

Short Answer Collection

Year (2026-27)



Dr Brajesh yadav



Chemistry Department



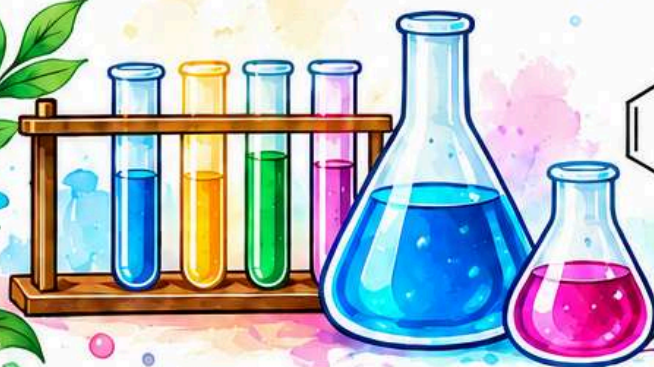
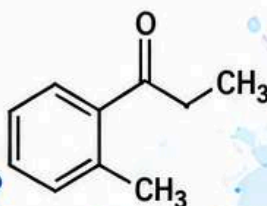
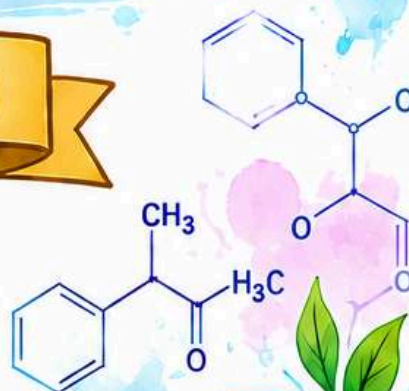
**Brahmavart p g college
mandhana kanpur (UP)**



B.Sc Fifth Semester



**Rearrangement and
Chemistry of Main Group Elements
Paper Code : B 02 05 02 T**



Q. Write the use of haemoglobin.

Answer: Haemoglobin is a respiratory pigment present in red blood cells. Its main use is to **transport oxygen** from the lungs to different parts of the body and a small amount of **carbon dioxide** from the tissues back to the lungs.

Structure of Haemoglobin

- Haemoglobin is a **metalloprotein** (respiratory pigment).
- Molecular weight $\approx 65,000$ RMM.
- It is made up of **4 haem** units and **4 globin** chains.

(4 haem + 4 globin)

[4 Fe^{2+} ions + 4 units of globular protein (globin)]

Haemoglobin $\Rightarrow$ Haem + Globin

* Each globin chain contains a polypeptide chain.

6%

94%

Non-protein part
(haem)

Protein part
(globular protein)
(globin)

2 α -chains

2 β -chains

Each chain contains
141 amino acids.

Each chain contains
146 amino acids.

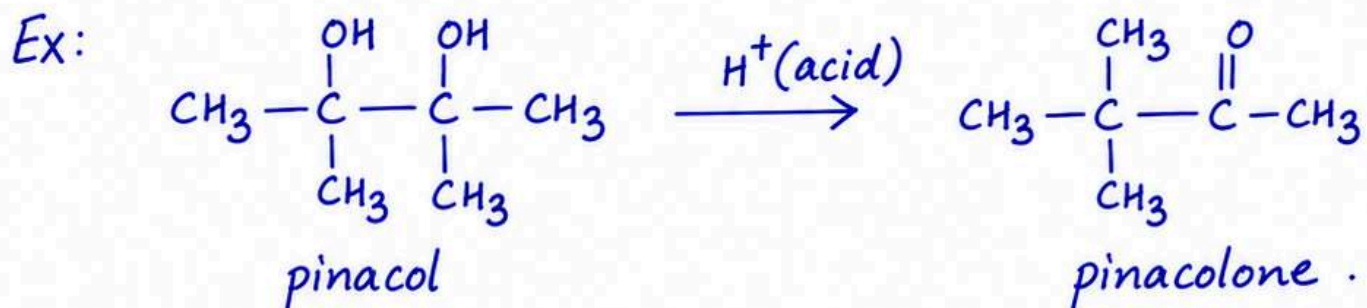
These chains are held together by **non-covalent interactions**.

QES 1.

Acid catalyzed rearrangement of glycol.

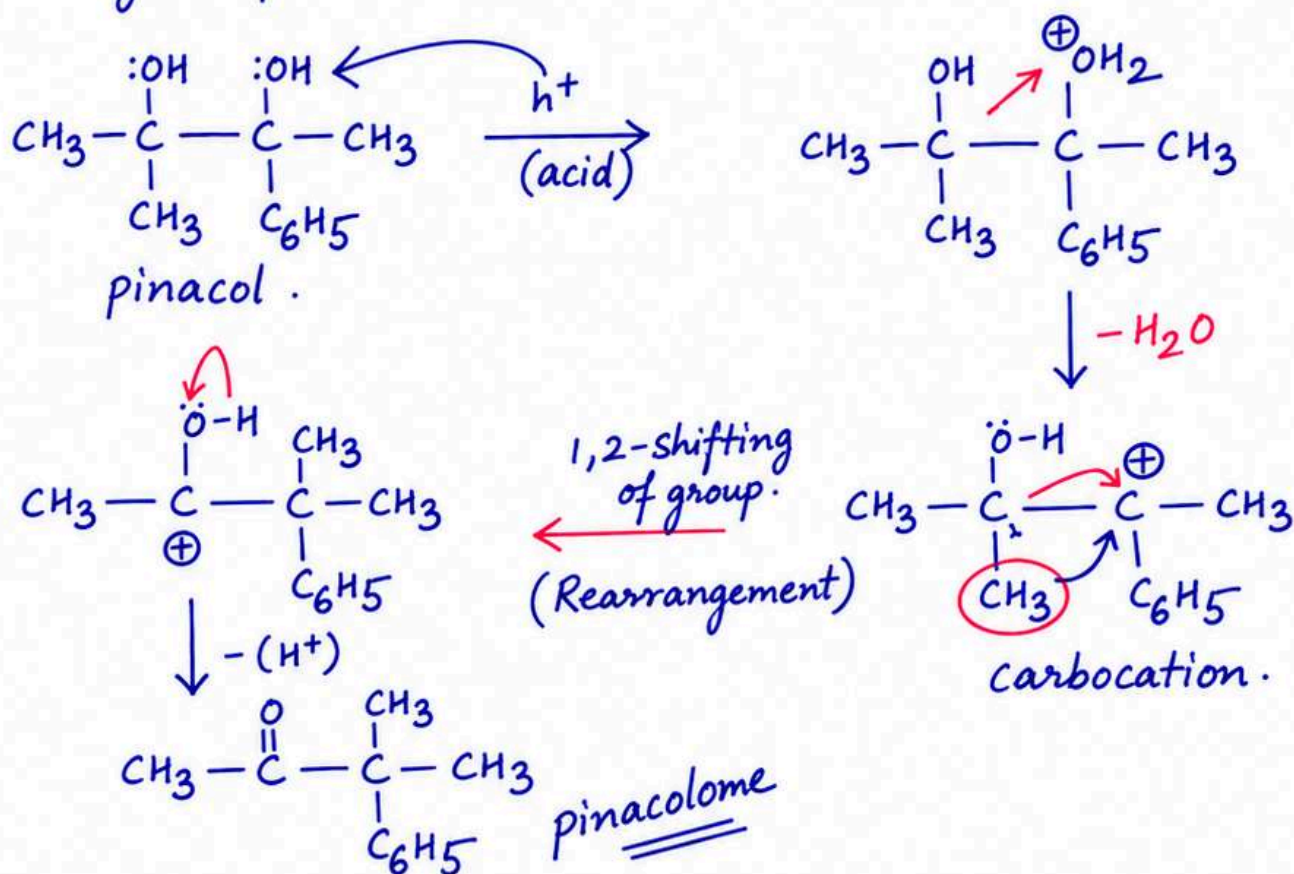
(Pinacol - Pinacolone Rearrangement) $\Rightarrow$

The Acid catalysed rearrangement of glycol produce a ketone, is called pinacol - pinacolone rearrangement



This Reaction have Two Steps —

- I) formation of more stable carbocation in 1st step.
- II) In Step 2nd, the rearrangement of carbocation/(1,2)shift to give product.



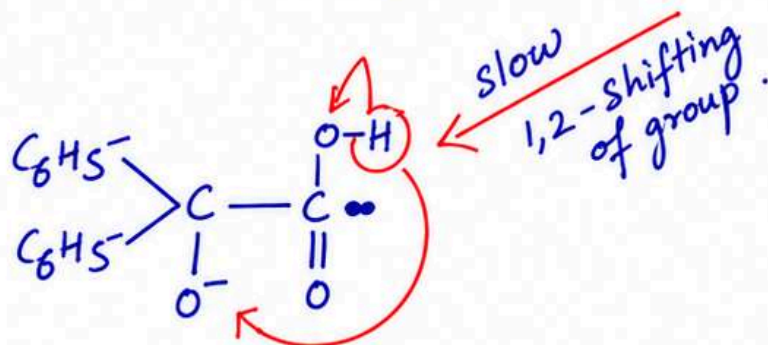
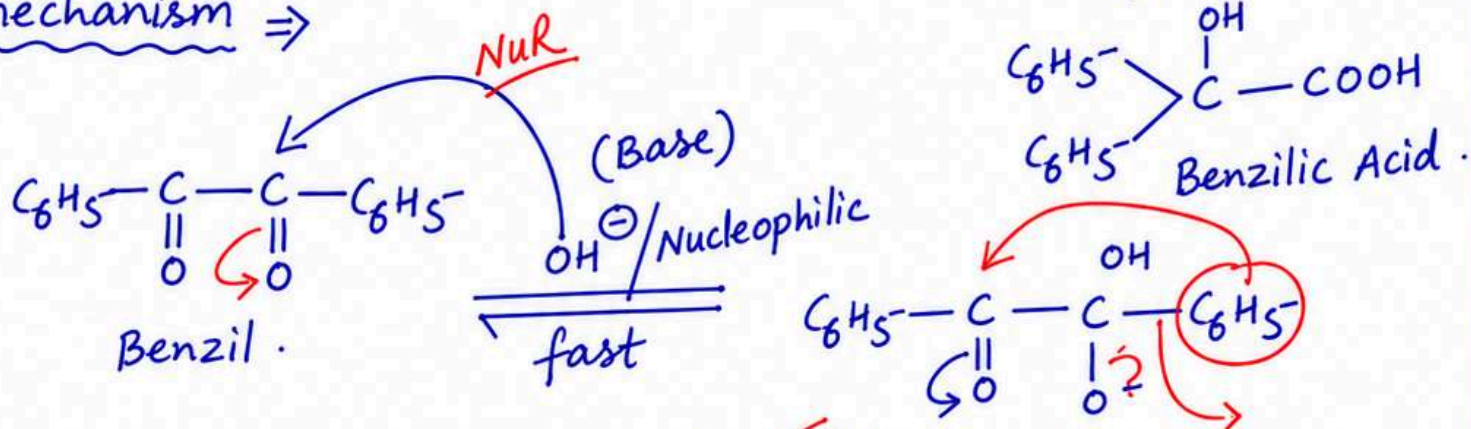
migration power : $\text{C}_6\text{H}_5 > \text{H} > \text{CH}_3 -$

QES 2. Benzil - Benzilic Acid Rearrangement $\Rightarrow$

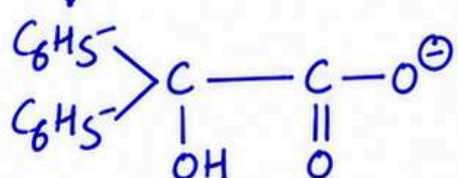
it is The Rearrangement Reaction of Benzil with KOH (Base) to Benzilic Acid. The reaction is given by 1,2-diketone. These 1,2-diketones can be Aliphatic / Aromatic. The product is an α -Hydroxy Carboxylic Acid.



