S-BLOCK

Date

(Alkali Metals)

	IA		
$d = 0.534$ g/mL	Li	3	$[He]\,2s^1$
	Na	11	$[Ne]\,3s^1$
	K	19	$[Ar]\,4s^1$
	Rb	37	$[Kr]\,5s^1$
	Cs	55	$[Xe]\,6s^1$

→ All the metals of I(A) are called alkali metals because their oxides and hydroxides are strongly alkaline

→ Sodium is most abundant alkali metal in earth crust.

→ None of the alkali metal exist in elementary form in nature because of their high reactivity.

→ Alkali metals are extracted by fused salt electrolysis.

→ After extraction alkali metals are required to store in kerosene or paraffin oil but Li is required to store in paraffin wax because it is lighter than kerosene

→ All the alkali metals are soft because of weak metallic bonding or cohesive forces b/w atoms. Softness ↑ increases on moving down the group.

Date

→ Because of high electropositivity they have extremely good metallic character

→ Most of the periodic properties have regular trends in I(A) but density of Na is higher than K
Density Cs > Rb > Na > K > Li

→ Because of very low IE, K and Cs are commercially used in photoelectric cell

Flame Test

→ All the alkali metals and their salt produce characteristic colour on flame

→ Flame colour arises due to emission spectra.

→ Conc. HCl is used to prepare paste of salt because chlorides of metal are relatively more volatile on flame.

→ Pt wire is preferred because of its inertness.

→ Flame test is very sensitive and reliable test for some metal ions.

→ Be, Mg do not produce colour on flame because of high excitation energy

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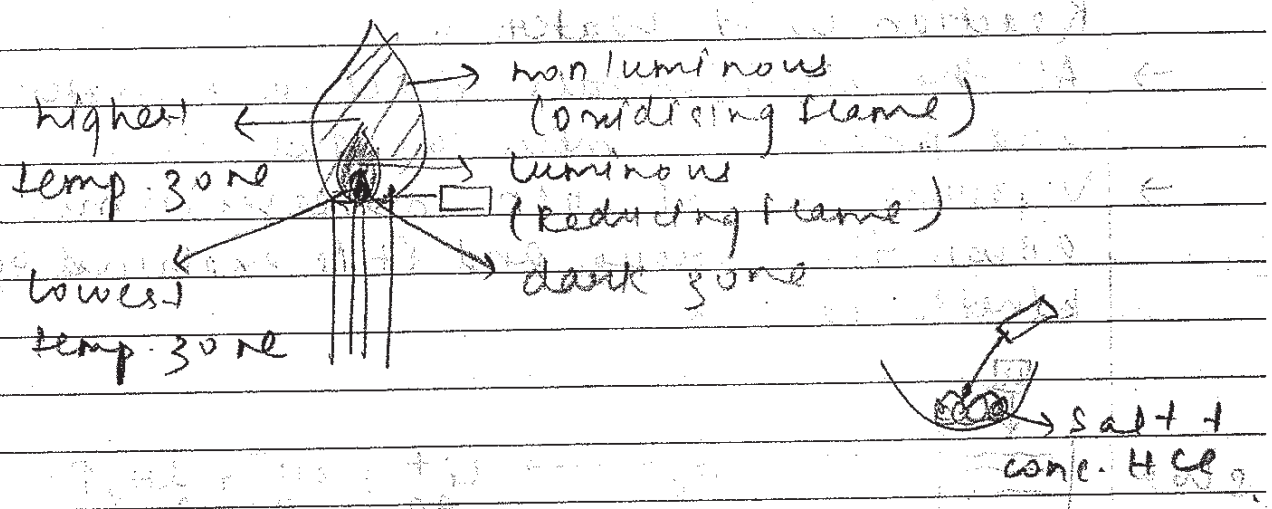
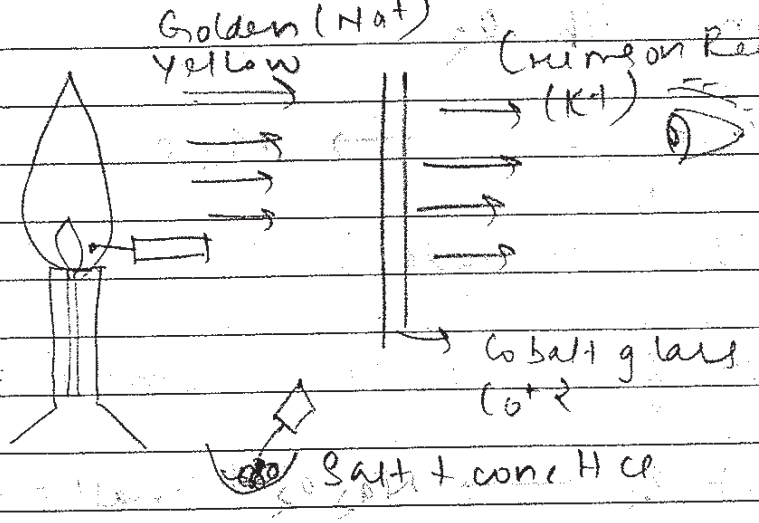


Li - Crimson Red
Na - Golden yellow
K - Lilac
Rb - red-violet
Cs - Blue

Be - X
Mg - X
Ca - Brick Red
Sr - Crimson Red
Ba - Apple Green

Mn^{+2} - green

Pb - Blue
BO_3^{3-} - green
Cu^{+2} - Blue-green



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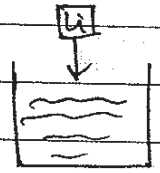
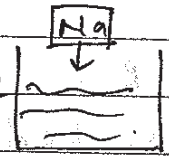
Reaction with Water

→ All the alkali metals react with water and produce combustible gas H_2

→ Vigorousness of the rxn increases on moving down the group and it is explained by kinetic factors.

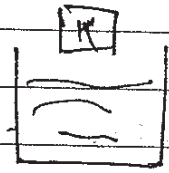


slow $\quad Li + H_2O \longrightarrow Li^+_{aq} + OH^-_{aq} + \frac{1}{2}H_2\uparrow \quad \Delta H_1 = -q_1$



moderate $\quad Na + H_2O \longrightarrow Na^+_{aq} + OH^-_{aq} + \frac{1}{2}H_2\uparrow$

$\Delta H_2 = -q_2$



fast $\quad K + H_2O \longrightarrow K^+_{aq} + OH^-_{aq} + \frac{1}{2}H_2\uparrow \quad \Delta H_3 = -q_3$

Reaction with O_2

$$2M + \underset{\text{limited}}{\frac{1}{2}O_2} \longrightarrow M_2O$$

(M = Any 1A metal)

$$Li + \underset{\text{excess}}{O_2} \longrightarrow Li_2O \quad (\text{small} = Li_2O_2)$$

$$Na + \underset{\text{excess}}{O_2} \longrightarrow Na_2O_2 \quad (\text{small} = Na_2O)$$

$$K + \underset{\text{excess}}{O_2} \xrightarrow[(Rb, Cs)]{\text{same as M}} KO_2$$

Date

$O_2 + e^- \longrightarrow O_2^- \xrightarrow{e^-} O_2^{2-} \xrightarrow{2e^-} 2O^{2-}$

Thermal stability -

$Li_2O > Na_2O > K_2O$

$Li_2O_2 < Na_2O_2 < K_2O_2$

$NaO_2 < KO_2$

Li^+ O^{2-}

Na^+ O_2^{2-}

K^+ O_2^-

→ All alkali metals produce oxides when combined with limited supply of oxygen but with excess oxygen, different alkali metals produce different product

→ Superoxide ion have low -ve charge density so that it is stabilized by cation with low +ve charge density. That is why K, Rb, Cs form superoxide

→ Oxide ion have high negative charge density so that it is stabilised by cation with high +ve charge density so that Li form oxide.

→ When dry KOH powder react with ozone, it produce orange solid called pottasium ozonoid. It is a paramagnetic compound

$KOH_{(s)} + O_3 \longrightarrow KO_{3(s)} + H_2O$

(dry) (orange)

Date

Q. A white/pale yellow crystalline solid (X) which is either Na_2O or Na_2O_2.

Freshly prepared soln of above ~~crystto~~ solid (X) convert red litmus paper to white. Identify X and justify.

Red → Blue

$$Na_2O + H_2O \longrightarrow 2NaOH$$

Red → White

$$Na_2O_2 + 2H_2O \xrightarrow[cold]{ice} 2NaOH + H_2O_2$$
$$(2Na^+, O_2^{2-})$$

Red → White

$$2KO_2 + 2H_2O \xrightarrow[(ice\ cold)]{disprn.} 2KOH + H_2O_2 + O_2\uparrow$$

$$Na_2O_2 + CO_2 \longrightarrow Na_2CO_3 + \frac{1}{2}O_2\uparrow$$

$$2KO_2 + CO_2 \longrightarrow K_2CO_3 + \frac{3}{2}O_2\uparrow$$

$$2KO_3 + CO_2 \longrightarrow K_2CO_3 + \frac{5}{2}O_2\uparrow$$

Superoxides and peroxides are used in space capsules and submarines because they absorb CO_2 and release O_2.

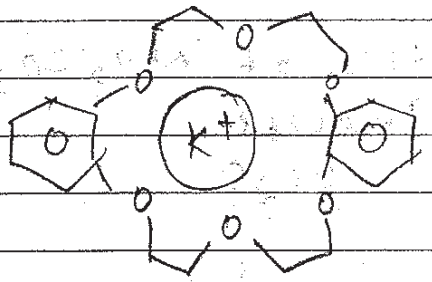
Complex Formation -

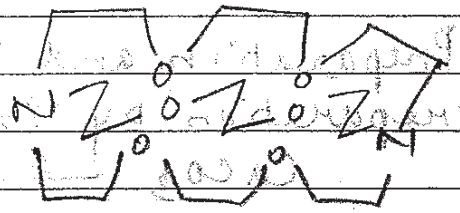
→ Alkali metal cations are not good complex forming cations because they have large size, low charge density and vacant orbital at high energy. But crown ethers and cryptands can form complex with alkali metal cations.

Eu, Yb of Lanthanide also form blue soln in liq. NH_3.

Date

It is called macrocyclic effect





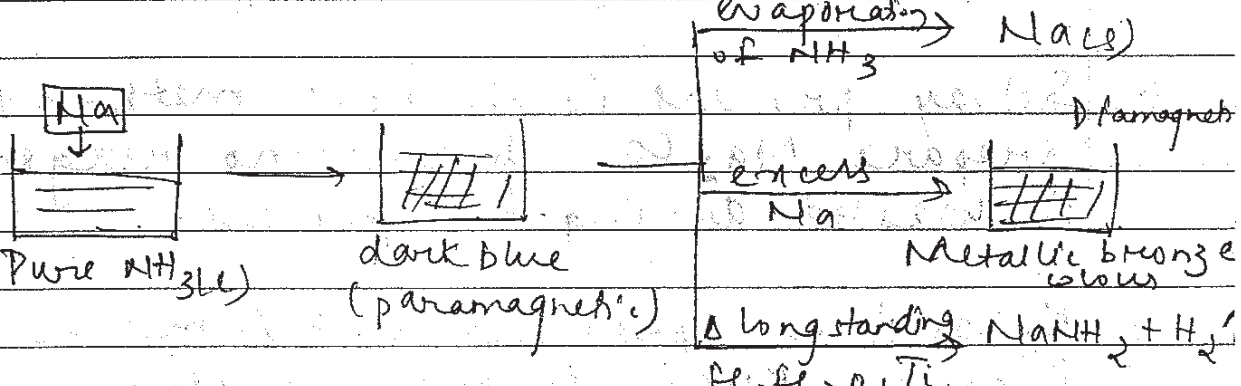
Cryptands

Solubility in liq. NH_3

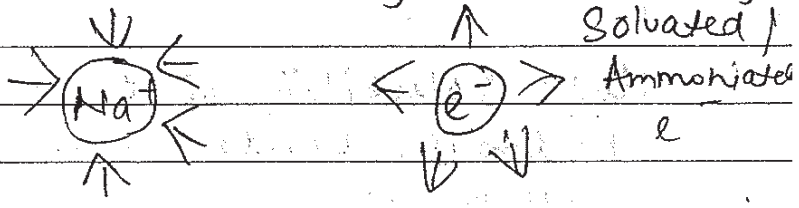
→ All the alkali metals produce dark blue soln in liq. NH_3.

→ Dark blue soln is strongly paramagnetic, excellent reducing agent, good conductor of electricity and all the properties are due to solvated or ammoniated e^-

→ Blue soln. of alkali metal in liq. NH_3 on decomposition produce metal amide and H_2 (Li produce Lithium Imide (Li_2NH))



$$Na + (x+y)NH_3 \rightleftharpoons [Na^+(NH_3)_x] + [e^-(NH_3)_y]$$



All carbonate salts are water insoluble except
$Na_2CO_3, K_2CO_3, Rb_2CO_3, Cs_2CO_3, (NH_4)_2CO_3$

Date

$K_2[\overset{II}{N}i(CN)_4] \xrightarrow[NH_3]{K \text{ in liq.}} K_4[\overset{0}{N}i(CN)_4]$

Preparation and Properties of Na_2CO_3

Preparation by Solvay Process

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2\uparrow$$

$$\underbrace{2NH_3 + H_2O}_{(NH_4OH)} + CO_2 \longrightarrow (NH_4)_2CO_3\,aq.$$

soluble

$$(NH_4)_2CO_3 + \underset{\text{excess}}{CO_2} + H_2O \longrightarrow 2NH_4HCO_3\,aq.$$

$$NH_4HCO_3\,aq + NaCl\,aq \longrightarrow NH_4Cl\,aq + \underset{\text{white ppt}}{NaHCO_3}\downarrow$$

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2\uparrow$$

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

$$2NH_4^+ + Ca(OH)_2 \longrightarrow Ca^{+2} + 2H_2O + 2NH_3\uparrow$$

→ Solvay process is the best method to prepare Na_2CO_3 because no reagent is wasted during the process.

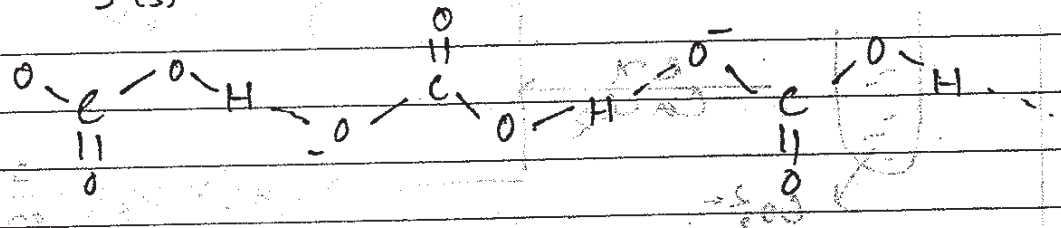
→ K_2CO_3 is not prepared by this method because $KHCO_3$ is fairly soluble in water so that it is not possible to separate from mix. of $KHCO_3$ and NH_4Cl

→ less solubility of $NaHCO_3$ is due to polymeric hydrogen bonded bicarbonate ion, in $NaHCO_3(s)$

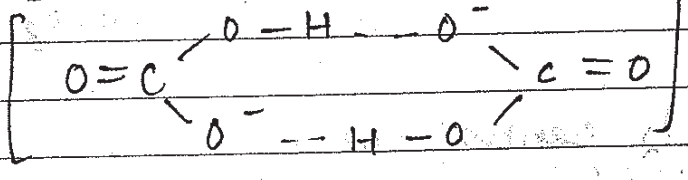
Date

→ K_2CO_3 is prepared by Le Blank process.

$NaHCO_3(s)$ –



$KHCO_3(s)$



Difference b/w CO_3^{2-} & HCO_3^-.

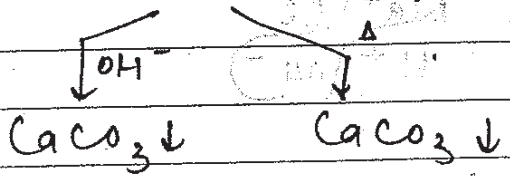
Na_2CO_3 aq.

$NaHCO_3$ aq

1)	HPh	Pink
2)	$CaCl_2$ aq.	$CaCO_3\downarrow$ white ppt.
3)	$HgCl_2$ aq.	$HgCO_3 \cdot 3HgO\downarrow$ Red brown ppt.

Colourless

$Ca(HCO_3)_2$ aq

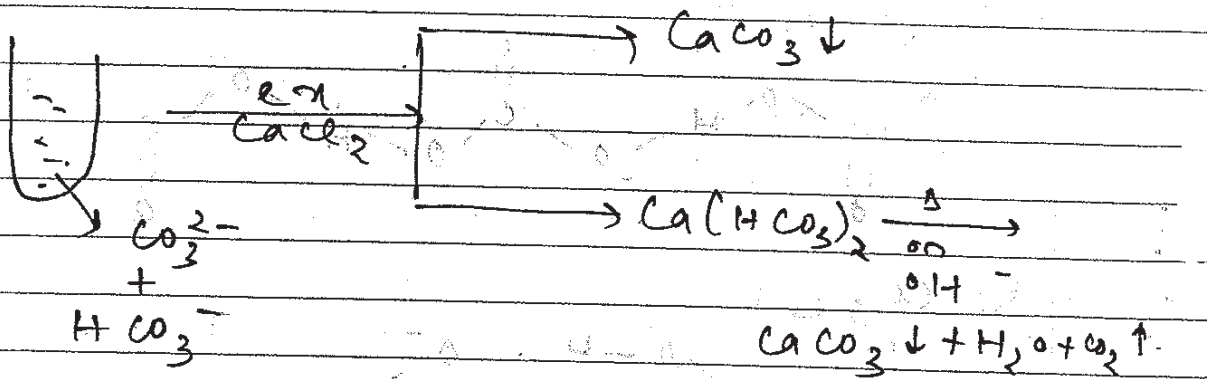


$CaCO_3\downarrow$ $CaCO_3\downarrow$

No ppt

Date

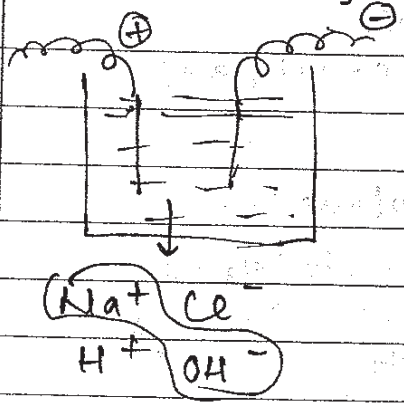
8 When both CO_3^{2-} & HCO_3^- in same test tube



$CaCl_2$ cannot be used both will give ppt.

Preparation and properties of NaOH

1) By electrolysis of NaCl(aq) using inert electrodes -

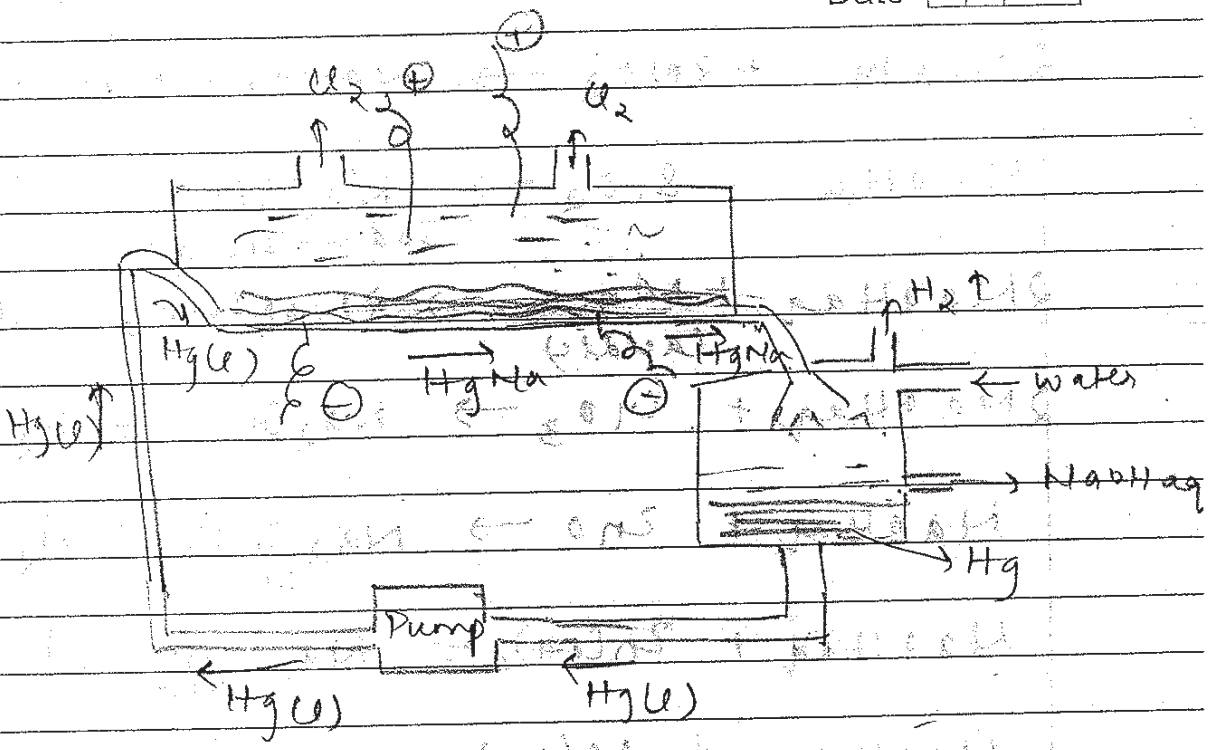


$\oplus$ $2Cl^- \longrightarrow Cl_2 + 2e^-$

$\ominus$ $2H^+ + 2e^- \longrightarrow H_2\uparrow$

2] Castner - Kellner cell (Hg - cathode cell)

Date



⊕ $2Cl^- \longrightarrow Cl_2 + 2e^-$

⊖ Hg electrode

$2Na^+ + 2e^- \longrightarrow 2Na$

$2Na + 2Hg \longrightarrow 2NaHg$

$2NaHg + 2H_2O \longrightarrow 2Hg + 2NaOH + H_2\uparrow$

Properties →

1) Alkaline Nature-

$2NaOH_{aq} + CO_2 \longrightarrow Na_2CO_3 + H_2O$

$NaOH_{aq} + CO_2(excess) \longrightarrow NaHCO_3$

$2NaOH_{aq} + SO_2 \longrightarrow Na_2SO_3 + H_2O$

$2NaOH_{aq} + H_3PO_3 \longrightarrow Na_2HPO_3 + 2H_2O$

$2NaOH_{aq} + SO_3 \longrightarrow Na_2SO_4 + H_2O$

NO_2 → mix anhydride of HNO_2 and HNO_3

Date

$2NaOH_{aq} + 2NO_2 \longrightarrow NaNO_3 + NaNO_2 + H_2O$

$NaOH_{aq} + SiO_2 \longrightarrow \underset{\text{Sodium silicate}}{Na_2SiO_3} + H_2O$

$2NaOH_{aq} + \underset{\text{(acidic)}}{Mn_2O_7} \rightarrow 2NaMnO_4 + H_2O$

$2NaOH_{aq} + CrO_3 \rightarrow Na_2CrO_4 + H_2O$

$NaOH_{aq} + ZnO \rightarrow \underset{\text{soln.}}{Na_2ZnO_2} + H_2O$

$NaOH_{aq} + Zn(OH)_2 \rightarrow \underset{\text{soln.}}{Na_2[Zn(OH)_4]}$

$NaOH_{aq} + Al(OH)_3 \rightarrow Na[Al(OH)_4]_{aq}$

$NaOH_{aq} + NH_4Cl \rightarrow NaCl + H_2O + NH_3\uparrow$

$NaOH_{aq} + PH_4I \rightarrow NaI + H_2O + \underset{\text{(Rotten fish smell)}}{PH_3\uparrow}$

$2NaOH + H_2S \longrightarrow Na_2S_{aq} + 2H_2O$

→ NaOH is a strong base so that it reacts with acid, acidic oxide, amphoteric oxide and acidic salt.

