

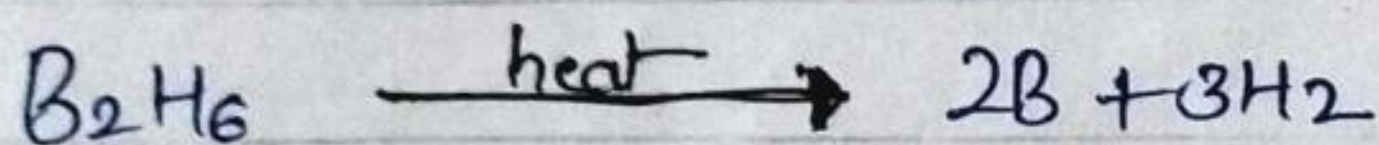
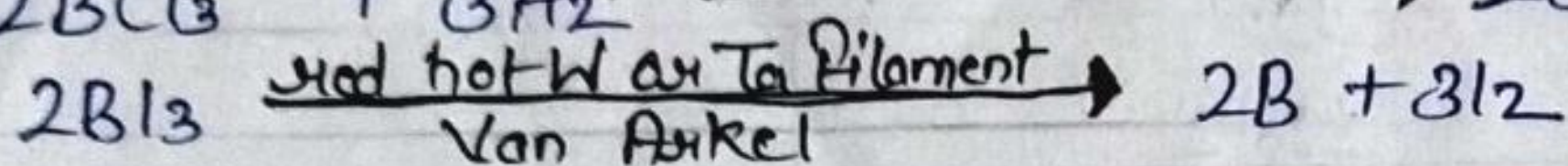
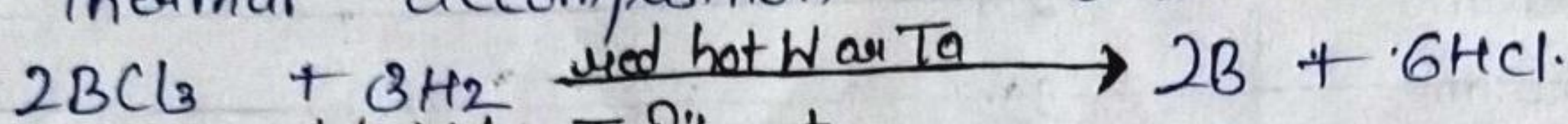
# P-Block Elements

1. Extraction of Boron :- Amorphous boron of low purity (called moisson boron) is obtained by reducing  $B_2O_3$  with Mg or Na at a high temp. It is 95-98% pure (being contaminated with metal borides) & is black in colour.

(a) By reducing  $BCl_3$  with  $H_2$ . This is done on the Kilogram scale.

(b) pyrolysis of  $BCl_3$  (Van Arkel method).

(c) Thermal decomposition of diborane or other boron hydrides.

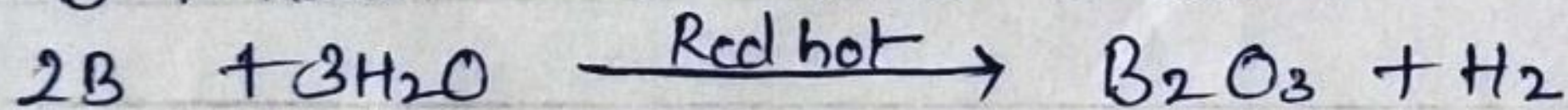
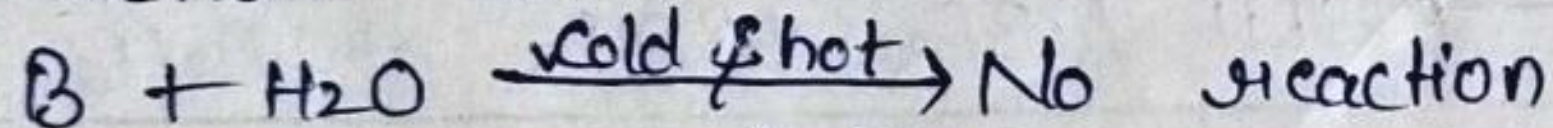


## Property of Boron :-

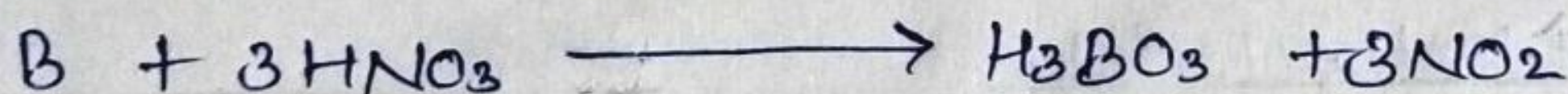
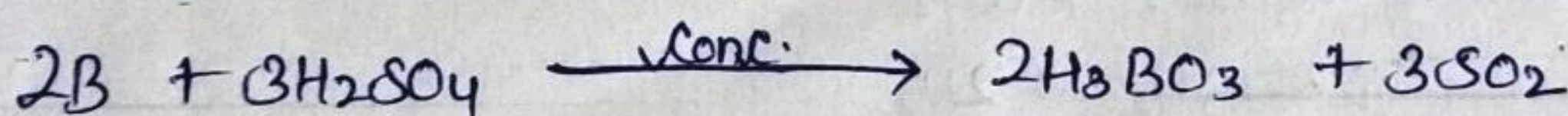
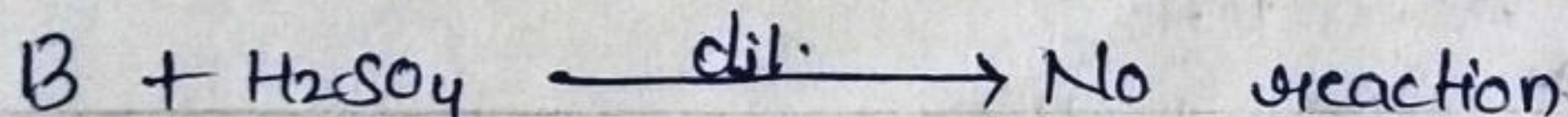
(a) Burning in air



(b) Reaction with water

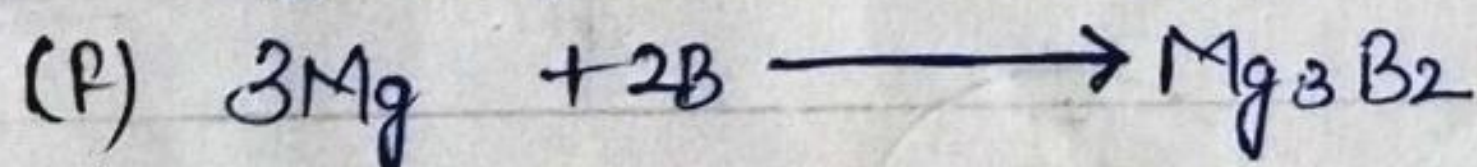


(c)  $B + HCl \longrightarrow$  No reaction.