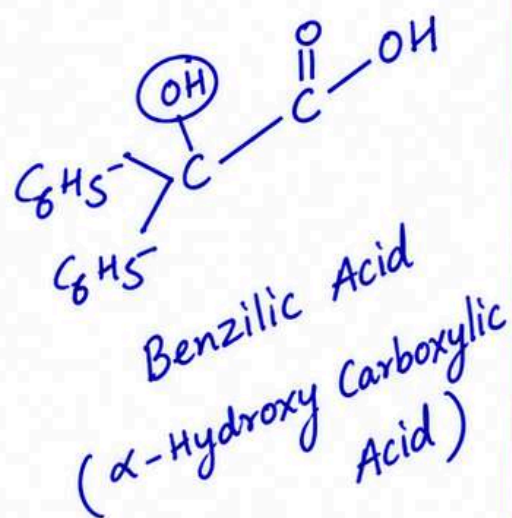
mechanism $\Rightarrow$



proton exchange

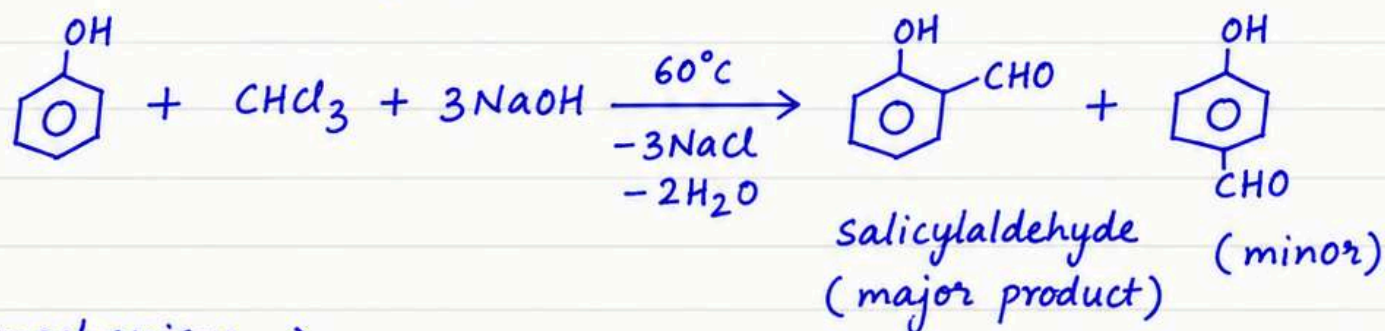


Acid $\text{H}^\oplus$



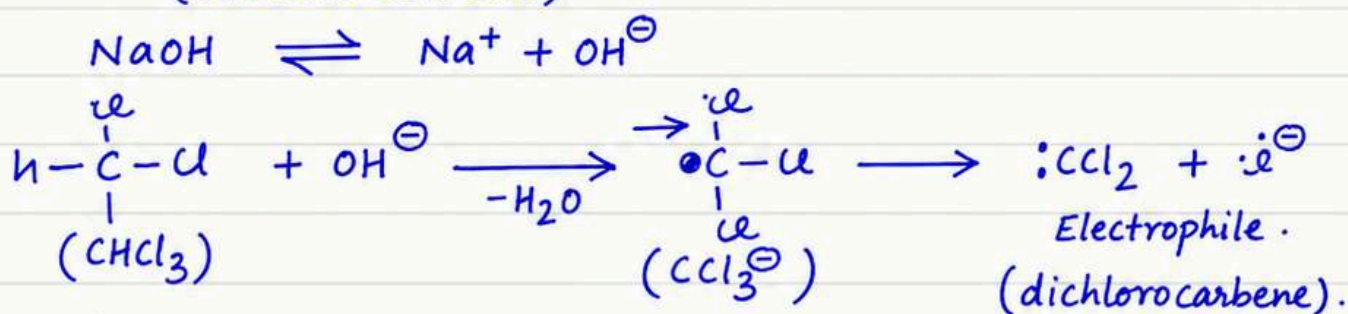
QES 3. Reimer - Tiemann Reaction $\Rightarrow$

When phenol is heated with chloroform and aqueous solution of Base at 60°C / $333\text{--}343\text{K}$ to give salicylaldehyde as the main product along with small amount of para Isomer.



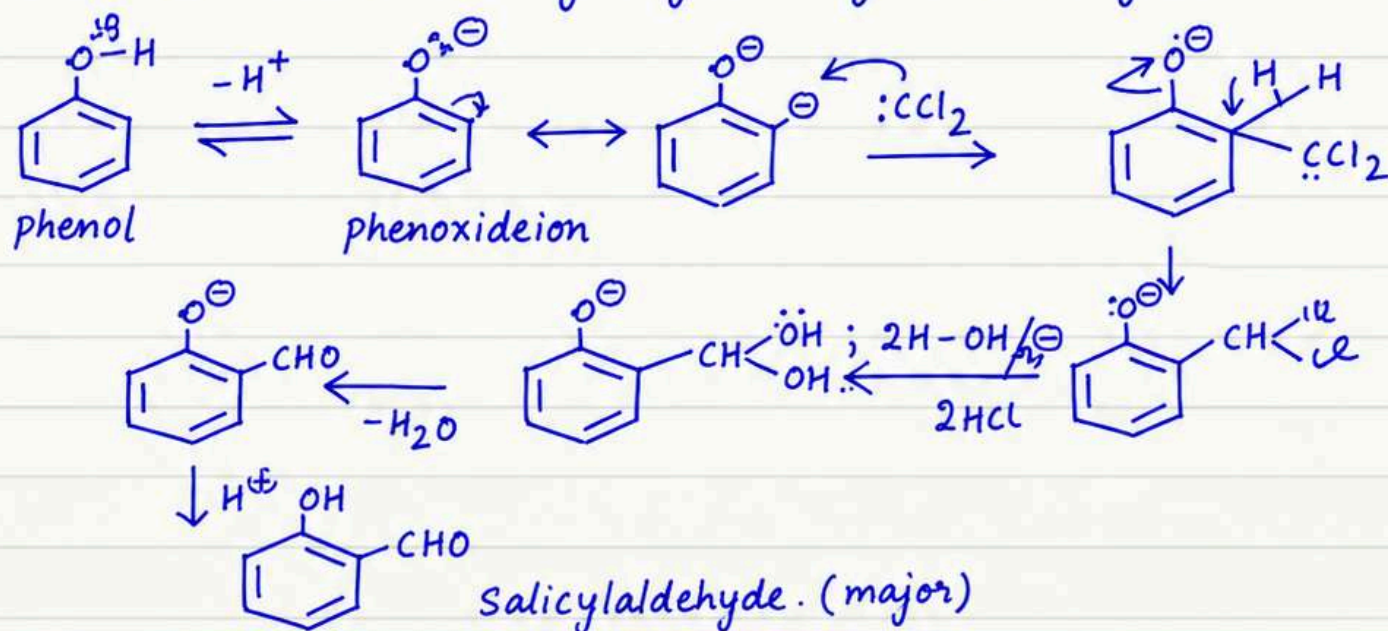
mechanism $\Rightarrow$

Step I $\Rightarrow$ Breaking of CHCl_3 with NaOH to give Electrophile. (dichlorocarbene).



Step II $\Rightarrow$

dichloro carbene attack on the phenoxide ion to form dichalide. which on hydrolysis to give aldehyde.



QES 4.

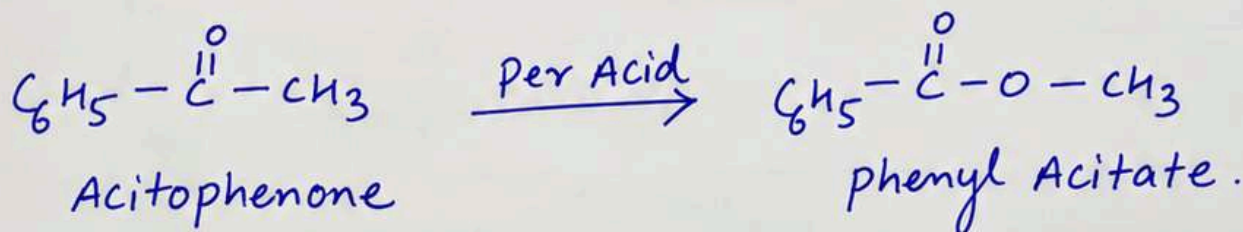
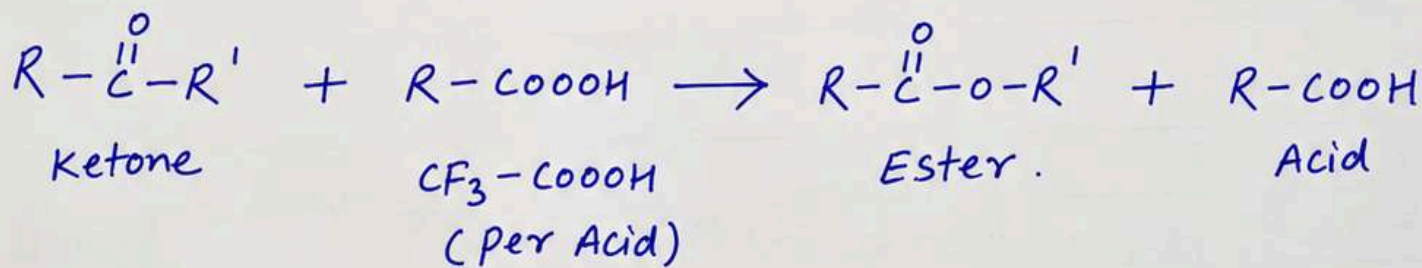
Write the mechanism of Baeyer-Villiger rearrangement

Baeyer - Villiger Rearrangement $\Rightarrow$

Baeyer - villiger oxidation $\Rightarrow$ } Given by Aliphatic/Aromatic
Ketone.