Rxns with metal salt

a) Metal salt which produce ~~white~~ ppt with NaOH which dissolves in excess NaOH.

$ZnSO_{4\,aq} + 2NaOH_{aq} \longrightarrow \underset{\text{white}}{Zn(OH)_2\downarrow} + Na_2SO_{4\,aq}$

$Zn(OH)_2\downarrow + 2NaOH \longrightarrow \underset{\text{colourless soln}}{Na_2[Zn(OH)_4]}$

Amphoteric, excess

Eg - $ZnSO_4$, $SnCl_2$, $SnCl_4$, $AlCl_3$, $BeCl_2$, $CrCl_3$, $Pb(NO_3)_2$

Date

b) Metal salt which produce hydroxide ppt with NaOH which does not dissolve in excess NaOH.

$CuSO_{4(aq)} + 2NaOH \longrightarrow Cu(OH)_2\downarrow + Na_2SO_4$
light blue

$Cu(OH)_2\downarrow + NaOH \longrightarrow$ Not soluble
(Basic) excess

Eg - $MnSO_4$, $FeSO_4$, $FeCl_3$, $CoCl_2$, $NiSO_4$, $MgCl_2$

c) Metal salt produces oxide ppt with NaOH

$2AgNO_{3(aq)} + 2NaOH \longrightarrow Ag_2O\downarrow + 2NaNO_3 + H_2O$
brown colouration

$Ag_2O + NaOH \longrightarrow$ Not soluble ✗
excess

Eg - Hg^{2+}, Hg_2^{2+}, Ag^+

3] Rxn with non-metals -

$X_2 \xrightarrow[(cold,\ dil)]{OH^-} X^- + OX^-$ (X = Cl, Br, I)

$X_2 \xrightarrow[(hot,\ conc)]{OH^-} X^- + XO_3^-$ (X = Cl, Br, I)

P_4 (white) $\xrightarrow{OH^-} PH_3 + H_2PO_2^-$

$S \xrightarrow{OH^-} S^{2-} + S_2O_3^{2-}$

4] Rxn with metals -

$Zn + 2NaOH_{(aq)} \longrightarrow Na_2ZnO_2 + H_2\uparrow$
or
$Na_2[Zn(OH)_4]_{aq}$

$Si + NaOH \longrightarrow Na_2SiO_3 + H_2\uparrow$
or
Na_4SiO_4

$B + NaOH \longrightarrow NaBO_2 + H_2\uparrow$ Date
or
Na_3BO_3

$Al + NaOH + H_2O \longrightarrow NaAlO_2\,aq + H_2\uparrow$
or
$Na[Al(OH)_4]\,aq$

$Be + 2NaOH_{aq} \longrightarrow Na_2BeO_2 + H_2\uparrow$

$Sn + 2NaOH \longrightarrow Na_2[\overset{\text{II}}{Sn}(OH)_4] + H_2\uparrow$

$Pb + NaOH \longrightarrow Na_2[\overset{\text{II}}{Pb}(OH)_4] + H_2\uparrow$

NOTE :

→ NaOH is a white crystalline solid (ionic compound). It is strongly deliquescent substance. It absorbs moisture and dissolve in it.

→ In laboratory practice, NaOH is used in aqueous soln.

→ All the rxns of KOH aq are similar to NaOH aq.

Alkaline Earth Metals (IIA) -

Be
Mg
Ca
Sr
Ba
} store in paraffin oil

Rxn with water

Be —
- H_2O room temp. → X
- H_2O Δ → X
- H_2O steam red hot → ? X

Date

$Mg \xrightarrow[\text{room temp.}]{H_2O} X$

$Mg \xrightarrow{H_2O,\ \Delta} Mg(OH)_2 + H_2\uparrow$

$M + 2H_2O \longrightarrow M(OH)_2 + H_2\uparrow$

$M = Ca, Sr, Ba$

Rxn with O_2 -

$M + \frac{1}{2}O_2 \xrightarrow{(M = \text{All IIA elements})} MO$

(limited)

$M + O_2 \xrightarrow[Ca]{M = Be, Mg,} MO$

excess

$M + O_2 \xrightarrow{(M = Sr, Ba)} MO_2$

ex (peroxide)

1) $Ba + O_2 \xrightarrow{\Delta} BaO_2 \xrightarrow{\text{water}} Ba(OH)_2 + H_2O_2$

ex

2) $Mg + \text{Air} \xrightarrow{\Delta} MgO + Mg_3N_2 \xrightarrow{\text{water}} Mg(OH)_2\downarrow + NH_3\uparrow$

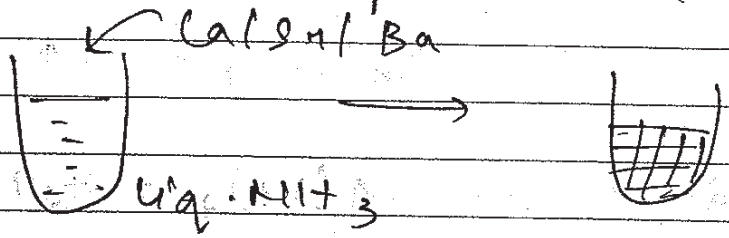
Solubility of liq. NH_3 :

→ Similar to alkali metals, Ca, Sr, Ba also produce blue black soln when dissolved in liq. NH_3. All the properties are similar to blue soln of alkali metals due to the presence of solvated e^-

→ Recovery of metal from blue black soln is not possible for II(A) elements because they produce hexa ammoniated metal when

Date

ammonia is vapourised



$M + (n+2y)NH_3 \rightarrow [M^{+2}(NH_3)_n] + 2[e^-(NH_3)_y]$

M (in Liq. NH_3) $\xrightarrow[\text{of } NH_3]{\text{evaporation}}$ $M \cdot 6NH_3$ or $[M(NH_3)_6]$ $\xrightarrow{\Delta}$ $M(NH_2)_2 + H_2\uparrow + 4NH_3\uparrow$

Write formula of

Gypsum $CaSO_4 \cdot 2H_2O$

Plaster of Paris $CaSO_4 \cdot \frac{1}{2}H_2O$

Dead Plaster / Burnt Plaster $CaSO_4$

Epsom $MgSO_4 \cdot 7H_2O$

Hydrolith CaH_2

Lithophone $BaSO_4 + ZnS$

Milk of Magnesia $Mg(OH)_2$

Bordeaux Mixture $CuSO_4 + CaO$

Sorel Cement $MgO + MgCl_2$

Portland Cement

Bleaching Powder $Ca(OCl)Cl$

Calcium salt which is present $\approx 51\%$ Ca_3SiO_5 (composition of cement)

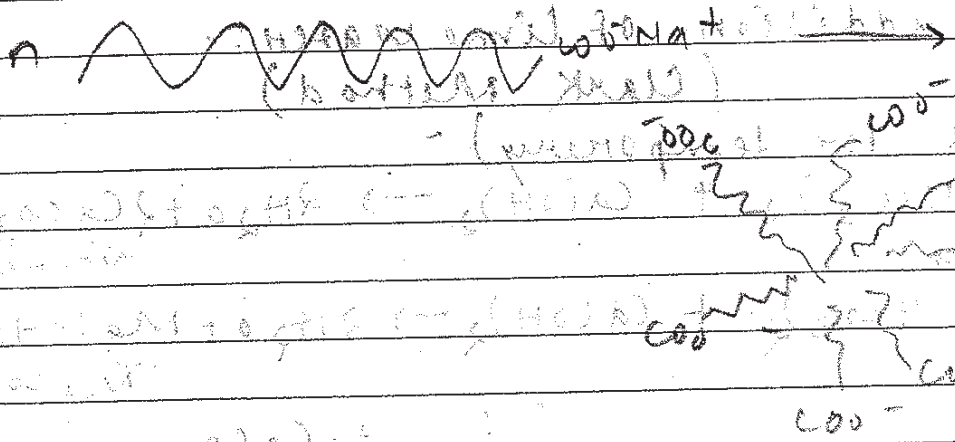
Pearl Ash K_2CO_3

Date

Hard Water -

→ Water which does not produce lathers with soap is called hard water

→ Hardness of water is due to soluble Ca^{+2} and Mg^{+2} salts



$$2(R-COO^- Na^+) + Ca^{+2} \longrightarrow (R-COO)_2 Ca\downarrow + 2Na^+$$

ppt

Hardness

Temporary	Permanent
HCO_3^- of Ca^{+2}/Mg^{+2}	due to other
$Ca(HCO_3)_2$ aq. / $Mg(HCO_3)_2$ aq.	soluble salts of Ca^{+2}, Mg^{+2}

Date

Removal of Hardness

1] By Boiling :-
(Only for temporary)

$M(HCO_3)_2\,aq \xrightarrow{\Delta} MCO_3 \downarrow + CO_2 \uparrow + H_2O$

2) By addition of lime water :-
(Clark Method)
(Only for temporary) -

$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2H_2O + 2CaCO_3 \downarrow$ white

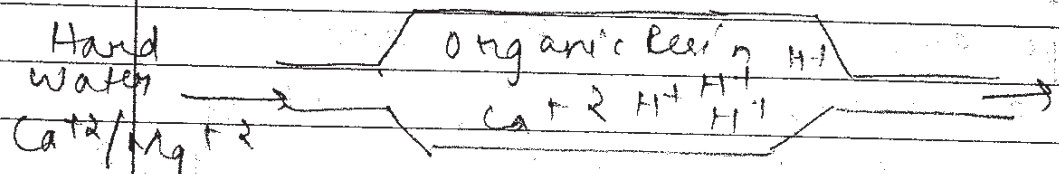
e.g.

$Mg(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2H_2O + Mg(OH_2) \downarrow$
$MgCO_3 \downarrow$
$+ CaCO_3 \downarrow$

3) By addn of calculated amount of Na_2CO_3 -

$Ca^{+2}/Mg^{+2} + Na_2CO_3 \longrightarrow CaCO_3 \downarrow +$
$MgCO_3 \downarrow + Mg(OH)_2 \downarrow + 2Na^+$

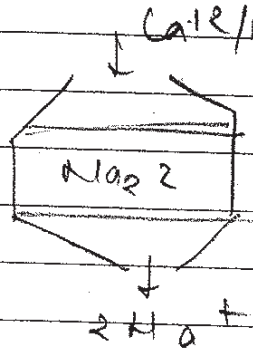
4) By ion exchange resin -



5) Zeolite Method or Permutit Method

$Na_2Al_2Si_2O_8 \cdot xH_2O$
Na_2Z

$Na_2Z + Ca^{+2} \longrightarrow CaZ + 2Na^+$



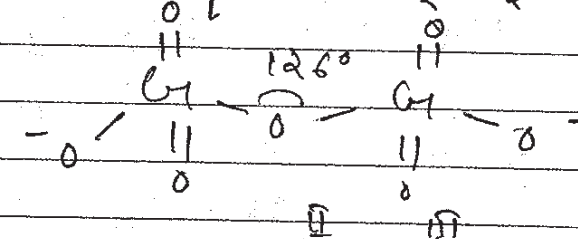
Date

6) Calgon Method -
$(NaPO_3)_6$ or $Na_2[Na_4(PO_3)_6]$

$$[Na_4(PO_3)_6]^{2-} + 2Ca^{+2} \longrightarrow \underset{(coln)}{[Ca_2(PO_3)_6]^{2-}} + 4Na^+$$

Some Important Reagents - Date

1) Chemistry of $K_2Cr_2O_7$



$FeO \cdot Cr_2O_3$ (Chromite ore)

↓ fused with Na_2CO_3 + O_2 excess

$Fe_2O_3 + 2CrO_3 + Na_2O + CO_2 \uparrow$

(Basic) (Acidic) (Basic)

↓

$Na_2CrO_4 + Fe_2O_3$ (solid)

↓ water

Na_2CrO_4 aq. yellow soln | $Fe_2O_3 \downarrow$ residue

↓ conc. H_2SO_4

$Na_2Cr_2O_7$ aq + Na_2SO_4 aq

↓ cooling

$Na_2Cr_2O_7 \cdot 2H_2O$ | Na_2SO_4 aq

↓ KCl aq

$K_2Cr_2O_7$ aq. + NaCl aq

↓ crystallize

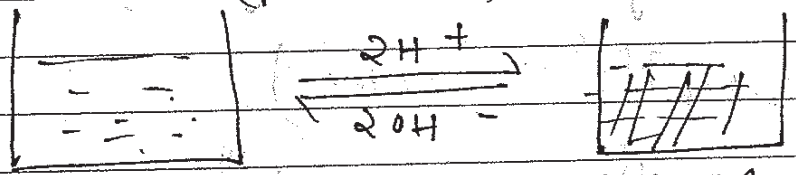
$K_2Cr_2O_7$ (crystals) Orange

Date

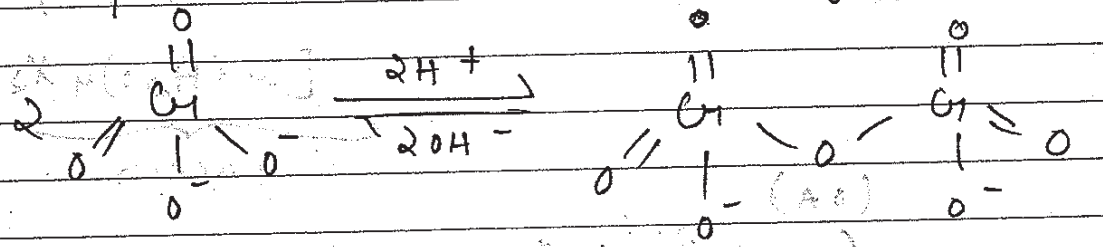
Q. When aq. soln of sodium chromate react with conc. HNO_3. H_2CrO_4

A) Cr is oxidise to Cr+7.
B) $Cr_2O_7^{2-}$ is reduce to Cr+3
✓C) $Cr_2O_7^{2-}$ & H_2O produce
D) $Cr_2O_7^{2-}$ × Cr+3 "

(pH = 4 to 6)



yellow soln — orange



NOTE:

→ Chromate and dichromate ion exist in eqm b/w pH = 4 to 6.

→ In acidic medium, predominant species is dichromate so that when yellow soln of chromate ion is treated with sulphuric, nitric, acetic acid it is converted to orange soln of dichromate.
(During volumetric titration HNO_3 is not used because it acts as O.A. also)

→ When orange soln of dichromate ion react with strong base it produce yellow soln of chromate ions.

Date

→ To prepare std. soln of dichromate, $Na_2Cr_2O_7$ crystals are not preferred, because it is a moisture absorbing substance

→ Solubility of $K_2Cr_2O_7$ is slightly less than $Na_2Cr_2O_7$.

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

(Orange) (green) $E^\circ = 1.33\ V$

($[Cr(H_2O)_6]^{+3}$ = violet)

$$[Cr(H_2O)_6]^{+3} + X^- \rightleftharpoons [Cr(H_2O)_5X]^{+2} / [Cr(H_2O)_4X_2]^{+}$$

green

(OA) $Cr_2O_7^{2-}/H^+$

(RA) $SO_3^{2-}/SO_2 \longrightarrow SO_4^{2-}$

$S^{2-}/H_2S \longrightarrow S$

$NO_2^- \longrightarrow NO_3^-$

$S_2O_3^{2-} \longrightarrow SO_4^{2-} + S$

$X^-_{aq} \longrightarrow X_2$ ($X = I^-, Br^-$)

$C_2O_4^{2-} \longrightarrow CO_2\uparrow$

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

$Sn^{+2} \longrightarrow Sn^{+4}$

$CH_3CH_2OH \longrightarrow CH_3COOH$

$CH_3CHO \longrightarrow CH_3COOH$

$\downarrow$

Cr^{+3}

Date

Q. What happen when $K_2Cr_2O_7$ crystals are heated with conc. HCl?

$K_2Cr_2O_7(aq) + HCl(aq) \longrightarrow X$

But,

$K_2Cr_2O_7(s) + 2HCl(conc) \xrightarrow{\Delta} Cl_2\uparrow + Cr^{+3} + H_2O + 2K^+$

(green)

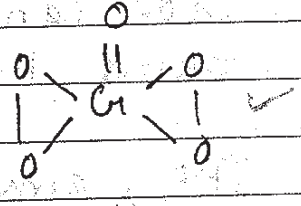
Q. What is the observation when acidic soln of $K_2Cr_2O_7$ react with H_2O_2?

$\xrightarrow{H_2O_2/H_2SO_4}$

(dark blue soln)

Orange soln of $K_2Cr_2O_7(aq)$

CrO_5 or $Cr(O)(O_2)_2$



(after some time)

$2CrO_5 \rightarrow Cr_2O_3 + \frac{7}{2}O_2\uparrow$

$Cr_2O_3 + 6H^+ \longrightarrow 3H_2O + Cr^{+3}_{aq}$

THF

amyl alcohol

n-pentanol

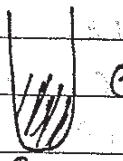
$C-(CH_2)_4-OH$

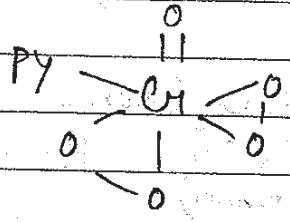
O_2

Cr^{+3}_{aq} (green)

ethanol > pentanol (volatile nature)

Date

$CrO_5 \xrightarrow{Py}$  $CrO_5 \cdot Py$ (Blue ppt)



Blue colour stabilize in organic layer

→ When orange soln of dichromate react with H_2O_2 in presence of H_2SO_4, it produces intense blue colour due to formation of CrO_5.

→ CrO_5 is unstable so that it decompose easily and produce $Cr^{+3} + O_2$

→ CrO_5 can be stabilized by Py because it forms blue ppt of $CrO_5 \cdot Py$

→ THF, amyl alcohol and some other non-volatile alcohol can stabilize CrO_5 in separate layer.