(d)  $2B + 2NaOH + 2H_2O \longrightarrow 2NaBO_2 + 3H_2$

(e)  $2B + N_2 \longrightarrow 2BN$



2. Boranes :- Boranes are boron hydrogen compounds with general molecular formula  $B_nH_{n+4}$  or  $B_nH_{n+6}$ . They are electron deficient compounds. The lighter boranes (upto  $B_5$ ) spontaneously react with air whereas remaining compounds are air stable. The physical properties of boranes are given as under :-



Formula	Name	Melting point	Boiling point
B <sub>2</sub> H <sub>6</sub>	Diborane	-155.6	-92.5
B <sub>4</sub> H <sub>10</sub>	Tetraborane	-120	18
B <sub>5</sub> H <sub>9</sub>	Pentaborane -9	-46.6	48
B <sub>5</sub> H <sub>11</sub>	Pentaborane -11	-123	63
B <sub>6</sub> H <sub>10</sub>	Hexaborane -10	-62.5	110
B <sub>6</sub> H <sub>12</sub>	Hexaborane -10	-82.3	80-90
B <sub>8</sub> H <sub>12</sub>	Octaborane -12	-20	-
B <sub>8</sub> H <sub>14</sub>	Octaborane -14	-20	-
B <sub>9</sub> H <sub>15</sub>	Enneborane	2.6	-
B <sub>10</sub> H <sub>14</sub>	Decaborane	99.7	213
B <sub>20</sub> H <sub>16</sub>	icosaborane -16	196.2	-

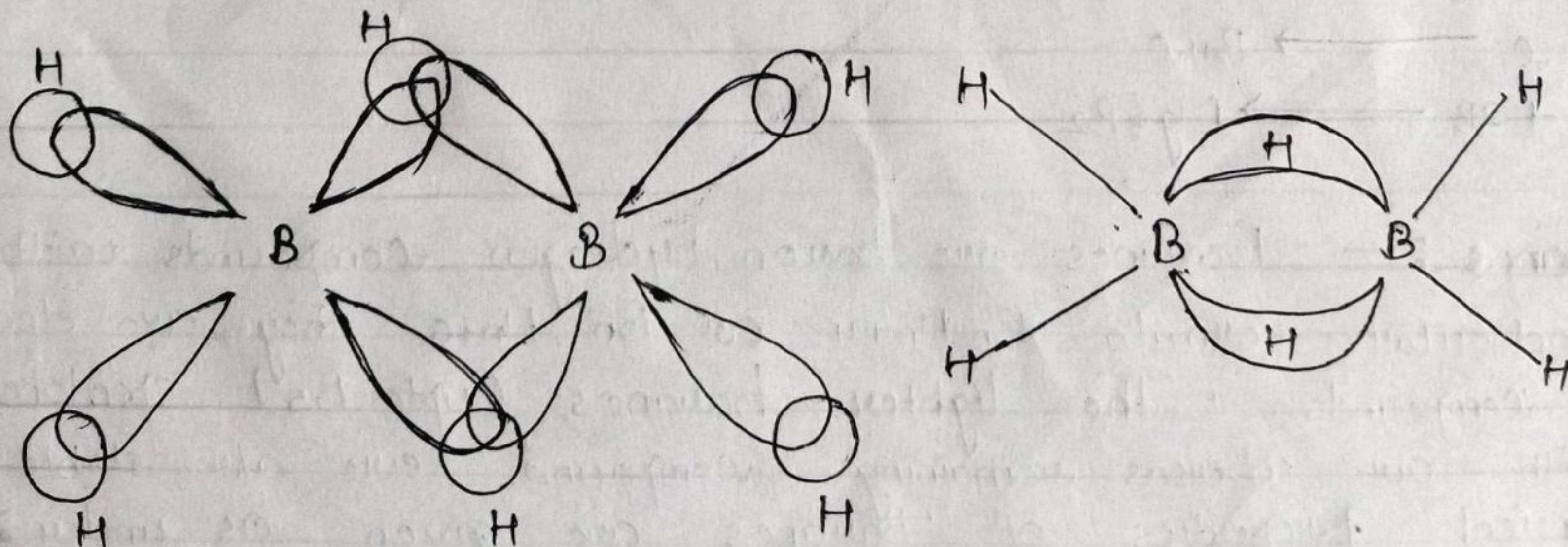
### Preparation of Diborane :-

- (i)  $Mg_3 B_2 + HCl (10\%) \longrightarrow B_2H_6 + B_6H_{10} + B_5H_9 \text{ etc.}$
- (ii)  $B_4H_{10} \xrightarrow{100^\circ C} B_2H_6 + H_2 + \text{higher borane.}$
- (iii)  $2 \cdot BCl_3 (or B \cdot BCl_3) + 6H_2 \xrightarrow{\text{Electric}} B_2H_6 + 6HCl$
- (iv)  $3LiAlH_4 / LiBH_4 + 4BF_3 \longrightarrow 3LiF / 3BF_3 + 3AlF_3 + 2B_2H_6$

### Chemical properties :-

- (a)  $B_2H_6 + O_2 \longrightarrow B_2O_3 + H_2O$
- (b)  $B_2H_6 + H_2O \xrightarrow{\text{cold is enough}} H_3BO_3 + 6H_2$
- (c)  $B_2H_6 + 2KOH \longrightarrow 2KOBH_2 + 2H_2$
- (d)  $B_2H_6 + HCl \xrightarrow{\text{anh. AlCl}_3} B_2H_5Cl + H_2$

### Structure of diborane :-





The structure of diborane is shown in Fig. The four terminal hydrogen atoms & the two boron atoms lie in one plane. Above & below this plane, there are two bridging hydrogen atoms. The four terminal B-H bonds are regular two centre - two electron bonds while the two bridge (B-H-B) bonds are different & can be described in terms of three centre - two e<sup>-</sup> bonds.

Bonding in diborane :- Each B atom uses sp<sup>3</sup> hybrids for bonding. Out of the four sp<sup>3</sup> hybrids on each B atom, one is without an electron (shown in broken lines). The terminal B-H bonds are normal 2e-2e bonds but the two bridge bonds are 3e-2e bonds. The 3e-2e bridge bonds are also referred to as banana bonds or tau bonds.

### 3. BORIC ACID :-

Preparation :- It is prepared by borax reacting with sulphuric acid.

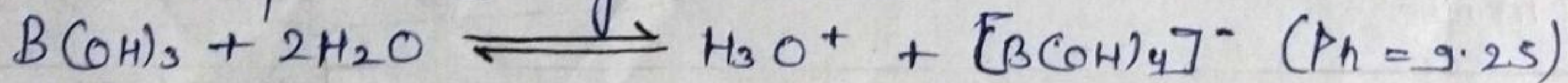
$$\text{Na}_2\text{B}_4\text{O}_7 + \text{H}_2\text{SO}_4 + 5\text{H}_2\text{O} \longrightarrow \text{Na}_2\text{SO}_4 + 4\text{H}_3\text{BO}_3$$

Physical properties :-

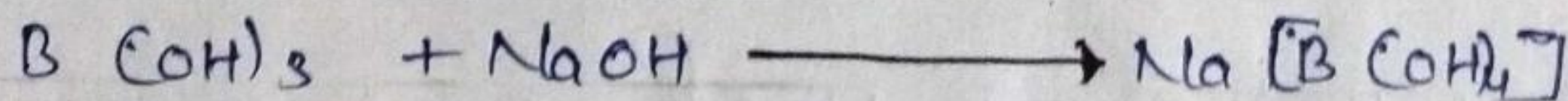
- Its crystals are soft, white, needle like having a soapy touch.
- It is steam volatile.

Chemical properties :-

- Ortho boric acid does not donate proton, like most of the acids but rather it accepts OH<sup>-</sup> therefore it is a Lewis acid & is represented by B(OH)<sub>3</sub>.

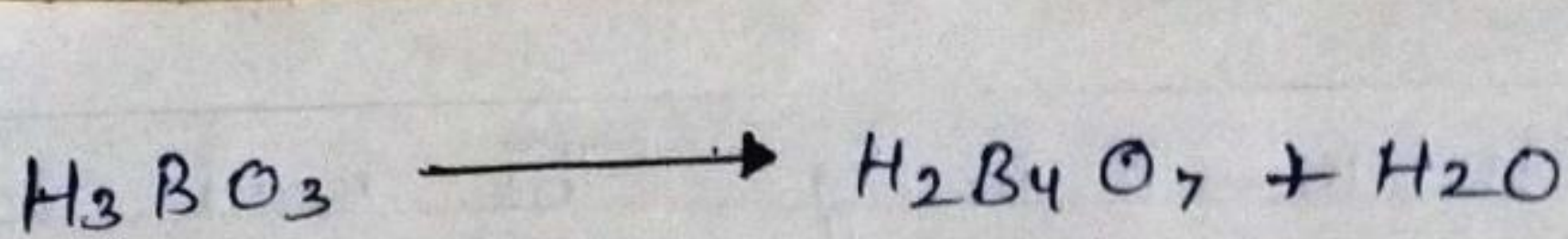


- B(OH)<sub>3</sub> partially reacts with water to form H<sub>3</sub>O<sup>+</sup> & [B(OH)<sub>4</sub>]<sup>-</sup> & behaves as a weak acid. Thus B(OH)<sub>3</sub> can not be titrated (satisfactory) with NaOH because a sharp end point is not obtained. If polyhydroxy compound like glycerol, mannitol or sugar are added to titration mixture then it can be titrated with NaOH.