Aliphatic / Aromatic Ketone is oxidised to an Ester by Treating with Per Acid / H_2O_2 . This Reaction is called as Baeyer - Villiger oxidation of ketone.

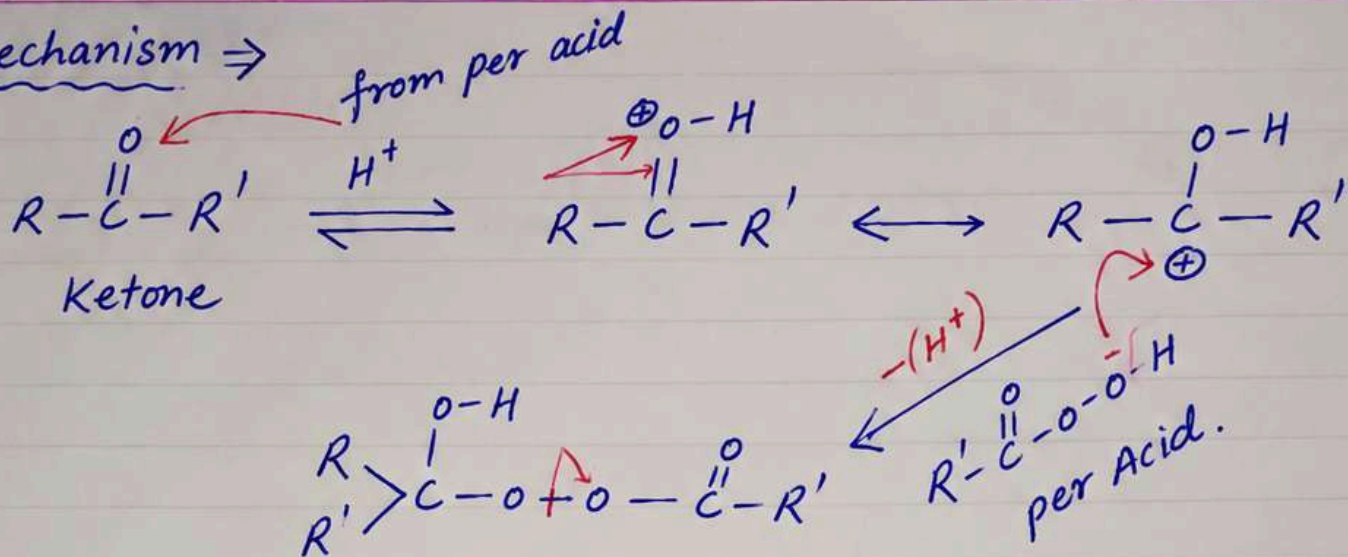
Ex:



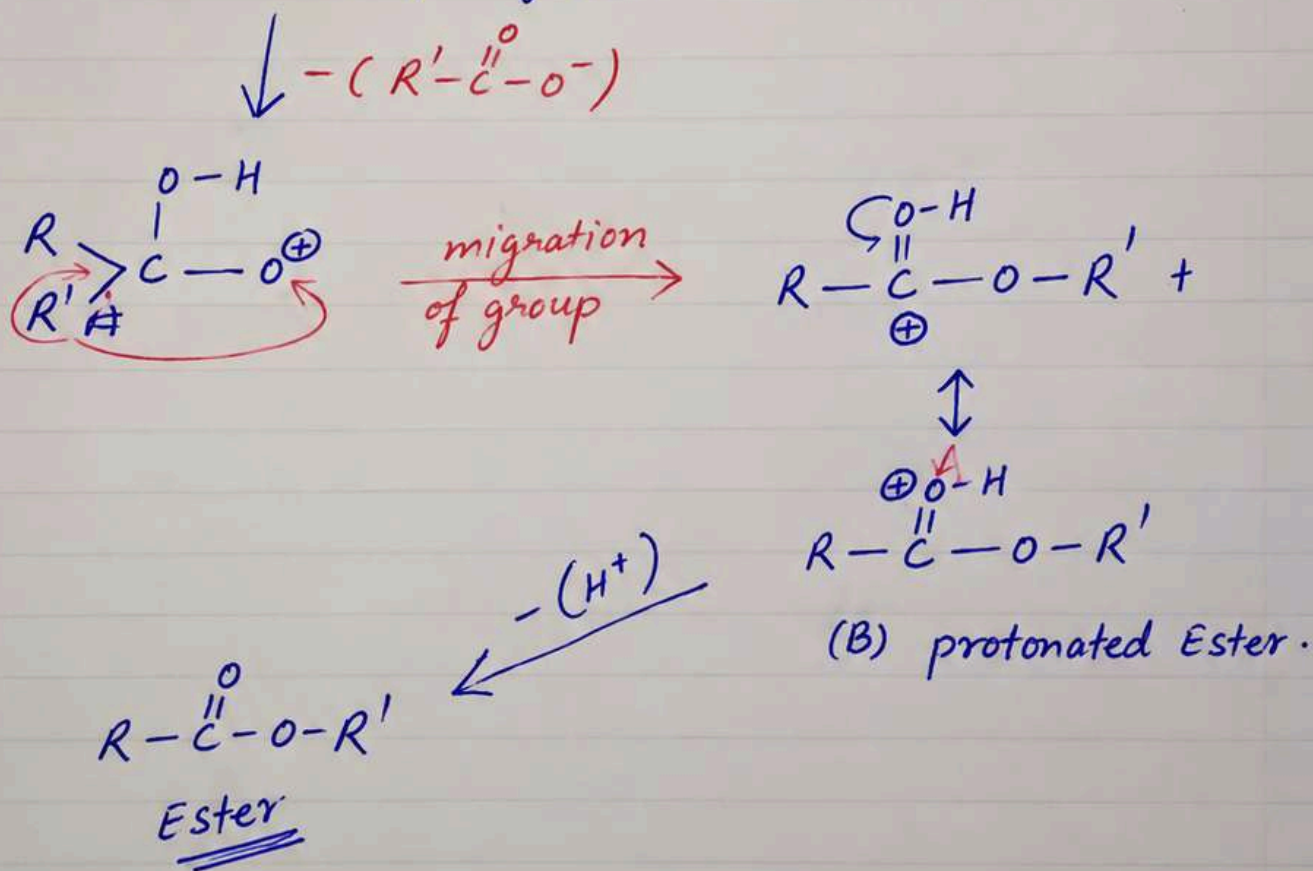
Note: The reagent used for this Reaction are m-CPBA.
(meta-chloroperoxybenzoic Acid) or Carro Acid.

ie. overall reaction is an Insertion of oxygen b/w The carbonyl group and adjacent carbon atom in ketone.

mechanism $\Rightarrow$



(A) peroxy Intermediate.



Note: ① The presence of +I group on the ketone & -I group on the per Acid. }

Increases the rate of reaction.

② In unsymmetrical ketone the group migrate which is more $\bar{e}$ donating. ie. $3^\circ > 2^\circ > 1^\circ > \text{methyl}$.

QES 5.

Write short note on nitrogen fixation.

Introduction : Nitrogen fixation is the process of conversion of atmospheric nitrogen (N_2) into simple inorganic compounds like ammonia (NH_3) or nitrates (NO_3^-) which can be utilized by plants and other living organisms. Atmospheric nitrogen is very stable due to the strong triple bond between the two nitrogen atoms, so it cannot be used directly by most organisms. Therefore, it must be fixed into a usable form.

Methods of nitrogen fixation :-

Nitrogen fixation occurs by three main methods :

① Biological nitrogen fixation :

- Carried out by certain microorganisms such as Rhizobium, Azotobacter, Clostridium and cyanobacteria (e.g. Anabaena, Nostoc).
- These bacteria contain an enzyme called nitrogenase which converts atmospheric nitrogen into ammonia.
- In leguminous plants, Rhizobium lives in root nodules and fixes nitrogen in association with the plant.

② Atmospheric (natural) nitrogen fixation :

- Occurs during thunderstorms and lightning.
- The high temperature and energy of lightning convert nitrogen and oxygen into nitrogen oxides (NO , NO_2) which are further converted into nitric acid (HNO_3) and finally into nitrates (NO_3^-) in the soil.

③ Industrial nitrogen fixation (Haber process) :

- Nitrogen reacts with hydrogen in the presence of iron catalyst at high temperature (about $450^\circ C$) and high pressure (about 200 atm) to form ammonia.

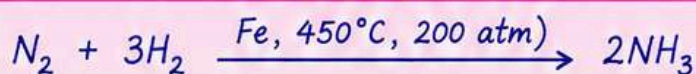
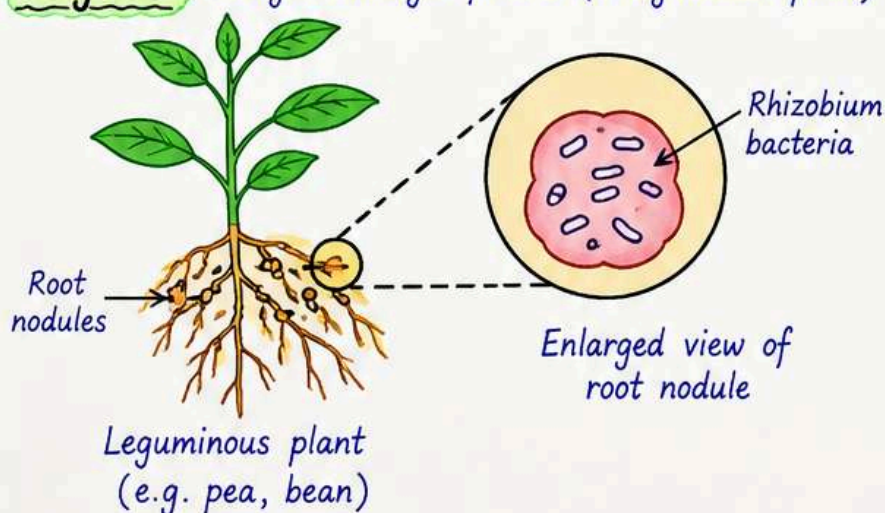


Diagram : Biological nitrogen fixation (in leguminous plant)



Importance :

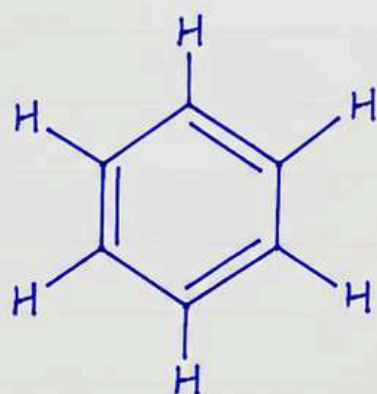
- Provides usable nitrogen compounds for plants.
- Maintains soil fertility and increases agricultural productivity.
- Essential for the synthesis of proteins, nucleic acids and other nitrogenous compounds in living organisms.
- Helps in maintaining the nitrogen cycle in nature.

