the moves in clockwise direction the configuration is assinged as R and if the eye moved in anticlockwise direction then the configuration is assinged as S.



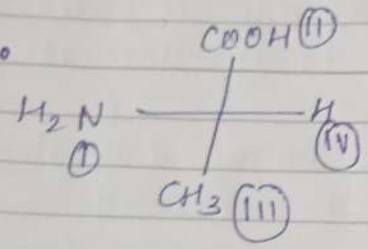
Priority order: $Br > Cl > COOH > H$

Clockwise or R Configuration

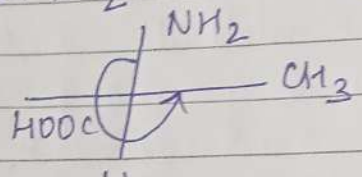




Br > Cl > COOH > H

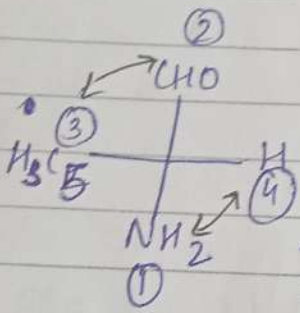


Priority order $NH_2 > COOH > CH_3 > H$

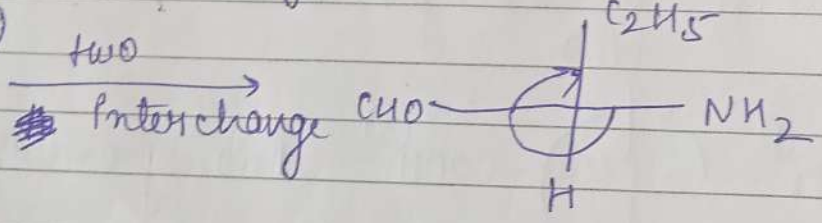


anticlockwise

∴ S configuration.

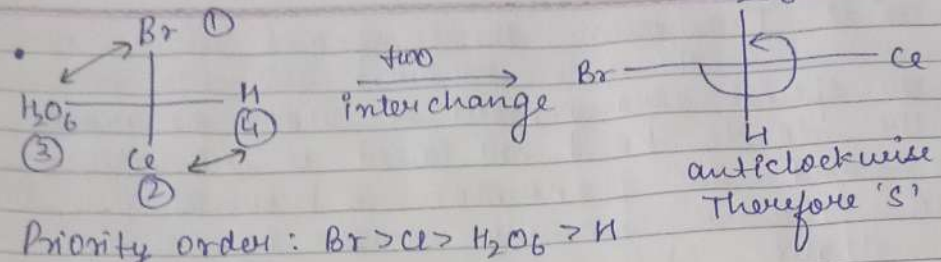


Priority order : $NH_2 > CHO > H_2C_5 > H$



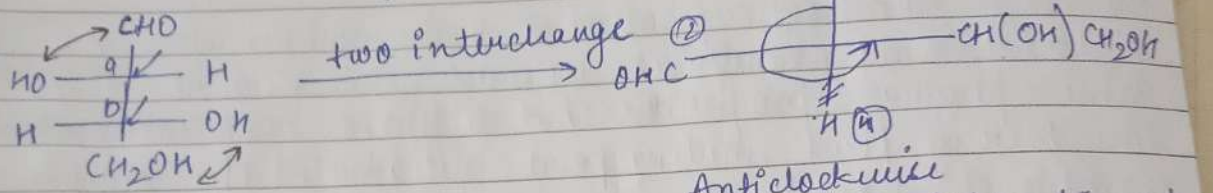
R

Therefore clockwise

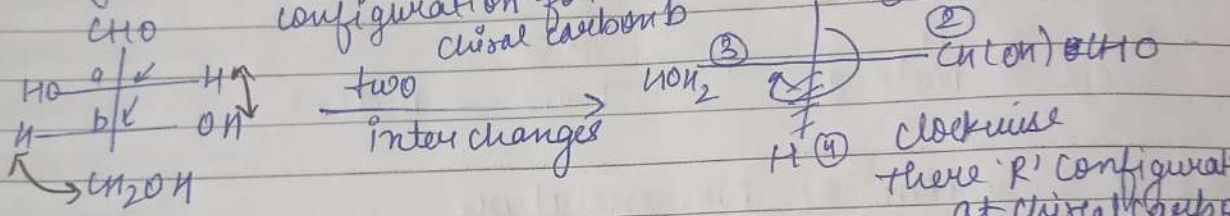


Priority order : Br > Cl > H_2O_6 > H

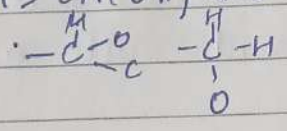
17/11/22 Thursday



priority order HO > CHO > CH_2OH > H



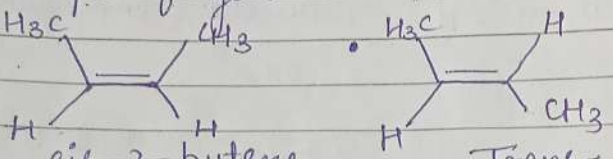
priority order: OH > $CH(OH)CHO$ > CH_2OH > H



* Geometrical Isomerism the compound which have the same structural formula but differ in the special arrangement of atoms or groups around the double bond are called as Geometrical isomerism and this phenomeon is know as geometri isomerism This is generally shown by certain members of alkaline.

To show the geometrical isomerism the molecule must have the double.

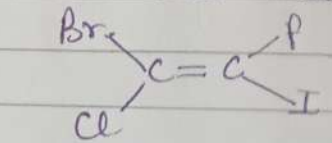
The two atoms / group attached to the carbon atom must be different. In geometrical isomers, the isomers have same physical properites but different chemical properties like boiling point, melting point refractive indexThe simple example of geometrical isomerms is



cis-2-butene Trans-2-butene

* E-Z System of Nomenclature

The conversional cis trans nomenclature does not work with tri and tetra substituent. Such, as



1-Bromo-1-chloro-2-fluoro-2-iodoethene

for such type of compound a new system of nomenclature i.e EZ was developed by

This system is based on sequence-s rule atoms / groups are given priority by the following rules:—

1. A group get priority if its atomic no. high.

2. When
atomic
priorit
numb

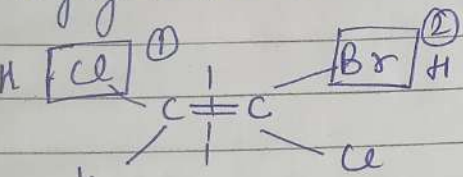
3. If t
side
is
mean

4. If
opp
is
Ex

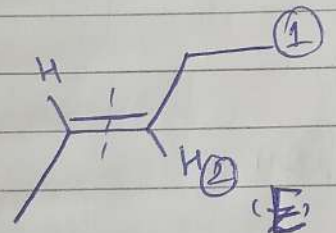
2. When the atoms attached to double bond has same atomic no, then the second atoms are considered. priority given to second atom / group of higher atomic number.

3. If the two higher priority group are on the same side of double bond the configuration is Z. It is derived from a german word ZUSAMMEN which means together.

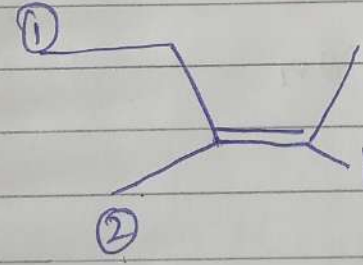
4. If the two higher priority group are present on the opposite side of them of the double then configuration is given E. It is derived from german word Entgegon which means opposite.