- Effect of temperature at 100°C H<sub>3</sub>BO<sub>3</sub> loses water & convert into metaboric acid.





metaboric acid form tetraboric acid

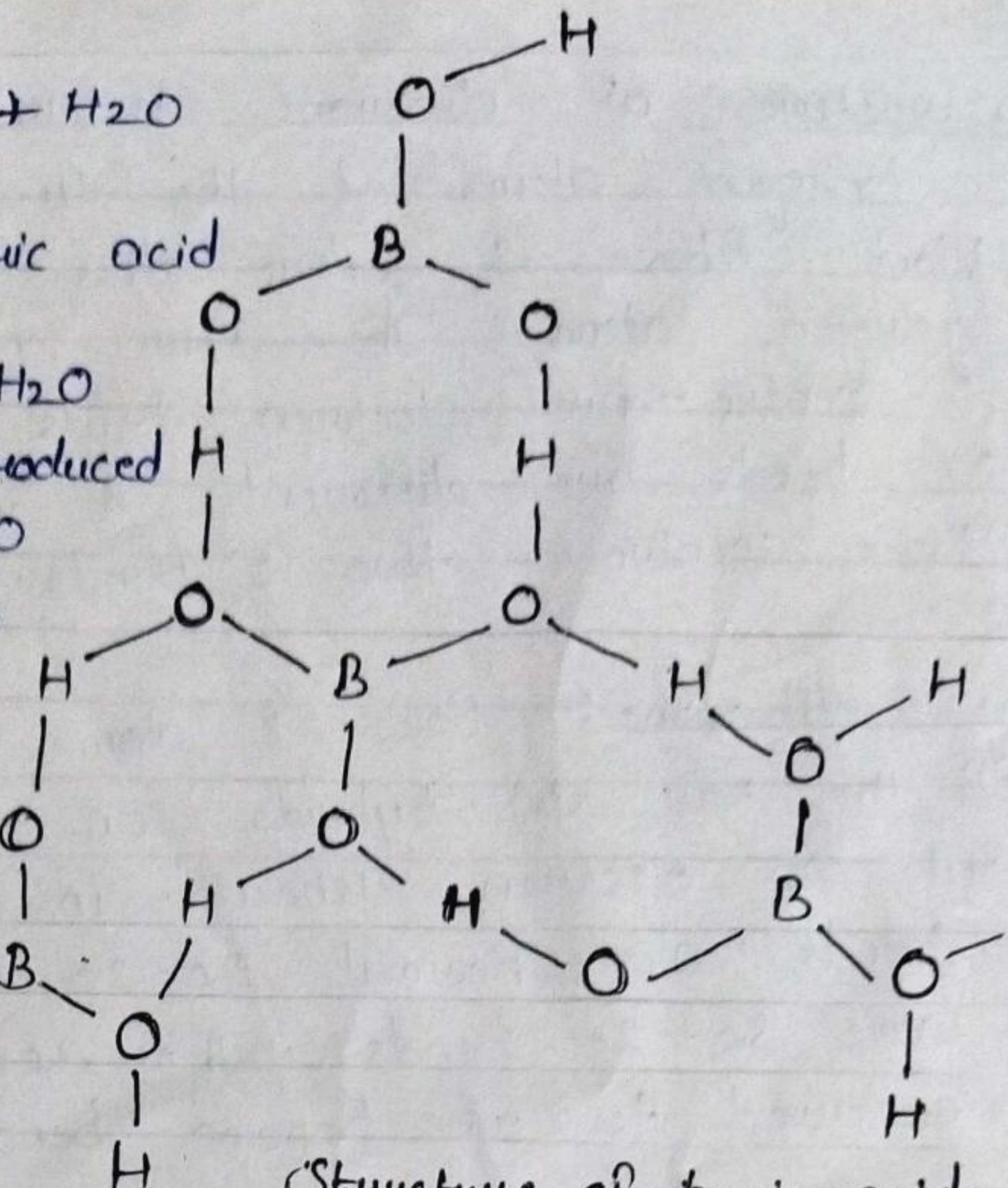
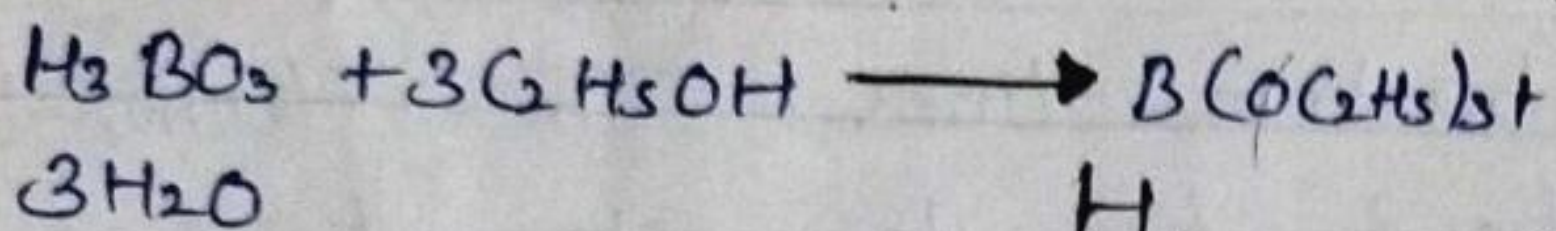
On heating at 160°C.



On strong heating  $B_2O_3$  is produced



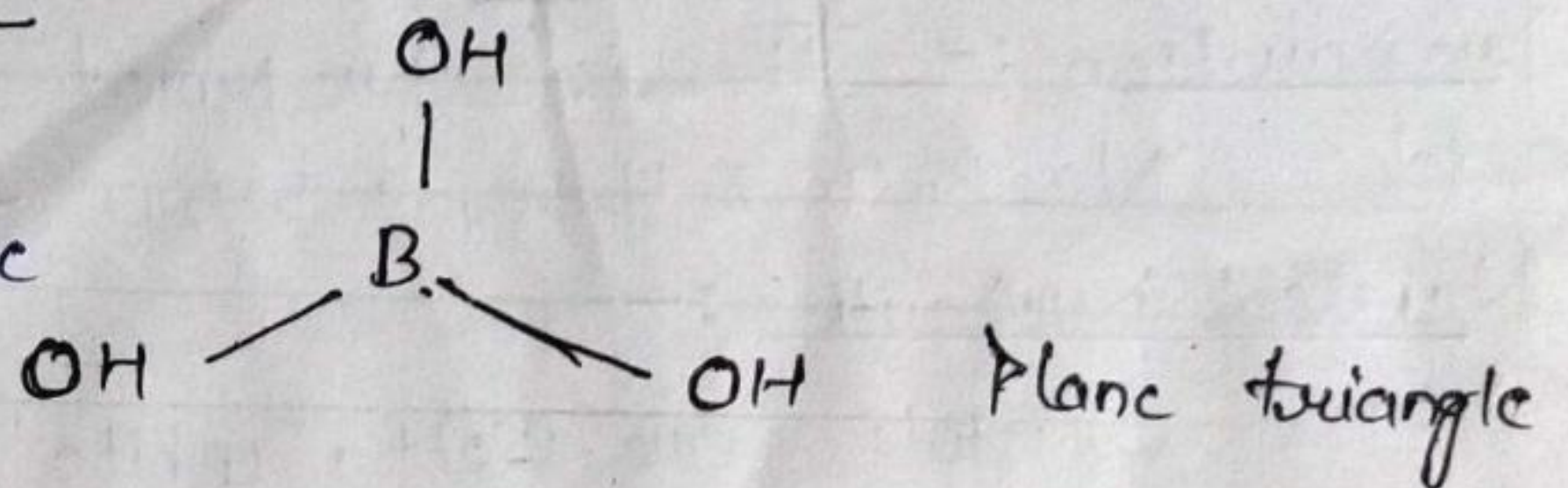
(d) Boric acid react with ethyl alcohol to form ethyl borate which



Structure of boric acid.