QES 6. What is borazine? Give one method of its preparation.

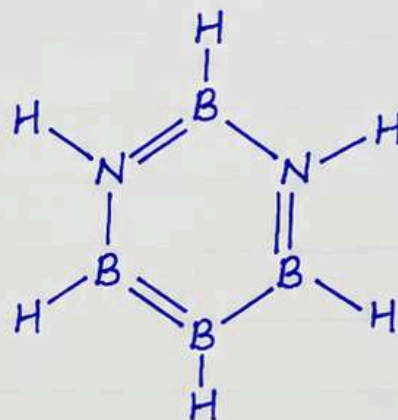
Borazine / Borazole / Inorganic benzene :-

Borazine is isoelectronic with benzene. Its some property are similar to that of benzene hence, it is called as Inorganic Benzene.

Its molecular formula is - $(B_3N_3H_6)$.



Benzene (C_6H_6)
(organic molecule)



Borazine
($B_3N_3H_6$) (Inorganic molecule)

Total e^- count $\Rightarrow$

$$6 \text{ C atom} = 6 \times 6 e^- = 36 e^-$$

$$6 \text{ H atom} = 6 \times 1 e^- = 6 e^-$$

$$\text{Total } e^- \Rightarrow 42 e^-$$

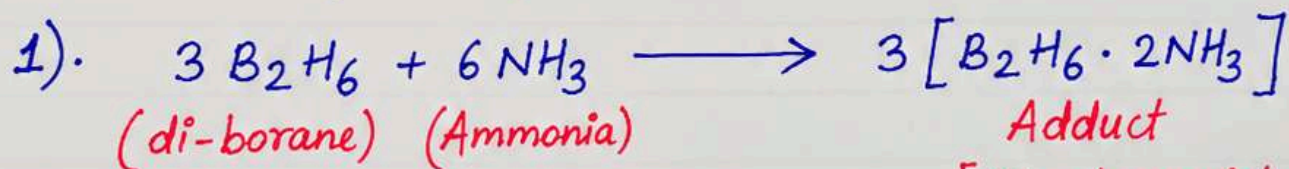
$$3 \text{ B - atom} = 3 \times 5 e^- = 15 e^-$$

$$3 \text{ N - atom} = 3 \times 7 e^- = 21 e^-$$

$$6 \text{ H - atom} = 6 \times 1 e^- = 6 e^-$$

$$\text{Total } e^- = 42 e^-$$

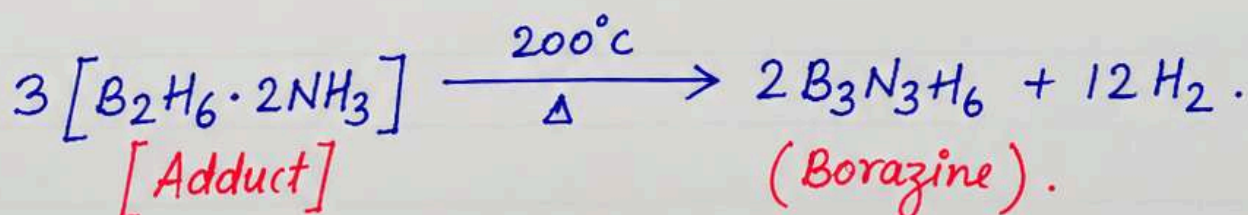
Preparation of Borazine :-



(di-borane) (Ammonia)

Adduct

[Di-Ammoniat di Borane]



[Adduct]

(Borazine).

QES 7.

Write the diagonal relationship of lithium with magnesium.

Diagonal relationship of Li with Mg :-

Li (IA group element) differs in many respect from the other members of its family. But it shows similarities with mg which is placed at the diagonal in the periodic table. As,

Groups $\Rightarrow$ Period $\downarrow$	IA	IIA	IIIA	IVA
2 nd	Li	Be	B	C
3 rd	Na	Mg	Al	Si

Li shows similarities with Mg as -

i). Both, Li & Mg have same atomic radii in the crystal as -
 $\text{Li}^+ = 1.34 \text{ \AA}$ $\text{Mg}^{2+} = 1.36 \text{ \AA}$

ii). The ionic radius of both, Li & Mg are also same as -
 $\text{Li}^+ = 0.60 \text{ \AA}$ $\text{Mg}^{2+} = 0.65 \text{ \AA}$

iii). The electronegativity of both Li & Mg are also same as -
 $\text{Li} = 1.0$ $\text{Mg} = 1.2$

iv). Both Li & Mg have same electro +ve character.

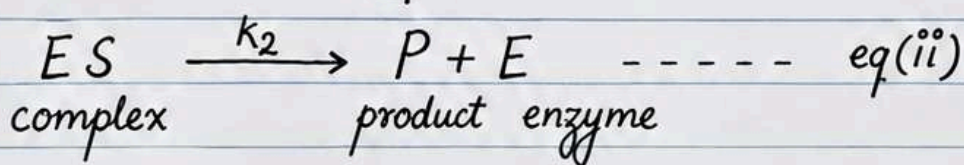
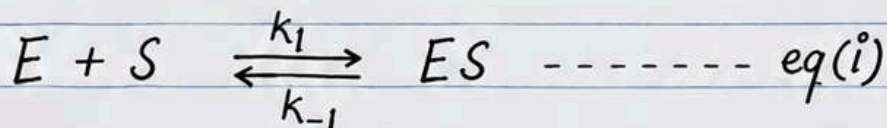
v). Both Li & Mg are hard metals.

Question No. 8.

Kinetic Of Enzymatic Rxn Or Michaelis-Menten Equation or Michaelis-Menton constant :-

The theory of enzyme catalysed rxn. was proposed by Michaelis and Menton is based on the assumption-

“The enzyme & substrate (reactant) react together to form a (enzyme-substrate) complex by the reversible rxn which is then converted into product with rate constant k_2 ”



∴ The step 2nd is rate determining step.

$$\begin{aligned} \therefore \text{Rate of rxn } (r) &= k_2 [\text{Reactant}] \\ r &= k_2 [ES] \text{ ----- eq(iii).} \end{aligned}$$

According to the steady state approximation, the rate of formation and decomposition of intermediate complex $[ES]$ is —

i.e. change of concentration of $[ES]$ with respect to time $[t]$ is —

$$\therefore \frac{d[ES]}{dt} = k_1 [E][S] - k_{-1} [ES] - k_2 [ES] \text{ ----- eq(iv)}$$

∴ Since, $E_0 =$ Total Enzyme concentration.

$$E_0 = E + ES \text{ ----- eq (v).}$$

where, $E =$ Enzyme present in free state.

$E_S =$ Enzyme present in free state with substrate.

$$\therefore E = E_0 - E_s$$

put in eq (v).

$$\begin{aligned} \frac{d[ES]}{dt} &= k_1 [E_0 - E_s][S] - k_{-1} [ES] - k_2 [ES] \\ &= k_1 [E_0][S] - k_1 [ES][S] - k_{-1} [ES] - k_2 [ES] \end{aligned}$$

----- eq (vi).

At steady state:-

The rate of formation and decomposition of $[ES]$ is 0.
i.e. $\frac{d[ES]}{dt} = 0$.

put in eq (vi).

$$k_1 [E_0][S] - k_1 [ES][S] - k_{-1} [ES] - k_2 [ES] = 0 \text{ ----- eq (vii)}$$

$$k_1 [E_0][S] = k_1 [ES][S] + k_{-1} [ES] + k_2 [ES]$$

$$k_1 [E_0][S] = [ES] \left\{ k_1 [S] + k_{-1} + k_2 \right\}$$

$$[ES] = \frac{k_1 [E_0][S]}{k_1 [S] + k_{-1} + k_2}$$

put in eq (iii).

$$r = k_2 \left\{ \frac{k_1 [E_0][S]}{k_1 [S] + k_{-1} + k_2} \right\}$$

$$r = \frac{k_1 k_2 [E_0][S]}{k_1 \left\{ [S] + \frac{k_{-1}}{k_1} + \frac{k_2}{k_1} \right\}}$$

$$r = \frac{k_2 [E_0][S]}{[S] + \left\{ \frac{k_{-1} + k_2}{k_1} \right\}} \text{ ----- eq (viii).}$$

$$r = \frac{k_2 [E_0][S]}{[S] + k_m}$$

where, $k_m = \frac{k_{-1} + k_2}{k_1}$

This k_m is known as Michaelis-Menten constant.

Question No. 9.

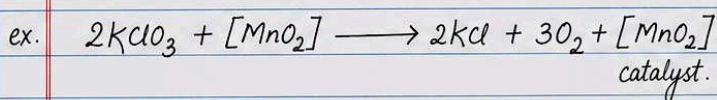
Explain the catalyst and type of catalyst with example.

Catalyst

A catalyst is a substance which change the rate of chemical reaction without itself undergoing any chemical change and this phenomenon is called catalyst.

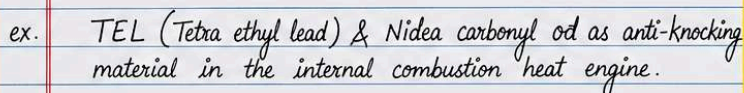
Types Of Catalyst :-

1. Positive catalyst :- These substance which increases the rate of chemical rxn without itself undergoing any chemical change, are called (+ve) catalyst & the process is called (+ve) catalyst.

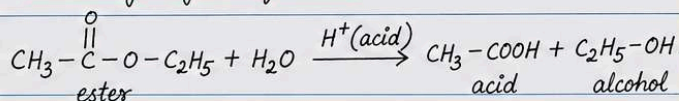


2. Negative catalyst / Anti catalyst / Inhibitor :-

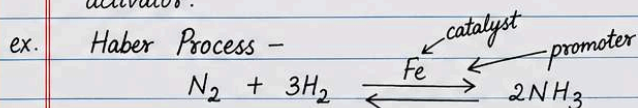
Those substance which decreases the rate of chemical rxn without itself undergoing any chemical change, are called (-ve) catalyst & the process is called (-ve) catalyst.



3. Auto-catalyst :- Sometimes it is observed that the rate of chemical rxn increases suddenly as the rxn proceed in which the product formed during the rxn, od as catalyst. Such substances are called auto-catalyst.



4. Catalytic Promoter :- Those substance which itself are not catalyst but to increase rat of chemical rxn. are called catalyst promoter/ activator.



Question No. 10.

What are carbides? Write the preparation of different type of carbides.

CARBIDES :-

The binary compounds of carbon with more electropositive elements, are called carbides. Hence, the carbides of N, S, P & Halogen are excluded from this class.

ex:- CaC_2 , Be_2C , Al_4C_3 , Mg_2C_3 ----- etc.