- 

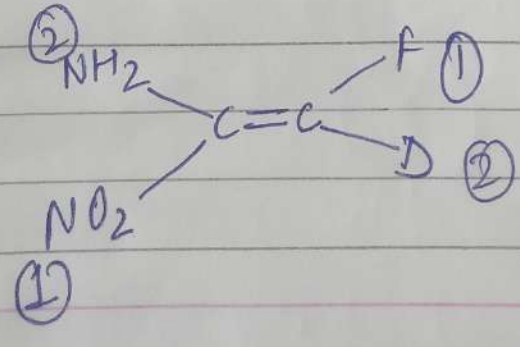
'Z' configuration

- 

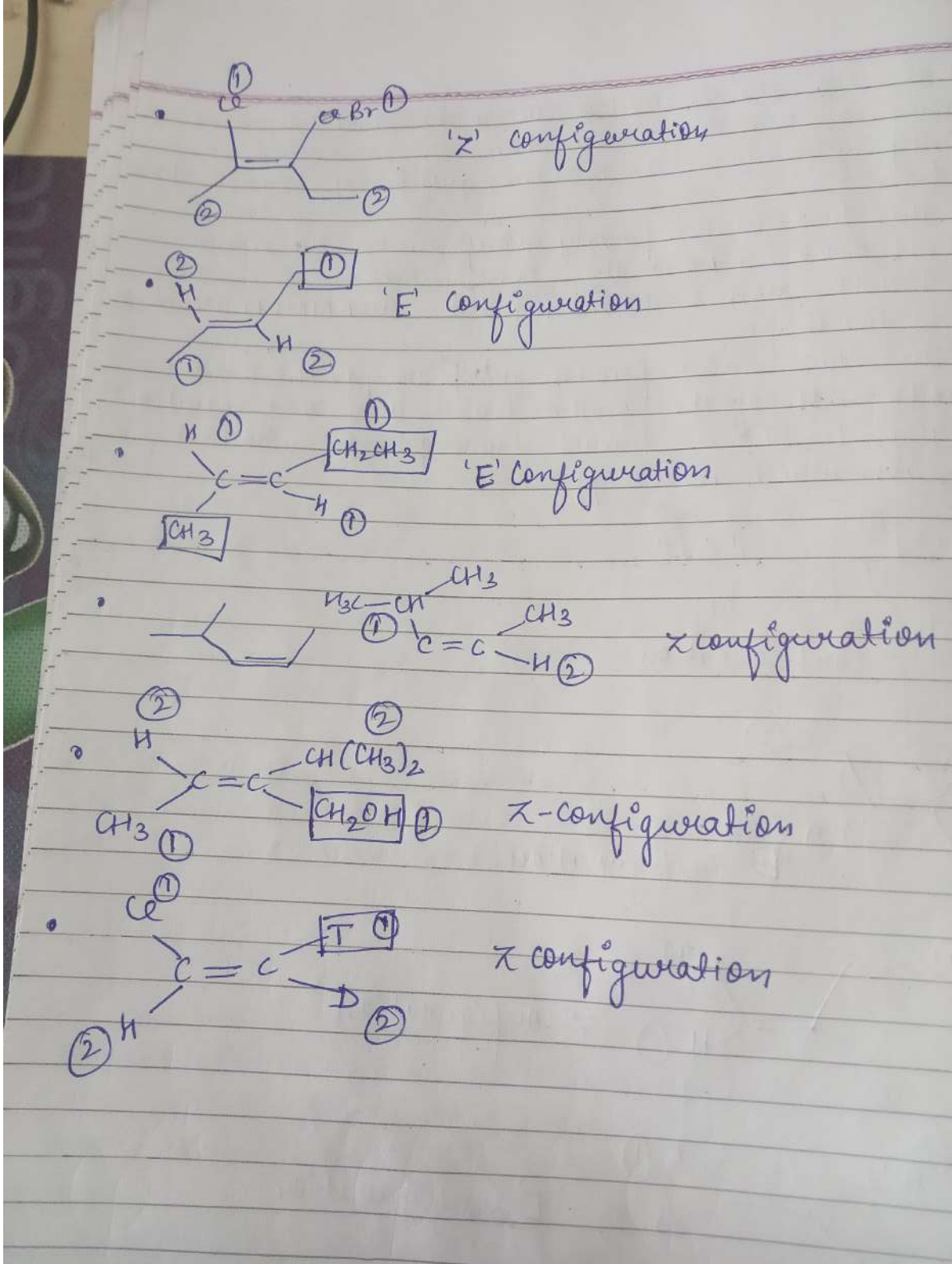
'E' configuration

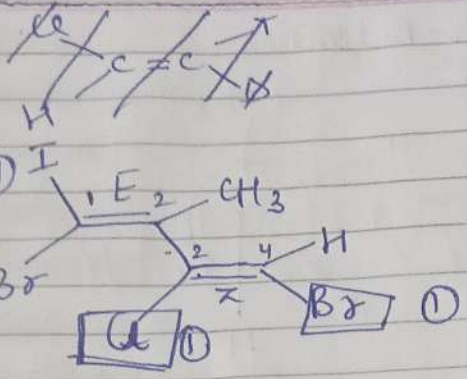
- 

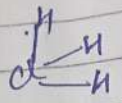
'Z' configuration

- 

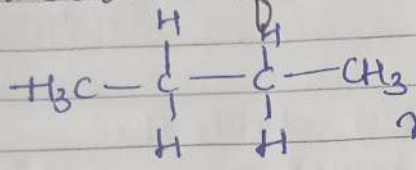
'E' configuration


'Z' configuration
'E' configuration
'E' configuration
Z configuration
Z-configuration
Z configuration

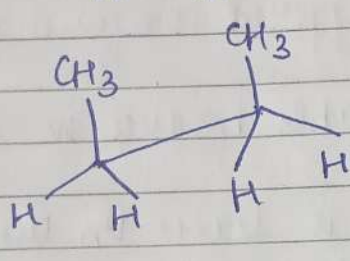




* Conformations of N- butane

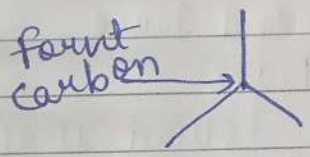


n-butane



Saw-horse projection

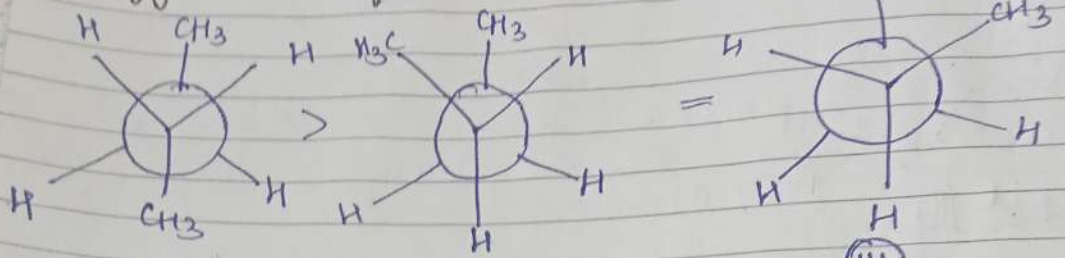
* Newman Projection formula



Distant Carbon or Rear carbon

Acc to this formula the carbon atom which is near to the eye is front carbon atom and groups attached to it are represent by equally spaced radii. At distant carbon / atom is represented by the circle.

* Staggered conformation of N-Butene



(I) Anti/Trans most stable

(II) Gauce/skew

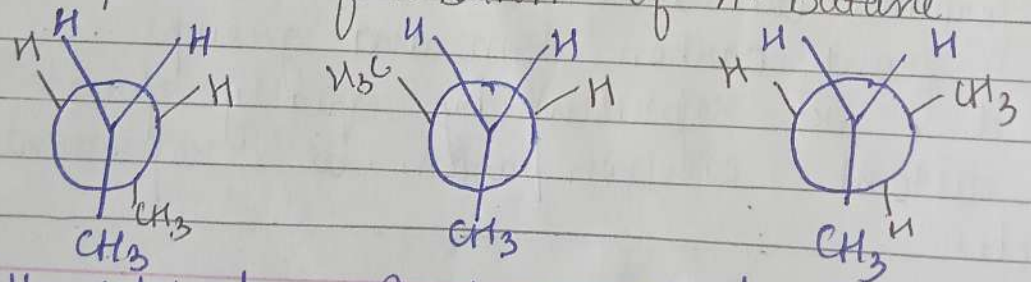
(III) Gauce/skew

Staggered conformation are more stable the conformation, there three staggered conformation.

Anti/Trans form is most stable because in structure 1 methyl groups are as and therefore steric repulsion is least. On the other hand in the Gauce form the methyl groups are close to each other and therefore Vander Waal's forces of repulsion start operating, and Gauce forms become less stable then Anti/Trans.

From energy consideration of it is found that conformation 1 is more stable than Gauce 2, 3 by 0.8 - 0.9 kg/c per mol

Eclipsed conformation of n-Butane

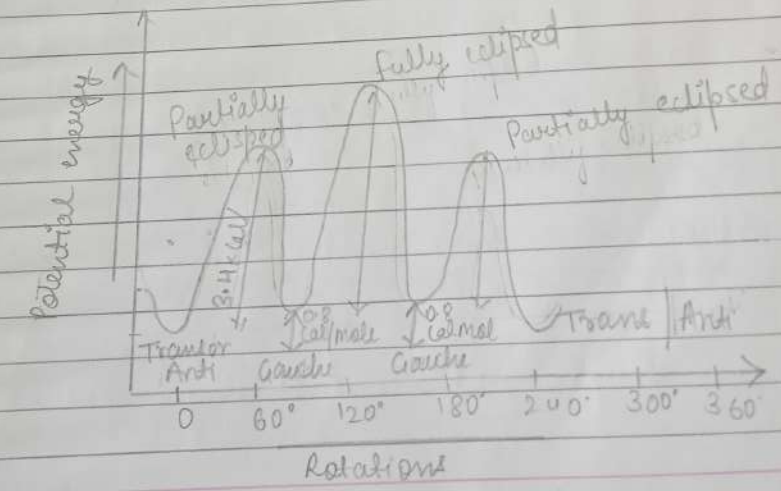


Fully eclipsed Partially eclipsed Partially eclipsed

Relative Stability
Trans/Anti > Gauche ≡ Gauche > P. eclipsed ≡ P. eclipsed
(v) (iv)

Que Define optical Activity how it is measured ?
Que - what is optical isomerism what are the condition to show optical isomerism by a compound.
Que Discuss about stereoisomers (Enantiomers & Diastereomers of tartaric acid.
Que Diff b/w Enantiomers & dia
Que what is E-Z system of nomenclature Explain this nomenclature with example.
Que Explain the reasons for optical inactivity in racemic mixture.
Que Discuss about various conformations of n-butane with the help of energy profile diagram.
Que Write relative stabilities of various conformations of n-butane.

Potential Energy Diagram



In fully eel form methyl group eclipsed by another methyl group whereas in partially each of the methyl group is eclipsed by hydrogen. Therefore 4 will have more repulsion than structure 5 and 6 and partially other eclipsed formed 5 and 6 will be more

The fully staggered (Anti) form is more stable than fully eclipsed formed by 5.2 kcal/mole by rotating n-butane molecule we come across to different eclipsed and the energy barries are 4.4kcal/mole 3.4 kcal/mole

12 Principle of Green Chemistry

Paul T Anastas father of green chemistry
The concept of green chemistry was established at the environmental protection Agency (EPA) in response to Pollution Prevention Act 1990
Paul T Anastas and John C Warner publish a set of principle to guide the practise of green chemistry the 12 principle finds the ways to reduce the environmental pollution caused by chemical manufacturing units, it also focuses on research activities for the development of green chemistry technology.

Principle :-

1. Preventions = it is better to prevents formation of waste than to treat or clean up waste after it is formed. Zero Waste technology (ZWT)
   Ex: Waste product one system should be used as a raw material for other system for ex: bottom ash of thermal power plant can be use raw material for cement and brick industry.
2. ATOM - ECONOMY = maximum incorporation of raw material and no waste product should be formed.

$$\% \text{ atom economy} = \frac{\text{formula weight of the desired product}}{\text{Sum of the formula Weight of all the reactant used}} \times$$

Conversion of butane-1-ol to 1-bromo-butane

12 Principle of Green Chemistry

Paul T Anastas father of Green chemistry
The concept of green chemistry was established at the environmental protection Agency (EPA) in response to Pollution Prevention Act 1990
Paul T Anastas and John C Warner · publish a set of principle to guide the practise of green chemistry. the 12 principle finds the ways to reduce the environmental pollution caused by chemical manufacturing units, it also focuses on research activities for the development of green Chemistry technology.

Principle :-

1 Preventions = it is better to prevents formation of waste than to treat or clean up waste after it is formed. Zero Waste technology (ZWT)
Waste product one system should be used as raw material for other system for ex: bottom ash of thermal power plant can be use raw material for cement and brick industry.