Chemistry of $KMnO_4$

→ Preparation by Pyrolusite (MnO_2)

$MnO_2(s)$ + $K_2CO_3(s)$ + $O_2 \xrightarrow[\text{fused}]{\Delta} \overset{+6}{Mn}O_3 + K_2O + CO_2\uparrow$

(Black)

$\downarrow$

$K_2MnO_4 + CO_2\uparrow$

(dark green)

Date

OR

$MnO_2 + K_2CO_3 + O_2 \xrightarrow{\Delta\ (Fused)} K_2MnO_4 + CO_2\uparrow$
(dark green)

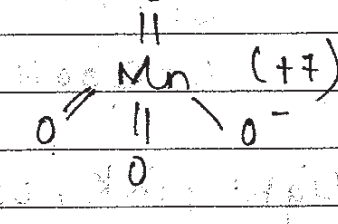
Mn^{+6} → stable in solid state or strongly alkaline medium

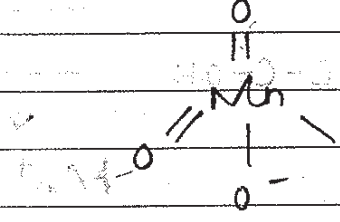
Oxidation of MnO_4^{2-} to MnO_4^-

(i) $K_2MnO_4 \xrightarrow[\text{strongly alk. medium}]{\text{electrolysis in}} KMnO_4 + O_2\uparrow$
(purple)

(ii) $K_2MnO_4 + O_3 \xrightarrow[\text{alkaline}]{\text{strongly}} KMnO_4 + O_2\uparrow$
(purple)

(iii) $K_2MnO_4 + Cl_2 \longrightarrow KMnO_4 + KCl$

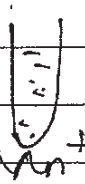




$5C_2O_4^{2-} + 2MnO_4^- + 16H^+ \xrightarrow[(Mn^{+2}\ \text{catalyst})]{H^+\ (60°C)} 10CO_2 + 2Mn^{+2} + 8H_2O$

$m = 2$ $\quad n = 5$

$[Mn(H_2O)_6]^{2+}$
(Light pink)



Mn^{+2}_{aq}
Light pink

i) $PbO_2 / H^+, \Delta$
ii) $Pb_3O_4 / H^+, \Delta$
iii) $NaBiO_3 / H^+, \Delta$
iv) $S_2O_8^{2-} / H^+$
v) IO_4^-

purple
MnO_4^-

i) Pb^{2+}
ii) Pb^{2+}
iii) Bi^{+3}
iv) SO_4^{2-}
v) IO_3^-

Date

MnO_4^- / H^+ (OA)

(RA)

SO_2 / SO_3^{2-}	→	SO_4^{2-}
NO_2^-	→	NO_3^-
S^{2-} / H_2S	→	S
$S_2O_3^{2-}$	→	$SO_4^{2-} + S$
I^-	→	I_2
BH^-	→	BH_2
HCl	→	Cl_2
F^-	→	X
H_3PO_3 / H_3PO_2	→	H_3PO_4
H_2O_2	→	O_2
$HCOOH / C_2O_4^{2-}$	→	CO_2
Fe^{+2}	→	Fe^{+3}
Sn^{+2}	→	Sn^{+4}
$C-CHO$, $C-C-OH$	→	$C-COOH$

Mn^{+2} (light pink, colourless)

MnO_4^- / OH^-

I^-	→	IO_3^-
$C=C$	→	$C(OH)-C(OH)$
H_2O_2	→	O_2
$S_2O_3^{2-}$	→	SO_4^{2-}

MnO_2

$MnO_2 + H_2SO_4 \xrightarrow{\text{room}} X$

$MnO_2 + H_2SO_4 \xrightarrow[\text{conc}]{\Delta} MnO + \frac{1}{2}O_2$

$MnO \xrightarrow{H_2SO_4} MnSO_4$

Date

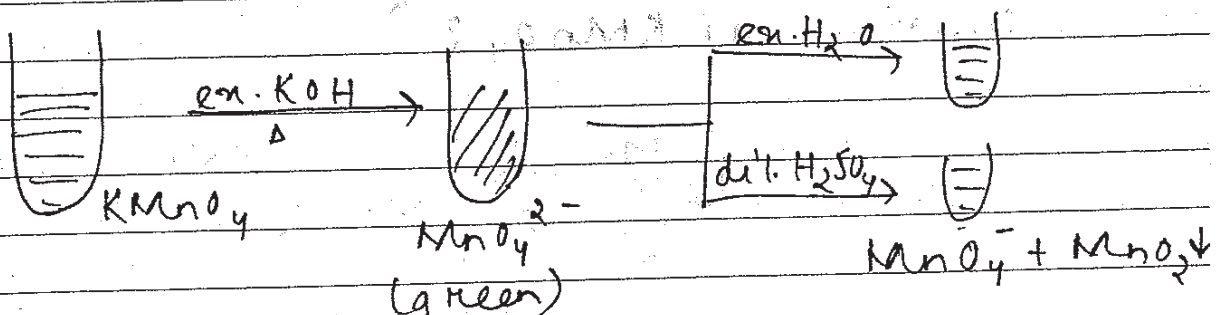
→ When aq. soln of oxalic acid is titrated by $KMnO_4$, initially colour of $KMnO_4$ disappear only on mixing on slow heating because Rxn is kinetically slow at room temp. but easily completed at 60°C

→ Once Mn^{+2} produced in beaker, they can catalyse further Rxn so that heating on mixing is not required in remaining titration.

→ To prepare acidic medium, HCl is not used as $KMnO_4$ can oxidise HCl to Cl_2

→ No external indicator is required during titration because it is self indicator titration

Q What happen when aq. soln of $KMnO_4$ is heated with excess KOH?



MnO_4^- + H_2O $\xrightarrow[\Delta]{ex.\ OH^-}$ $O_2\uparrow$ + MnO_4^{2-}

(permanganate) (manganate)

Date

→ K_2MnO_4 (manganate) is stable only in strongly alkaline medium or solid state but in less alkaline soln, neutral soln or addition of acid, K_2MnO_4 disproportionates to $KMnO_4 + MnO_2$

$$MnO_4^{2-} \longrightarrow MnO_4^- + e^-$$
$$2H_2O + MnO_4^{2-} + 2e^- \longrightarrow MnO_2 + 4OH^-$$
$$3MnO_4^- + 2H_2O \xrightarrow{\text{disp}} 2MnO_4^- + MnO_2 + 4OH^-$$

→ $KMnO_4$ can slowly oxidize water to O_2 and the rxn is catalysed by sunlight, so it is stored in dark coloured bottle. Due to same reason, $KMnO_4$ must be standardized before its use in titration

$$MnO_4^- + H_2O \xrightarrow{h\nu} MnO_2\downarrow + O_2\uparrow$$
(brown ppt)

Q Why ~~crystals~~ conc. H_2SO_4 is not added in crystals of $KMnO_4$?

$$KMnO_4 + \text{conc } H_2SO_4 \longrightarrow HMnO_4 + KHSO_4$$
$$2HMnO_4 \xrightarrow[-H_2O]{H_2SO_4} Mn_2O_7 \text{ (yellow green oily liquid)}$$

(Mn_2O_7: anhydride of permagnic acid)

$$Mn_2O_7 \xrightarrow{\Delta} MnO_2 + \tfrac{1}{2}O_2$$
(Mn_2O_7 explosive)

Date

Q. Write heating effect on i) $KMnO_4$ (crystal)
ii) $K_2Cr_2O_7$ (s)

$KMnO_4 \xrightarrow{513K} K_2MnO_4 + MnO_2 + O_2$
(dark purple) (green) (black)

$K_2Cr_2O_7 \xrightarrow{\Delta} K_2CrO_4 + Cr_2O_3 + 3/2\, O_2\uparrow$
(orange) yellow green

Q. What happen when $KMnO_4$ soln is treated with Mn^{+2} in presence of Zn^{+2} (catalyst)

$2KMnO_4 + 3MnSO_4 + 2H_2O \xrightarrow{Zn^{+2}} 5MnO_2 + K_2SO_4 + 2H_2SO_4$

In absence of Zn^{+2}, some of Mn^{+2} may escape. Oxidation through formation of insoluble $Mn^{II}[Mn^{IV}O_3]$.

Magnous permanganate

Chemistry of H_2SO_4

→ Preparation (By contact process)

$S + O_2 \xrightarrow{\text{burning}} SO_2$

$2FeS_2 + 1/2\, O_2(ex) \xrightarrow{\text{roasting}} Fe_2O_3 + 4SO_2\uparrow$

SO_2 (impure form) ← hydrated Fe_2O_3

$SO_2(g) + 1/2\, O_2(g) \xrightarrow[Pt]{V_2O_5 \text{ or } Pt} SO_3(g)$
$(\Delta H = -ve)$

$SO_3 + H_2SO_4 \longrightarrow H_2S_2O_7$

$H_2S_2O_7 + H_2O \longrightarrow 2H_2SO_4$

Date

Properties of H_2SO_4 -

→ It is a strong acid which dissociates to corresponding ion and react with base, basic oxide, amphoteric oxide, basic salt, etc.

$H_2SO_4 + Ba(OH)_2 \longrightarrow BaSO_4\downarrow + 2H_2O$

$H_2SO_4 + CuO \longrightarrow CuSO_4 + H_2O$

$H_2SO_4 + Fe(OH)_3 \longrightarrow Fe_2(SO_4)_3 + H_2O$

$H_2SO_4 + Pb(OH)_2 \longrightarrow PbSO_4\downarrow + H_2O$

$H_2SO_4 + Zn(OH)_2 \longrightarrow ZnSO_4 + H_2O$

$H_2SO_4 + 2NaHCO_3 \longrightarrow Na_2SO_4 + H_2O + CO_2\uparrow$

$H_2SO_4 + Na_2CO_3 \longrightarrow Na_2SO_4 + H_2O + CO_2\uparrow$

$H_2SO_4 + CdO \longrightarrow CdSO_{4\,aq} + H_2O$

$Na_2SO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2SO_3$

$\hookrightarrow H_2O + SO_2$

$KHSO_3 + H_2SO_4 \longrightarrow K_2SO_4 + SO_2 + H_2O$

$FeS + H_2SO_4 \longrightarrow FeSO_4 + H_2S\uparrow$

$2CH_3COO^- + H_2SO_4 \longrightarrow CH_3COOH + Na_2SO_4$

$Na_2S_2O_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2S_2O_3$

$\downarrow$

$H_2O + SO_2 + S\downarrow$

$1/8\,S_8$

$2NaNO_2 + H_2SO_4 \longrightarrow Na_2SO_4 + 2HNO_2$

$NaCl + H_2SO_4\,(dil) \longrightarrow X$

$NaCl + H_2SO_4\,(conc) \longrightarrow NaHSO_4 + HCl\uparrow$

$NaNO_3 + H_2SO_4\,(conc) \longrightarrow HNO_3 + NaHSO_4$

$\downarrow \Delta$

$H_2O + NO_2 + 1/2\,O_2\uparrow$

$NaNO_3 + H_2SO_4\,(dil) \longrightarrow X$

MnO_2 in one form - black
ppt form - brown.

Date

$3HNO_2 \xrightarrow{disp.} HNO_3 + 2NO\uparrow + H_2O$

$\downarrow$ air

$2NO_2\uparrow$ (brown)

* $HClO_4 > H_2SO_4 > HBr > HCl > HNO_3 > HSO_4^-$

Dehydrating Properties

It is a strong dehydrating agent and its dehydrating properties are due to strong hydrate formation ability (high hydration energy)

Charring of sugar -

$C_{12}H_{22}O_{11} \xrightarrow{conc\ H_2SO_4} 12C + 11H_2O$

$C_6H_{12}O_6 \xrightarrow{"} 6C + 6H_2O$

$HCOOH \xrightarrow{"} CO_2\uparrow$ (pure)

$COOH \xrightarrow{"} CO\uparrow + CO_2\uparrow$

$|$

$COOH$

Oxidising Nature

→ H_2SO_4 does not act as OA in dilute soln but its conc. soln can act as mild oxidising agent

Half cell product of conc. H_2SO_4 in most of the reaction is SO_2

$2H^+ + H_2SO_4\ (conc) + 2e^- \longrightarrow SO_2 + 2H_2O$

→ Only those metals, which are placed above H in reactivity series, react with dil. H_2SO_4 and produce H_2 + metal sulphate.

All metals (except Au, Pt) react with conc. H_2SO_4 and produce SO_2 + metal sulphate

Date

→ $Zn + dil.\ H_2SO_4 \longrightarrow ZnSO_4 + H_2\uparrow$

$Zn \longrightarrow Zn^{+2} + 2e^-$

$2H^+ + conc.\ H_2SO_4 + 2e^- \longrightarrow SO_2 + 2H_2O$

$Zn + H_2SO_4 + 2H^+ \longrightarrow SO_2\uparrow + Zn^{+2}$

$Zn + 2H_2SO_4 \longrightarrow SO_2\uparrow + ZnSO_4$

→ $Cu + dil.\ H_2SO_4 \longrightarrow X$

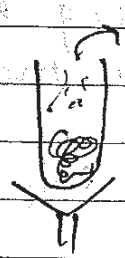
$Cu + 2H_2SO_4 \longrightarrow CuSO_4(aq) + SO_2\uparrow$

→ Non-metal or metalloid + conc. $H_2SO_4 \longrightarrow$ $SO_2\uparrow$ + its acid

$S_8 + conc.\ H_2SO_4 \xrightarrow{\text{Comproportionation}} SO_2\uparrow + SO_2\uparrow$

→

$NaCl + H_2SO_4 \xrightarrow[conc.]{} HCl + NaHSO_4$



$2BH^- \longrightarrow BH_3 + 2e^-$

$H_2SO_4 + 2H^+ + 2e^- \longrightarrow SO_2 + 2H_2O$

$2BH^- + H_2SO_4 + 2H^+ \longrightarrow SO_2\uparrow + 2H_2O + BH_3\uparrow$

$2I^- + H_2SO_4 + 2H^+ \longrightarrow SO_2 + 2H_2O + I_2\uparrow$

Date

NOTE:
OS of conc H_2SO_4 is sufficient to gain e^- from strong reducing I^- and Br^- and not sufficient to gain e^- from poor reducing Cl^- and F^-. So iodide and bromide salt produce I_2 and BH_2 respectively. Chloride and flouride salt produce HCl and HF resp. with conc. H_2SO_4

Chemistry of HNO_3

Preparation

1] Birkland Method

$$N_2 + O_2 \xrightarrow[\text{arc}]{\text{electric}} 2NO$$
$$2NO + O_2 \longrightarrow 2NO_2 \uparrow$$
$$2NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$$
$$3HNO_2 \longrightarrow HNO_3 + 2NO + H_2O$$

2] Ostwald Method

$$2NH_3 + 5/2\ O_2 \xrightarrow[9\ bar,\ 500K]{Pt\ Rh} 2NO + 3H_2O$$

$$2NO + O_2 \longrightarrow 2NO_2 \uparrow$$
$$2NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$$
$$3HNO_2 \longrightarrow HNO_3 + 2NO + H_2O$$

Nitric acid is colourless liquid, also called aqua fortis (strong water). Nitric acid appears yellow on long standing in sunlight, the yellow colour is due to dissolved NO_2 in it

$$2HNO_3 \xrightarrow{h\nu} H_2O + NO_2 + 1/2\ O_2$$

Date

On bubbling dry air, yellow colour disappear → HNO_3 when reacts with protein, it produce a yellow substance Xanthoprotein

Properties of HNO_3 -

i) Acidic Properties

$Na_2CO_3 + 2HNO_3(dil) \longrightarrow 2NaNO_3 + H_2O + CO_2\uparrow$

$NaHCO_3 + dil.\ HNO_3 \longrightarrow NaNO_3 + H_2O + CO_2$

$Sn(OH)_2 + 2HNO_3 \rightarrow Sn(NO_3)_2 + 2H_2O$

$CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$

$Fe_2O_3 + HNO_3 \rightarrow 2Fe(NO_3)_3 + 3H_2O$ (yellow soln)

$Zn(OH)_2 + HNO_3 \rightarrow Zn(NO_3)_2 + 2H_2O$

$PbO + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O$

No redox, acidic OA

No acid-base $PbO_2 + HNO_3 \xrightarrow{OA} X$

$(2PbO.PbO_2)\ Pb_3O_4 + HNO_3 \longrightarrow 2Pb(NO_3)_2 + PbO_2\downarrow + 2H_2O$ (brown ppt)

$HgO + HNO_3 \longrightarrow Hg(NO_3)_2 + H_2O$

$PbO_2 + 2HNO_3 \xrightarrow{(HOT)} PbO + \frac{1}{2}O_2\uparrow$

$2HNO_3 \downarrow$

$Pb(NO_3)_2$

Oxidising Properties -

Nitric Acid is a strong OA and its oxidising strength depends on concentration, temperature, partial pressure of gases (if any).

Half cell product of nitric acid change acc. to condition.

Date

M (Metal which are placed above H+ in reactivity series) Eg - Zn, Fe, - -.

- v. dil HNO_3 (6%) → Metal nitrate + NH_3 (NH_4NO_3)
- dil. HNO_3 (20%) → Metal nitrate + $N_2O\uparrow$
- conc. HNO_3 (70%) → Metal nitrate + $NO_2\uparrow$

M (Metal which placed below H+ in reactivity series) Eg - Cu, Hg, Ag.

- v. dil. HNO_3 → No rxn
- dil. HNO_3 → Metal nitrate + $NO\uparrow$
- conc. HNO_3 → Metal nitrate + $NO_2\uparrow$

Non-metal or Metalloid + HNO_3 (conc.) → ic acid + $NO_2\uparrow$

Exceptions -

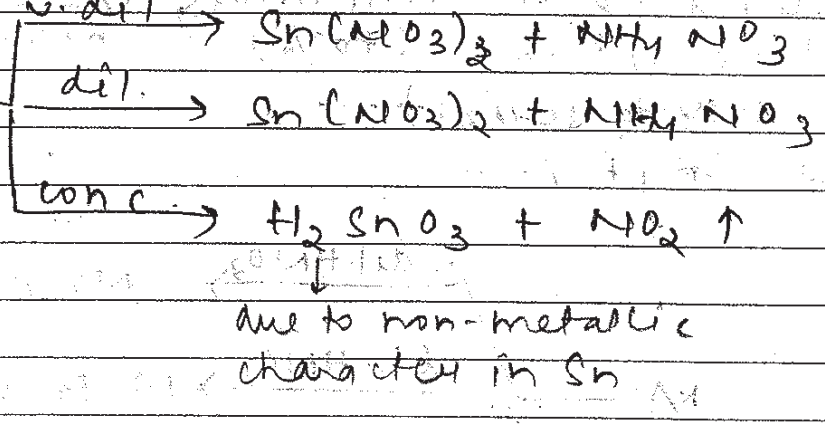
1) Au / Pt do not react with HNO_3
2) Al / Cr do not react with HNO_3 due to formation of inert layer of oxide on the surface.
3) Fe + 80% HNO_3 (Cr above) → Fe_3O_4 Inert coating on surface of Fe

Date

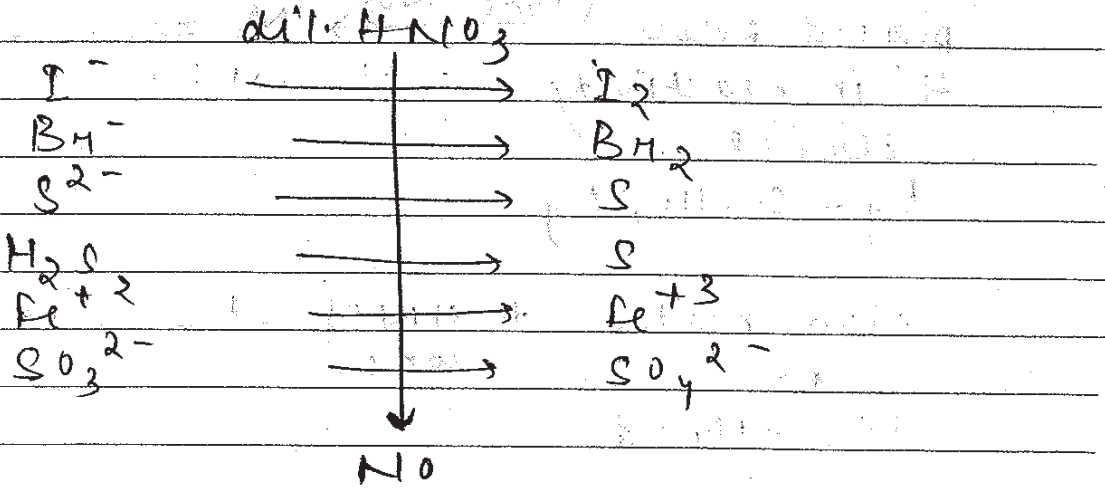
4) $Mg/Mn + 2\%\ HNO_3 \longrightarrow H_2\uparrow + Mn(NO_3)_2 / Mg(NO_3)_2$

5) Rxns of Pb are same as Cu

6)



Some other rxns -



8. Write balance rxn of

$Zn + v.\ dil.\ HNO_3 \longrightarrow$

$[Zn \longrightarrow Zn^{+2} + 2e^-] \times 4$

$8H^+ + HNO_3 + 8e^- \longrightarrow NH_3 + 3H_2O$

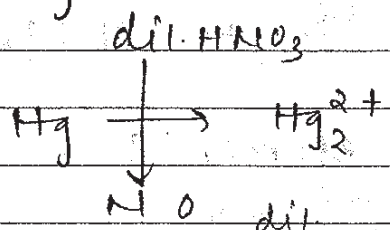
$4Zn + 8H^+ + HNO_3 \longrightarrow NH_3 + 4Zn^{+2} + 3H_2O$

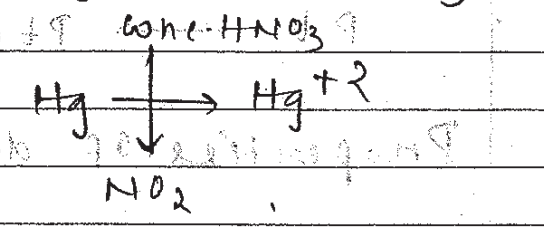
$4Zn + 10HNO_3 \longrightarrow NH_4NO_3 + 4Zn(NO_3)_2 + 3H_2O$

Date

Q Write balanced rxns

1) $Ag + dil.\ HNO_3$
2) $Cu + conc.\ HNO_3$
3) $Zn + dil.\ HNO_3$
4) $Fe + conc.\ HNO_3$
5) $P_4 + conc.\ HNO_3$
6) $Hg + dil.\ HNO_3$
7) $Hg + conc.\ HNO_3$
8) $S + conc.\ HNO_3 \rightarrow$





1) $3Ag + 4\underset{dil}{HNO_3} \longrightarrow 3AgNO_3 + NO + 2H_2O$
2) $Cu + 4\underset{conc}{HNO_3} \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$
3) $4Zn + 10\underset{dil}{HNO_3} \longrightarrow 4Zn(NO_3)_2 + N_2O + 5H_2O$
4) $Fe + 4\underset{conc}{HNO_3} \longrightarrow Fe(NO_3)_2 + 2NO_2 + 2H_2O$
5) $P_4 + 20\underset{conc}{HNO_3} \longrightarrow 4H_3PO_4 + 20NO_2 + 4H_2O$
6) $6Hg + 8\underset{dil}{HNO_3} \longrightarrow 3Hg_2(NO_3)_2 + 2NO + 4H_2O$
7) $Hg + 4\underset{conc}{HNO_3} \longrightarrow Hg(NO_3)_2 + 2NO_2 + 2H_2O$
8) $S + 6\underset{conc}{HNO_3} \longrightarrow H_2SO_4 + 6NO_2 + 2H_2O$

Date

Write Hxn of Au and Pt with aqua regia.

$$\underset{\text{conc.}}{HNO_3} + \underset{\text{conc.}}{3HCl} \longrightarrow \underset{\text{(red-orange)}}{NOCl} + 2H_2O + 2[Cl]$$

$$Au \longrightarrow AuCl_3 \xrightarrow{HCl} H[AuCl_4]$$

$$Pt \longrightarrow PtCl_4 \xrightarrow{HCl} H_2[PtCl_6]$$

Properties of d-block elements -

		IIIB	IVB	VB	VIB	VIIB	VIII (triad)			IB	IIB
4th Per.	(3d)	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
5th	(4d)	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
6th	(5d)	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg

Fe, Co, Ni → ferrous metal

Ru Rh Pd } → Platinum metal

Os Ir Pt }

→ Element in which last e^- goes to fill d-subshell (acc to (n+ℓ) rule) are considered as d-block elements (except La, Lu, Ac, Lr)

→ d-block elements are also considered as transition elements because their properties are transitional b/w s and p block

Date

→ Acc to modern def., elements in which d subshell is incomplete in their elemental state or in their ionic state are considered as transition elements

→ Zn, Cd, Hg are not considered as transition elements.