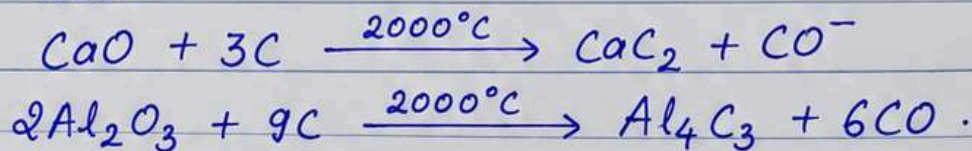
Types of carbide :-

On the basis of linkage,
carbide are of 4 type -

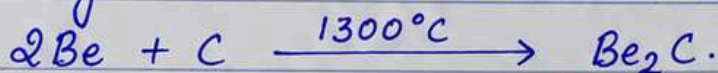
- (i) Ionic / salt type carbide
- (ii) covalent carbide
- (iii) metallic carbides
- (iv) intermediate carbides.

Preparation :-

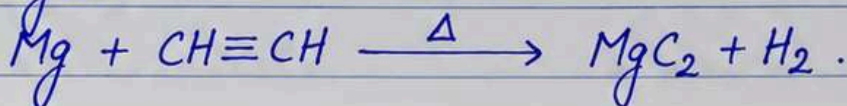
- (i) By heating oxide of the metals with carbon at red heat.



- (ii) By heating metal with carbon.



- (iii) By heating metal with hydrocarbon as ethylene or Acetylene.



Question No. 11.

What are fullerenes? and write the characteristic of C_{60} fullerene.

Fullerenes :-

Carbon has two allotropes namely diamond and graphite. But there are many other form of carbon like active carbon, black carbon, nano-tubules, fibres, carbon black, nano-beads, fullerenes, etc.

Diamond has carbon-atom with sp^3 -hybridization Graphite has sp^2 -hybridization. whereas fullerenes contain C-atom. with varying ratio of sp^3 & sp^2 -hybridization. Now a-day, C_{60} , C_{70} & higher fullerenes have been reported.

Structure of C_{60} :-

In C_{60} , it is observed that 60 C-atom form a ring in which mainly sp^3 & sp^2 -hybridization. The shape of C_{60} fullerenes is just like the football of, with 60 C-atom form 20 hexagonal and 12 pentagonal rings.

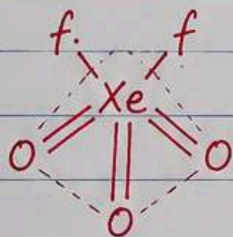
Characteristics of C_{60} :-

- (i) It is also known as buckminster fullerene.
- (ii) It is mustard coloured solids.
- (iii) It is generally soluble in organic solvent.
- (iv) It is extremely hard material and does not break easily.
- (v) Its molecule is circular in which 60 carbon atom are held together.
- (vi) It is neutral and can move freely at a rate of 10^9 cm per second.
- (vii) It becomes harder than diamond when compressed about 70%.
- (viii) It decomposes to form another molecule having atomic weight less than carbon.

Question No. 12.

Write the structure of oxyfluorides of xenon.

Xenon (xenic) Fluoride (XeO_3)



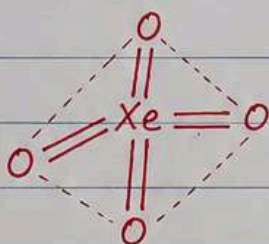
$(3\sigma + 3\pi)$ Bond + 1lp

Hybridisation - $3\sigma + 1\text{lp} \rightarrow sp^3$

Geometry - Tetrahedral

shape - Trigonal Pyramidal

Xenon Tetraoxide (XeO_4)

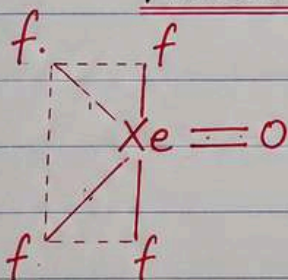


Hybridisation - $4\sigma + 0\text{lp} \rightarrow sp^3$

Geometry - Tetrahedral

shape - Tetrahedral.

Xenon Oxydifluoride (XeOF_2)

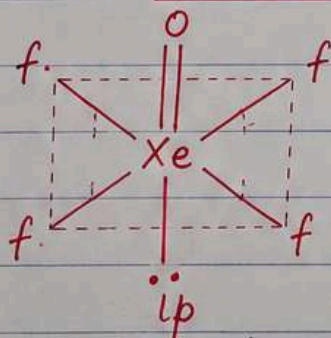


Hybridisation - $(3\sigma + 2\text{lp}) \rightarrow sp^3d$

Geometry - Trigonal Bipyramidal

shape - T-shape.

Xenon Oxytetrafluoride (XeOF_4)

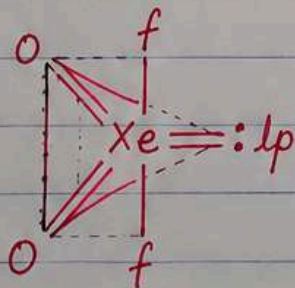


Hybridisation - $(5\sigma + 1\text{lp}) \rightarrow sp^3d^2$

Geometry - Octahedral

shape - square pyramidal

Xenon d'ory difluoride (XeO_2F_2)

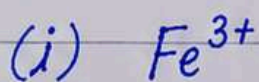


Hybridisation - $(4\sigma + 1\text{lp}) \rightarrow sp^3d$

Geometry - Trigonal Bipyramidal.

Question No. 13.

Calculate in Bohr magneton the expected magnetic moment for the following ions (spin magnetic moment):



Solution. Spin magnetic moment is given as :

$$\mu = \sqrt{n(n+2)} \text{ B.M.}$$

where n is number of unpaired electrons.

(i) For Fe^{3+} : $[\text{Ar}] 3d^5$ No. of unpaired electrons = 5

$$\mu = \sqrt{5(5+2)} = \sqrt{35} = 5.96 \text{ B.M.}$$

(ii) For Ni^{2+} : $[\text{Ar}] 3d^8$ No. of unpaired electrons = 2

$$\mu = \sqrt{2(2+2)} = 2\sqrt{2} = 2.828 \text{ B.M.}$$

(iii) For Cu^+ : $[\text{Ar}] 3d^{10}$ No. of unpaired electrons = 0

$$\mu = 0$$

Question No. 14.

Calculate the magnetic moment (expected from spin only) for the following ions: Cr^{3+} , Fe^{3+} , Cu^{+} ;

(ii) Which of the above ions do you expect to be coloured and why?

Solution. (i) Cr^{3+} : $[\text{Ar}] 3d^3$

No. of unpaired electrons = 3, substituting values in the spin-only formula,

$$\mu = \sqrt{3(3+2)} = \sqrt{15} = 3.86 \text{ B.M.}$$

(ii) Fe^{3+} : $[\text{Ar}] 3d^5$

No. of unpaired electrons = 5, substituting the values in the spin-only formula,

$$\mu = \sqrt{5(5+2)} = \sqrt{35} = 5.96 \text{ B.M.}$$

(iii) Cu^{+} : $[\text{Ar}] 3d^{10}$

No. of unpaired electrons = 0

$$\mu = 0$$

(ii) Cr^{3+} and Fe^{3+} are coloured because they have unfilled d-subshell.

Question No. 15.

Calculate in Bohr magneton the expected magnetic moment for Mn^{2+} ion (μ spin only).

Solution. Spin magnetic moment is given by the relation:

$$\mu = \sqrt{n(n+2)} \text{ B.M.}$$

where n is the number of unpaired electrons.

Mn^{2+} : $3d^5$

No. of unpaired electrons = 5.

$$\mu = \sqrt{5(5+2)} = \sqrt{35} = 5.96 \text{ B.M.}$$

Question No. 15.

Write the outer electronic configuration of $3d$ transition series elements.

Solution. The $3d$ transition series elements are from Sc ($Z = 21$) to Zn ($Z = 30$). Their outer electronic configurations are as follows :

Atomic number (Z)	Element	Outer electronic configuration
21	Sc	$3d^1 4s^2$
22	Ti	$3d^2 4s^2$
23	V	$3d^3 4s^2$
24	Cr	$3d^5 4s^1$
25	Mn	$3d^5 4s^2$
26	Fe	$3d^6 4s^2$
27	Co	$3d^7 4s^2$
28	Ni	$3d^8 4s^2$
29	Cu	$3d^{10} 4s^1$
30	Zn	$3d^{10} 4s^2$

Question No. 16.

Write the outer electronic configuration of 4d series and 5d series.

Solution. The 4d series elements are from Y ($Z = 39$) to Cd ($Z = 48$). Their outer electronic configurations are as follows :

Atomic number (Z)	39	40	41	42	43	44	45	46	47	48
Element	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
Outer electronic configuration	$4d^1 5s^2$	$4d^2 5s^2$	$4d^4 5s^1$	$4d^5 5s^1$	$4d^5 5s^2$	$4d^7 5s^1$	$4d^8 5s^1$	$4d^{10} 5s^0$	$4d^{10} 5s^1$	$4d^{10} 5s^2$

The 5d series elements are from La ($Z = 57$) to Hg ($Z = 80$). Their outer electronic configurations are as follows :

Atomic number (Z)	57	72	73	74	75	76	77	78	79	80
Element	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg
Outer electronic configuration	$5d^1 6s^2$	$5d^2 6s^2$	$5d^3 6s^2$	$5d^4 6s^2$	$5d^5 6s^2$	$5d^6 6s^2$	$5d^7 6s^2$	$5d^9 6s^1$	$5d^{10} 6s^1$	$5d^{10} 6s^2$

Question No. 18.

Explain why transition elements show variable oxidation state.

"Most of the transition elements exhibit variable oxidation state".

This unique property is due to the fact that —

- Since the energy of $(n-1)$ d-orbital is approx. equal to the energy ns-orbital. $\therefore$ electron can remove from $(n-1)$ d-orbital as easily as ns orbital.
- After removing of (ns) electron, the remaining core/ferral is unstable. Hence it can remove one or more electrons from $(n-1)$ d-orbital.
- A variable no. of $(n-1)$ d electrons are used for the complex formation.

<u>Symbol.</u>	<u>Oxidation state</u>
Sc - 21	+2, +3
Ti - 22	+2, +3, +4
V - 23	+2, +3, +4, +5
Cr - 24	+1, +2, +3, +4, +5, +6
Mn - 25	+2, +3, +4, +5, +6, +7
Fe - 26	+2, +3, +4, +5, +6
Co - 27	+2, +3, +4, +5
Ni - 28	+2, +3, +4
Cu - 29	+1, +2
Zn - 30	+2

Question No. 19.

Explain the lanthanoid contraction.