2. ATOM - ECONOMY = maximum incorporation of raw material and no waste product should be formed.

$$\% \text{ atom economy} = \frac{\text{formula weight of the desired product}}{\text{Sum of the formula weight of all the reactant used}} \times 100$$

Conversion of butane-1-ol to 1-bromo-butane

$CH_3CH_2CH_2OH + NaBr + H_2SO_4 \longrightarrow CH_3CH_2CH_2CH_2Br + NaHSO_4 + H_2O$

% Atomeconomy = $\frac{\text{formula wt of } CH_3CH_2CH_2CH_2Br}{\text{formula wt of } CH_3CH_2CH_2CH_2OH + NaBr + H_2SO_4} \times 100$

$= \frac{137}{74+103+98} \times 100$

$= \frac{137}{275} \times 100$

$= 49.8\%$.

30/11/22

3. Less Hazardous chemical Synthesis = the process of formation of chemical product should be as safe as possible, so that the formation of hazardous waste can be avoided or stoped for example: DDT was used insecticide but it is harmful to human and animals also. Therefore now, BHC Benzene hexachloride is used in place of DDT. One of the isomers of ~~BHC~~ called as gammexene or lindane

4. Designing safer chemicals: the raw material used and the product formed should be less toxic whenever, praticable synthetic method should be design to use and generate substances that possess little no toxicity to human health and environment ~~Ben~~ ex: benzen starting material of for the Sythesis of Adipic acid which is used in the polymer industry.

Benzene is a

Therefore, nowdays Adipic acid enzymatically synthesized from gulcose.

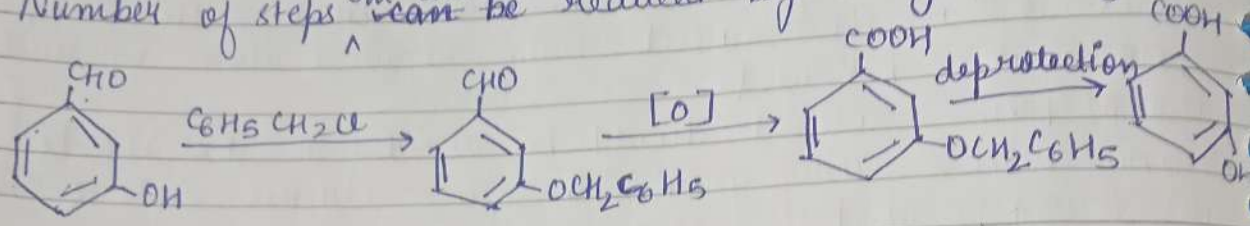
5) USE SAFER SOLVENTS AND AUXILIARIES = to avoid the unesscary formation of waste product amount of solvents and auxiliaries like separation agents should be minimized. Green solvent should be use for ex: Water and supercritical CO_2 can be use in place of dichloromethane CH_2Cl_2, $CHCl_3$, CCl_4 Water is a safe solvent. Only required ~~ston~~ amount ~~should~~ should be used.
Use of toxic solvent should be avoided as it's affects many works every year and cause adverse affects on the works and environment.

6) Design for energy efficiency = energy like temp, pressure and electricity is used during chemical synthesis in some reactions very high amount of heat has to given to initiate this can be avoided by using proper catalyst and bicatalyst at to room temperature in the existing conditions.
Various synthetic method should be conducted at ambient temperature & pressure.
Use of microwave heating is an alternative to safe energy.

7) Use of renewable raw materials (Feed-stocks) = avoid use of non-renewable resources such as petrochem-icals use of resource renewable like aquiculture

for example (B20) → Biodiesel is prepared from pathy non ediable oil and diesel. It is an excellent green fuel

8) Reduce Derivatives / minimization of steps.
formation of derivatives can be reduced during synthesis of any chemical
ex: protecting, deprotecting and blocking group should not be used during chemical synthesis
Number of steps in chemical reaction can be reduced by using catalyst.



9) Catalysis = catalytic are suprior to stiochiometric reagents because catalyt are used in small amount and can carried about single reaction many times.
Used of the catalyst in chemical reaction speed's up up of rate of chemical.
Catalyst are selective and they safe energy.

10) Design for Degradation = the raw materials used and the product form should be breaking down into the harmless substances at the end of their function. these degradation product should be not toxic and not persistent in the environment. They should not accumulate and bio accumulate. The waste product should be automatically degradated to clean the environment.

1/12/22

11) Real time analysis for pollution Prevention-
The reaction process should be maximize in during the synthesis of chemical to prevent formation of biproduct i-e, the reaction should be monitored and stoped in the correct without the formation any biproduct or any hazardous substance along with the product.
Analytic method should developed so, that the continous monitoring of the manufacturing and the processing unit is possible.
Example: Chemical industries and ~~chemical~~ nuclear reactor where real time analysis is very Important.

12) Safer Chemicals for Accident Prevention
Substances and the forms → (gas, liquid, solid) used in a chemical process should be choosen in such a way that the potential for chemical accident releases, explosions & fires should be minimize. The main aim of this principle is to avoid chemical accidents.
Example: if the chemical process works with gaseous substance then the possibility of the accident and explostion is reliniately higer compare to the system working with non violet liquid or solid substance.

1/12/22

Moudle-4 Polymers

A polymer is a natural molecule which is form by repeating of several molecule, these repeating units are knoib as monomers. These monomers are linked in a polymer chain through strong covalent bond. The properties of polymers are diff of that several repeating unit.

$$n[\underset{\text{Ethene}}{CH_2=CH_2}] \xrightarrow{\text{Polymerization}} \underset{\text{Polythene}}{[CH_2-CH_2]}$$

- Classification of Polymer Based on ORIGIN/SOURCE

It can be classified into two natural polymer and synthetic polymers.

- The polymers which are obtained from nature like plants and animals are called as natural polymers.
  example: proteins, cellulose, starch, wool, silk, cotton, Natural rubber etc.
- The polymers which are made in laboratories by man are called as synthetic polymers
  example: polythene, Nylon, BUNA-S, Dacron etc.

- Classification of Polymers Based on Mode of Synthesis

- Addition polymers: these polymers are formed by the repeated addition of monomers in this type of polymerisation the

When the monomeric unit of repeatedly added to from long chain of monomers without the

elimination of any small molecule or product. The product found is called addition polymer and the process is know as addition polymers.
elimination molecule → H_2O, NH_3, HCl
example: Polyethen PE, Polypropylene PP, Poly Vinyl Chloride PVC, Polytetra fluoride ethene PTFE

1) $n[CH_2=CH_2] \xrightarrow{\text{Polymerization}} -[CH_2-CH_2]_n-$

2) $nCH_2=\underset{Cl}{CH} \xrightarrow{\text{Polymerization}} -\left[CH_2-\underset{Cl}{CH}\right]_n-$

Vinyl chloride → PVC

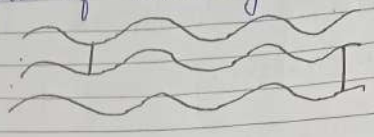
- Condensation Polymers the monomers react together with the elimination of simple molecule like H_2O, ROH, NH_3 and HCl etc. Therefore, in this type of reaction is complete the elimination of small molecule
Example: Nylon 66 is formed by the condensation ~~polymerisation~~ of of hexamethylenediame adaptic acid.

$$nH_2N-(CH_2)_6-\overset{H}{N}-H + nHO-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-OH \xrightarrow{\text{Polyamide}}$$

$$n-\left[\overset{H}{N}-(CH_2)_6-\overset{H}{N}-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-\right]_n + 2nH_2O$$

- Classification based on Intermolecular forces
1) Elastomers the polymeric chains are held together by
2) ~~They~~ weakest intermolecular forces which allow the

polymer to be streached by applying small forces. The elastomer regain it normal shape after the force is removed, the example is natural rubber, these have long linear & coiled chain which show high degree of elasticity.



Thermoplastics	Thermosetting
This polymer become soft on heating and hard on cooling	1. These polymers on heating become infusible materials.
2. They contain long linear chain	2. They contain 3 dimensional cross link structure.
3. Thermoplastics polymers are formed by addition polymerisation	3. These polymers are formed by condensation polymerisation
4. They can be remoled / re-shaped or reused.	4. They can not be remoled, reshaped or reused.
5. They are usually soft, weak and less brittle	5. They are hard strong and more brittle.
example: PP, PTFE, PVC PE, PMMA	example: Uf Resin, Mf Resin Bakelite.

* Fibres = have strong intermolecular forces b/w the polymeric chains in fibres the polymeric chain are closely packed and therefore they have tensile strength, they long thin and thread like.
example; nylon, Dacron etc.

* Classification polymers based on structure and shape

They are of three types

1) Linear: these are polymers in which monomeric unit are linked together to form linear chains. These linear chains are well packed and therefore they have high density.

ex: HDPE (High density polyethene)

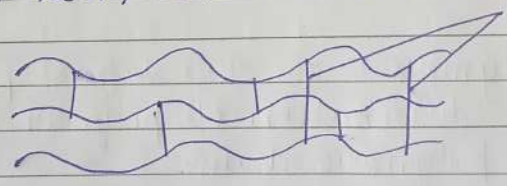
2) Branched: in branched type of polymer the monomer linked to form long chain with diff branches

LDPE = Low density polyethene Glycogen

3) Cross linked: these type of polymers the monomer units are cross linked to form 3D network structure

these are hard brittle because of the network structure.

example: UF Resin, MF Resin and Bakelite.

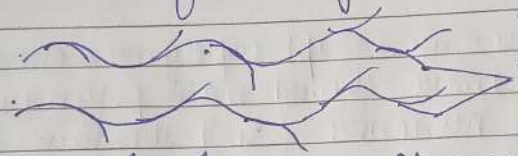


* Classification polymers based on structure and shape

They are of three types

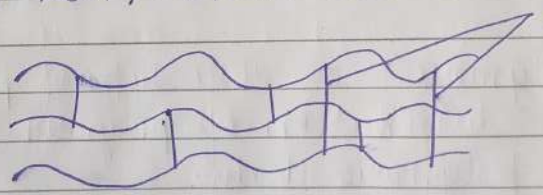
1) Linear: these are polymers in which monomeric unit are linked together to form linear chains. These linear chains are well packed and therefore they have high density.
ex: HDPE (High density polyethene)

2) Branched: in branched type of polymer the monomer linked to form long chain with diff branches



LDPE = Low density polyethene Glycogen

3) Cross linked: these type of polymers the monomer units are cross linked to form 3D network structure these are hard brittle because of the network structure.
example: VF Resin, MF Resin and Bakelite.