→ Most of the periodic properties are irregular in d-block

→ In 3d series, Zn has lowest MP and BP and Cr/V has highest MP

→ Heat of atomisation is lowest for Zn and highest for V

→ In d-block, Hg has lowest MP and BP and W has highest MP.

→ Tc is the first synthetic or man-made element.

→ Os/Ir are the most dense metal.

→ Cu, Ag, Au are collectively called coinage meta

→ There is only one d-block metal which does not have 18 e^- in outermost shell - Pd

Date

1] Variable ON
2] Complex formation
3] Magnetic nature
4] Colouration
5] Alloy formation
6] Interstitial compound formation
7] Catalytic action

Variable ON -

→ Most of the d-block elements have more than one type of OS.

→ In 3d series, all the elements can form more than ~~two~~ one type of ion (except Sc/Zn)

→ +2 oxid^n state is the most common oxd^n state of 3d series (Sc^{2+} is virtually ~~k~~ unknown)

→ +3 ion is the most stable ion of 3d series

→ On moving left to right in d-block, tendency to show highest OS upto Mn increases then decreases

→ Mn has highest variety of OS in 3d-series

→ +7 is the highest OS of 3d-series by Mn

→ +8 is the highest OS of d-block by Os/Ru

Date

→ For a particular metal on ↑ OS, covalent character ↑ in their compounds

→ Higher OS (+6, +7) are generally stabilized by electronegative elements like O, F, etc

O has more ability to stabilize higher OS of d-block metals

→ Sometimes -ve OS is also observed in d-block compounds when ligands have π-acceptor ability.

→ In 3d-series, stability of the ions depends on various factors like IE, heat of atomisation HE, LE, half-filled, full-filled config. and symm., unsymm. distribution of e^- in t_{2g} and e_g orbitals so that overall stability is decided by E° in aq. soln.

→ All the 3d-metals are placed above H^+ in reactivity series except Cu.

→ Ti^{+2}, V^{+2} and Cr^{+2} can displace H^+ ion from acidic soln

$$Ti^{+2}/V^{+2}/Cr^{+2} + 2H^+ \longrightarrow Ti^{+3}/V^{+3}/Cr^{+3} + H_2\uparrow$$

(most spontaneous for Cr^{+2})

→ Out of all M^{+3} ions Co^{+3} and Mn^{+3} are least stable so that they have strong tendency to convert in +2 form

$$aqCo^{+3}/Mn^{+3}_{aq} + e^- \longrightarrow Co^{+2}/Mn^{+2}$$

(Most spontaneous for Co^{+3})

Date

$Fe = [Ar]\,3d^6 4s^2$ $\quad Cu = [Ar]\,3d^{10} 4s^1$

$Fe^{+2} = [Ar]\,3d^6$ $\quad Cu^{+} = [Ar]\,3d^{10}$

$Fe^{+3} = [Ar]\,3d^5$ $\quad Cu^{+2} = [Ar]\,3d^9$

(RA)

$[Cu(H_2O)_6]^{+2} \longrightarrow [Cu(H_2O)_6]^{+3} + e^-$

d^4: $\uparrow$ | $\uparrow$ $\uparrow$ $\uparrow$ $\quad$ d^3: | $\uparrow$ $\uparrow$ $\uparrow$

(OA)

$[Mn(H_2O)_6]^{+3} + e^- \longrightarrow [Mn(H_2O)_6]^{+2}$

d^4: $\uparrow$ | $\uparrow$ $\uparrow$ $\uparrow$ $\quad$ d^5: $\uparrow$ $\uparrow$ | $\uparrow$ $\uparrow$ $\uparrow$

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
	+2	+2	+2	+2	+2	+2	+2	+2	+2
+3	+3	(+3)	+3	+3	+3	+3	+3		
	+4	+4	+4	+4	+4	+4	+4		
		+5	+5	+5					
			+6	+6	+6				
				+7					

Ti^{+4} - colourless

Ti^{+3} - violet purple

V^{4+} - blue

V^{2+} - violet

Cr^{3+} - violet

Mn^{2+} - light pink

Fe^{3+} - yellow

Fe^{2+} - light green

Ni^{2+} - green

Zn^{2+} - colourless

Sc^{3+} - colourless

V^{3+} - green

Cr^{2+} - blue

Mn^{3+} - violet

Co^{2+} - pink

Cu^{2+} - blue

Date

Blue soln of $CuSO_4$ is converted to green when its aq. soln is treated with ex. of Cl^- ion. Explain

$$[Cu(H_2O)_4]^{+2} + 4\,Cl^- \rightleftharpoons [CuCl_4]^{2-}$$

(conc) ex.

Blue ← Yellow

Green

Rxn not complete H_2O strong ligand than Cl

$$Fe^{+3} \xrightarrow[Cl_2/NaOCl]{OH^-} FeO_4^{2-}$$

Ferrate ion (unstable)

(violet)

$$FeO_4^{2-} \xrightarrow{\text{stand}} Fe_2O_3 + O_2\uparrow$$

Date

Catalyst	Used
$TiCl_3$	→ Used as the Ziegler-Natta catalyst in the production of polythene
V_2O_5	→ Convert SO_2 to SO_3 in the contact process for making H_2SO_4
MnO_2	→ Used as a catalyst to decompose $KClO_3$ to O_2
Fe	→ Promoted iron is used in the Haber-Bosch process for making NH_3
$FeCl_3$	→ Used in the production of CCl_4 from CS_2 and Cl_2
$PdCl_2$	→ Wacker process for converting $C_2H_4 + H_2O + PdCl_2$ to $CH_3CHO + 2HCl + Pd$
Pd	→ Used for hydrogenation (eg phenol to cyclohexanone)
Pt/PtO	→ Adams catalyst, used for reductions
Pt	→ formerly used for $SO_2 \rightarrow SO_3$ in the contact process for making H_2SO_4
Pt/Rh	→ formerly used in the Ostwald process for making HNO_3 to oxidize NH_3 to NO
Cu	→ Is used in the direct process for manufacture of $(CH_3)_2SiCl_2$ used to make silicones
Cu/V	→ Oxidation of cyclohexanol/ cyclohexanone mixture to adipic acid which is used to make nylon-66

Date

$CuCl_2$ → Deacon process of making Cl_2 from HCl

Ni → Raney nickel, numerous reduction processes (eg manufacture of hexamethylenediamine, production of H_2 from NH_3, reducing anthraquinone to anthraquinol in the production of H_2O_2

$FeSO_4 + H_2O_2$ → Used as fenton's reagent for oxidizing alcohols to aldehydes.

→ d-block elements and their compounds act as catalyst in many rxns. Their catalytic activities are probably due to following three reasons

1. Due to the presence of unpaired e^- and their paramagnetic nature, they can adsorb reactants on their surface
   eg - Hydrogenation of alkene by raney Ni or Pd/Pt catalyst

2. Sometimes variable OS of d-block elements help for alternate mechanism of rxn. For eg - Deacon process and Contact process

Deacon Process

$$2HCl + \frac{1}{2}O_2 \xrightarrow[\Delta]{CuCl_2} H_2O + Cl_2$$

$$2CuCl_2 \xrightarrow{\Delta} Cu_2Cl_2 + Cl_2\uparrow$$

$$Cu_2Cl_2 + \frac{1}{2}O_2 \longrightarrow CuO \cdot CuCl_2$$

$$CuO \cdot CuCl_2 + 2HCl \longrightarrow 2CuCl_2 + H_2O$$

Cu + Zn Cu + Sn Cu + Zn + Ni Pb + Sn

Dura-aluminium, Electron

Date

Contact -

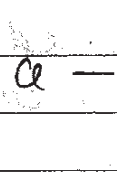
$$SO_2 + \frac{1}{2}O_2 \xrightarrow{V_2O_5} SO_3$$

$$2SO_2 + V_2O_5 \longrightarrow 2SO_3 + V_2O_3$$

$$V_2O_3 + O_2 \longrightarrow V_2O_5$$

3. Sometimes - unstable, intermediate complexes are formed by d-block elements and their compounds during rxn mechanism eg - Wilkinson catalyst, Ziegler Natta Catalyst

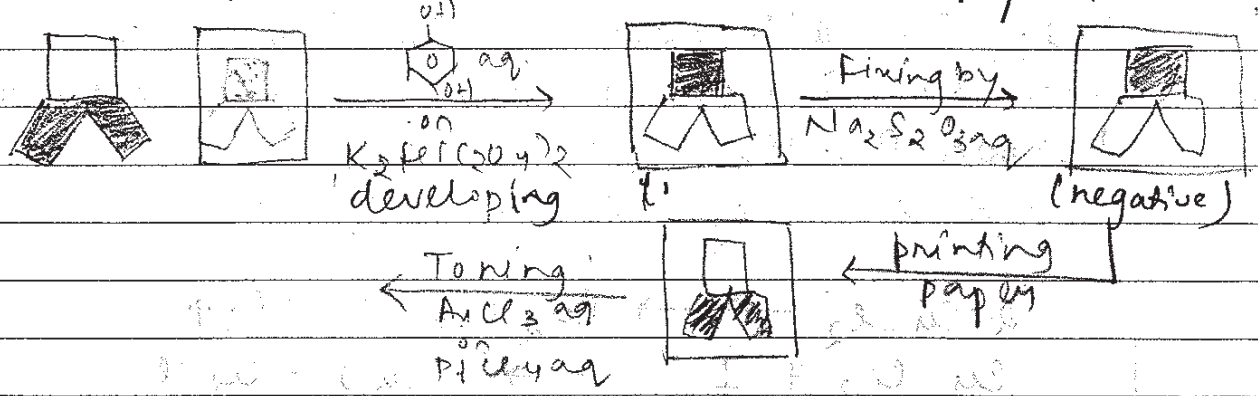
$$CH_2 = CH_2 \xrightarrow[\Delta]{TiCl_4 + (C_2H_5)_3Al} \left[CH_2 - CH_2\right]$$



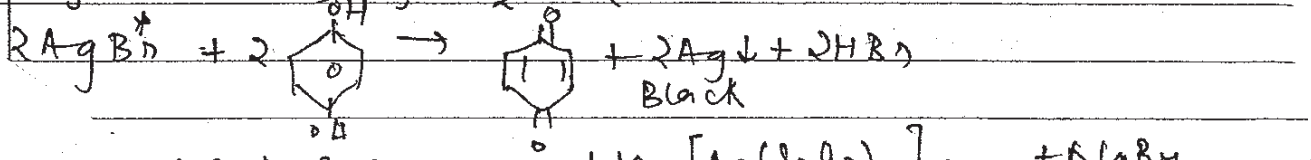
AgO $Ag[AgO_2]$

linear sq. planar

Chemistry of black and white photography



$$AgBr \xrightarrow{h\nu} Ag + \frac{1}{2}Br_2$$



Ga, Ge, Bi - liquid form more dense than solid form

p-BLOCK

Date

Boron family -

13 A	$ns^2 np^1$
5 B	$[He]\ 2s^2 2p^1$
13 Al	$[Ne]\ 3s^2 3p^1$
31 Ga	$[Ar]\ 3d^{10} 4s^2 4p^1$
49 In	$[Kr]\ 4d^{10} 5s^2 5p^1$
81 Tl	$[Xe]\ 4f^{14} 5d^{10} 6s^2 6p^1$

B_{12} - icosahedron - covalent solid

12 = Vertex — B_{12} units are linked by

20 = Faces — covalent bonds

Size = B < Al > Ga < In < Tl

or

B < Ga ≤ Al < In < Tl

$Ga_{(s)} \xrightarrow{29^\circ C} Ga_{(l)} \xrightarrow{BP = 2400^\circ C} Ga_{(g)}$

IE = B > Tl > Ga > Al > In

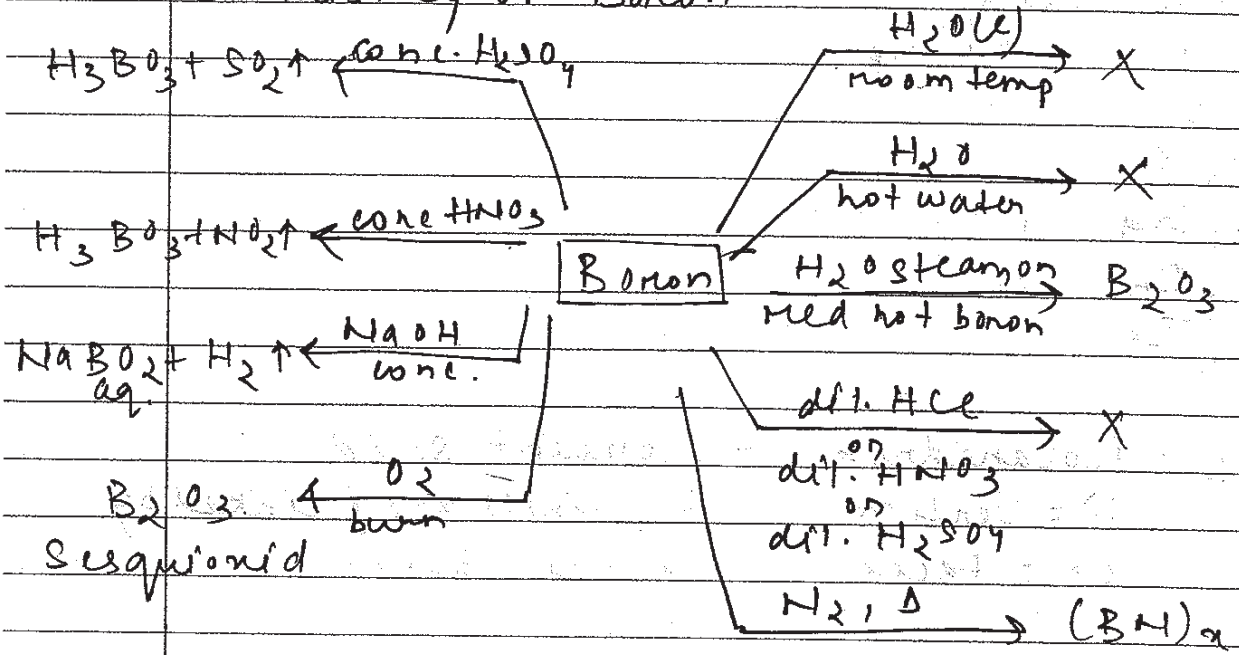
→ Boron is a non-metal, still it has high MP because of the efficient packing of B_{12} units and each B_{12} unit is covalently linked with adjacent B_{12} units (It is a covalent solid).

→ Ga(l) is more dense as compared to Ga(s) and it is special feature of only 3 metals - Ga, Ge, Bi

→ Due to large diff. of MP and BP, Ga is used to prepare high temp. thermometer

Date

Chemistry of Boron -



Preparation -

$$BI_3 \xrightarrow[\text{Van Arkel}]{\Delta} B + \frac{3}{2} I_2$$

$$B_2O_3 + 2Al \xrightarrow[Na/K/Mg]{\Delta} 2B + Al_2O_3$$

Chemistry of H_3BO_3 -

Preparation -

1. $BCl_3 + 3H_2O \longrightarrow H_3BO_3 + 3HCl$

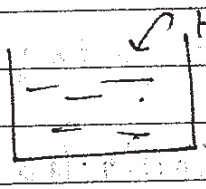
2. $2NaBO_2 + 3H_2SO_4 \xrightarrow[conc.]{\Delta} 2H_3BO_3\uparrow + 3Na_2SO_4$ (white fumes)

3. $B + H_2SO_4 \xrightarrow[conc.]{} H_3BO_3 + SO_2\uparrow$

4. $B + HNO_3 \xrightarrow[conc.]{} H_3BO_3 + NO_2\uparrow$

5. $Na_2B_4O_7 + 2HCl + 5H_2O \longrightarrow 2NaCl + 4H_3BO_3\downarrow$ white

Date



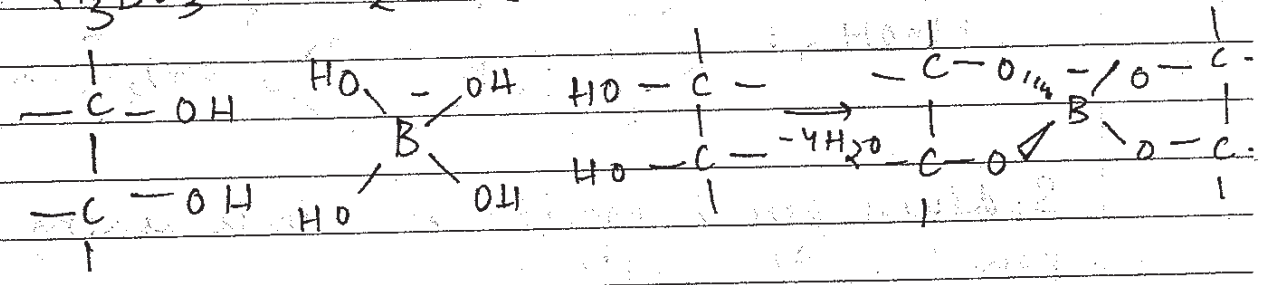
$$H_3BO_3 + H_2O \overset{pKa = 9.25}{\rightleftharpoons} [B(OH)_4]^- + H^+$$

* Monobasic
* Lewis Acid
* It is not H^+ donor
* It is OH^- acceptor
* Weak Acid

Q. Boric Acid titration perform in the presence of

A) Ethanol
B) Propanol
C) Glycerol
D) Trans 1,2 diol

$$H_3BO_3 + H_2O \rightleftharpoons [B(OH)_4]^- + H^+$$



NOTE :→ Boric Acid is a weak acid so that sharp end point is not observed when aq. soln of boric acid is titrated by NaOH so that titration of boric acid is completed in the presence of cis 1,2 diol, for eg - glycerol, manitol catechol, glucose, sugar, etc.

→ Titration of boric acid by NaOH (in the presence of cis 1,2 diol) requires Hph indicator

Date

Write rxn of Boric Acid with NaOH aq and NaOH fused.