- iii) Ionic Radii : — The value of ionic radii of lanthanides +3 ions (Ln^{3+}), ions decreases continuously from Ce^{3+} to Lu^{3+} .

Ln^{3+} ions	Ionic radii of Ln^{3+} ions ($\text{\AA}$)
La^{3+}	1.06 $\text{\AA}$
Ce^{3+}	1.03 $\text{\AA}$
Pr^{3+}	1.01 $\text{\AA}$
Nd^{3+}	1.000 $\text{\AA}$
Pm^{3+}	0.98 $\text{\AA}$
Sm^{3+}	0.96 $\text{\AA}$
Eu^{3+}	0.95 $\text{\AA}$
Gd^{3+}	0.94 $\text{\AA}$
Tb^{3+}	0.92 $\text{\AA}$
Dy^{3+}	0.91 $\text{\AA}$
Ho^{3+}	0.89 $\text{\AA}$
Er^{3+}	0.88 $\text{\AA}$
Tm^{3+}	0.87 $\text{\AA}$
Yb^{3+}	0.86 $\text{\AA}$
Lu^{3+}	0.85 $\text{\AA}$

size decreases

This continuous decrease in the atomic/ionic radii, is called lanthanide contraction.

Cause of Lanthanide contraction : —.

- (i) In the lanthanide series, the lanthanide contraction increases as the atomic no./no. of proton increases while the additional electron would enter into 4f orbital but not in the valence shell (6s). Hence, the extra electron has not participated in increasing of ionic size.

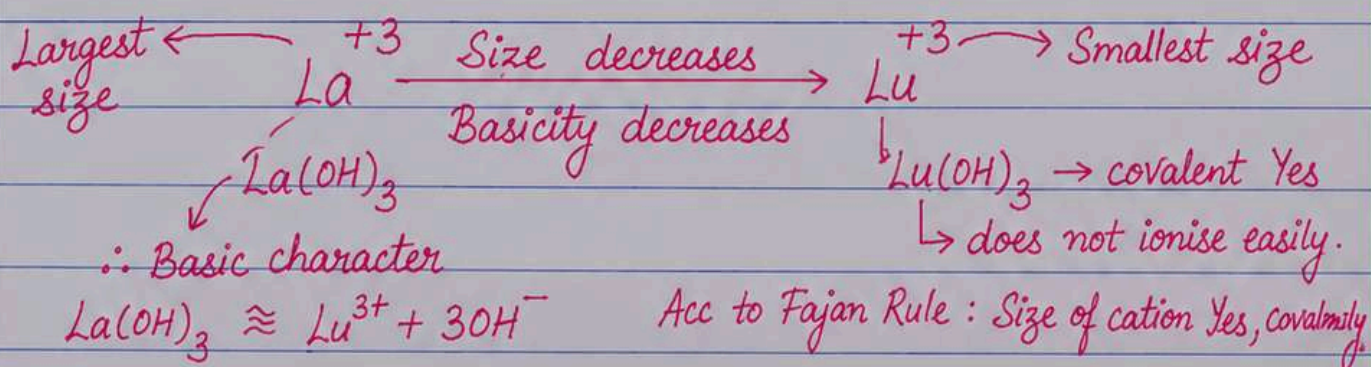
Question No. 21.

Explain why $\text{La}(\text{OH})_3$ is most basic
what $\text{Lu}(\text{OH})_3$ is least basic ?

Ans. Since the chemical property of an element or ion depend on the size of atom/ion i.e. greater the size of atom/ion, greater will be easy with which e^- are lost and hence, greater will be the basicity.

Basicity $\propto$ size of atom/ion.

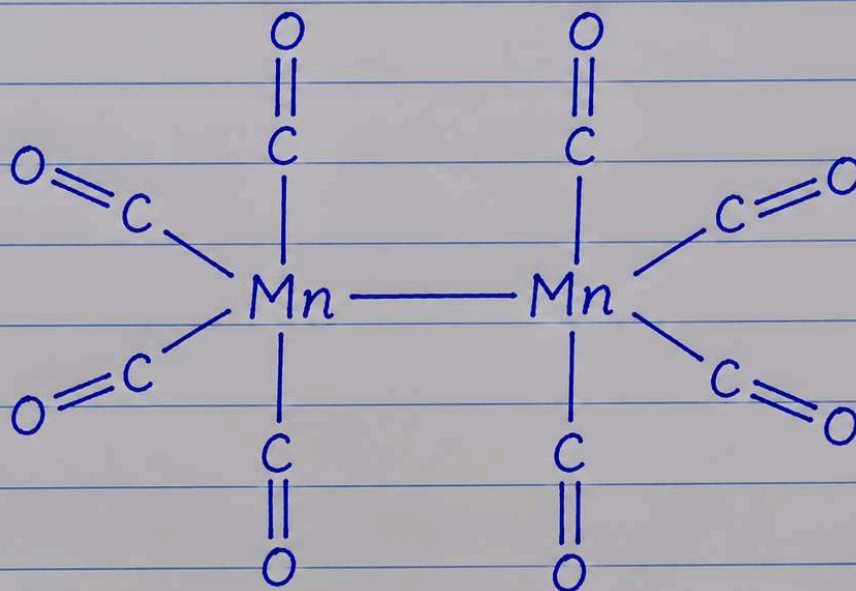
Therefore, In lanthanide series on moving from La to Lu the size of ion decreases due to lanthanide contraction $\therefore$, the basicity of ions decreases from La to Lu. Hence, $\text{La}(\text{OH})_3$ or La_2O_3 is most basic while $\text{Lu}(\text{OH})_3$ or Lu_2O_3 are least basic



Question No. 23.

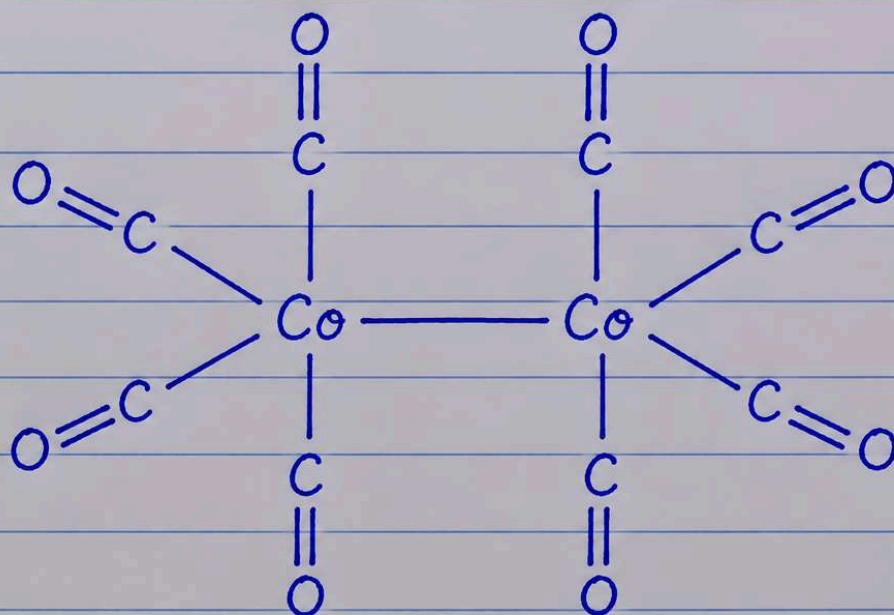
Draw the structure of Mn_2CO_{10} .

Ans.

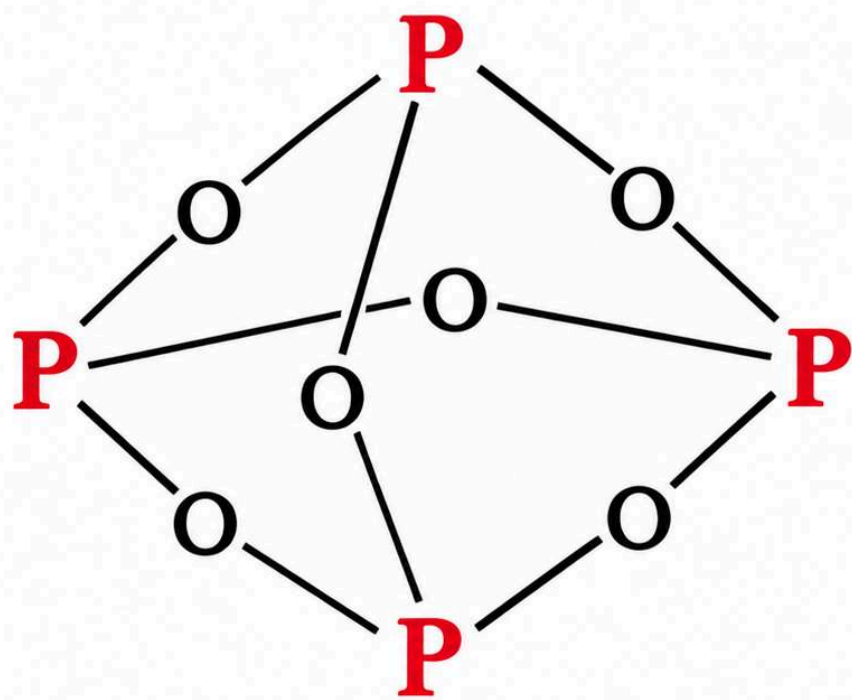


Draw the structure of octa carbonyl dicobalt.

Ans.



Structure of P_4O_6



Question number 24. Write the role of hemoglobin.

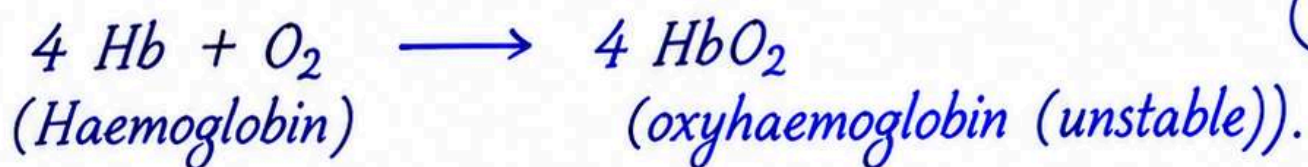
(1) Haemoglobin is a molecule inside the RBC of human blood. It has two parts, the heme and globin. The haem contains Iron and transport O_2 from the lungs to the Tissues as well as Takes CO_2 from the Tissues To the lungs.

ie. the function of Haemoglobin is to picks up oxygen at the lungs and delivers it to the rest of the Body.

$\Rightarrow$ Haemoglobin is oxygen carrier from lungs (high pressure) to Tissue (low pressure)".