Homopolymer

1. The polymer which consist of only one type of monomer unit is called as homopolymer
ex: PE, PVC, PTFE, PP

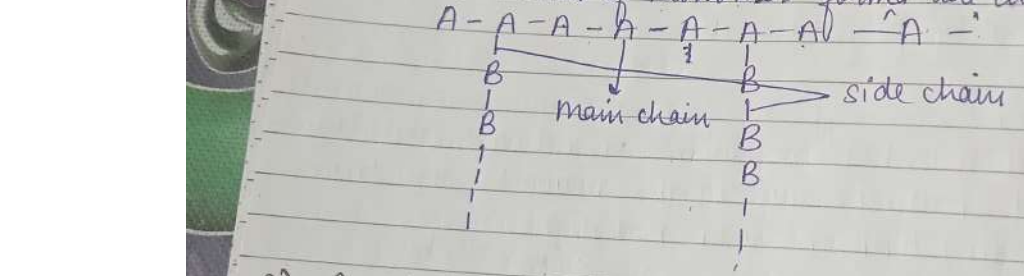
copolymer

1. The polymers in which there are two or diff types of monomer are called as co polymer
ex: nylon 6,6, BUNA-S Dacron, Bakelite etc.

* Copolymers can be classified into the following types-

1) Block copolymers - in these types of polymers blocks form a continous long linear polymeric chain.
Ex: A-A-A-A-B-B-B-B-A-A-A-A

2) Graft copolymers - in graft copolymers one kind of monomers formed main polymer chain and another kind of monomer formed the side chain.

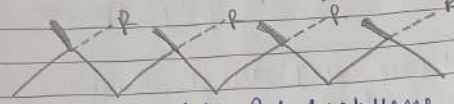


3) Random copolymers - in these type of polymer the distribution of polymer is random around the main polymeric chain.
A-A-B-A-B-AA-B-A-A-B

4) Alternating copolymers - the monomers are arranged in alternating fashion in polymeric chain.
A-B-A-B-A-B-A-B-A-B-A

* Classification of polymers based on tacticity / Spatial arrangement / configuration

1) Isotactic : in this type arrangement the group are present in same side of main polymeric chain.

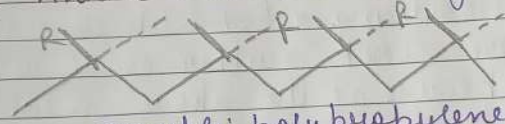


Example Polyisoprene

2) Syndiotatic : in this type of arrangment the side group are ~~are~~ present at alternating fashion around the main polymeric chain.

Example: Guttapercha

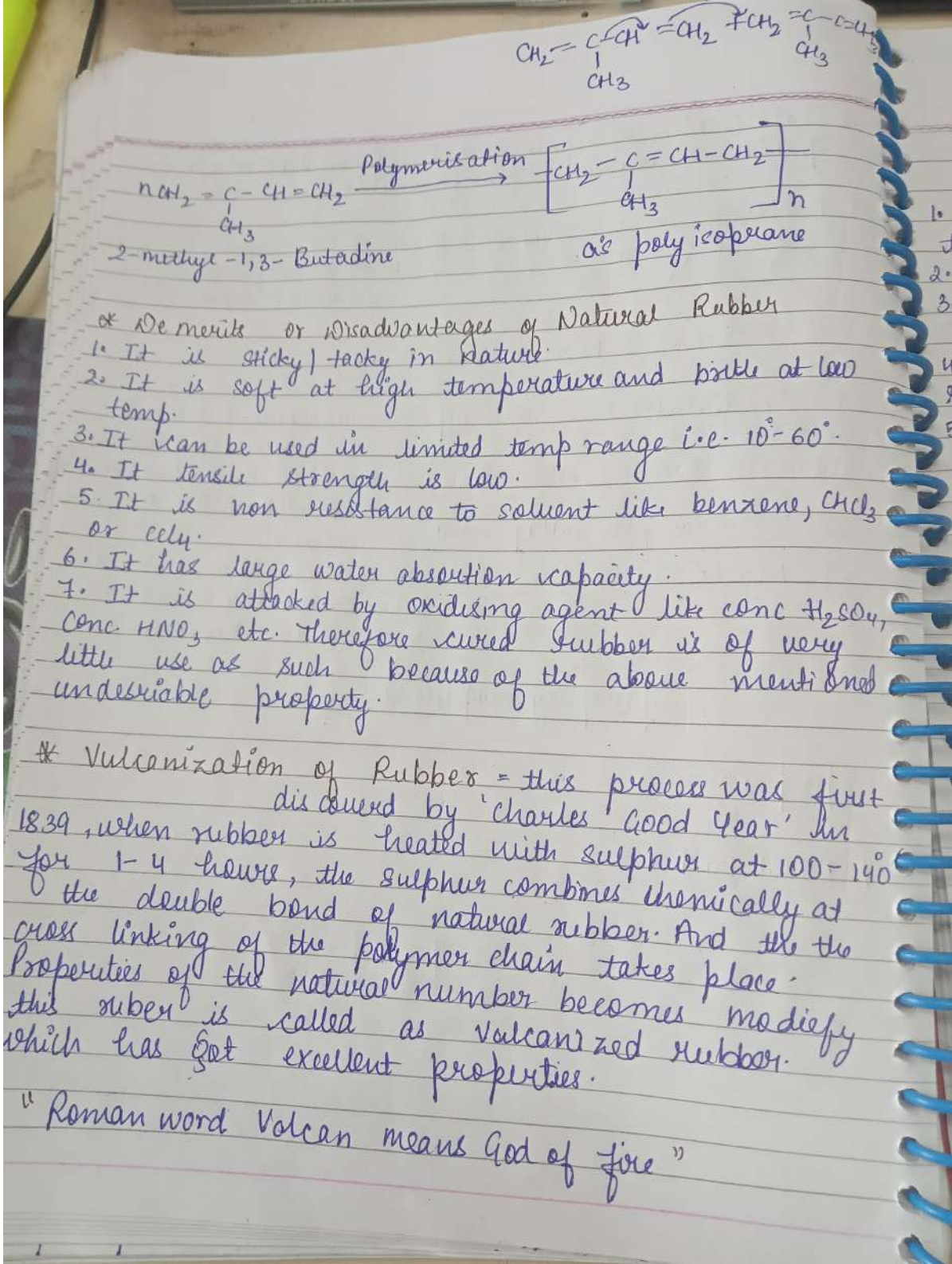
3) Atactic : in this the groups are present randomly around the main chain



example: polypropylene

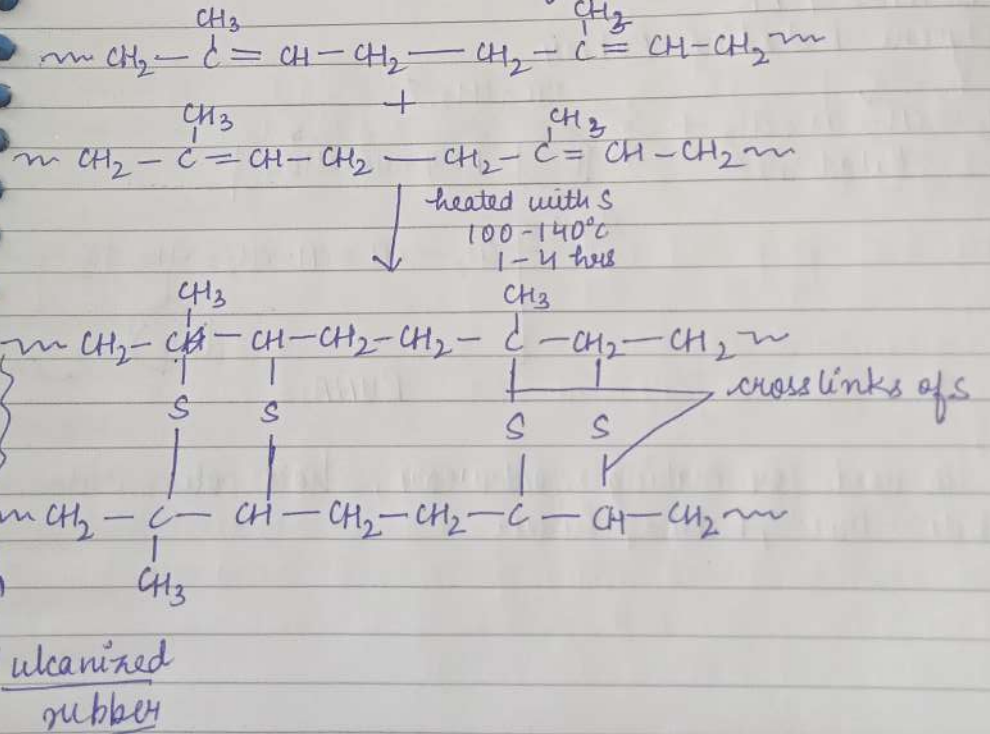
5/12/22

Natural Rubber =


Polymerisation
2-methyl-1,3-Butadine
as poly isoprene
* Demerits or Disadvantages of Natural Rubber
1. It is sticky / tacky in nature.
2. It is soft at high temperature and brittle at low temp.
3. It can be used in limited temp range i.e. 10°-60°.
4. It tensile strength is low.
5. It is non resistance to solvent like benzene, $CHCl_3$ or CCl_4.
6. It has large water absorption capacity.
7. It is attacked by oxidising agent like conc H_2SO_4, Conc. HNO_3 etc. Therefore cured rubber is of very little use as such because of the above mentioned undesirable property.
* Vulcanization of Rubber = this process was first discoverd by 'Charles Good Year' in 1839, when rubber is heated with sulphur at 100-140° for 1-4 hours, the sulphur combines chemically at the double bond of natural rubber. And the the cross linking of the polymer chain takes place. Properties of the natural rumber becomes modify this ruber is called as Valcanized rubber. which has got excellent properties.
" Roman word Volcan means God of fire "

Properties and Advantages of Valcanized Rubber

1. It has very good tensile strength 10 times the tensible strength of crude rubber.
2. It become hard and durable.
3. It has good resistance towards solvent Benzene, CCl_4 & $CHCl_3$ etc.
4. The water absorption of capacity of valcanized Rubber is considerly lowered.
5. The working temp of valconized rubber becomes $-40 - 100°C$.
6. It is attack become resistance towards oxidising agent
7. The elasicity of valcanized rubber becomes low (it decrease with extent of Valconized rubber)



* Synthetic Rubber
It is classified into two types.