$H_3BO_3 + NaOH_{aq} \longrightarrow Na[B(OH)_4]_{aq}$

$H_3BO_{3(a)} + NaOH_{fused} \longrightarrow Na_3BO_3 + 3H_2O$
(Sod. Borate)

$H_3BO_{3(s)}$ (Orthoboric acid) $\xrightarrow[-H_2O]{100^\circ C}$ HBO_2 metaboric acid

$\downarrow 140^\circ C$

$H_2B_4O_7$ tetraboric acid

$\downarrow$ Red hot

B_2O_3 (boron sesquioxide)

Q. What happens when aq. soln of H_3BO_3 react with H_2O_2 in alkaline medium?

⇒ $H_3BO_3 + H_2O_2 \longrightarrow H_2O + (OH)_2-B-O-O-H$

$\xrightarrow{NaOH} Na_2\left[(HO)_2B\begin{matrix}O-O\\O-O\end{matrix}B(OH)_2\right]\cdot 6H_2O$

Sodium peroxyborate used in washing powder as bleachner

Chemistry of Borax :-

$(Na_2B_4O_7\cdot 10H_2O)$

Preparation of borax from Colemanite -

$Ca_2B_6O_{11}\cdot 5H_2O + 2Na_2CO_{3\,aq} \xrightarrow{\text{hot water}}$

$2CaCO_3\downarrow + Na_2B_4O_{7\,aq} + 2NaBO_{2\,aq}$

white ppt

$\downarrow$ cooling

$Na_2B_4O_7\cdot 10H_2O$ crystals

$\uparrow$ cooling

$4NaBO_2 + CO_2 \longrightarrow Na_2B_4O_{7\,aq} + Na_2CO_{3\,aq}$

Date

Q. Aq. soln of borax is

A) Acidic

✓B) Basic

C) Neutral

$Na_2B_4O_7 + 7H_2O \longrightarrow 4H_3BO_3 + 2NaOH$

$2H_3BO_3 + 2NaOH \longrightarrow 2Na[B(OH)_4]$

$Na_2B_4O_7 + 7H_2O \longrightarrow 2Na[B(OH)_4] + 2H_3BO_3$

pH = 9.25

Q. 1 mol borax is completely titrated by

✓A) 2 mol HCl

B) 2 mol H_2SO_4

C) 2 mol NaOH

D) 4 mol KOH

$Na_2B_4O_7 + 7H_2O \longrightarrow 2NaOH + 4H_3BO_3$

$2NaOH + 2HCl \longrightarrow 2NaCl + 2H_2O$

$2HCl + Na_2B_4O_7 + 5H_2O \xrightarrow{MeOH} 2NaCl + 4H_3BO_3\downarrow$

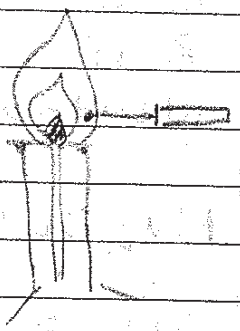
↑ Indicator

white

Date

Borax Bead Test

$Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta}$
$Na_2B_4O_7 + 10H_2O\uparrow$
swell up



$Na_2B_4O_7 \xrightarrow[hot]{red} 2NaBO_2 + B_2O_3$
glassy bead

$CuSO_4 \longrightarrow CuO + SO_2 + \frac{1}{2}O_2\uparrow$

$CuO + B_2O_3 \longrightarrow Cu(BO_2)_2 / Na_2[\overset{II}{Cu}(BO_2)_4]$
Cu-metaborate
(L. blue)

$2\overset{II}{Cu}(BO_2)_2 + C \longrightarrow \overset{I}{Cu_2}(BO_2)_2 + B_2O_3 + CO_2\uparrow$
colourless

$Cu_2(BO_2)_2 + C \longrightarrow 2Cu + B_2O_3 + CO\uparrow$
(red-opaque)

Oxidising Flame
(cold)

$Cu(BO_2)_2$	- Light blue
$Co(BO_2)_2$	- dark blue
$Cr(BO_2)_3$	- green
$Fe(BO_2)_3$	- yellow
$Ni(BO_2)_2$	- brown
$Mn(BO_2)_2$	- Light violet

Date

$Na(NH_4)HPO_4 \cdot 4H_2O$ - Microcosmic Salt

$Na(NH_4)HPO_4 \cdot 4H_2O \xrightarrow{\Delta} Na(NH_4)HPO_4 + 4H_2O$
swells up

$Na(NH_4)HPO_4 \xrightarrow{\Delta} NaPO_3 + NH_3\uparrow + H_2O\uparrow$
sodium metaphosphate
(glassy bead)

$CuO + NaPO_3 \xrightarrow{\Delta} NaCuPO_4$
(light blue glass bead)

→ Borax bead test is applicable to those metal ions which can produce coloured metaborates on heating with bead of borax

→ Microcosmic salt bead test is similar to borax bead test and colour observations are almost same. Coloured bead is formed due to the formation of coloured phosphates

Write rxns to prepare B_2H_6 (Diborane)

i) Prepared by treating boron trifluoride with $LiAlH_4$ in diethyl ether

$3LiAlH_4 + 4BF_3 \rightarrow 3LiF + 3AlF_3 + 2B_2H_6$

ii) $2NaBH_4 + I_2 \rightarrow B_2H_6 + 2NaI + H_2$

iii) $BF_3 + 6NaH \xrightarrow{450\,K} B_2H_6 + 6NaF$

$Mg_3B_2 + 6HCl \rightarrow 3MgCl_2 + 2BH_3$
$(3Mg^{+2}\,2B^{3-})$ ↓ B_2H_6

Date

ALUMS

→ All the alums are isomorphous to each other

→ Li^+ does not form alum because of its small size, it does not accomodate in the lattice of alum.

→ Alums are coloured when they have any coloured ion

→ Alums swell up on heating & and finally produce amorphous residue

→ Aq. soln of alums is acidic.

→ Alums of Tl contain Tl^+ rather than Tl^{+3} because Tl^+ is more stable ion of Tl.

$[M(H_2O)_6]_2SO_4 \cdot [M'(H_2O)_6]_2(SO_4)_3$

$M_2SO_4 \cdot M_2'(SO_4)_3 \cdot 24H_2O$

M = uni positive ion (Na^+, K^+, Rb^+, Cs^+, NH_4^+, Tl^+)

M' = tri tve ion (Al^{+3}, Ga^{+3}, In^{3+}, Cr^{+3}, Fe^{+3}, Co^{+3})

$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$ = Potash Alum (white)

$KAl(SO_4)_2 \cdot 12H_2O$

$K_2SO_4 \cdot Cr_2(SO_4)_3 \cdot 24H_2O$ = Chrome Alum (violet)

$(NH_4)_2SO_4 \cdot Fe_2(SO_4)_3 \cdot 24H_2O$ = Ferric Alum (yellow)

Quantum No
Q 3 - Ans (4)
d-Block
Q 3 - Ans - (1)

Date

$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O \xrightarrow{\Delta} K_2SO_4 + Al_2(SO_4)_3 + 24H_2O \uparrow$

swell up

$\downarrow \Delta$

$K_2SO_4 + Al_2O_3 + SO_2 + \frac{1}{2}O_2$

Amorphous powders

$K_2SO_4 \cdot 2MnSO_4 \cdot 24H_2O$ - pseudo alum

Carbon family

C
Si
Ge
Sn
Pb } → Not show allotropy

(Metallic)

M = C < Si < Ge < Sn < Pb

IE = C > Si > Ge > Pb > Sn

Oxide -

	Mono	di	Suboxide
C	CO	CO_2	C_3O_2 / $C_{12}O_9$
Si	~~SiO~~	$(SiO_2)_n$	
Ge	GeO	GeO_2	
	acidic	acidic	
Sn	SnO	SnO_2	
Pb	PbO	PbO_2	(Pb_3O_4 + Pb_2O_3)

Mixoxide

Date

Chemistry of CO:-

Preparation

1. $C + \underset{\text{limited}}{O_2} \longrightarrow CO$

2. $\underset{\text{red hot}}{C} + \underset{\text{steam}}{H_2O} \longrightarrow \underbrace{CO + H_2}_{\text{water gas}}$

3. $C + \underset{\text{limited}}{Air} \longrightarrow \underbrace{CO + H_2}_{\text{producer gas}}$

4. $HCOOH \xrightarrow[-H_2O]{\text{conc.}\ H_2SO_4} CO\uparrow$

5. $\begin{matrix} COOH \\ | \\ COOH \end{matrix} \xrightarrow[-H_2O]{\text{conc.}\ H_2SO_4} CO\uparrow + CO_2\uparrow$

6. $CH_4 + \underset{\text{limited}}{O_2} \longrightarrow CO + H_2O$

7. $2KCN + \underset{\text{conc.}}{H_2SO_4} \longrightarrow K_2SO_4 + 2HCN$

$H-C\equiv N + H_2O \longrightarrow HCOOH + NH_3$

$HCOOH \xrightarrow{\text{conc.}\ H_2SO_4} CO\uparrow$; $NH_3 \xrightarrow{H_2SO_4} (NH_4)_2SO_4$

$2KCN + \text{dil.}\ H_2SO_4 \longrightarrow 2HCN\uparrow + K_2SO_4$

8. $K_4[Fe(CN)_6] \xrightarrow[H_2SO_4]{\text{dil.}} HCN\uparrow + K_2SO_4 + FeSO_4 / Fe_2(SO_4)_3$ (Kadwe badam ki smell)

$K_3[Fe(CN)_6] \xrightarrow[K_2SO_4]{\text{conc.}} CO\uparrow + K_2SO_4 + FeSO_4 / Fe_2(SO_4)_3$

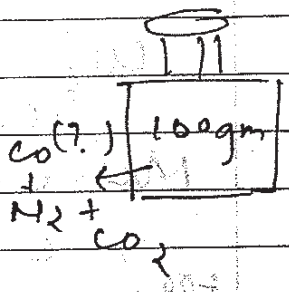
Date

Estimation of CO

$$5CO + I_2O_5 \rightarrow I_2 + 5CO_2 \uparrow$$

steam

$$I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$$



Test of CO

1. Burn with blue flame
2. CO — red litmus → red; blue litmus → blue
3. $PdCl_2 aq + CO + H_2O \rightarrow Pd\downarrow + 2HCl + CO_2 \uparrow$ (Black ppt)

Absorber of CO

$CuCl + CO + 2H_2O \rightarrow [Cu^{I}Cl(CO)(H_2O)_2]^{\circ}$

(ammoniacal soln)

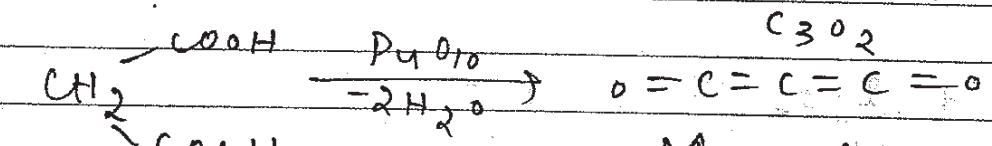
NOTE : CO is neutral but

$$CO + NaOH_{(s)} \xrightarrow[\Delta]{200-250^\circ C} HCOO^-Na^+$$

Gas	Absorber
NO	$FeSO_4$ (aq)
CO	ammonical CuCl soln
CO_2	KOH
SO_2	$K_2Cr_2O_7 / H^+$
O_2	Pyrogallol / OH^-
O_3	Turpentine oil / oil of Cinamon
NH_3	conc H_2SO_4
PH_3	$CuSO_4 / HgCl_2 / CaOCl_2$
N_2	CaC_2

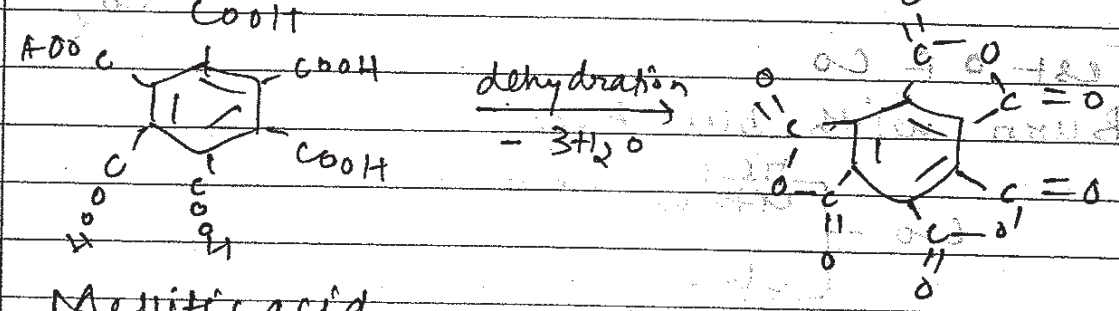
Date

Carbon suboxide



Malonic Acid

Malonic Acid anhydride



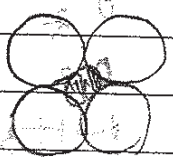
Mellitic acid

Carbide

Binary compound of C in which C has -ve charge or partial -ve charge or C is present with electropositive elements are considered as carbides (except hydrocarbon)

Carbide

- Ionic Carbide or Salt like Carbide
  - CaC_2 (Ca^{+2} C_2^{2-})
  - Al_4C_3 ($4Al^{+3}$ $3C^{-4}$)
  - Be_2C ($2Be^{+2}$ C^{-4})
  - Mg_2C_3 ($2Mg^{+2}$ C_3^{-4})
  - Na_2C_2
- Covalent Carbide
  - B_4C
  - SiC
- Interstitial Carbide
  - Fe_3C (Cementite)



C_3^{4-}

Date

$CaC_2 + H_2O \rightarrow Ca(OH)_2 + C_2H_2$

$Al_4C_3 + H_2O \rightarrow Al(OH)_3 + CH_4$

$Be_2C + H_2O \rightarrow Be(OH)_2 + CH_4$

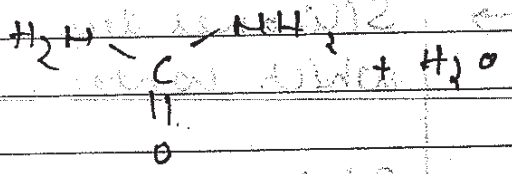
$Mg_2C_3 + H_2O \rightarrow Mg(OH)_2 + HC \equiv C-CH_3$

$CaC_2 + N_2 \xrightarrow{1100°C} \underbrace{CaCN_2}_{\text{calcium cyanamide}} + C$ (carbon)

Nitrolim fertilizer

$Ca^{+2}\ \bar{N}=C=N^{-} + 2H_2O \rightarrow Ca(OH)_2 +$

$HN=C=NH \xrightarrow{2H_2O}$

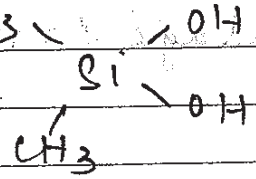


$CaCN_2 + 4H_2O \rightarrow CaCO_3 + 2NH_4OH$

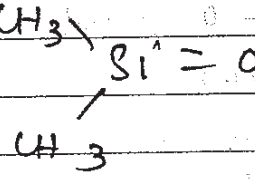
Silicones

Q. $(CH_3)_2SiCl_2$ on hydrolysis produce

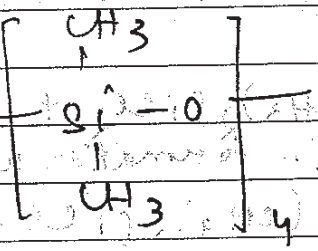
A)



B)

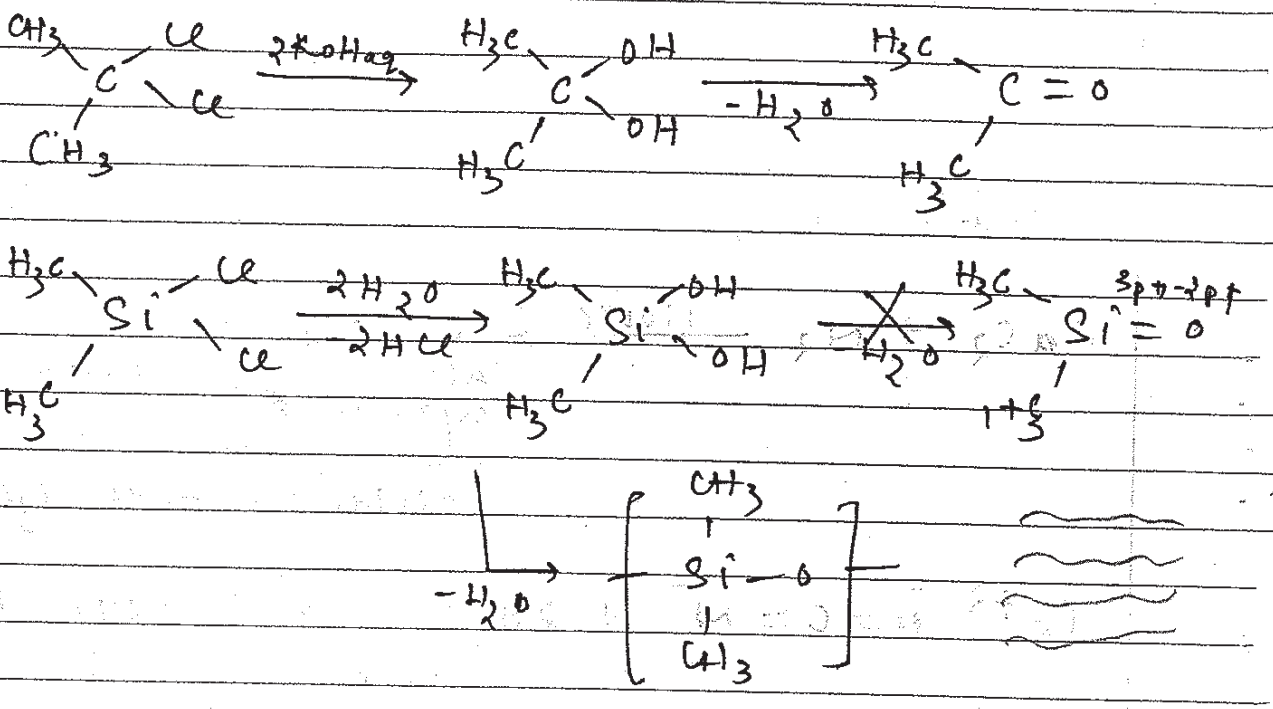


C)



D) $(SiO_2)_n$

Date



→ Silicones are organo-silicon polymers which contain $\rightarrow Si-O-Si-$ linkage

→ Silicones are prepared by hydrolysis of alkyl or aryl substituted chlorosilanes.

→ Silicones are chemically inert and water-proof polymers due to the presence of Si–O and Si–C linkage in their structure.

$$CH_3MgCl + SiCl_4 \longrightarrow CH_3SiCl_3 + MgCl_2$$

$$CH_3MgCl + CH_3SiCl_3 \longrightarrow (CH_3)_2SiCl_2 + MgCl_2$$

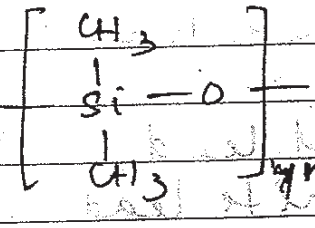
chain formation unit

$$CH_3MgCl + (CH_3)_2SiCl_2 \longrightarrow (CH_3)_3SiCl + MgCl_2$$

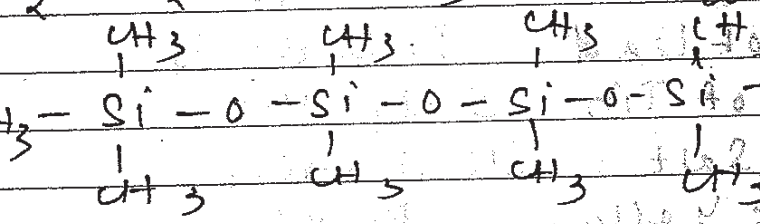
chain termination

$$CH_3Cl \xrightarrow[\Delta]{Cu-Si} (CH_3)_2SiCl_2 + Cu$$

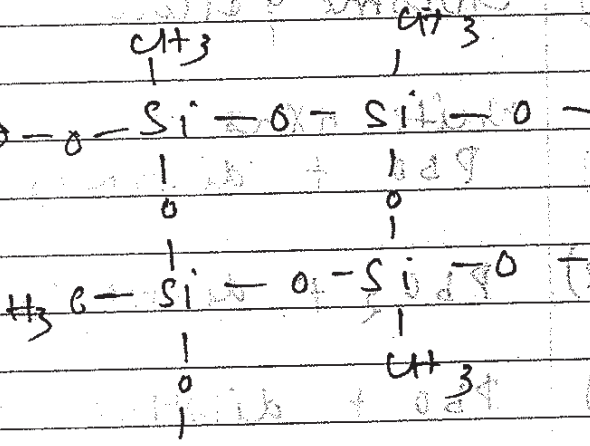
Date

$(CH_3)_2SiCl_2 \xrightarrow[\text{condensation}]{\text{hydrolysis}}$ 

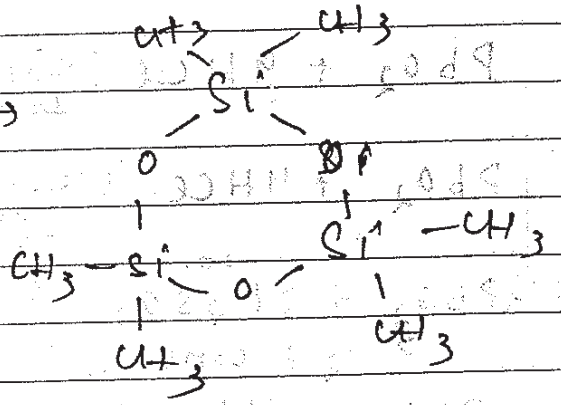
$2(CH_3)_2SiCl_2 + 2(CH_3)_3SiCl \xrightarrow{hyd.}$

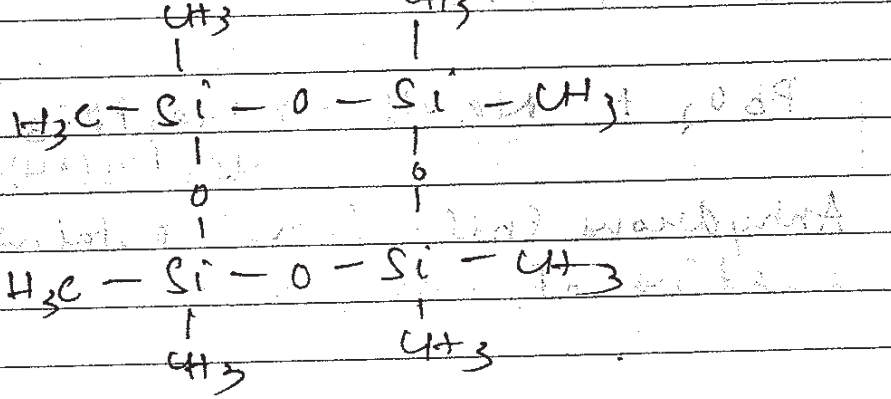


$(CH_3)SiCl_3 \xrightarrow[cond.]{hyd.}$



$(CH_3)_2SiCl_2 \xrightarrow[hyd.]{\text{controlled}}$





Date

Write formula of following cpds -

1] Red lead - Pb_3O_4
2] White lead - $2(PbCO_3)_2 \cdot Pb(OH)_2$
3] Litharge - PbO (Reddish Yellow)
4] Messicot - PbO (Yellow)
5] Sugar of lead - $Pb(CH_3COO)_2$
6] Butter of Tin - $SnCl_4 \cdot 5H_2O$
7] Pink's Salt - $(NH_4)_2SnCl_6$
8] Chrome yellow - $PbCrO_4$

Write RXns -

1] $PbO + dil.2HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$

2] $PbO_2 + dil.HNO_3$ X

3] $PbO + dil.2HCl \longrightarrow PbCl_2 + H_2O$

4] $PbO_2 + 4HCl$ (room temp) $\longrightarrow PbCl_2 + Cl_2 + 2H_2O$ redox

5] $PbO_2 + 4HCl$ (ice cold water) $\longrightarrow PbCl_4 + 2H_2O$ acid-base

$PbCl_4 + 2HCl \longrightarrow H_2PbCl_6$

6] $2PbO_2 + 2H_2SO_4$ (conc) $\xrightarrow{\Delta} 2PbSO_4 + 2H_2O + O_2$

$PbO_2 + conc.H_2SO_4 \longrightarrow$ X

7] $PbO + 2NaOH \longrightarrow Na_2PbO_2 + H_2O$

$Na_2[Pb(OH)_4]$

8] $PbO_2 + NaOH \longrightarrow Na_2PbO_3 + H_2O$

$Na_2[Pb(OH)_6]$

Q. Anhydrous $SnCl_2$ is not obtained on direct heating of $SnCl_2 \cdot 2H_2O$.

Date

$SnCl_2 \cdot 2H_2O \xrightarrow{\Delta} Sn(OH)Cl + HCl\uparrow + H_2O\uparrow$

$\downarrow$

$SnO + HCl\uparrow$

Hence, anh. $SnCl_2$ cannot be obtained

Q. What happen when aq. soln of Mn^{+2} is heated with PbO_2 in acidic medium?

$2Mn(NO_3)_2 + 5PbO_2 + 2H_2SO_4 \longrightarrow$

$3Pb(NO_3)_2 + 2PbSO_4\downarrow + 2HMnO_4 + 2H_2O$.