Structure of orthoboric acid :-

At lower conc., its structure is a plane triangle.

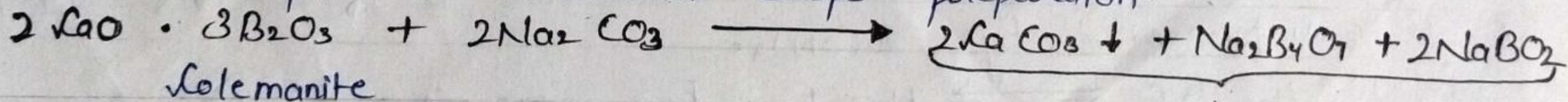


## 4. BORAX :-

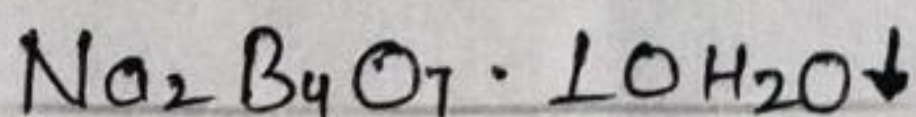
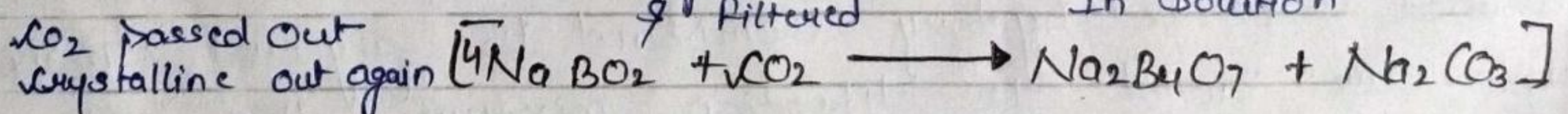
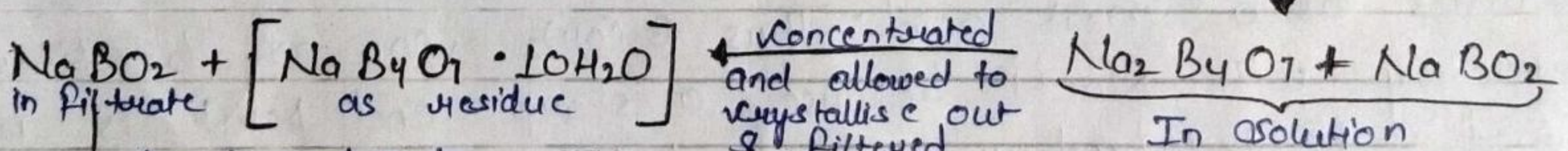
Properties :-

(a) In making glass, enamel & glaze of pottery.

(b) As antiseptic in medicinal ointments preparation.



Filtered -  $CaCO_3$  (as residue)

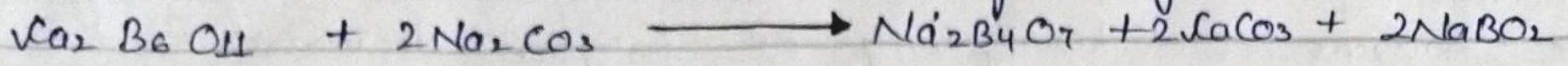


(c) Orthoboric acid on neutralization with  $Na_2CO_3$  gives borax.



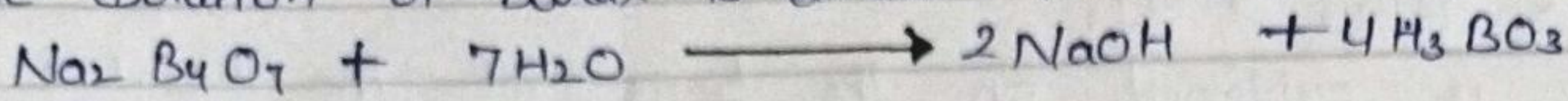


(d) Colemanite is converted into borax by boiling it with concentrated.



Chemical properties :-

The solution of borax is alkaline in nature due to hydrolysis.

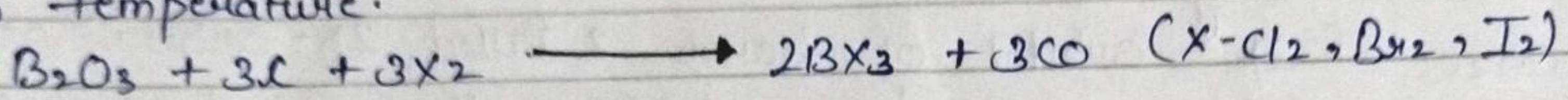


## 5. BORON TRIHALIDES :-

Boron combines with halogens & forms the halides of type  $\text{BX}_3$

(X - F, Cl, Br, I)

Preparation :- Except  $\text{BF}_3$ , other trihalides can be prepared by the treatment of halogens on a mixture of  $\text{B}_2\text{O}_3$  & carbon at high temperature.



Properties :-

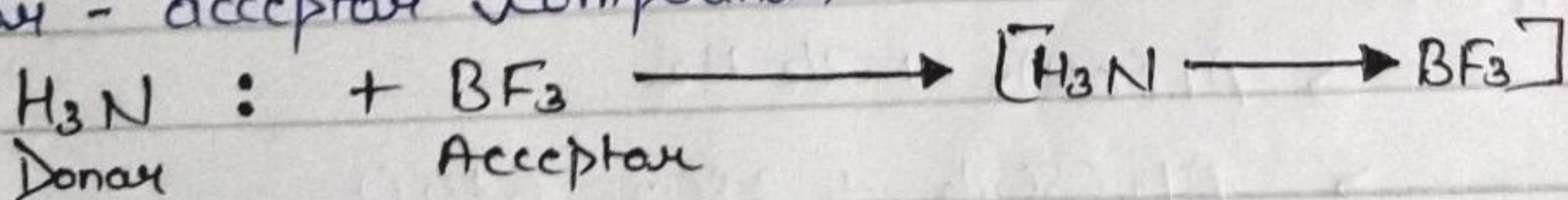
(a) Due to small size & high charge density of  $\text{B}^{3+}$  ion, halides are covalent in nature.

(b) These are non-electrolytes as in liquid state they do not conduct electricity.

(c) The boiling point are very low. The boiling point increases as the atomic no. of halogen increases.

(d)  $\text{BF}_3$  is gas,  $\text{BCl}_3$  (B.P.  $13^\circ\text{C}$ ),  $\text{BBr}_3$  (B.P.  $90^\circ\text{C}$ ) are fuming liquids while  $\text{BI}_3$  (M.P.  $310^\circ\text{C}$ ) is a fusible solid.

(e) The trihalides are electron deficient compounds. Boron atom acquires six electrons on account of three B-X bonds, i.e., 2 electrons, short to complete an octet. Thus the boron atom in  $\text{BX}_3$  molecule can accept two more electrons, i.e., an electron pair from the donor atoms like N, P, O, S, F etc. in  $\text{NH}_3$ ,  $\text{PH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{H}_2\text{S}$ ,  $\text{HF}$ ,  $\text{F}$  etc. respectively to form addition compounds (donor-acceptor compounds).