① Neoprene / Poly chloroprene

$$n CH_2 = C(Cl) - CH = CH_2 \xrightarrow{\text{Polymerise}} -[CH_2 - C(Cl) = CH - CH_2]_n-$$

2 chloro - 1-3 - butadine
chloroprene

Poly chloroprene.

• Properties and Uses

1. It posses high temperature Therefore used in making conveyor belts, Gaskets and for the insulation of heating wire.

* BUNA-S / SBR
Styrene Butadine Rubber

$$n CH_2 = CH - CH = CH_2 + n \, C_6H_5 - CH = CH_2 \xrightarrow{\text{Polymerisation}} -[CH_2 - CH = CH - CH_2 - CH(C_6H_5) - CH_2]_n-$$

1, 3 - Butadiene

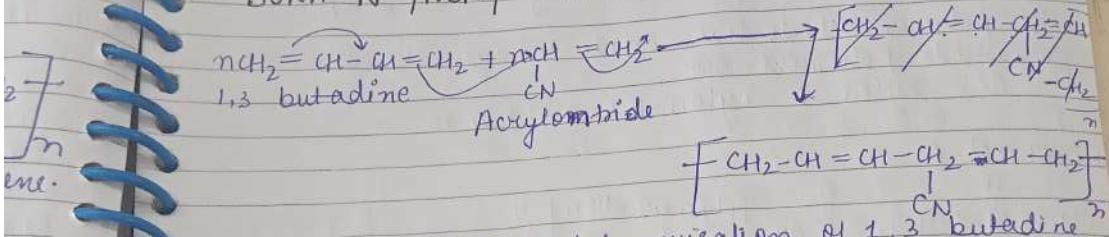
Styrene

BUNA-S

1. It is used for making foot wear, shoes soles, automobile tried, belts, hoses.

6/12/22

* BUNA-N /NBR/ NITRILE RUBBER

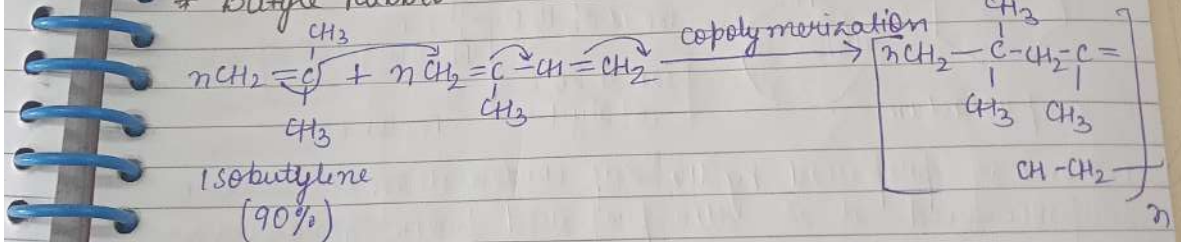


- It is prepared by co polymerisation of 1,3 butadine and Acrylonitride

- Properties and uses

- It has high resistance to oils and organic solvents and therefore used for storage of oils and solvents. it is used for the manufacture of tank-linings.

* Butyle Rubber



Butyle Rubber

- Properties and uses

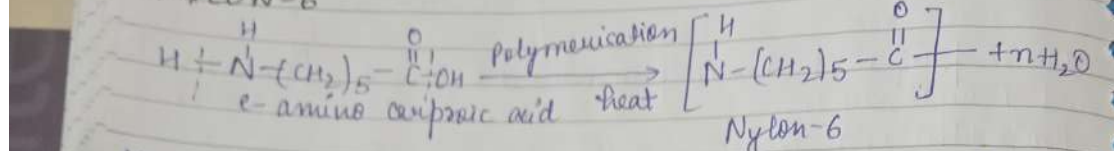
- It is less sensitive to oxidative ageing Therefore it is used for manufacture of inner tubes of tyres

- It is also used for insulation of high voltage wires

* Condensation Polymers Polyamide $-\overset{O}{\overset{\|}{C}}-\overset{H}{\underset{|}{N}}-$

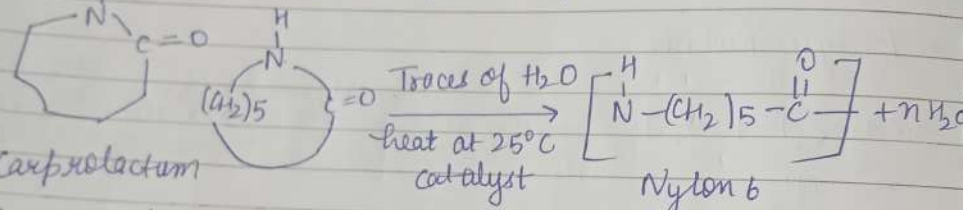
The polymer which has amide linkage are called as polyamide polymers. ex
ex: nylon-6, nylon 6-6 and kevlar.

• NYLON-6



Nylon 6 is obtained by the polymerisation of ε-amino caproic acid

It is also prepared from Caprolactum



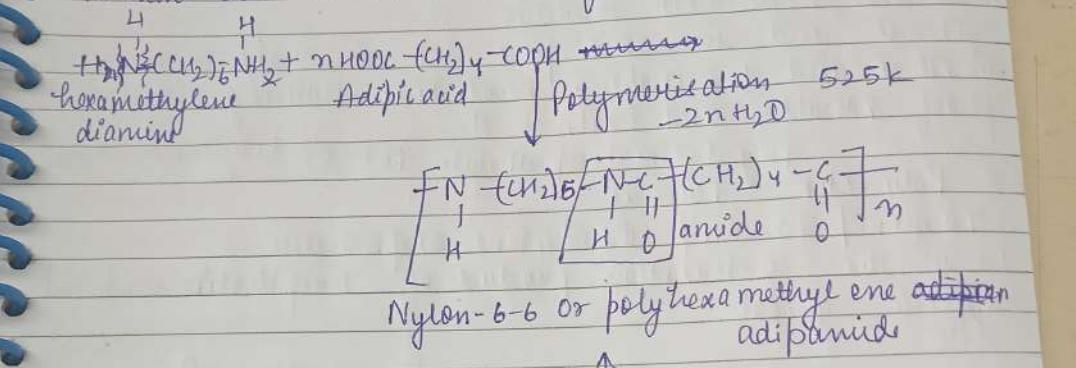
Nylon 6 is prepared by the self condensation of ε amino caproic acid it is also prepared from caprolactam. Caprolactum is better because it is easier to make and purify caprolactum than ε-amino caproic acid.

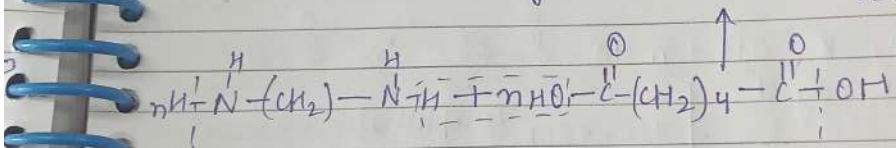
Uses —

1. It has very good tensile strength and it is use for making rope tayre ropes and fabrics etc.
2. It is also used for making threads and bristles of toothbrushes, for making strings of musical instruments Ex: sitar, guitar and violin.

* Nylon 6-6
copolymer

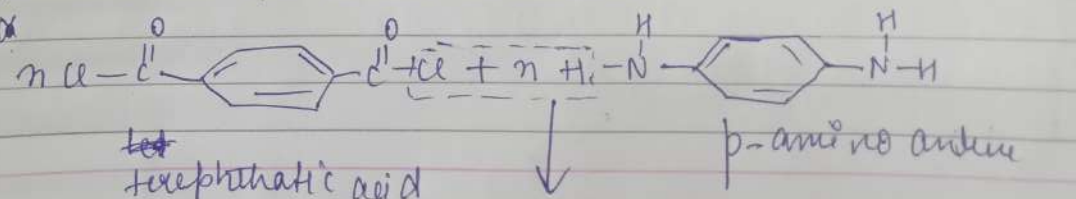
It is prepared by the poly condensation of hexamethylene diamine and adipic acid. By heating the equimolar parpotion to the two reaction nylon 6-6 is obtain with the elemination of water molecule.

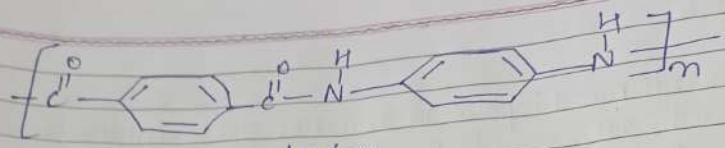




Properties

- It has very high tensile strength
- It shows very good resistance to abbrasion.
- It used in making parasuits, air bags, carpets, ropes, hoses (mota pipe).
- It is also used for making nylon fibres which are use to make elastic hoisery.
- It is also used for making sheets, bristles of tooth brushes and in textile industries.





Kevlar

7/12/22

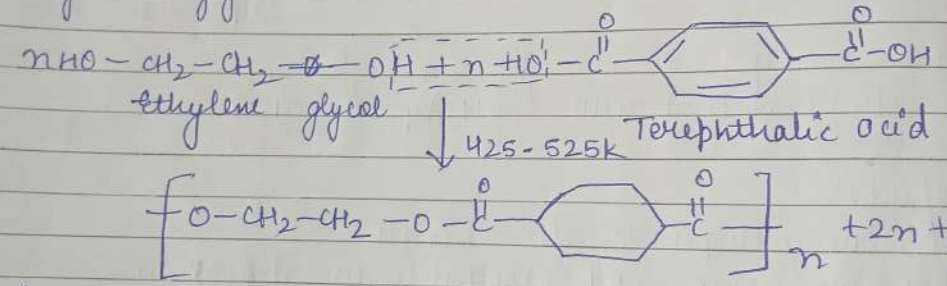
1. It is five time stronger than steel.
2. It has high heat stability.
3. It is used in aero space and air craft industries
4. It is used for making protective clothing, bullet proof vests and heatmet etc.

Polyethylene terephthalate (PET) or terylene or Dacron

* Polyester - Terelene

Terylene / Dacron / Polyethylene terephthalate

It is the condensation product of terephthalic acid and Ethylene glycol.