Q. $SnCl_2$ and $HgCl_2$ do not exist together in a soln Explain.

$2HgCl_2 + SnCl_2 \longrightarrow 2Hg\downarrow + SnCl_4$

Q. Write the amorphous form of SiO_2.

Kieselghur

(Used in Filtration plants)

Q. $(NH_4)_2Cr_2O_7$ produce a gas on heating, same gas is produce on -

A) Heating NH_4NO_3

B) Heating NH_4NO_2

C) " NH_4Cl

D) Rxn of $NH_4Cl + KOH_{aq}$

E) Rxn of Mg_3N_2 + water

Date

N	N_2
P	P_4
As	As_4
Sb	Sb_4
Bi	Metallic

Mg_3Bi_2 (Magnesium Bismuthide)

4° Heating effect of Ammonium Salt

1) When anion is oxidising anion

$(NH_4)_2Cr_2O_{7(s)} \xrightarrow{\Delta} 4H_2O + Cr_2O_3 + N_2\uparrow$ (green)

(Volcanic Rxn)

$NH_4NO_3 \xrightarrow[\text{(Below 300°C)}]{\Delta} 2H_2O + N_2O\uparrow$

$NH_4NO_2 \xrightarrow{\Delta} 2H_2O + N_2\uparrow$

$NH_4MnO_{4(s)} \xrightarrow{\Delta} 2H_2O + \underset{\text{black}}{MnO_2} + \frac{1}{2}N_2\uparrow$

$NH_4ClO_{4(s)} \xrightarrow{\Delta} 2H_2O\uparrow + \frac{1}{2}Cl_2\uparrow + O_2\uparrow + \frac{1}{2}N_2\uparrow$

$H_2NH_5NO_2^- \xrightarrow{\Delta} 2H_2O + HN_3$

2) When anion is non-oxidising anion

$NH_4Cl_{(s)} \xrightarrow{\Delta} NH_3\uparrow + HCl\uparrow$

$NH_4X_{(s)} \longrightarrow NH_3\uparrow + HX\uparrow$

$(NH_4)_2S_{(s)} \longrightarrow NH_3\uparrow + H_2S\uparrow$

$(NH_4)CO_3 \xrightarrow{\Delta} 2NH_3 + H_2O + CO_2\uparrow$

$(NH_4)_2SO_4 \xrightarrow{\Delta} 2NH_3 + H_2O + SO_2\uparrow + \frac{1}{2}O_2\uparrow$

Apatite minerals - [illegible]

Date

Preparation of N_2 -

1. $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} 4H_2O + Cr_2O_3 + N_2\uparrow$

2. $NH_4NO_2 \xrightarrow{\Delta} 2H_2O + N_2\uparrow$

3. $3CuO + 2NH_3 \xrightarrow{\Delta} 3H_2O + 3Cu + N_2$
(red hot)

4. $Cu + NO \longrightarrow CuO + \frac{1}{2}N_2\uparrow$
(red hot)

5. $Ba(N_3)_2(s) / NaN_3(s) \xrightarrow{\Delta} Ba(s) / Na(s) + 3N_2\uparrow(g)$
(pure)

Used to fill in air bags in car.

Preparation of P_4 -

$Ca_3(PO_4)_2$ (Bone Ash) $\xrightarrow{\text{high temp}}$ $3CaO + P_4O_{10}$

P_4O_{10} $\xrightarrow{\text{red hot C}}$ $P_4(g) + 10CO\uparrow(g)$

$P_4(g) + 10CO\uparrow(g)$ $\xrightarrow{\text{cooling water}}$ $P_4(s) + 10CO\uparrow$
(waxy solid)

Chemistry of NH_3 -

Preparation

1. $Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3\uparrow$

2. $AlN + 3H_2O \longrightarrow Al(OH)_3 + NH_3\uparrow$

3. $NH_4^+ + KOH \longrightarrow K^+ + NH_3\uparrow + H_2O$

Date

4) $NH_4X_{(s)} \xrightarrow{\Delta} NH_3 + HX$ (X = Non-oxidising anion)

5) NO_2^- or HO_3^- $\xrightarrow{Zn + NaOH \text{ or } Al + NaOH \text{ or } (Zn + Al + Cu) + NaOH}$ NH_3

(Devayda Alloy)

6) Haber's Process

$$N_2 + 3H_2 \underset{200\ atm}{\overset{(Fe_3O_4 + Al_2O_3 + K_2O)\ (Fe\text{-}Mo)\ 773K}{\rightleftharpoons}} 2NH_3$$

Bosch Process - $CO + H_2 + H_2O \xrightarrow[\text{water gas shift rxn}]{Fe_2O_3/Cr_2O_3} \underbrace{CO_2 + 2H_2}$

$\downarrow Na_3AsO_4\ aq$

$2H_2 \uparrow$

Apatite family - $Ca_9(PO_4)_6 \cdot CaX_2$ ($X = F, Cl$ or OH)

Fluorapatite - $Ca_9(PO_4)_6 \cdot CaF_2$

Chlorapatite - $Ca_9(PO_4)_6 \cdot CaCl_2$

Q NH_3 can be dryed by

A) conc. H_2SO_4

B) anhy. $CaCl_2$

C) P_4O_{10} $\quad P_4O_{10} + H_2O \longrightarrow (HPO_3)_4$

D) quick lime $CaO + H_2O \longrightarrow Ca(OH)_2$ Base.

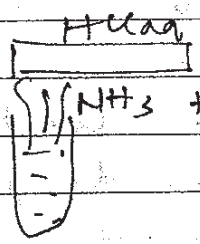
$CaCl_2(anhy) + 6H_2O \longrightarrow CaCl_2 \cdot 6H_2O$

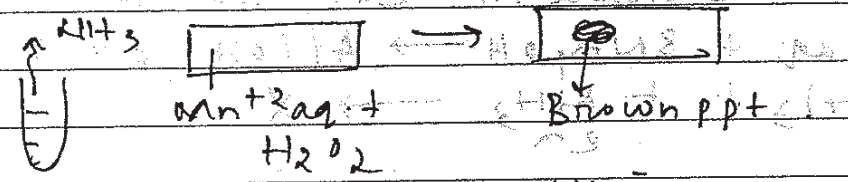
$CaCl_2 + 8NH_3 \longrightarrow CaCl_2 \cdot 8NH_3$

Date

Test of NH_3 :-

1. Red litmus $\xrightarrow[NH_4OH]{NH_3OH}$ Blue

2. 

3. 

$$Mn^{+2} + H_2O_2 \xrightarrow{OH^-} MnO_2\downarrow$$
brown

4. By Nessler's Reagent
$K_2[HgI_4] + KOH$

$$NH_3 + 2[\overset{II}{Hg}I_4]^{2-} + 3OH^- \longrightarrow \overset{II}{Hg}O\cdot\overset{II}{Hg}\overset{NH_2}{\underset{I}{}}\downarrow + 7I^-$$

Brown ppt
Iodide of Millon's Base.

Rxn of $NH_4OH/NH_3{}_{aq}$ with metal salt

I. Most of the d-block metal ions initially produce hydroxide ppt with small amt. of NH_4OH (Ag produce Ag_2O, Hg produce HgO).
Metal hydroxide or oxides formed by above Rxns are soluble in ex. NH_4OH except (Fe^{3+}, Fe^{2+}, Mn^{2+}, Hg^{2+}).
($NiSO_4$, $CdSO_4$, $AgNO_3$, $ZnSO_4$, etc)

Date

$CuSO_4 aq + 2NH_4OH \longrightarrow Cu(OH)_2 \downarrow + (NH_4)_2SO_4$
(l. blue ppt.)

$CuSO_4 aq. + \underset{\text{excess}}{4NH_3} \longrightarrow [Cu(NH_3)_4]^{2+} + 2OH^-$

II) p-block metal salts initially react with NH_4OH and produce hydroxide ppt which is insoluble in ex. NH_4OH.

$AlCl_3 aq + 3NH_4OH \longrightarrow Al(OH)_3 \downarrow + 3NH_4Cl$

$Al(OH)_3 \downarrow + \underset{ex}{NH_3} \longrightarrow X$

(other eg - $SnCl_2$, $Pb(NO_3)_2$, $BiCl_3$, $AsCl_3$, $MgCl_2$, $BeCl_2$)

Chemistry of PH_3 -

Preparation :-

1. $Ca_3P_2 + 6H_2O \longrightarrow 3Ca(OH)_2 + 2PH_3 \uparrow$ (Holme's signal)
(small P_2H_4)

2. $AlP/Zn_3P_2 + 3HCl \longrightarrow \underset{\text{or } AlCl_3}{ZnCl_2} + PH_3 \uparrow$

3. $PH_4I + KOH \longrightarrow PH_3 \uparrow + KI + H_2O$

4. $P_4 \xrightarrow[\text{(Dis'pp.)}]{OH^-} PH_3 + H_2PO_2^-$

5. $H_3PO_3 / H_3PO_2 \xrightarrow{\Delta} PH_3 + H_3PO_4$

6. $P_4O_6 \xrightarrow{\text{hot water}} H_3PO_4 + PH_3 \uparrow$

Date

Properties of PH_3

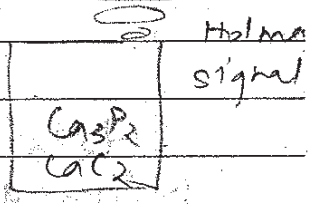
1. $PH_3 + \underset{\text{excess}}{O_2} \xrightarrow{\text{burn}} P_4O_{10} + H_2O$

2. $3CuSO_4 + 2PH_3 \longrightarrow Cu_3P_2\downarrow + 3H_2SO_4$

   $3HgCl_2 + 2PH_3 \longrightarrow Hg_3P_2\downarrow + 6HCl$

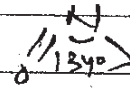
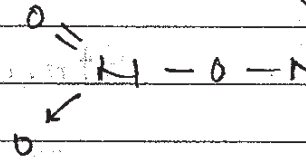
   Black

$PH_3(aq) \xrightarrow{h\nu}$ Red Phosphorous $+ H_2\uparrow$



Oxide	Preparation	Structure and other properties
N_2O(+1) Nitrous oxide	$NH_4NO_3 \xrightarrow[\text{below } 300^\circ C]{\Delta} N_2O\uparrow + 2H_2O$ $Zn/Fe \xrightarrow[HNO_3]{\text{dil.}} N_2O + Fe^{+2}/Zn^{+2}$	$\bar{N}=\overset{+}{N}=O$ $-N\equiv\overset{+}{N}-O^-$ * It supports combustion $N_2O \xrightarrow{\Delta} N_2 + \frac{1}{2}O_2$ * Neutral, Di'a * Anaesthetic.
NO(+2) Nitric oxide	$N_2 + O_2 \xrightarrow[\text{arc}]{\text{electric}} 2NO$ $NH_3 + O_2 \xrightarrow{Pt\text{-}Rh} NO + H_2O$ $Ag/Hg/Cu \xrightarrow{\text{dil. } HNO_3} NO$	NO BO = 2.5 para. * Neutral * Colourless
N_2O_3(+3) (anhy. of HNO_2) Sesquioxide	$Cu + (6M)HNO_3 \longrightarrow Cu^{+2} + NO + NO_2$ (1:1) $NO + NO_2 \xrightarrow{-30^\circ C} N_2O_3$ (Blue liq.) (1:1)	$O=N-O-N=O$ IP $O=N-\underset{+}{N}-O^-$ * Acidic, Di'a

Date

Oxide	Preparation	Properties
NO_2 (+4) (Mixed anhy.)	$M/MM + conc\ HNO_3 \rightarrow NO_2\uparrow$	(1) Acidic Para
	$M(NO_3)_2 \xrightarrow{\Delta} MO + 2NO_2 + \frac{1}{2}O_2$	
	$NO + \frac{1}{2}O_2 \rightarrow 2NO_2$	$2NO_2 \rightleftharpoons N_2O_4$ (HDC)
	$NO_3^- + conc.\ H_2SO_4 \xrightarrow{\Delta} NO_2\uparrow$	brown colourless
N_2O_5 (+5) Nitric acid anhy.	$2HNO_3 \xrightarrow[-H_2O]{P_4O_{10}} N_2O_5$	NO_2^+, NO_3^- solid
		acidic nitronium nitrate.
	$N_2O_5 + Na \rightarrow Na^+NO_3^- + NO_2\uparrow$	
	$N_2O_5 + I_2 \rightarrow I_2O_5 + NO_2$	

Oxygen family

ns^2np^4

O O_2

S S_8

Se Se_8

Te

Po (radioactive)

Date

Preparation of O_2 –

1. $2KClO_3 \xrightarrow[MnO_2]{\Delta} 2KCl + \frac{3}{2} O_2$

2. $NaNO_3 \xrightarrow{800^\circ C} Na_2O + N_2 + \frac{5}{2} O_2$

3. $H_2O \xrightarrow{\text{electrolysis}} H_2\uparrow + O_2\uparrow$ (cathode) (anode)

4. $HgO \mid Ag_2O \xrightarrow{\Delta} Hg_{(l)} \mid 2Ag + O_2\uparrow$

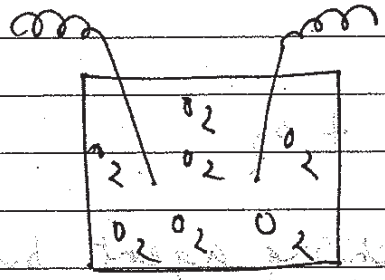
5. $PbO_2 \mid Pb_3O_4 \xrightarrow{\Delta} PbO + \frac{1}{2} O_2\uparrow$

6. $H_2O_2 \xrightarrow{\text{decompose}} H_2O + \frac{1}{2} O_2$

Chemistry of O_3 –

Preparation –

(i)



$O_2 \longrightarrow O + O$

$O + O \longrightarrow O_2$

$O_2 + O \longrightarrow O_3$ } ozonised oxygen

(ii) $H_2O + F_2 \longrightarrow HF + HOF$

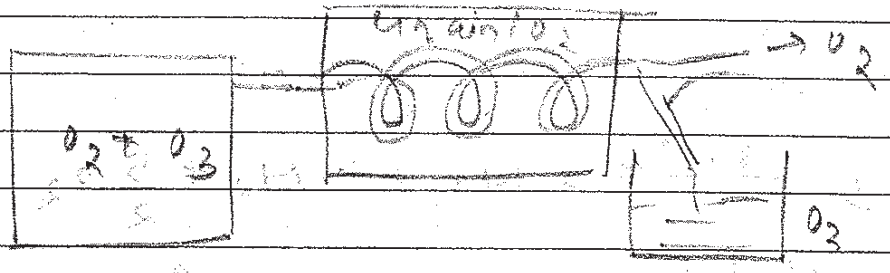
$HOF \longrightarrow HF + [O]$

$O + O \longrightarrow O_2$

$O_2 + O \longrightarrow O_3$ } ozonised oxygen.

Date

Separation of O_2 & O_3

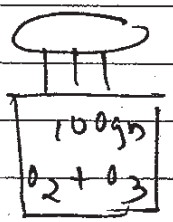


Estimation of O_3 -

$$KI_{aq} + O_3 \xrightarrow{pH=9.25} I_2 + O_2$$

$$I_2 \xrightarrow{KI} KI_3$$

brown



$$2S_2O_3^{2-} + I_3^- \longrightarrow S_4O_6^{2-} + 3I^-$$

brown — colourless

Tailing of Hg -

$$2Hg + O_3 \longrightarrow Hg_2O + O_2$$

Q. Cl_2 is a permanent bleaching agent but SO_2 is temporary bleaching agent. Explain?

$$Cl_2 + H_2O \longrightarrow HCl + HOCl$$

Cl_2 (OA)

HOCl $\rightarrow HCl + [O]$

$Cl_2 + 2e^- \longrightarrow 2Cl^-$ (OA)

Coloured substance (X) $\xrightarrow{\text{oxidation of X by } Cl_2}$ Colourless cmpd (Y)

Permanent bleaching :-

Cl_2, H_2O_2, O_3, ClO_2, BrO_2, $CaOCl_2$.

Date

Temporary

RA

$SO_2 + 2H_2O \longrightarrow H_2SO_4 + 2[H]$

$SO_2 + 2H_2O \longrightarrow H_2SO_4 + 2H^+ + 2e^-$

Coloured substance (X) —reduction by SO_2→ Colourless - Z

Colourless - Z —Air oxidation→ Coloured substance (X)

Chemistry of H_2O_2 -

Q. Wof produce H_2O_2 on reaction with water

A) Na_2O_2

B) BaO_2

C) MnO_2

D) PbO_2

E) KO_2

F) $H_2S_2O_8$

Preparation of H_2O_2

1. $Na_2O_2 + 2H_2O \longrightarrow 2NaOH + H_2O_2$

2. $2KO_2 + 2H_2O \longrightarrow 2KOH + H_2O_2 + O_2$

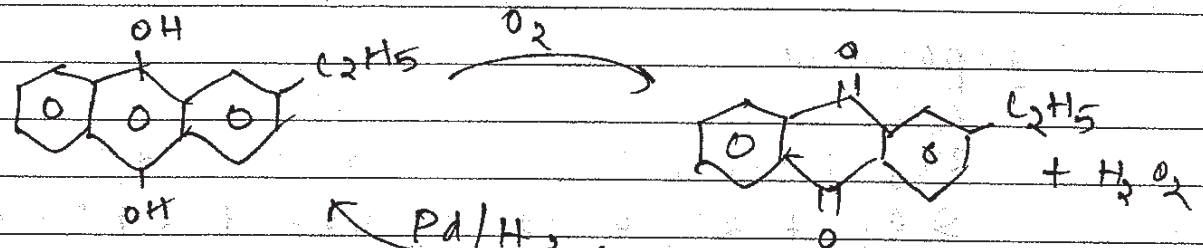
3. $BaO_2 + H_3PO_4 \longrightarrow Ba_3(PO_4)_2 \downarrow + H_2O_2$

4. H_2SO_4 (50%) —electrolysis→ $H_2\uparrow + H_2S_2O_8$

$H_2S_2O_8 \xrightarrow{H_2O} 2H_2SO_4 + H_2O_2$

Date

5)



(2 ethyl anthraquinol)

2 ethyl anthraquinone

(OA)

H_2O_2

(RA)

$I^- \longrightarrow I_2$

$Fe^{+2}/H^+ \longrightarrow Fe^{+3}$

$SO_2/H^+ \longrightarrow SO_4^{2-}$

$H_2S \longrightarrow S$

$MS\downarrow \longrightarrow MSO_4$

$NO_2^- \longrightarrow NO_3^-$

$NH_2-NH_2 \longrightarrow N_2$

$NH_2-OH \longrightarrow N_2O$

$Cr^{+3}/OH^- \longrightarrow CrO_4^{2-}$

$Mn^{+2}/OH^- \longrightarrow MnO_2$

$H^+/K_4[Fe(CN)_6] \longrightarrow K_3[Fe(CN)_6]$

yellow

H_2O

Oxidising strength -

$F_2 > O_3 > Cl_2 > Br_2 > H_2O_2 > I_2$

→ Removal black particles from lead painting

$PbS + H_2O_2 \longrightarrow PbSO_4 + H_2O$

black white

→ $Ti^{+4} \xrightarrow[\text{Test of } Ti^{+2}]{H_2O_2/H^+} H_2TiO_4$ (yellow-orange)

per titanic acid

Date

(RA)