(f) The relative Lewis acid character of boron trihalides is follow the following order.





but the expected order on the basis of electronegativity of the halogens (electronegativity of halogens decreases from F to I) should be :-

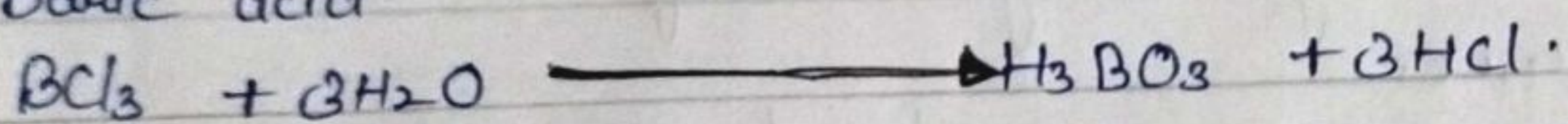


This anomaly is explained on the basis of the relative tendency of the halogen atom to back donate its unutilised electrons to vacant p-orbital of boron atom forming  $p\pi-p\pi$  bond.

Extent of back bonding decrease from  $BF_3$  to  $BI_3$  with inc $\uparrow$  in size p-orbital of halogen.

$p\pi-p\pi$  back bonding is maximum in  $BF_3$  due same energy & same size of 2p orbital of boron & filled 2p-orbital of F.

(g) All boron trihalides, except boron trifluoride, are hydrolysed to boric acid.



The degree of hydrolysis inc $\uparrow$  from  $BCl_3$  to  $BI_3$  becoz covalent character inc $\uparrow$ . Due to resistance of  $BF_3$  to hydrolysis & its tendency to act as Lewis acid  $BF_3$  is used as a catalyst in organic rxns.

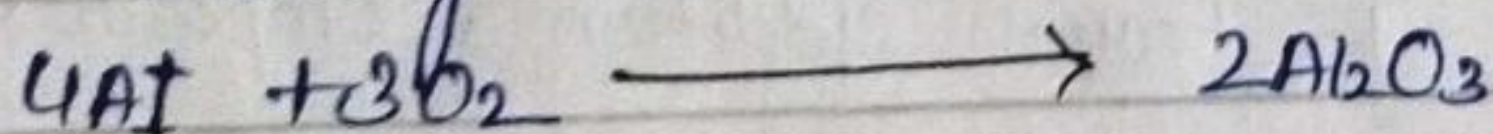
$BF_3$  form addition product with water as B-F bond is very strong.



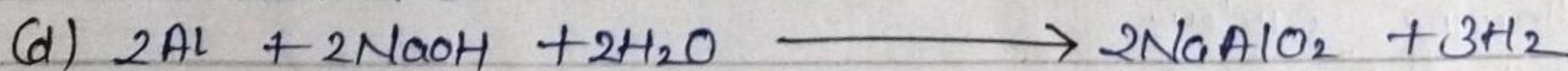
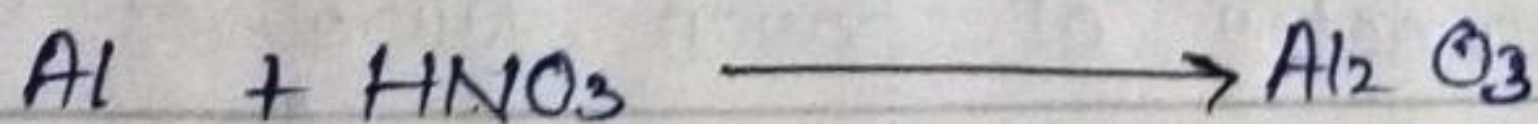
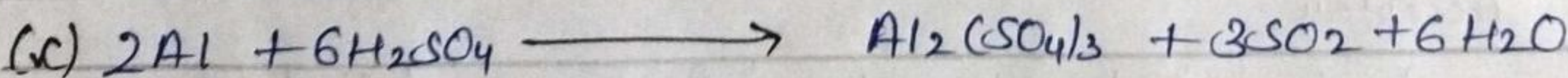
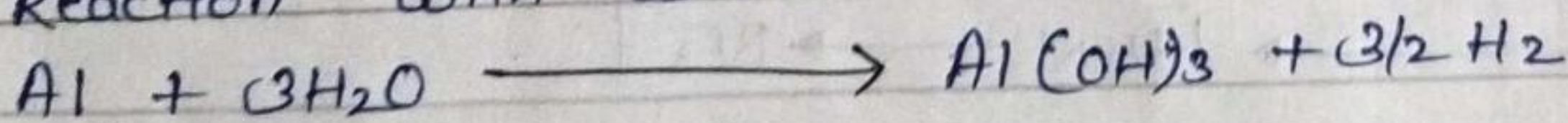
## 6. ALUMINIUM :-

Properties :-

(a) Burning in air

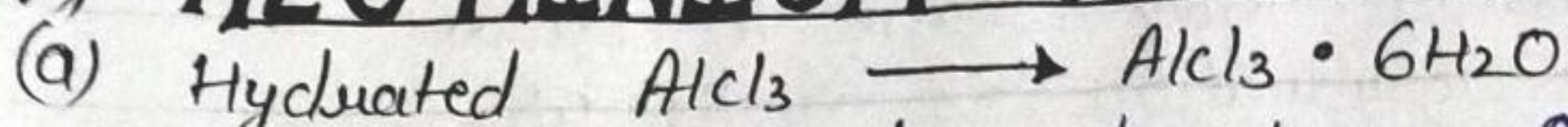


(b) Reaction with water

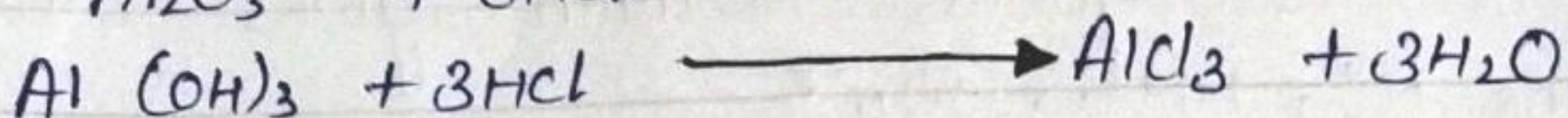
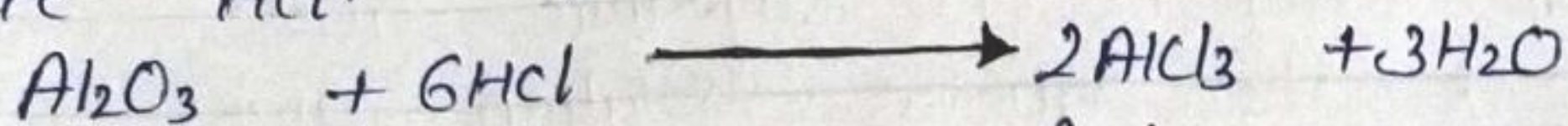




## 7.) ALUMINIUM CHLORIDE ( $AlCl_3$ ) :-

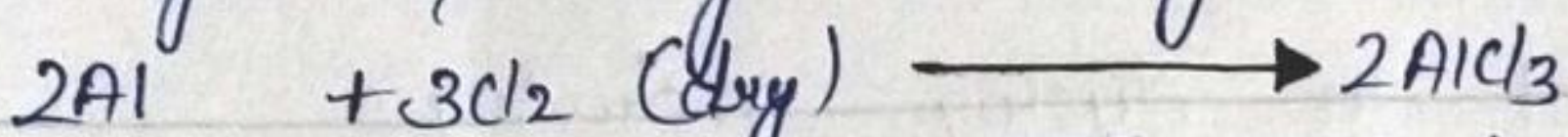


(i)  $AlCl_3$  is prepared by dissolving aluminium oxide or its hydroxide in dilute HCl.