Properties & uses

1. It has very good tensile strength
2. Used to make fibres & seat belts
3. Also used for making safety helmets

Addition Polymer

1) Polythene

$$n CH_2 = CH_2 \xrightarrow{\text{Polymerization}} \left[CH_2 - CH_2 \right]_n$$

Polythene

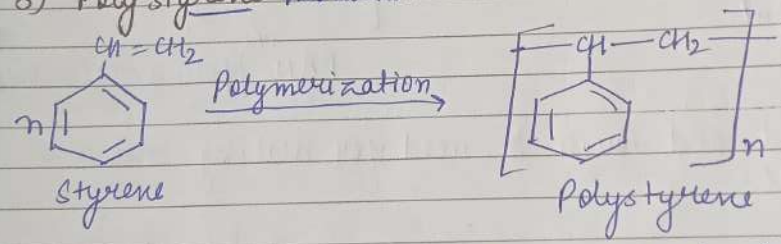
- It is used in making packing material as well insulation of electric wires

2) Polypropene: is stronger and lighter than polyethene and it used for packing of textile materials.

$$n CH(CH_3) = CH_2 \xrightarrow{\text{Polymerization}} \left[CH(CH_3) - CH_2 \right]_n$$

Polypropene

3) Polystyrene monomer



Styrene — Polystyrene

- It is used for making comb and plastic handles
- Used for insulation of wires.

4) PVC

$$n CH(Cl) = CH_2 \xrightarrow{\text{Polymerization}} \left[CH_2 - CH(Cl) \right]_n$$

PVC

Poly vinyl chloride

Properties & Uses
- It is used for making pipes and seats
- Used for making rain coats.

5) Polytetrafluoro ethylene (PTFE) or Teflon

$$nCF_2 = CF_2 \longrightarrow \left[CF_2 - CF_2\right]_n$$

Teflon

Used
- It is used for making non stick kitchen wares, burette stoppers and for insulation purpose.

6) Poly acrylonitrile PAN | ORLON / orlon — homopolymers

$$\left[CH_2 - \underset{CN}{CH}\right]_n \xrightarrow{\text{Polymerisation}} \left[CH_2 - \underset{CN}{CH}\right]_n$$

PAN | poly acrylonitrile

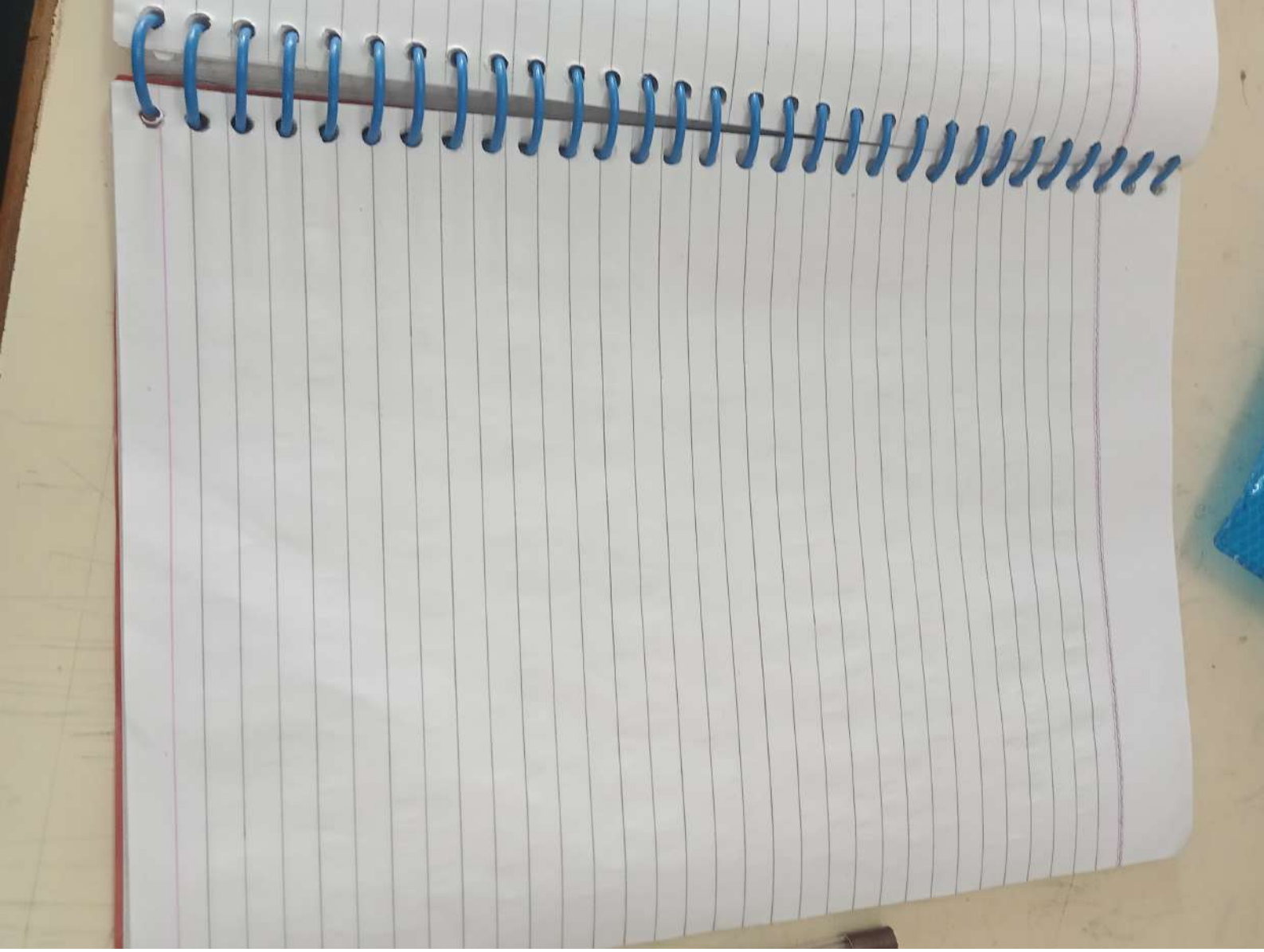
- It is hard and tough & used for making carpets & bath blankets.

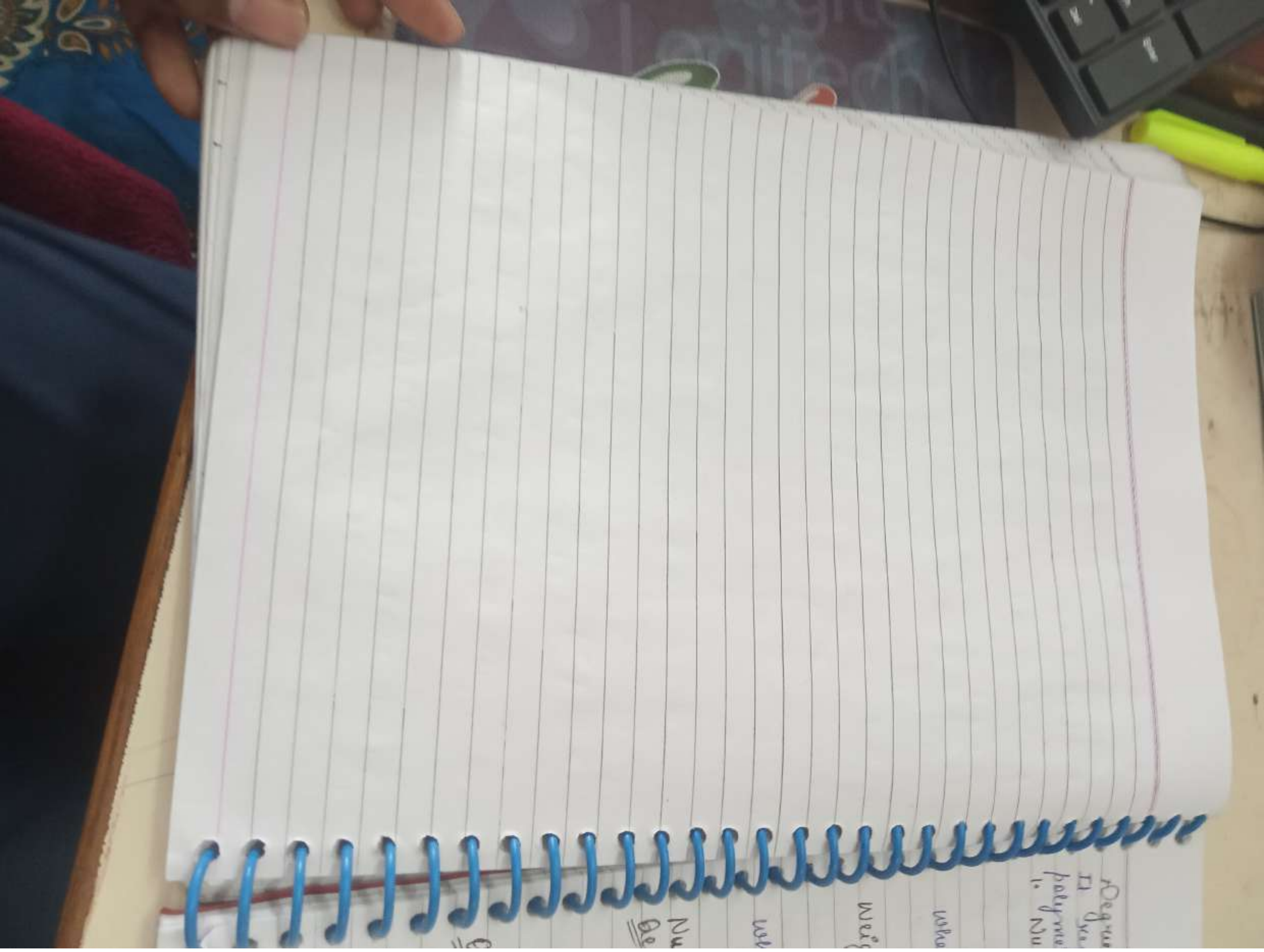
7) Polymethyl methacrylate (PMMA) Lucite | perspex | plexiglas

$$nCH_2 = \underset{COOCH_3}{\overset{CH_3}{C}} \xrightarrow{\text{polymerisation}} \left[CH_2 - \underset{COOCH_3}{\overset{CH_3}{C}}\right]_n$$

- It is hard and transparent
- Used in manufacture of air craft windows, TV screens because of its high clearity, it is used for making lenses and optical glass.

Chain growth polymer	Step Growth polymer
1. Addition polymer	1. condensation polymer
2. It requires the presence of double bond in monomer.	2. It requires two reactive functional group which are present at the both ends.
$H_2N-(CH_2)_6-NH_2$	
3. No biproduct formed.	3. Generally a biproduct is formed.
4. Homochain polymer generally a plastic thermo obtained	4. Generally a heterochain polymer either thermo plastic or thermosating polymer is obtained.