H_2O_2

$MnO_4^-/H^+ \longrightarrow Mn^{+2}$

$MnO_4^-/OH^- \longrightarrow MnO_2$

$MnO_2/H^+ \longrightarrow Mn^{+2}$

$Fe^{+3}/OH^- \longrightarrow Fe^{+2}$

$K_3[Fe(CN)_6]/OH^- \longrightarrow K_4[Fe(CN)_6]$

$Cl_2 \longrightarrow 2Cl^-$

$BrO_2^- \longrightarrow 2Br^-$

$IO_4^- \longrightarrow IO_3^-$

$PbO_2 \longrightarrow PbO$

$Cr_2O_7^{2-} \longrightarrow Cr^{+3}$

O_2

$$H_2O_2 \xrightarrow[\text{or } h\nu]{Fe/TiO_2/} H_2O + \frac{1}{2}O_2$$

Allotropes of Sulphur

Rhombic sulphur $\underset{}{\overset{95.6^\circ C}{\rightleftharpoons}}$ Monoclinic sulphur

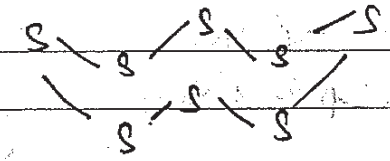
(α - Sulphur) — (β - Sulphur)

S_8 — (colourless)

Yellow granules — Yellow fibres

Soluble, CS_2, C_6H_6

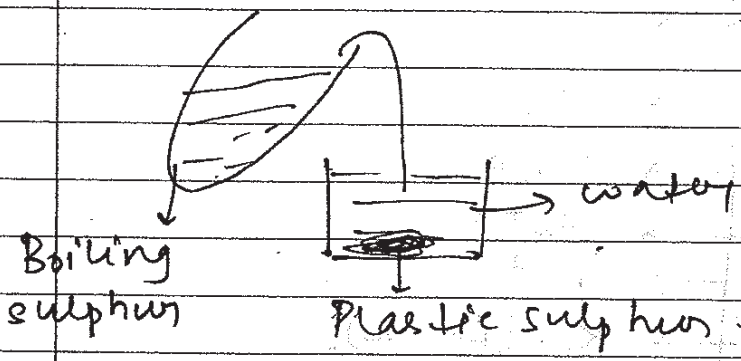
Insoluble in water

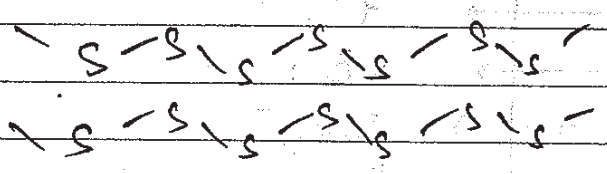


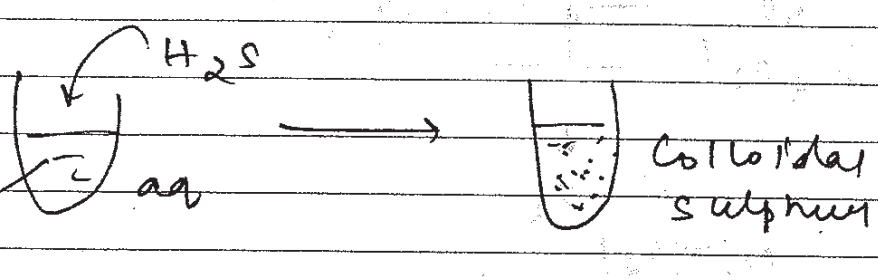
Soluble in CS_2, C_6H_6

Insoluble in water

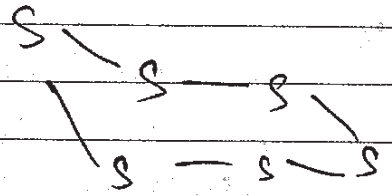
Date







$SO_2 + H_2S \xrightarrow{\text{Comproportionation}} 3S + H_2O$

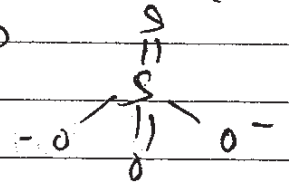


S_2 → Blue, para

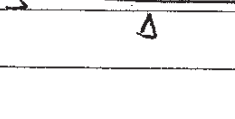
S_6 = Angel Sulphur

Chemistry of $Na_2S_2O_3$.

Preparation



1) $S_8 + NaOH \longrightarrow Na_2S_{aq} + Na_2S_2O_{3aq}$

2) $Na_2SO_3\,aq + S \xrightarrow[\Delta]{\text{Boil}} Na_2$  $\xrightarrow{\text{cooling}}$ $aq\,Na_2S_2O_3 \cdot 5H_2O$ (crystals)

$Na_2S_2O_3$ and SO_2 are used as anti chlor in bleaching industry.

Date

Reaction →

1) $Na_2S_2O_3 + 2HCl \longrightarrow 2NaCl + H_2O + SO_2\uparrow + S\downarrow$
(+ H_2SO_4 dil.)

2) Reducing nature of $S_2O_3^{2-}$ ion

$S_2O_3^{2-}$ aq (RA)

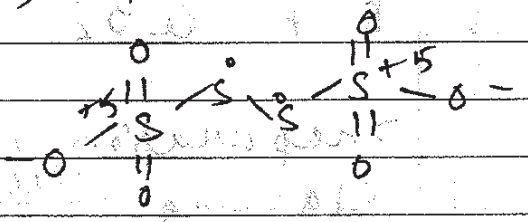
Strong OA:
1) MnO_4^-/OH^-
2) MnO_4^-/H^+
3) $Cr_2O_7^{2-}/H^+$
4) Cl_2/H^+

→ $SO_4^{2-} + S\downarrow$ when rxn is acidic

1) MnO_2
2) Mn^{+2}
3) Cr^{+3}
4) Cl^-

Mild OA:
1) I_2
2) I_3^-
3) Fe^{+3}
4) Cu^{+2}

→ $S_4O_6^{2-}$



1) I^-
2) Br^-
3) Fe^{+2}
4) $Cu_2S_2O_3$

Halogen family

$F_2(g)$ $Cl_2(g)$ $BrH_2(l)$ $I_2(s)$

Q. Write correct order

1) F < Cl < Br < I (Size)
2) F > Cl > Br > I (IE 1)
3) F Cl Br I (EA) Cl > F > Br > I
4) F_2 Cl_2 Br_2 I_2 (BE) $Cl_2 > Br_2 > F_2 > I_2$
5) $F_2 > Cl_2 > Br_2 > I_2$ (Oxidising St.)

Date

6) $F^- < Cl^- < Br^- < I^-$ (Reducing St.)

7) $F^- > Cl^- > Br^- > I^-$ (Basic St.)

Preparation of F_2

1) Moisson's Cell -

$KHF_2 \xrightarrow{\text{electrolysis}} H_2\uparrow + F_2\uparrow + KF$

(fused) (cathode) (anode)

2] $K_2[\overset{IV}{Mn}F_6] + 2SbF_5 \longrightarrow 2K^+[SbF_6]^- + MnF_4$

$MnF_4 \xrightarrow{\Delta} \overset{III}{Mn}F_3 + \frac{1}{2}F_2$

3] $F^- + XeO_6^{4-} \longrightarrow F_2 + XeO_3$

Preparation of Cl_2

1) $NaCl_{aq} \xrightarrow{\text{electrolysis}} H_2\uparrow + Cl_2\uparrow + NaOH$

2) $NaCl_{(molten)} \xrightarrow{\Delta} Cl_2\uparrow + Na_{(l)}$

3] $KMnO_4 + HCl_{aq} \longrightarrow Cl_2\uparrow + Mn^{+2}$

4) $NaCl + MnO_2 \xrightarrow[\Delta]{H^+} Cl_2 + Mn^{+2}$

5) $2HCl + O_2 \xrightarrow[\Delta]{CuCl_2} Cl_2 + H_2O$

Date

Preparation of BH_2

BH^-

conc H_2SO_4	$\rightarrow SO_2$
dil HNO_3	$\rightarrow NO$
MnO_4^-/H^+	$\rightarrow Mn^{+2}$
$Cr_2O_7^{2-}/H^+$	$\rightarrow Cr^{+3}$
O_3	$\rightarrow O_2$
MnO_2/H^+	$\rightarrow Mn^{+2}$

BH_2

BH^-

F_2	$\rightarrow F^-$
Cl_2	$\rightarrow 2Cl^-$

Preparation of I_2

I^-

conc H_2SO_4	$\rightarrow SO_2$
dil. HNO_3	$\rightarrow NO$
MnO_4^-/H^+	$\rightarrow Mn^{+2}$
$Cr_2O_7^{2-}/H^+$	$\rightarrow Cr^{+3}$
O_3	$\rightarrow O_2$
H_2O_2/H^+	$\rightarrow H_2O$
NO_2^-/H^+	$\rightarrow NO$
H^+/MnO_2	$\xrightarrow{\Delta} Mn^{+2}$
Pb^{+4}	$\rightarrow Pb^{+2}$
Fe^{+3}	$\rightarrow Fe^{+2}$
Cu^{+2}	$\rightarrow CuI$
$K_3[Fe(CN)_6]$	$\rightarrow K_4[Fe(CN)_6] + I_3^-$ (brown)

I_2

Date

When I_2 vapours passed in aq. soln of KF, KCl, KBr in separate test tube it produce -

A) F_2, Cl_2, BrH_2 resp
B) Cl_2 & Br_2
C) only Br_2
D) None

OS - $F_2 > Cl_2 > BrH_2 > I_2$
RS - $F^- < Cl^- < Br^- < I^-$

$$X_2 + 2Y^- \longrightarrow Y_2 + 2X^-$$
(OA) (RA)

NOTE: Lighter halogen can displace heavier halide from aqueous soln.

Cl_2 is greenish yellow gas but Cl_2 water is colourless because Cl_2 dissolve in water in the form of HCl and HOCl

$$Cl_2 + H_2O \rightleftharpoons HOCl + HCl$$

Hydracid

Conc. H_2SO_4 is used to prepare HF and HCl from NaF and NaCl resp. but not used to prepare HBr and HI from NaBr and NaI resp. Explain
conc. H_2SO_4 can oxidize I^- to I_2 and Br^- to Br_2 as a major pdt so that H_2SO_4 is not used

Date

$NaBH + H_3PO_4$ (conc.) $\xrightleftharpoons{\Delta}$ $HBH\uparrow + NaH_2PO_4$

$NaI + H_3PO_4$ (conc.) $\xrightleftharpoons{\Delta}$ $HI\uparrow + NaH_2PO_4$

Oxy acid -

	F	Cl	Br	I
HOX / HXO	✓	✓	✓	✓
$HOXO / HXO_2$	X	✓	–	–
$HOXO_2 / HXO_3$	X	✓	✓	✓
$HOXO_3 / HXO_4$	X	✓	✓	✓

Q. Write correct order

I) $HClO > HBrO > HIO$ (K_a)

II) $HClO < HClO_2 < HClO_3 < HClO_4$ (K_a)

III) $HClO_3 > HBrO_3 > HIO_3$ (K_a)

IV) $HClO < HClO_2 < HClO_3 < HClO_4$ (Th. Stability)

V) $HClO > HClO_2 > HClO_3 > HClO_4$ (O. St.)

An inorganic compound X gives following observations

i) produce brick red colour in flame.

ii) produce dark brown colour with aq. soln of KI and acetic acid

iii) produce an anaesthetic compound Z when it reacts with ethanol

iv) produce smell of chlorine when placed in moist air.

Identify X, Y, Z and write balanced rxn.

Date

Chemistry of Bleaching Powder -

$Ca^{+2}\ Cl^-\ OCl^- \;/\; CaOCl_2$

or

$CaCl_2 \cdot Ca(OCl)_2 \cdot Ca(OH)_2 \cdot 2H_2O$

(X)

Preparation -

$$Cl_2 + \underset{(cold)}{Ca(OH)_2} \longrightarrow \underset{OCl^-}{Ca^{+2}\ Cl^-} + H_2O$$

1. $$Ca^{+2}\ \underset{OCl^-}{Cl^-} + CO_2 \xrightarrow[air]{moist} CaCO_3 + Cl_2$$

2. $$Ca^{+2}\ \underset{OCl^-}{Cl^-} \xrightarrow[standing]{long} CaCl_2 + Ca(ClO_3)_2$$

3. $$Ca^{+2}\ \underset{OCl^-}{Cl^-} \xrightarrow[(catalyst)]{Co^{+2}} CaCl_2 + \frac{1}{2}O_2\uparrow$$

4. $$Ca^{+2}\ \underset{OCl^-}{Cl^-} + 2CH_3COOH \longrightarrow Ca(CH_3COO)_2 + Cl_2 + H_2O$$

$$2KI_{(aq)} + Cl_2 \longrightarrow 2KCl + I_2$$

I_2 (excess) $\downarrow$

KI_3 (Y)

(Brown)

5. $$CH_3-\underset{OH}{CH}-CH_3 \xrightarrow[ii)\ OCl^-]{i)\ Ca^{+2}\ \underset{OCl^-}{Cl^-}} CHCl_3\ (Z)$$

iii) $Cl_2/NaOH$

Haloform rxn

* $$X_2 \underset{H^+}{\overset{OH^-}{\rightleftharpoons}} X^- + XO^- \qquad X_2 \underset{H^+}{\overset{OH^-}{\rightleftharpoons}} X^- + XO_3^-$$

5. $RbICl_2 \xrightarrow{\Delta}$?

A) $RbI + Cl_2$

B) $RbCl + ICl$

Date

Interhalogen Compounds

AB	AB_3	AB_5	AB_7
IF			
ICl	$(ICl_3)_2$	IF_5	IF_7 .
IBr	orange	BrF_5	
-		ClF_5	

$5\,IF \xrightarrow{\text{decompose}} IF_5 + 2I_2$

→ All interhalogen compounds are more reactive as compared to halogens except F_2.

Q. Select correct for $CsBr_3$

A) It is covalent compound

B) It has Cs^{3+} and $3Br^-$ ions

C) It has Cs^+, Br^- & Br_2 as a lattice molecule

D) It has Cs^+ ; Br_3^- ions.

Polyhalide Compound -

→ When halogen or interhalogen compound react with alkali metal halides, they produce polyhalide compound.

→ Polyhalide compounds are typically ionic compound and decompose on heating.

When polyhalide compounds are heated, smaller halide remain bonded with alkali metal cation.

$KI + I_2 \longrightarrow KI_3\ (K^+, I_3^-)$

$CsBr + Br_2 \longrightarrow CsBr_3\ (Cs^+, Br_3^-)$

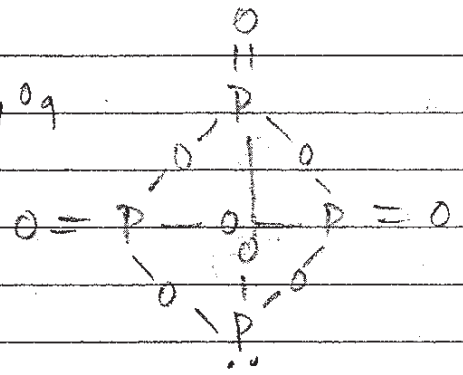
$RbCl + ICl \longrightarrow RbICl_2\ (Rb^+, ICl_2^-)$

$KCl + ICl_3 \longrightarrow KICl_4\ (K^+, ICl_4^-)$

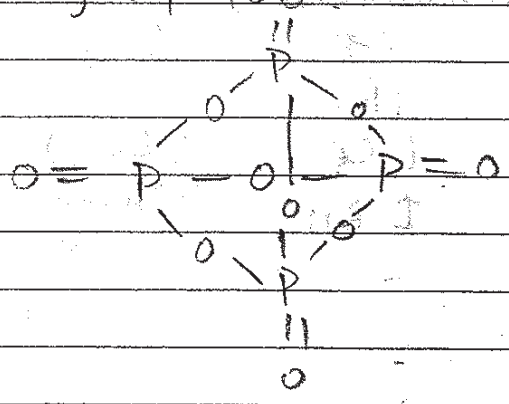
$KCl + IBr \longrightarrow KIBrCl\ (K^+, IBrCl^-)$

Date

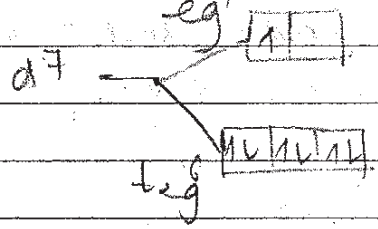
61] P_4O_9



62] P_4O_{10}

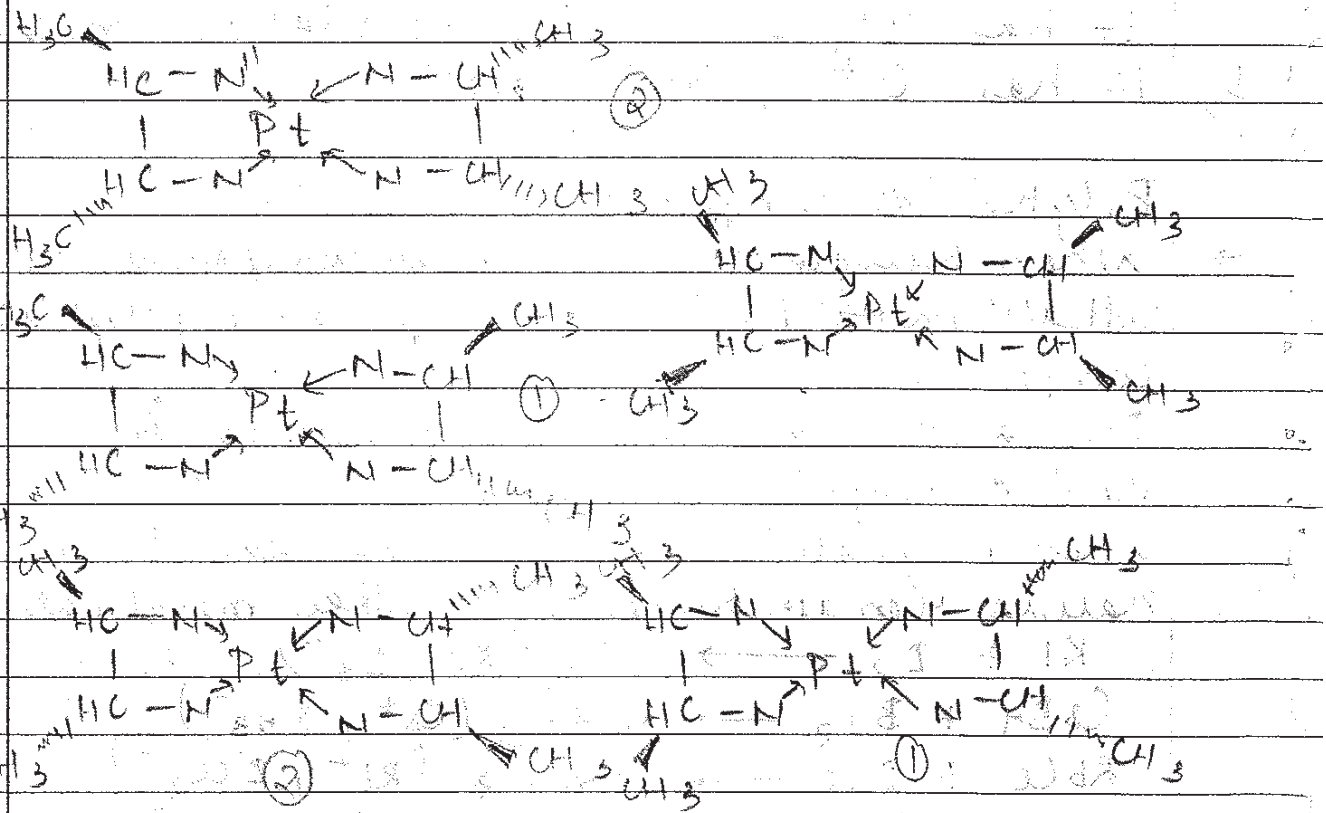


$[Co(NO_2)_6]^{4-}$ (+2)



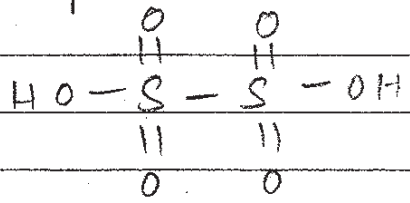
para
$\mu = \sqrt{3}$
the low spin
(CFSE) PE

$[Pt(bn)_2]$

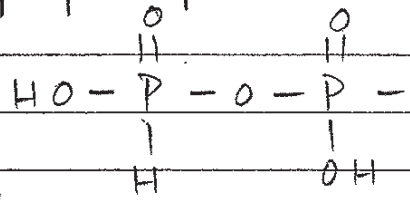


Date

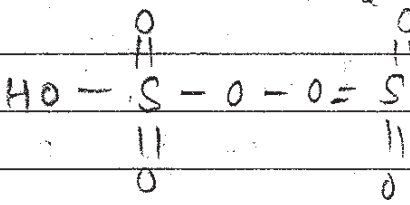
53] Hyposulphuric acid ($H_2S_2O_6$) Dithionic acid



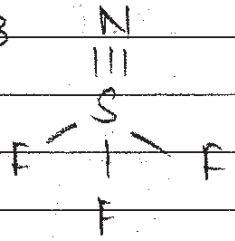
54] Isohypophosphonic acid ($H_4P_2O_6$)



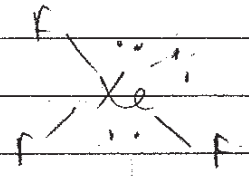
55] Marshall's Acid ($H_2S_2O_8$)