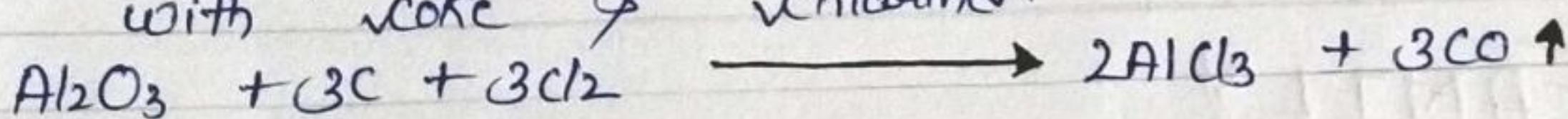


### (b) Anhydrous $AlCl_3$

(i) Anhydrous aluminium chloride can be obtained by passing dry chloride gas & dry HCl gas over heated aluminium in vacuum.

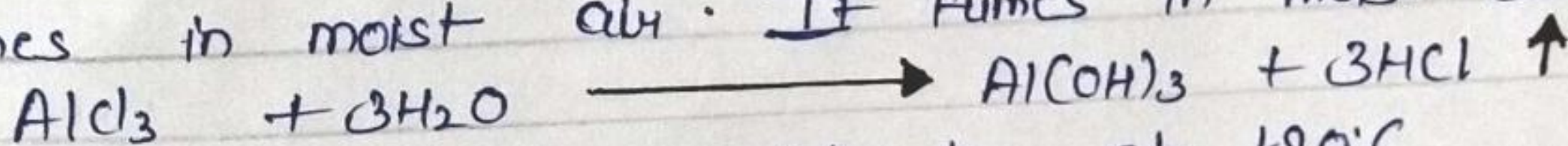


(ii) Marcelle's process :- The anhydrous salt is prepared by heating alumina with coke & chlorine.



### Properties :-

(a) Aluminium chloride is a white crystalline substance which fumes in moist air. It fumes in moist air due to its hydrolysis.



(b) On heating it sublimates at  $180^\circ C$

(c) At sublimation point its vapour density corresponds to formula  $Al_2Cl_6$  i.e., it exists as a dimer. At higher temp i.e., above  $750^\circ C$  it exists as a monomer  $AlCl_3$ .

(d) It is largely covalent hence it does not conduct current in fused state.

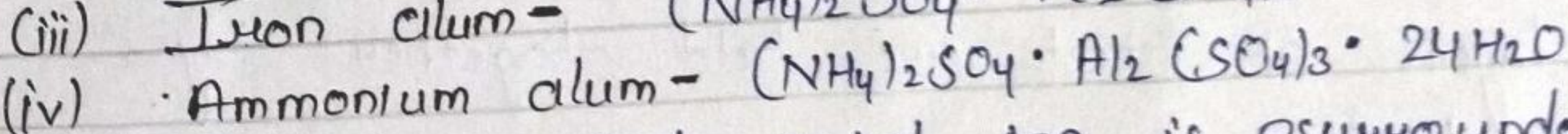
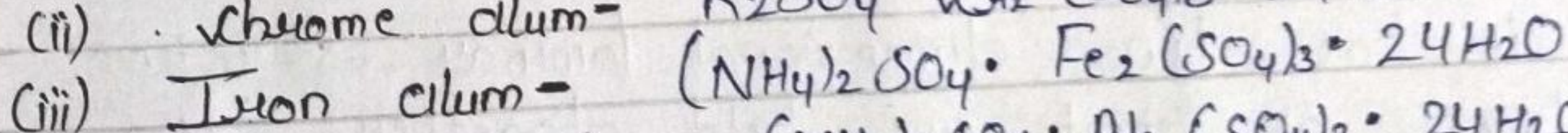
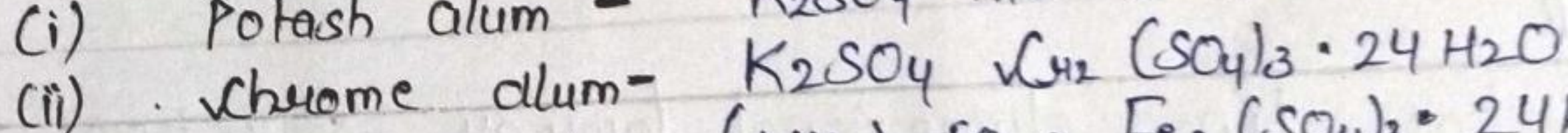
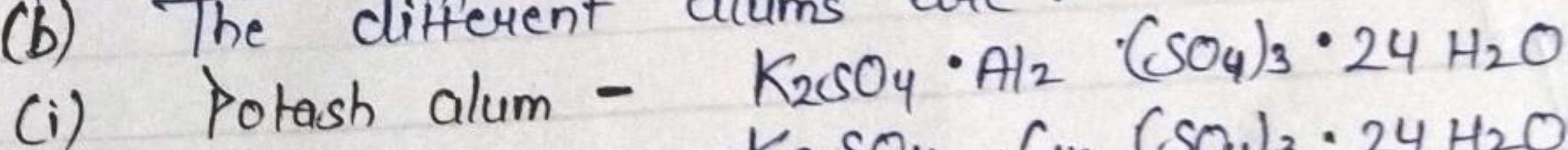
### Uses of $AlCl_3$ :-

Anhydrous  $AlCl_3$  is employed as a catalyst in organic rxns i.e. Friedel Crafts reaction

## 8.) ALUM :-

(a) Alums are double sulphates with their general formula  $R_2SO_4 \cdot M_2(SO_4)_3 \cdot 24H_2O$  where R = monovalent radical like  $Na^+$ ,  $K^+$ ,  $NH_4^+$  & M = trivalent radical like  $Al^{+3}$ ,  $Cr^{+3}$ ,  $Fe^{+3}$ .

(b) The different alums are :-



(c) In alums each metal ion is surrounded by six water molecules.

(d) Lithium does not form alum because Li ion is too small to have a coordination no. of six.



### Properties :-

- It is a white crystalline solid highly soluble in water.
- On heating it undergoes dehydration & swells up.
- It is highly it undergoes aqueous solution due to the hydrolysis of aluminium sulphate to sulphuric acid.
- It is double salt & its aqueous solution gives reaction of all the constituents ions  $K^+$ ,  $Al^{+3}$ ,  $SO_4^{-2}$

### Uses :-

- Alum is used to stop bleeding.
- It is used for purification of water.
- It is used as a mordant in dyeing industry.
- Alum is used for tanning of leather.

## CARBON FAMILY

### 1. ALLOTROPIC FORM OF CARBON :-

#### (A) Crystalline :-

##### (a) Diamond :-

- Three dimensional polymeric structure
- In diamond each carbon is in  $sp^3$  hybridized state & is linked to four other neighbouring carbon atoms held at the corners of a regular tetrahedron by covalent bonds.
- In this structure C-C distance is  $1.54 \text{ \AA}$  with a bond angle of  $109.5^\circ$ .
- Due to these strong covalent bonds, diamond is the hardest substance. Crystal structure of diamond having abnormally high melting point ( $3600^\circ C$ ) & is extremely inert chemically.
- It has very high refractive index (2.5) i.e., light rays are slowed down by the tightly bound electron.
- Due to unavailability of mobile electrons it is non-conductor of electricity.

##### (b) Graphite :-

- Unlike diamond, it has two dimensional laminar structure.
- The adjacent layers of sheet are held together by weak van der Waal forces.
- Here each carbon atom is in  $sp^2$  hybridised state & is thus attached to three other carbon atoms by three atoms bonds forming a hexagonal planar structure.