9/12/22

Degree of Polymerization

It represents average no. of monomer unit in a polymer chain, it is of two types.

1. Number average Degree of polymerization

$$\overline{DP_n} = \frac{\overline{M_n}}{M_0}$$

where, $\overline{M_n}$ = Number average molecular weight of polymer
M_0 = Molecular weight of the monomer

Weight average degree of polymerization

$$\overline{DP_w} = \frac{\overline{M_w}}{M_0}$$

where, $\overline{M_w}$ = weight average mole wt of polymer.
M_0 = Molecular weight of monomer.

Numerical

Qe If no. average molecular weight of
Cal number average degree of polymerization

$$\overline{DP_n} = \frac{\overline{M_n}}{M_0} = \frac{10^5}{104} = 961.4$$

Que Is if aver degree of polymethly
Cal its average molecular weight

$$\overline{DP_w} = \frac{\overline{M_w}}{M_0} = 10^3$$

$$\overline{DP_w} = \frac{\overline{M_w}}{M_0} =$$

$$\overline{M_w} = 10^5$$

Biodegradable Polymers

Biodegradable polymers are those polymers which are decomposed and aerobic and anaerobic conditions as results of action of the microorganisms like bacteria and fungi.

- Need for biodegradable polymers: the non biodegradable polymers are harmful for the environment because of following -
  1. Solid waste disposal problem.
  2. If we use non biodegradable polymer then marien pollution problem. Therefore to solve above problem there is an urgent need for the manufacturing of biodegrable polymers.
- Biodegrable polymers are of two types :-

1- Natural Biodegreable polymers
Natural rubber, lignin & collagen, Poly gammaglutamic acid

2- Synthetic Biodegreable polymers These are polyvinyl alcohol, ester polyamide esters, polyanhydrides, polylattic acid and Poly hydroxy PHBV etc.

Examples of biodegrable polymers and their preparation

- POLY-B-HYDROXY BUTYRATE CO-B-HYDROXY VALERATE it is a co-polymer of 3 hydroxy b and 3 hydroxy pentanoic acid in which the monomer unit are link by ester linkage.

Biodegradable Polymers

Biodegradable polymers are those polymers which are decomposed and aerobic and anaerobic conditions as results of action of the microorganisms like bacteria and fungi.

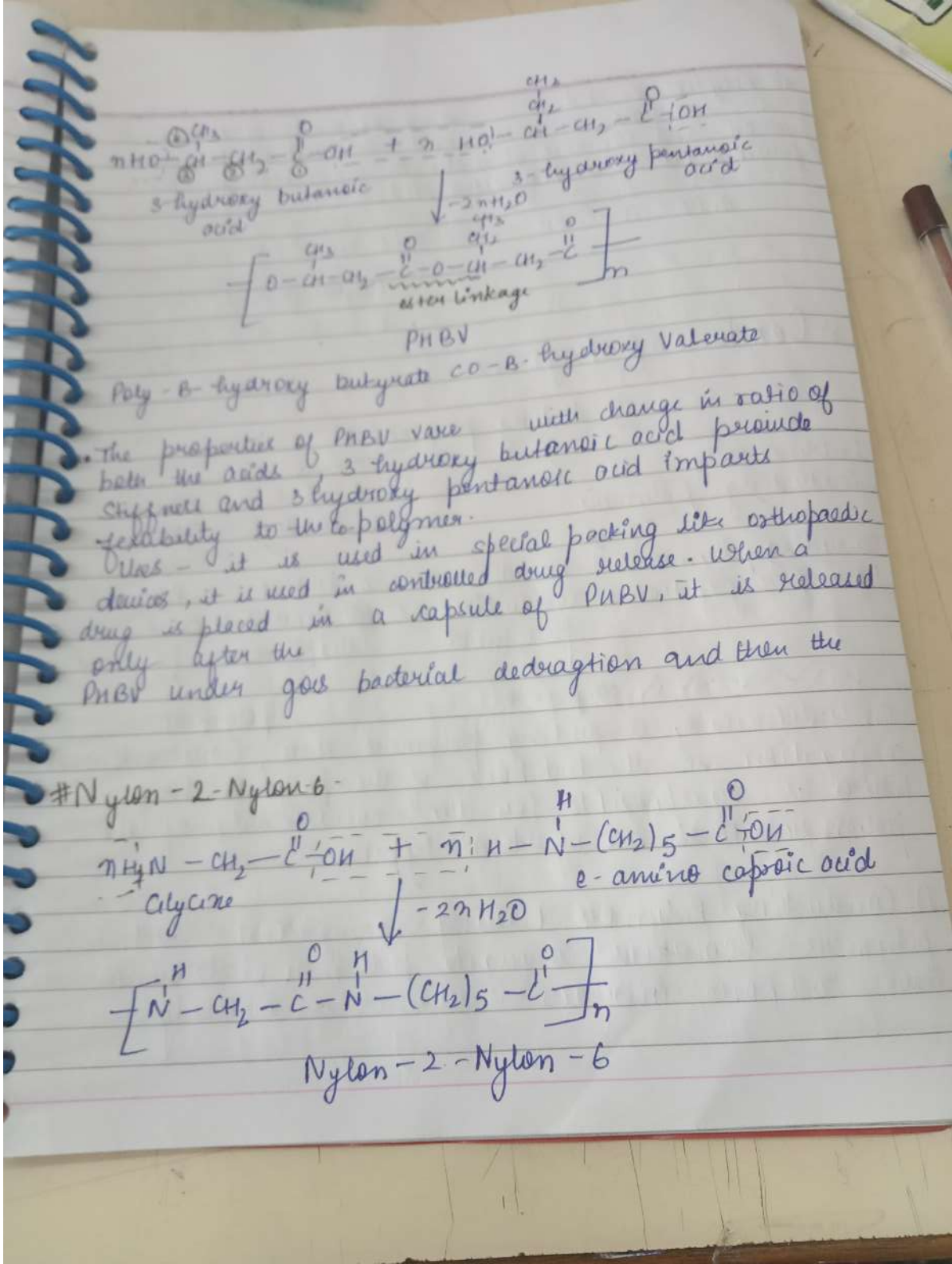
- Need for biodegradable polymers: the non biodegradable polymers are harmful for the environment because of following -
  1. Solid waste disposal problem.
  2. If we use non biodegradable polymer then marien pollution problem therefore to solve above problem there is an urgent need for the manufacturing of biodegrable polymers.
- Biodegrable polymers are of two types -

1- Natural Biodegreable polymers
Natural rubber, lignin & collagen, Poly gammaglutamic acid

2- Synthetic Bio degreable polymer These are polyvinyl alcohol, ester polyamide esters, polyanhydrides, polylattice acid and Poly hydroxy . PHBV etc.

Examples of biodegrable polymers and their preparation

- POLY-B-HYDROXY BUTYRATE CO-B-HYDROXY VALERATE it is a co-polymer of 3 hydroxy b and 3 hydroxy pentanoic acid in which the monomer unit are link by ester linkage.

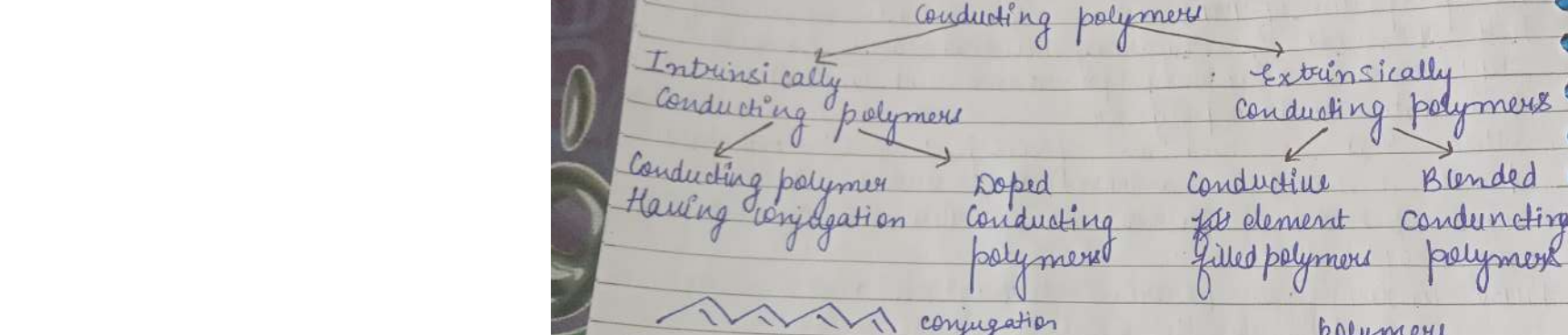

3-hydroxy butanoic acid
3-hydroxy pentanoic acid
-2nH2O
ester linkage
PHBV
Poly-B-hydroxy butyrate co-B-hydroxy Valerate
The properties of PHBV vary with change in ratio of both the acids 3 hydroxy butanoic acid provide Stiffness and 3 hydroxy pentanoic acid imparts flexibility to the co-polymer.
Uses - it is used in special packing like orthopaedic devices, it is used in controlled drug release. When a drug is placed in a capsule of PHBV, it is released only after the
PHBV undergoes bacterial degradation and then the
#Nylon-2-Nylon-6
Glycine
e-amino caproic acid
-2nH2O
Nylon-2-Nylon-6

#) Polylattic acid it is obtained by microbiological synthesis of lattice acid followed by polycondensation and removal of water to form biodegradable polymer called as polylattice acid.

Polylatic acid

12/12/22

#Conducting Polymers



conjugation

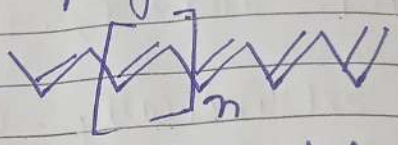
polymers

In intrinsically conducting polymers these have extensive conjugation in the backbone of the polymer chain which is responsible for the conductivity of the polymer. These are of two types.