(2) Deoxygenated Haemoglobin uses some of its Aminogroups to fix up CO_2 and then transport CO_2 back to the lungs. (in the form of HCO_3^-)

(3) The oxygenated form of Haemoglobin is called oxy haemoglobin ; in which Fe is in Fe (II), low spin & diamagnetic $[t_{2g}^6, e_g^0]$



- ④ The reduced form of Haemoglobin is called de-oxyhaemoglobin, in which Fe is in the Fe (II), high spin & paramagnetic ($t_{2g}^4 e_g^2$).
- ⑤ The Transfer of O_2 Involve only by Fe (II) and not by Fe (III).
- ⑥ Haemoglobin is made up of four polypeptide subunits, 2α & 2β . each of the four subunits contains a Hæm (contains iron) molecule; where the oxygen itself is bound through a reversible reaction.
ie: a Haemoglobin molecule can transport 4 oxygen molecules at a Time.
- ⑦ The oxygen Affinity of Haemoglobin varies with the pH of the medium.

This pH - sensitivity effect is called Bohr effect :

ie : "The Affinity of haemoglobin for O_2 decreases as The pH - decreases".

- ⑧ The Affinity of O_2 binding with Haemoglobin is caused by a conformational change , Structural change in Haemoglobin molecule , is called cooperativity . effect .

Question number 25. Role of Myoglobin

myoglobin (mb) $\Rightarrow$ $\longrightarrow$ m.wt = 17000 Rmm.

Iron containing porphyrin in which
Iron is in $\text{Fe}(\text{II})$.

$\longrightarrow$ pH - Independent.

myoglobin $\longrightarrow$ (1 Haem + 1 globin)

$\downarrow$
non protein
part.
 $\downarrow$
Fe-containing
porphyrin.

$\downarrow$
protein part
 $\downarrow$
protein chain
having 153/154
Amino Acid.

- ① myoglobin stored O_2 in muscles, supplied by Haemoglobin. and when O_2 is needed To muscle, it is supplied by myoglobin.
- ② myoglobin is an Iron and oxygen Binding protein.
- ③ myoglobin bind oxygen more strongly Then Haemoglobin.
- ④ myoglobin is responsible for Transport of O_2 from the lungs to the muscles in vertebrates (रीढ़ वाले प्राणी).

26. Explain the 18 electron rule in metal carbonyl.

The formation of binuclear carbonyls can also be explained on the basis of 18 e⁻ rule. According to this rule, a metal atom combined with a such a no. of CO molecules so that the valence shell (n-1)d, ns, np) of the metal atom acquires 18 electrons.

Ex:- ① $\text{Mn}_2(\text{CO})_{10}$

total e⁻ in valence shell,

$$\begin{array}{rcl} 2 \text{ Mn} & \Rightarrow & 2 \times 7 e^- \\ 10 \text{ CO} & \Rightarrow & \frac{2 \times 10 e^-}{2} \\ 1 (\text{Mn-Mn}) & \Rightarrow & 2 e^- \\ & & \hline & & 36 \text{ for } 2 \text{ Mn} \end{array}$$

$$\therefore \text{No. of } e^- \text{ about } 1 \text{ Mn} \Rightarrow \frac{36}{2} = \underline{18 e^-}.$$

② $\text{Ni}_2(\text{CO})_4 \Rightarrow \text{T.V.E.}$

$$\begin{array}{l} \text{Ni} \Rightarrow 10 e^- \\ 3d^8, 4s^2 \end{array}$$

$$\begin{array}{l} 4(\text{CO}) \Rightarrow \frac{4 \times 2 e^-}{2} \\ \quad \quad \quad = 8 e^- \\ \quad \quad \quad = 10 + 8 = \underline{18 e^-} \end{array}$$

27. Biological role of zinc (Zn) $\Rightarrow$

$\Rightarrow$ zinc is responsible for proper absorption of CO_2 by RBC in muscles. and for maintaining pH in muscle & Tissue.

Some of The zinc enzyme are useful in digestion of protein by animal.

$\Rightarrow$ Zn , catalyse esterpeptide hydrolysis in body.

$\Rightarrow$ largest amount of Zn occure in liver and bone.

$\Rightarrow$ Deficiency of Zn can lead dwarfism, sexual immaturity, diarrhea and pneumonia -- etc.

28.

Micro and Macronutrients

a) Macronutrients (4 Elements)

- These are of two type —
- Phase elements which requires more than **5 gm** and form nearly (60–80)% of all inorganic material in the body, i.e.,
- The elements that required in large quantity in body as — Na, K, Ca, Mg.

↓
Bulk elements

b) Micronutrients (9 Elements) / Trace Metals

- These elements required in very small amounts (microgram or nanogram). As —

Fe, Mo, Mn, Co, Ni, Cu, Zn, V, Cr.

⇒ According to WHO standard, maximum metal ion in water :-

Metal	Max. amount in mg/lit. in water
Hg	0.001 mg/l
Cd	0.01 mg/l
Se	0.01 mg/l
As	0.05 mg/l
Cr	0.05 mg/l
Cu	0.05 mg/l

29. Why are compound of s and p block elements are not colored?

Answer :- The compounds of s and p block elements are not colored because they do not have partially filled d-orbitals. Colour in compounds is usually due to the d-d electronic transitions in partially filled d-orbitals of transition metal ions. Since s and p block elements have completely filled or empty valence orbitals, such d-d transitions are not possible, so their compounds are generally colorless.

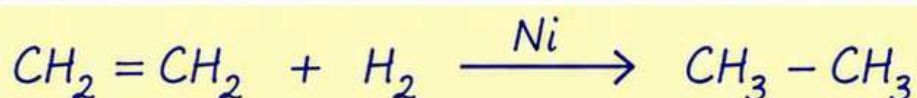
30. Give two examples of heterogeneous catalyst.

Answer :- A heterogeneous catalyst is a catalyst which is in a different physical phase from the reactants. In heterogeneous catalysis, the reactants and catalyst are in different phases (usually a solid catalyst with gaseous or liquid reactants). The reaction takes place on the surface of the solid catalyst.

Two examples of heterogeneous catalysts are :-

1 Finely divided Nickel (Ni)

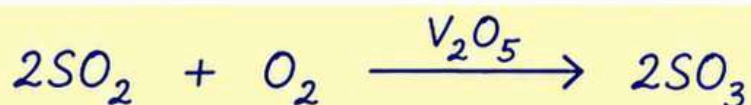
- Nickel acts as a heterogeneous catalyst in the hydrogenation of unsaturated hydrocarbons such as ethene to ethane.
- Reaction :



- Here, nickel is a solid catalyst, while ethene and hydrogen are gases. The reaction occurs on the surface of nickel.

2 Vanadium(V) oxide (V_2O_5)

- V_2O_5 acts as a heterogeneous catalyst in the oxidation of sulfur dioxide to sulfur trioxide in the Contact process for the manufacture of sulfuric acid.
- Reaction :



- Here, V_2O_5 is a solid catalyst, while SO_2 and O_2 are gases. The reaction takes place on the surface of V_2O_5 .

31. Give two example of homogeneous catalyst.

Answer:- A homogeneous catalyst is a catalyst which is in the same physical phase as the reactants. It is usually in liquid phase and is molecularly dispersed in the reaction mixture.

Two examples of homogeneous catalysts are :-

1 Hydrochloric acid (HCl)

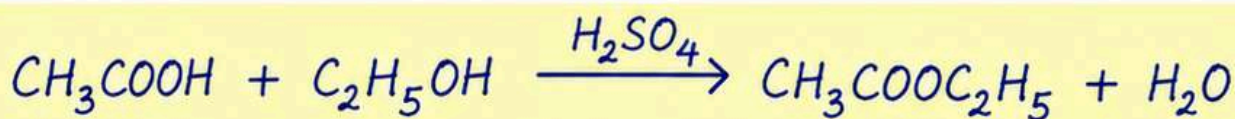
- HCl acts as a homogeneous catalyst in the hydrolysis of an ester (acid-catalysed hydrolysis).
- Reaction :



Here, both the reactants (ester and water) and the catalyst (HCl) are in the liquid phase, so HCl is a homogeneous catalyst.

2 Sulphuric acid (H₂SO₄)

- H₂SO₄ acts as a homogeneous catalyst in the esterification reaction between a carboxylic acid and an alcohol.
- Reaction :



Here, acetic acid, ethanol and H₂SO₄ are all in the liquid phase, so H₂SO₄ is a homogeneous catalyst.

32. Define turnover number with example.

Answer:- Turnover number (TON) is the total number of moles of product formed per mole of catalyst during the complete reaction. It shows how many times a catalyst can convert reactants into products before it becomes inactive.

$$\text{Turnover number (TON)} = \frac{\text{Total moles of product formed}}{\text{Moles of catalyst used}}$$

Example :- In the hydrogenation of ethene to ethane using a nickel catalyst, suppose 10 moles of ethane are formed using 0.1 mole of Ni catalyst. Then,

$$\text{TON} = \frac{10 \text{ moles}}{0.1 \text{ mole}} = 100$$

Thus, the turnover number is 100, meaning one mole of Ni catalyst converts 100 moles of ethene into ethane.

33. Why CO_2 is gas but SiO_2 is solid?

Answer:- CO_2 is a simple molecular compound. It consists of discrete molecules with weak intermolecular forces (van der Waals forces) between the molecules. These weak forces require very little energy to overcome, so CO_2 has a low melting and boiling point and therefore exists as a gas at room temperature.

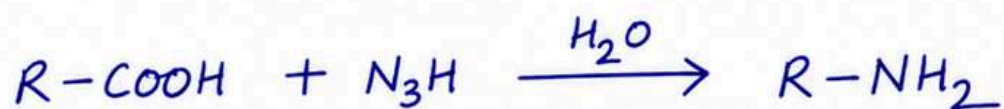
SiO_2 , on the other hand, has a giant three-dimensional covalent network structure. Each silicon atom is strongly bonded to four oxygen atoms and each oxygen atom is bonded to two silicon atoms, forming a continuous network of strong Si-O covalent bonds throughout the solid. A very large amount of energy is required to break this network, so SiO_2 has a very high melting point and exists as a solid at room temperature.

34. Schmidt Rearrangement $\Rightarrow$

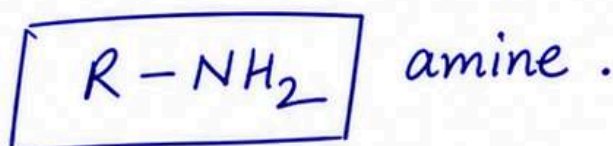
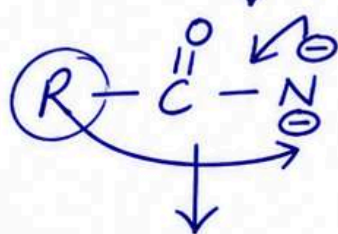
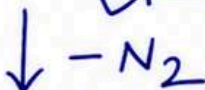
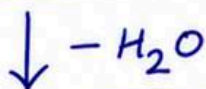
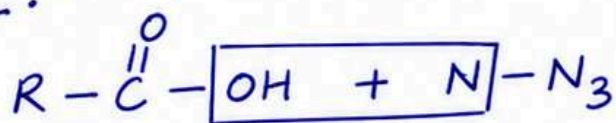
The conversion of carboxylic acid into primary amine having one carbon less, is called Schmidt Rearrangement.