- (iv) The fourth electron present in an unhybridised p-orbital of each carbon atom of a hexagonal unit then overlaps with each other to form a  $\pi$  bond.
- (v) The C-C bond length in graphite is shorter ( $1.42 \text{ \AA}$ ) than that of diamond ( $1.54 \text{ \AA}$ ).
- (vi) Since  $\pi$ -electrons ( $\pi$ -e<sup>-</sup>) are free to move throughout the entire layers, graphite is a good conductor of electricity. Its conductivity increases with temperature.
- (vii) It is a soft gray, dark greyish coloured crystalline solid having density  $2.5 \text{ g mL}^{-1}$ .
- (viii) Since it leaves a black mark on paper it is called black lead or plumbago.
- (ix) It is thermodynamically more stable than diamond & its free energy of formation is  $1.9 \text{ kJ}$  less than diamond.
- Graphite  $\xrightarrow[50,000-60,000 \text{ atm}]{1600^\circ \text{C}}$  diamond.

## (B) Amorphous :-

### (A) Fullerenes :-

- (i) Discovered by smily & robert curl (Nobel prize - 1996)
- (ii) Fullerenes normally contain  $C_{60}$  with smaller quantity of  $C_{70}$

### Structure of $C_{60}$ :-

- (i)  $C_{60}$  is also called buckminster fullerene in honour of robert buckminster fuller.
- (ii) Shape of  $C_{60}$  is soccer ball &  $C_{70}$  is Rugby ball.
- (iii)  $C_{70}$  &  $C_{60}$  having hexagonal & pentagonal unit.

### (d) Coal :-

- (1) Naturally form & artificially.
- (2) It is found in different form. e.g:- peat, lignite, bituminous, Anthracite
- (3) Max percent of C - Anthracite      Min percent of C - peat
- (4) Calorific value Max in - Anthracite.

## 2. CARBIDES :-

Carbides are of three types according to the type of bonding

### (a) Salt like carbides (ionic bonding) :-

- (i) These are formed by strong electropositive elements of groups 1, 2 & 13.
- (ii) These are transparent crystalline substances & do not conduct electric current in solid state.
- (iii) These are easily hydrolysed by water or dilute acids to give aliphatic hydrocarbons.



Methanides (Methides): Methanides are the carbides which give methane on hydrolysis. They contain  $\sqrt{C^{4-}}$  ions.



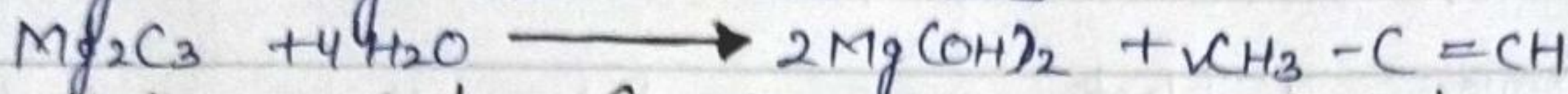
Acetylides: These are carbides have ionic NaCl-type of structure.

E.g:  $\sqrt{\text{CaC}_2}$ ,  $\sqrt{\text{BaC}_2}$  &  $\sqrt{\text{MgC}_2}$



Note: Most of these carbides have ionic-type of structure.

Allylides: These carbides give methylacetylene or allylene ( $\text{CH}_3-\text{C}\equiv\text{CH}$ ). On hydrolysis they contain  $\sqrt{\text{C}_3^{4-}}$  ions.



(b) Covalent carbides (giant molecular structure):

(i) Covalent carbides are compound of carbon with elements having similar electronegativity.

(ii) These are covalent, polymeric, thermally stable, extremely hard, high melting & technically inert solid.

(iii)  $\text{B}_4\text{C}$  &  $\text{SiC}$  are two main covalent carbides.

(c) Alloy type or interstitial type carbide:

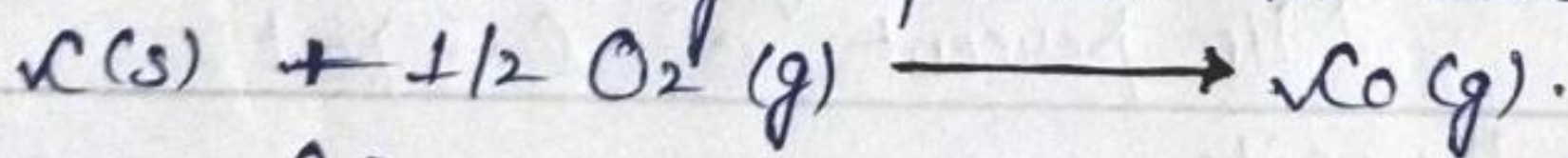
Transition metal like Ti, Zr, Hf, V, Nb, Ta & Mo form these carbides. The metals retains their close packed lattice & carbons are incorporated in their interstitial spaces. These carbides are extremely hard & have very high melting points.

The carbides of V & Ta are very hard hence they are used for manufacture of high speed cutting tools.

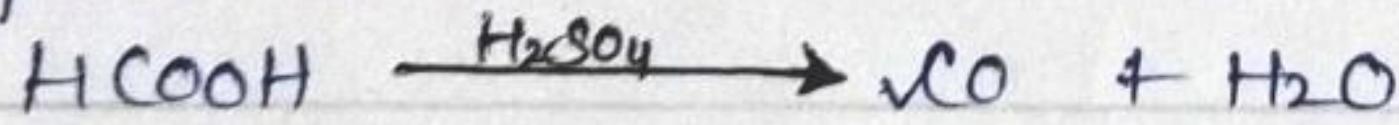
### 3. CARBON MONOXIDE (CO) : —

Preparation :-

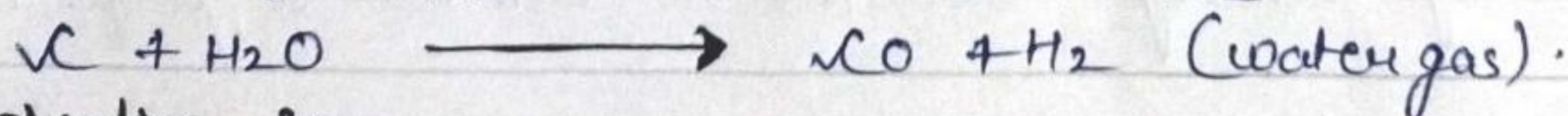
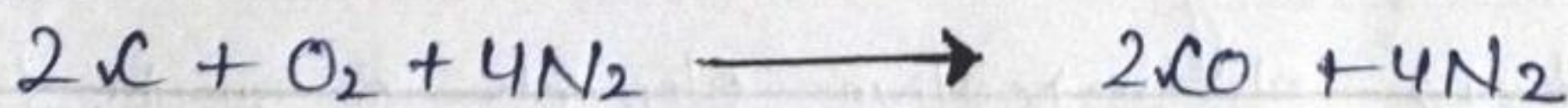
(a) It is invariably present in automobile exhaust gas.



(b) pure CO



(c) Industrially it is obtained in the form of water gas & producer gas when air (moist) is passed over a bed of white hot coke.