1) Conducting Polymers Having Conjugation: Such polymers contains conjugated polymer electron in their backbone increases there conductivity

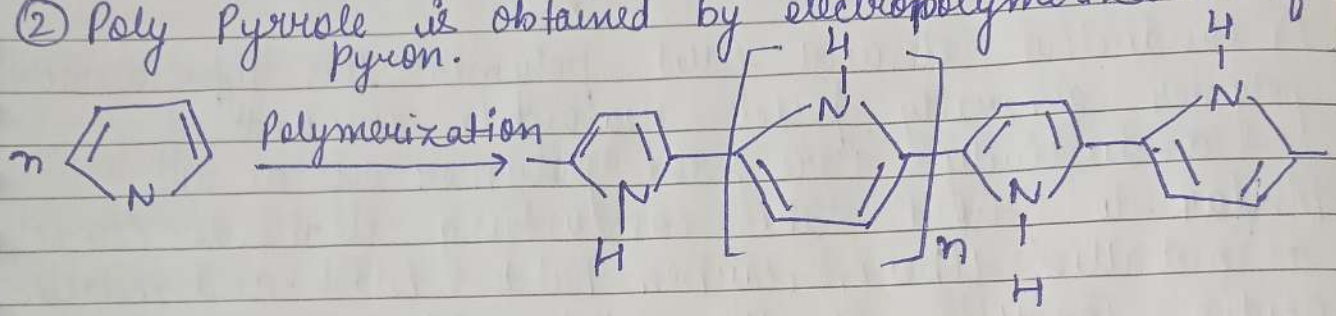
Presence of conjugate π electrons in a polymer is responsible for its conductivity

ex: ① Polyacetylene $nCH=CH \longrightarrow$



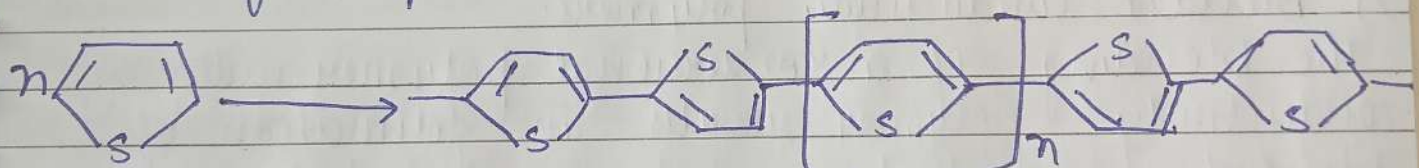
Trans-Polyacetylene

② Poly Pyrrole is obtained by electropolymerization of Pyrrole.



Poly-Pyrrole

③ Poly-Thiophene it is obtained by anodic oxidation of thiophene.



Poly thiopene

2) Doped Conducting Polymers these are obtained by a exposing a polymer of a charge agent in a gas phase or liquid or soln phase In general doping increases the surface conductivity of the polymers.

In ~~pure~~ polymers such as polya: possess low conductivity low ionisation and high electron affinities. There conductivity can be increase by a factor 10^{12} when they are doped with an electron donar such as alkali metals.

(N-doping). P doping done by an electron such as Asfs and I_2.

Extrinsically Conducting Polymers

This type of polymers impart conductivity due to presence of extrin externally added ingredient.

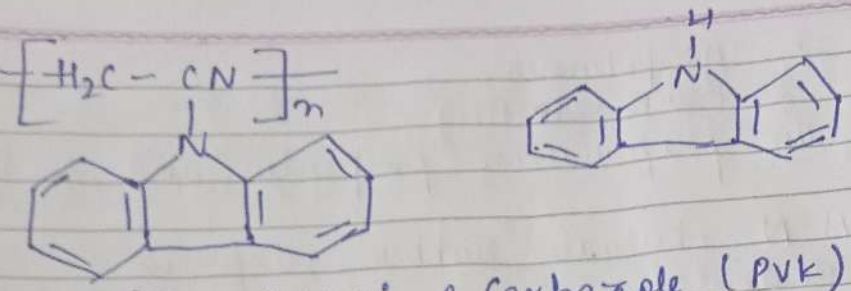
1) Conductive element filled polymer: this type conducting polymer generally posses reasonable amount of conductivity here, the polymer acts as the binder to hold the conducting elements. (such as metallic fibers, carbon batch / black and metallic oxidise. Together in the solid entity. These are usually low in cost, light in weight, mechanically sound and easily processable in different shapes, forms and sizes.

2) Blended Conductivity polymers.

The blending of a conventional polymer with a conductivity polymer results in formation of blended conducting polymer. These polymers possess better electrical, mechanical property and chemical these are easily processable.

3) Photoconductivity

Such polymers become conductive when illuminated in general photoconductivity can be caused to to ability to generate free charge carries (electron holes by the absorption of radiation. The most important photoconductivity polymer is Poly (-N- Vinyl carbazole) (PVk)



Poly - N - vinyl Carbazole (PVK)

Applications or Uses

1. These are used in anti radiation coating, electrochromatic windows and radar dishes.
2. There are used as anti static coating for clothing
3. Corrosion inhibitors.
4. Used in aleadyes bases on polyethene
5. Used in solar cells.
6. Used in smart windows and electro magnetic shielding for computer
7. Used in transistors
8. Used in making button type batteries.
9. These are long lasting and recharge able.

Que

① Classify the polymers on the basis of :-
1. Structure and shape
2. Mode of Synthesis
3. laticity or special arrangement

② Define graph polymer & block copolymer with ex!

③ Diff b/w the following
1. chain growth polymerization & step growth
2. ~~Ho~~

2 Homopolymer & co-polymer
3. Thermoplastic & thermosetting.
(4) Discuss of the preparation properties and structure of BUNA-S, BUNA-N, butyal-rubber, neoprene
(5) What are condensation polymers. Write preparation and structure and uses of following.
Nylon-6, Nylon 66, decron or terline, Kel
(6) Write the structure of natural rubber why there is a need of valcanized rubber.
(7) Disuss in detail about valacined of rubber. what are the benifits of valacined rubber
(8) What are Elastomers.
(9) Free radical polymerization Mechanicum
(10) Conducting polymers Describe in detail & there Application

Titrimetic Analysis

Titration is the process of adding the standard soln from the burette to the non volume of unknow soln, till the reaction is just complete.

Acid Base Titration:- in ABT the soln used are acid ankaline respectively these reaction involve neutralisation reaction i.e, the combination of OH^- and H^+ ion to form water. The proces of acid base titration is accompined by a the change in PH. The end point in these titration accurs at a definte PH value. Therefore substance which change colour acc to PH (indicators) are used to indicate the end point. Acid base

$K_3Fe(CN)_6$
Potassium ferric Cyanide

indicators are complex organic compounds, which have one in acid soln whereas, an all together different in basic soln or alkaline soln.

Redox Titration: the reduction and oxidation reaction take places simantenously i.e, one substance is oxidised and the other is reduced.

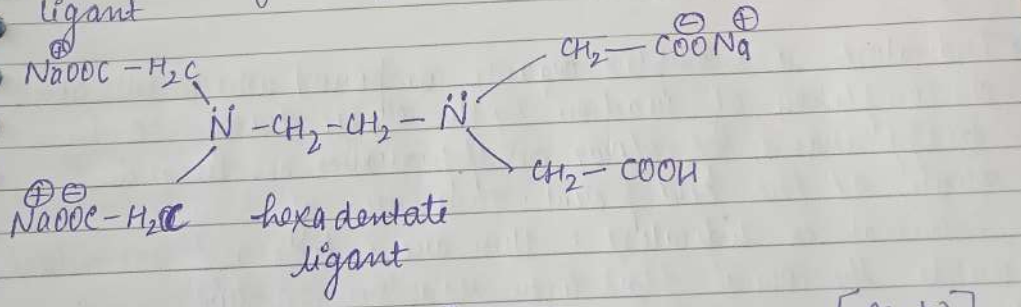
$Cr_2O_7^{-2} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$

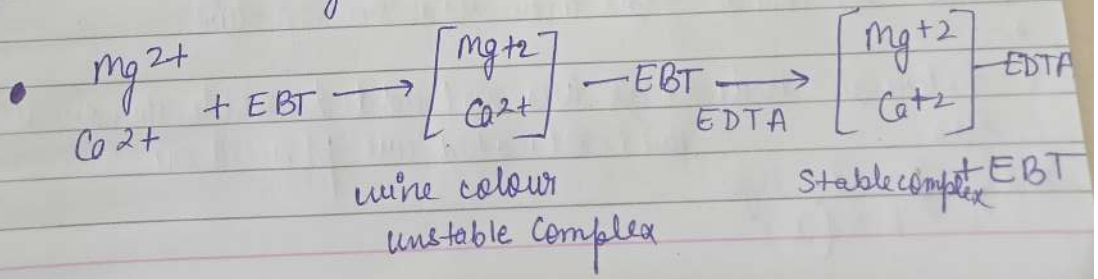
$Fe^{2+} \longrightarrow Fe^{3+} + 6e$

$Cr_2O_7^{-2} + 6Fe^{+2} + 14H^+ \longrightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

$K_3Fe(CN)_6$ external indicator

Complexometric titration: the titration in which the complex compound are formed are know as complexometric titration. These titrations are particularly used for the determination mixture of different ions in soln. In these type of titration chelating agent or complexometric agent are used. EDTA is generally used it has hexa ditatoned ligant





- Precipitation Titration in which precipitation take place know as precipitation titration in this titration generally silver nitrate is taken in burette sodium chloride KCl soln are taken in conical flask. The end point is indicated by the formation of sperging soluble salts along with colour change

$$AgNO_3 + NaCl \longrightarrow AgCl\downarrow + NaNO_3$$
$$2Ag + CrO_4^- \longrightarrow Ag_2CrO_4$$

less soluble → more soluble

$$Ag_2CrO_4 + 2Cl^- \longrightarrow AgCl\downarrow + CrO_4^{-2}$$
$$2AgNO_3 + K_2CrO_4 \longrightarrow Ag_2CrO_4\downarrow + 2KNO_3$$

- Titrant = the titrant is a soln used in the titration to determine the concn of an unknown soln the strength or concentration of the titration is known and it is taken to the burette.

- Tirant = it is taken in conical flask and the strength of tirant is not known.

- Indicators = is a complex organic compound which tells about the completion of reaction by the colour change i.e. by disappearance of colour or appearance or change in colour at the end point. There are of 3 types
1. Internal ~~ex~~ indicators : these are indicators are added inside the conical flask to the reaction mixture ex:
2. External indicators are not added inside the conical flask. this indicators are placed on and it glazed type ex: $K_3Fe(CN_6)$

• End point :the point at which reaction gets completed known as end point. It can be indicated by addition of indicator. the indicator changes the colour at the the end point.

BUNA-S
BUNA-N
Butyle Rubber
Nitrile