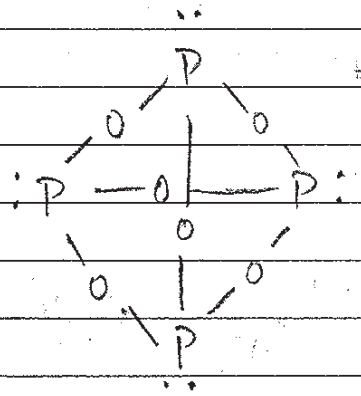
56] SNF_3



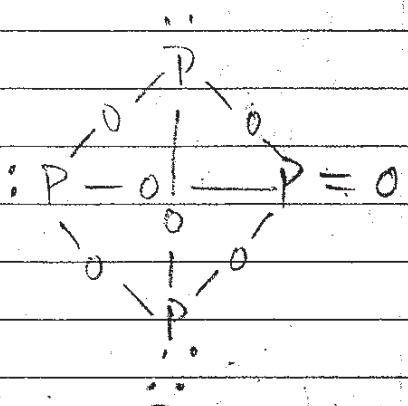
57] XeF_3^-



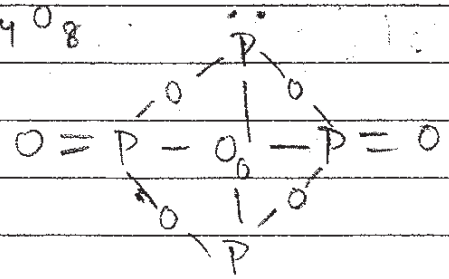
58] P_4O_6



59] P_4O_7

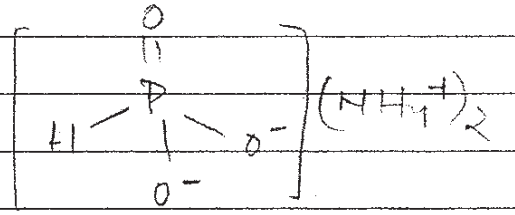


60] P_4O_8

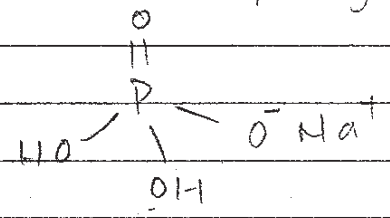


Date

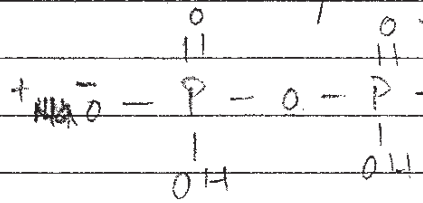
44] Ammonium phosphite $[(NH_4)_2HPO_3]$



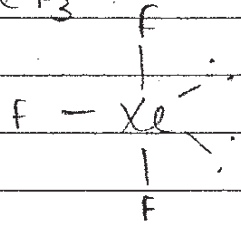
45] Sodium dihydrogen phosphate (NaH_2PO_4)



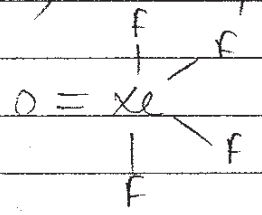
46] Sodium dihydrogen pyrophosphate



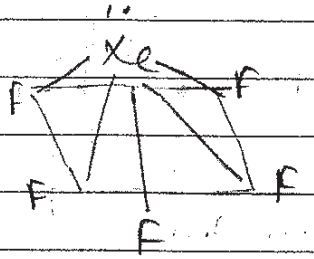
47] XeF_3^+



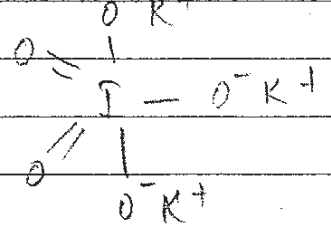
48] $XeOF_4$



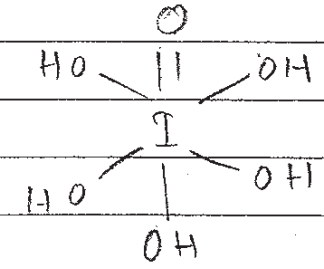
$[XeF_5]^+$



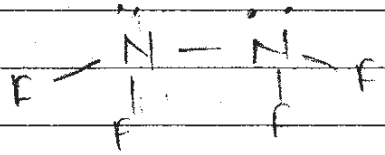
49] K_3IO_5



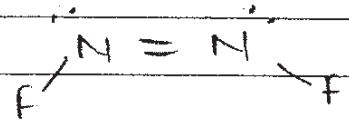
50] H_5IO_6



51] N_2F_4

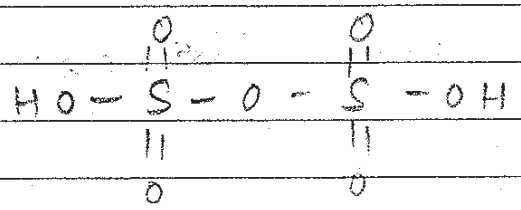


52] N_2F_2

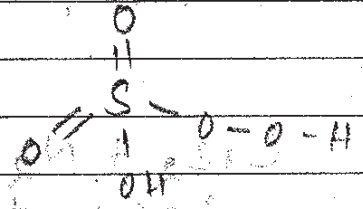


Date

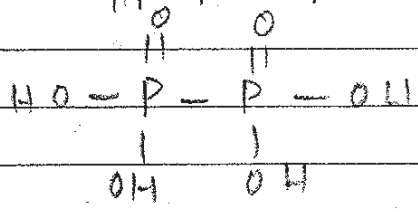
38] $H_2S_2O_7$



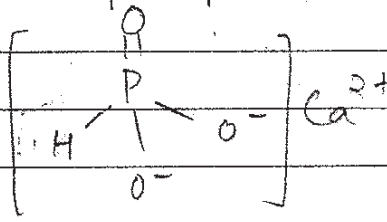
39] H_2SO_5 (peroxomonosulphuric acid) (Caro's acid)



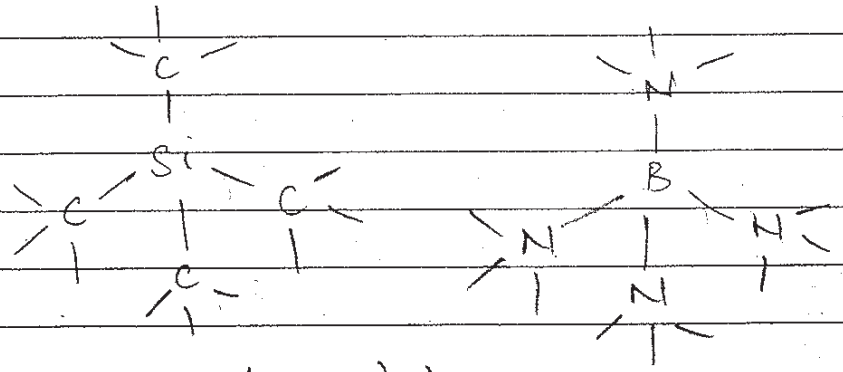
40] $H_4P_2O_6$ (hypophosphoric acid) (tetrabasic)



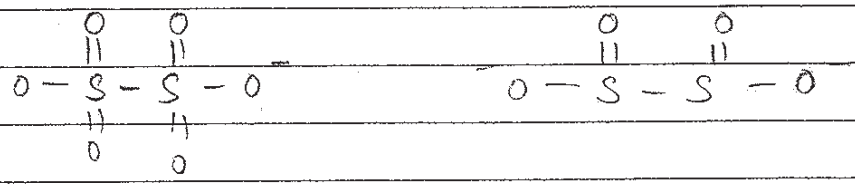
41] Calcium phosphite ($CaHPO_3$)



42] Carborundum and Borazone [SiC and $(BN)_x$]

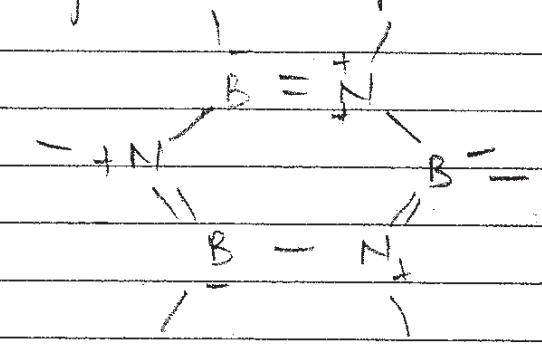


43] Dithionate ($S_2O_6^{2-}$) and Dithionite ion ($S_2O_4^{2-}$)



Date

31] Inorganic Graphite $(BN)_n$



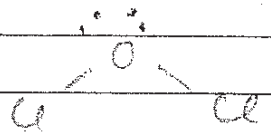
32] $CaCN_2$ (Calcium cyanamide)

$Ca^{2+}\ [\overset{\ominus}{N}=C=\overset{\ominus}{N}]$

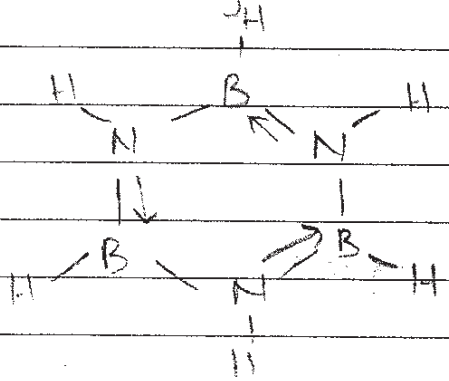
$CaC_2 + N_2 \xrightarrow{1100^\circ C} CaCN_2 + C$

Nitrolem

33] Cl_2O (dichlorine monoxide)

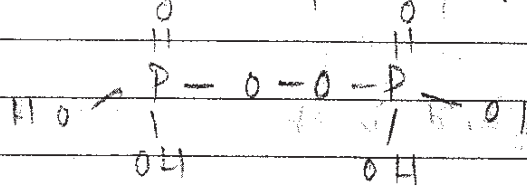


34] $B_3N_3H_6$ (inorganic benzene)

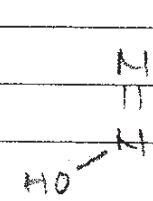


35] CaC_2 $Ca^{2+}\ [C\equiv C^-]$

36] $H_4P_2O_8$ (peroxydiphosphoric acid)

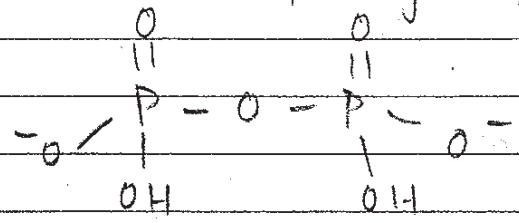


37] $H_2N_2O_2$ (hyponitrous acid)



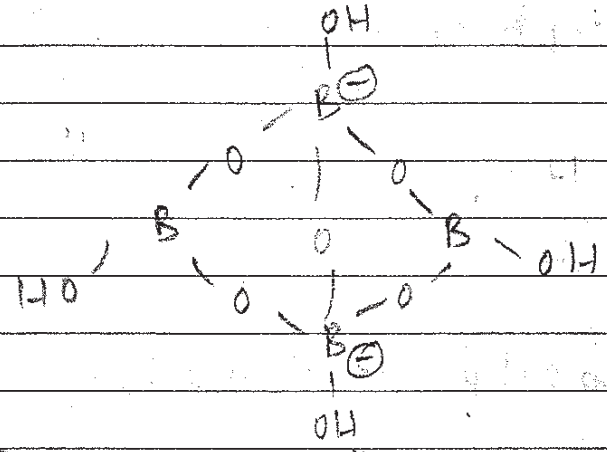
Date

27] $H_2P_2O_7^{2-}$ (dihydrogen pyrophosphate)

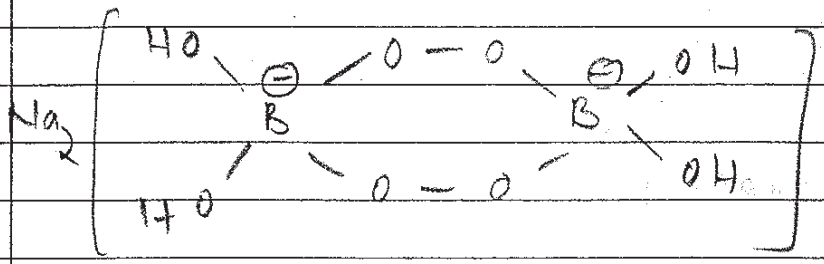


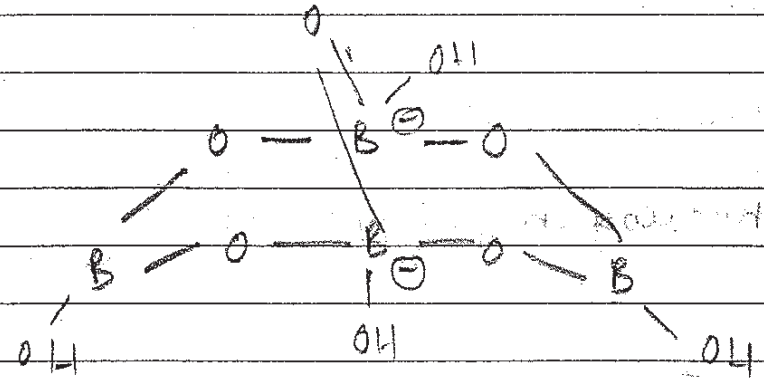
28] $Na[B_3O_3(OH)_4]$

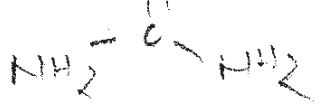
29] $Na_2[B_4O_5(OH)_4] \cdot 8H_2O$



29] $Na_2[B_2O_4(OH)_4]$



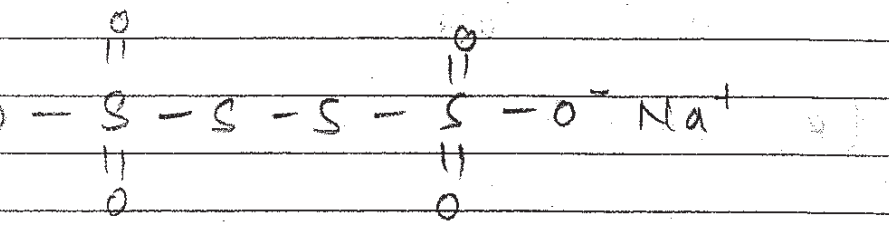


$NH_4OCN \xrightarrow{\Delta}$ 

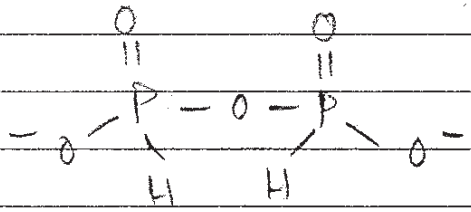
Date

21] NH_4OCN

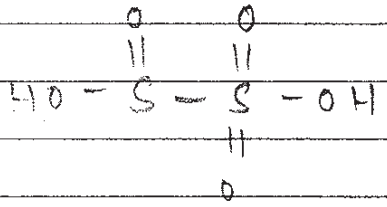
22] $Na_2S_4O_6$ (sodium tetrathionate)



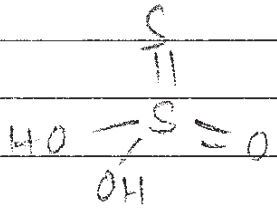
23] $H_2P_2O_5^{2-}$ (pyrophosphite) $H_3PO_3 + H_3PO_3$ $H_4P_2O_5$



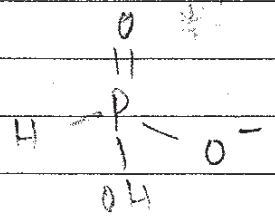
24] $H_2S_2O_5$ (pyrosulphurous acid)



25] $H_2S_2O_3$ (thiosulphuric acid)

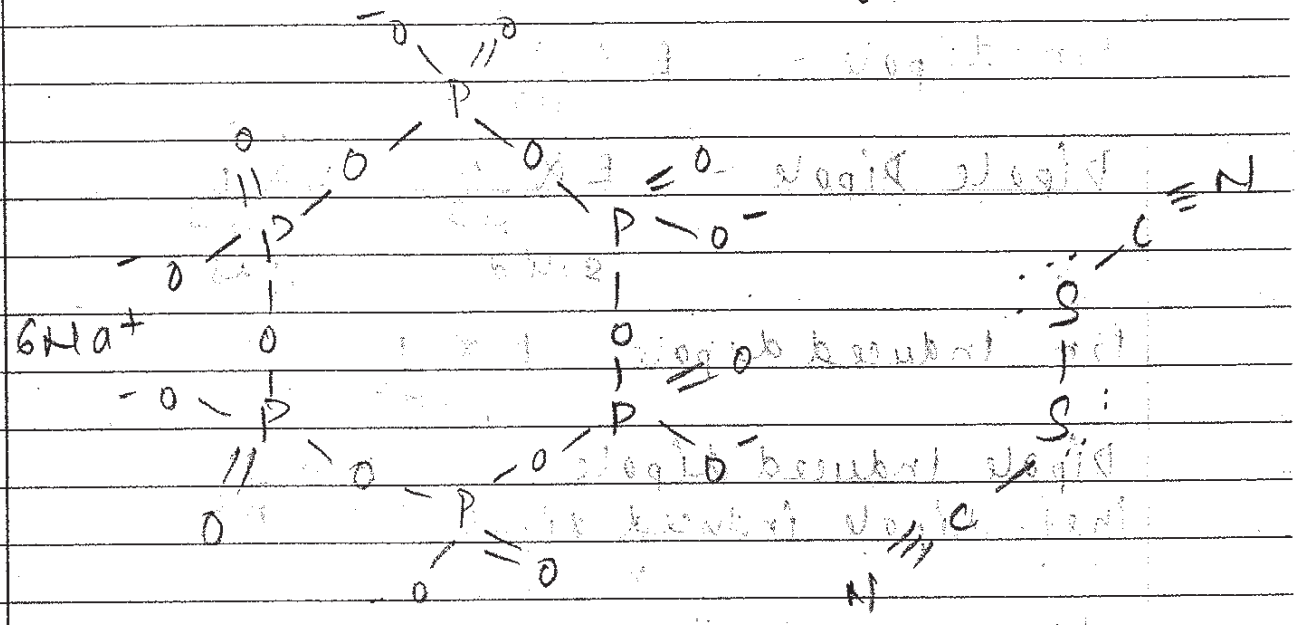


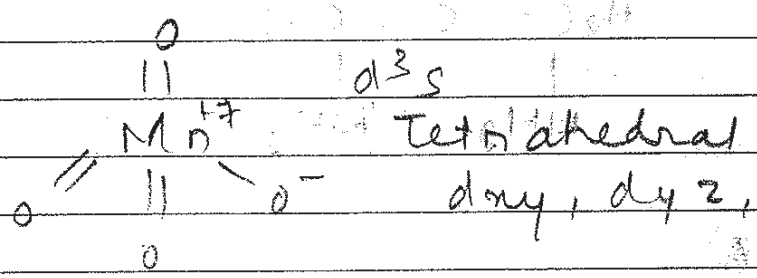
25] $H_2PO_3^-$ (hydrogen phosphite ion)



Date

$Na_6P_6O_{18}$ (Graham's salt) (calgon)





d^3s

Tetrahedral

$d_{xy}, d_{yz}, d_{xz}, s$

Date

Ionic - $E \propto \frac{1}{H}$

Ion dipole - $E \propto \frac{1}{H^2}$

Dipole Dipole - $E \propto \frac{1}{H^3}$ $E \propto \frac{1}{H^6}$

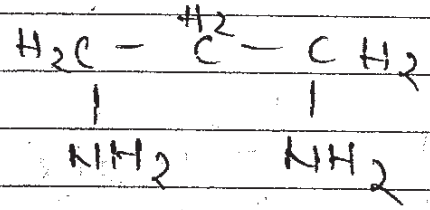
solid gas

Ion Induced dipole $E \propto \frac{1}{H^4}$

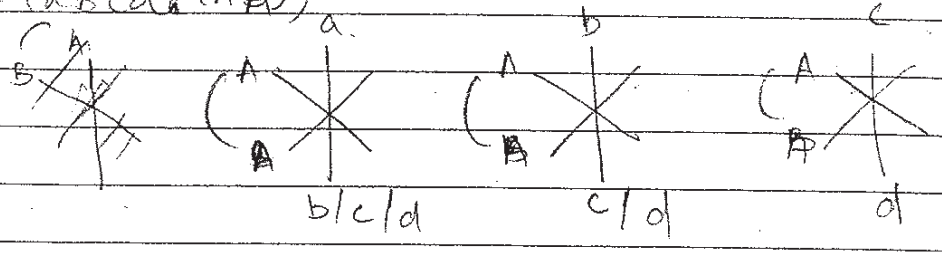
Dipole Induced dipole $E \propto \frac{1}{H^5}$

Inst. dipole induced dipole

th -



Le(abcda(AB))

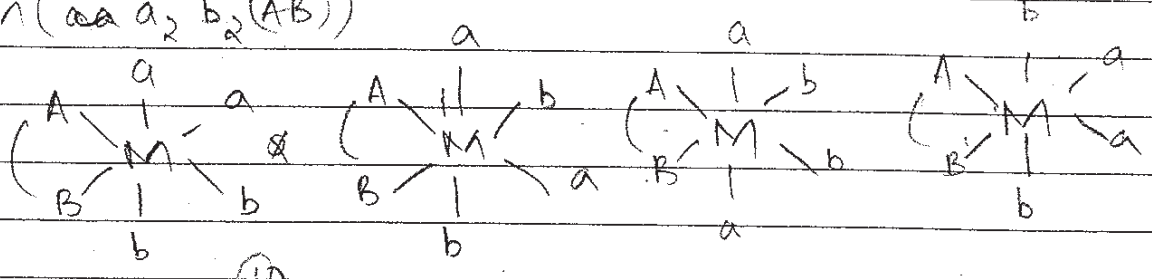


$\cancel{X2}$ $\cancel{X2}$ $\cancel{X2}$

3 + 2 + 1

6 X 2 = 12

M(aaaa_2 b_2(AB))



(4)