This reaction can be done by reacting carboxylic Acid with hydrazoic acid, in presence of H_2SO_4 .

Ex: carboxylic acid + Hydrazoic acid $\xrightarrow[(H_2O)]{H_2SO_4}$ Base.



mechanism :-



35. Ionic radii of actinoid ions or Actinoid contraction.

* Actinoid contraction is due to poor shielding effect of 5f orbital.

from ${}_{89}\text{Ac}$ to ${}_{103}\text{Lr}$. The gradual decrease in the ionic radii with increasing in the effective nuclear charge (No. of proton / atomic no.). It called Actinoid contraction. (Radius in Å).

Elements	An^{3+} ion.	An^{4+} ion.
Ac - 89	$\text{Ac}^{3+} = 1.12 \text{ Å}$	$\text{Ac}^{4+} = 0.99 \text{ Å}$
Th - 90	$\text{Th}^{3+} = 1.08 \text{ Å}$	$\text{Th}^{4+} = 0.94 \text{ Å}$
Pa - 91	$\text{Pa}^{3+} = 1.04 \text{ Å}$	$\text{Pa}^{4+} = 0.90 \text{ Å}$
U - 92	$\text{U}^{3+} = 1.02 \text{ Å}$	$\text{U}^{4+} = 0.89 \text{ Å}$
Np - 93	$\text{Np}^{3+} = 1.01 \text{ Å}$	$\text{Np}^{4+} = 0.87 \text{ Å}$
Pu - 94	$\text{Pu}^{3+} = 1.00 \text{ Å}$	$\text{Pu}^{4+} = 0.86 \text{ Å}$
Am - 95	$\text{Am}^{3+} = 0.97 \text{ Å}$	$\text{Am}^{4+} = 0.85 \text{ Å}$
Cm - 96	$\text{Cm}^{3+} = 0.97 \text{ Å}$	$\text{Cm}^{4+} = 0.85 \text{ Å}$
Bk - 97	$\text{Bk}^{3+} = 0.96 \text{ Å}$	$\text{Bk}^{4+} = 0.83 \text{ Å}$
Cf - 98	$\text{Cf}^{3+} = 0.95 \text{ Å}$	$\text{Cf}^{4+} = 0.82 \text{ Å}$

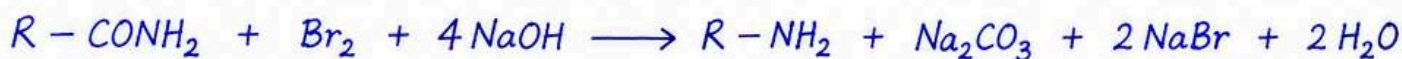
Reason / cause of Actinoid contraction: —

In the actinoid series, 5-f are added in 5-f orbital. The mutual shielding effect of 5-f electrons is very poor because the shape of f-orbitals is very much diffused, but the nuclear charge (no. of proton) increases by unity in each step while there is no comparable increase in the mutual shielding effect of 5-f electrons. Hence inward pull experienced by the 5-f electrons increases. i.e., the size of actinoids decrease gradually.

36. Explain the mechanism of Hofmann bromide reaction.

Answer :- Hofmann bromide reaction (also called Hofmann degradation) is the conversion of an amide into a primary amine having one carbon less, by the action of bromine in aqueous or ethanolic alkali. This reaction proceeds through the formation of an isocyanate intermediate which on hydrolysis gives the primary amine.

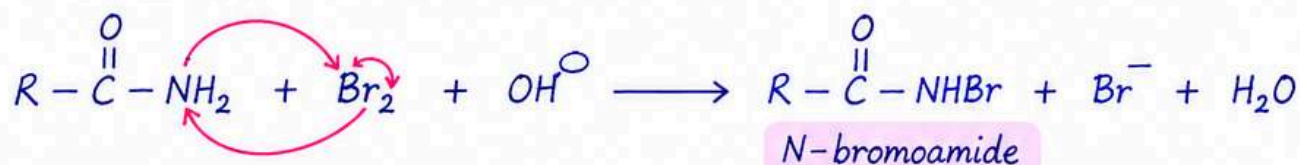
Overall reaction :-



Mechanism :-

Step 1 : N-Bromination of amide

The amide first reacts with bromine in the presence of base to form N-bromoamide.



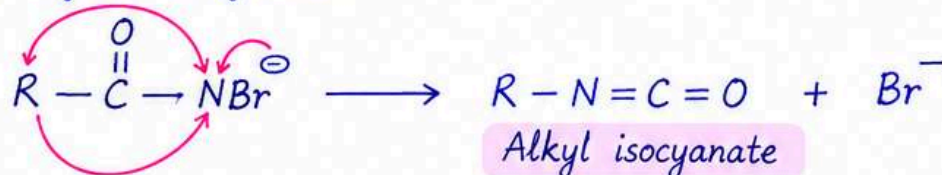
Step 2 : Deprotonation

Base removes the remaining N-H proton to form an anion.



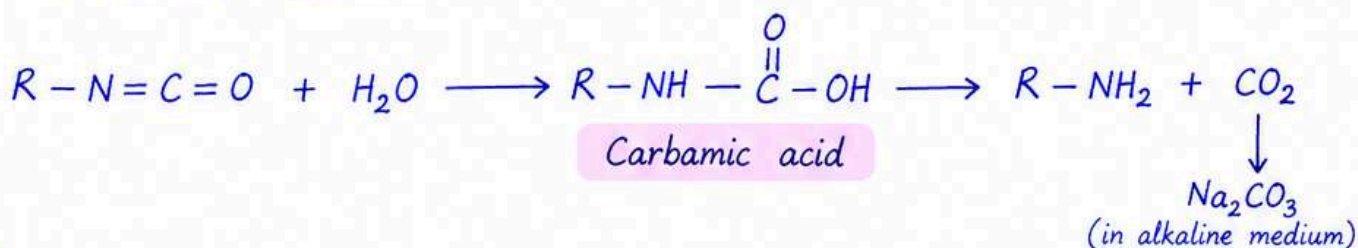
Step 3 : Rearrangement (1,2-migration)

The anion undergoes rearrangement in which the alkyl group (R) migrates from the carbonyl carbon to the nitrogen, with simultaneous loss of bromide ion, forming an isocyanate.



Step 4 : Hydrolysis of isocyanate

The isocyanate reacts with water to give a carbamic acid, which then decomposes to give the primary amine and carbon dioxide (as carbonate in alkaline medium).



37. Nitrogen form only trivalent halide, but phosphorus form pentavalent halides. Why?

Answer :-

1. Availability of d-orbitals

- Nitrogen ($Z = 7$) has electronic configuration $1s^2 2s^2 2p^3$. It has only 2s and 2p orbitals in its valence shell and no vacant d-orbitals. Therefore, it cannot expand its octet and can form only three covalent bonds with halogens, giving trivalent halides (e.g., NF_3).
- Phosphorus ($Z = 15$) has electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^3$. It has vacant 3d orbitals in its valence shell. Hence, it can expand its octet and form five covalent bonds with halogens, giving pentavalent halides (e.g., PCl_5).

2. Size of the atom

- Phosphorus has a larger atomic size than nitrogen, which helps in accommodating more electrons and reduces electron-electron repulsion, so it can form five bonds, whereas nitrogen being smaller cannot.

3. Octet rule

- Nitrogen strictly follows the octet rule and cannot have more than eight electrons around it. Phosphorus, being a third period element, can accommodate more than eight electrons due to the involvement of its vacant 3d orbitals.

38. Name any two different type of hydrides. Give a brief description of any one of them.

Answer :-

Two different types of hydrides are :

1. Ionic hydrides

2. Covalent hydrides

Brief description of Ionic hydrides :

Ionic hydrides are formed by the combination of electropositive elements, mainly alkali metals and alkaline earth metals, with hydrogen. In these hydrides, hydrogen exists as a hydride ion (H^-) and is bonded to the metal by an ionic bond due to a large difference in electronegativity.

Examples : NaH , KH , CaH_2 , LiH etc.

Properties :

- They are ionic and crystalline solids with high melting points.
- They are strong reducing agents.
- They react vigorously with water to give hydrogen gas and the corresponding metal hydroxide.

For example : $NaH + H_2O \longrightarrow NaOH + H_2 \uparrow$

39. Discuss the application of zeolites as catalyst.

Answer :-

Zeolites are crystalline aluminosilicates having a porous structure with cavities and channels. They act as effective solid acid catalysts due to the presence of exchangeable cations (e.g., H^+) and a large surface area. Their shape-selective nature and acidity make them useful in many industrial reactions.

1. Petroleum refining

- Zeolites such as ZSM-5 and Y-zeolite are used for catalytic cracking of heavy petroleum fractions into lighter and more useful products like gasoline, LPG and olefins.
- They are also used in hydrocracking and isomerization to improve octane number and yield of gasoline.

2. Shape-selective catalysis

- Due to their well-defined pore size, zeolites allow only molecules of certain size and shape to enter, giving high selectivity in reactions such as isomerization of n-alkanes to iso-alkanes.

3. Organic synthesis

- Zeolites are used in alkylation, aromatization and disproportionation reactions, e.g., conversion of methanol to hydrocarbons (MTO process).

4. Environmental applications

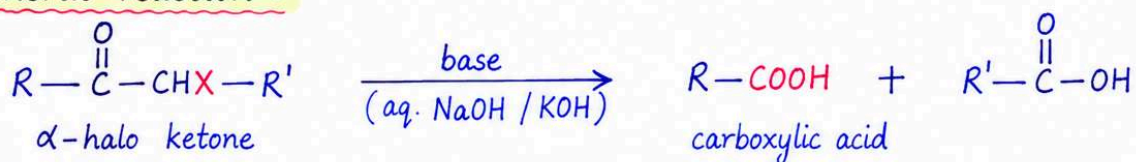
- They are used in catalytic converters to reduce harmful emissions such as CO , NO_x and unburnt hydrocarbons.

Q40. Favorskii rearrangement.

Answer :-

Favorskii rearrangement is the rearrangement of α -halo ketones in the presence of a base to give carboxylic acids having one carbon less than the original ketone.

General reaction :



Mechanism :

- ① Base abstracts an α -hydrogen to give a carbanion.
- ② The carbanion attacks the carbonyl carbon forming a cyclopropanone intermediate.
- ③ Cleavage of the cyclopropanone ring by OH^- gives a carboxylate ion with one carbon less.
- ④ Acidification gives the corresponding carboxylic acid.

Example :