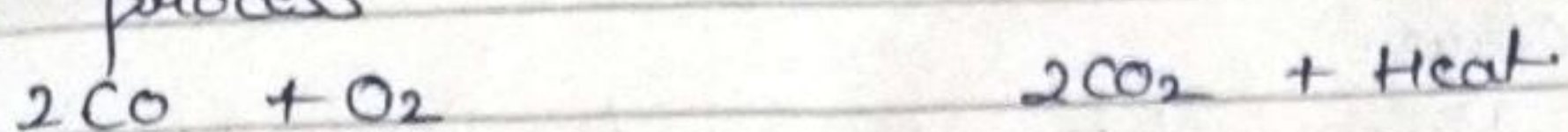


Properties :-

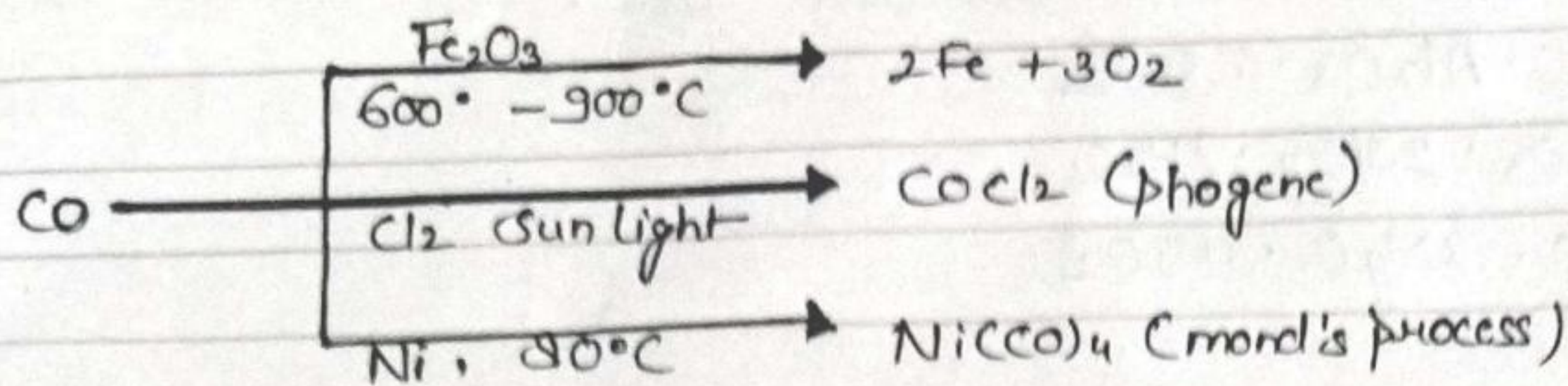
(a) It is highly poisonous as it combines with haemoglobin to form carboxy haemoglobin which is not capable to absorb oxygen.



(b) It burns with blue flame to form  $\text{CO}_2$ . This is an exothermic process

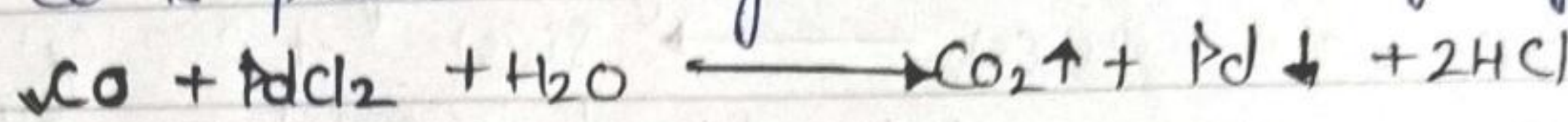


(c) Chemical reactions

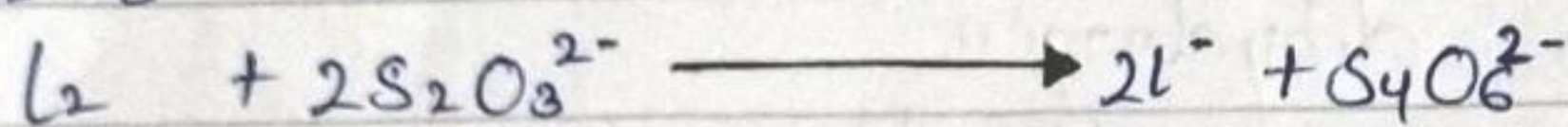
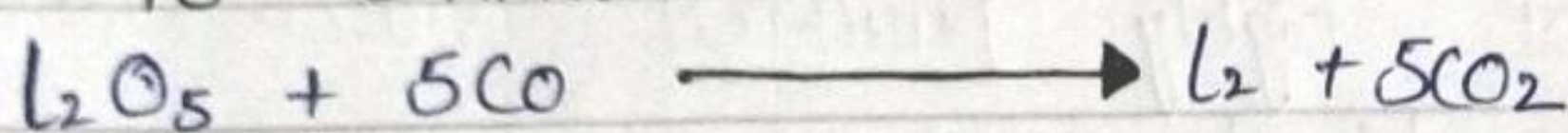


How to detect

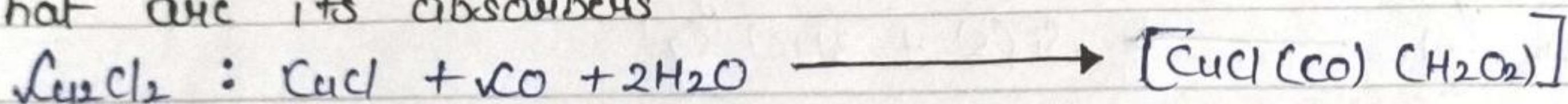
Burn with blue flame.  $\text{CO}$  is passed through  $\text{PdCl}_2$  solution giving rise to black ppt.



How to estimate.



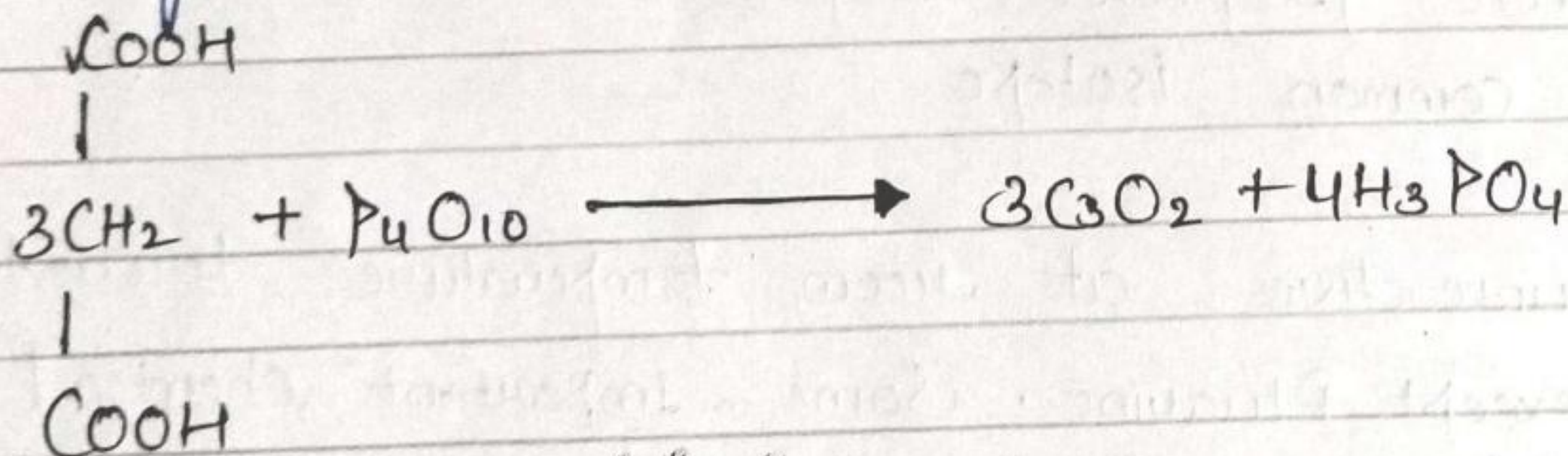
What are its absorbers



#### 4. CARBON SUB OXIDE :-

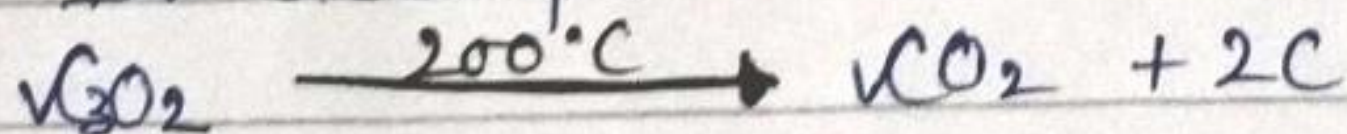
Preparation :-

By heating malonic acid with phosphorous pentoxide



Properties :-

- Colourless gas, boiling point  $6^\circ\text{C}$
- Very readily polymerises to give coloured salts.
- It decomposes at  $200^\circ\text{C}$



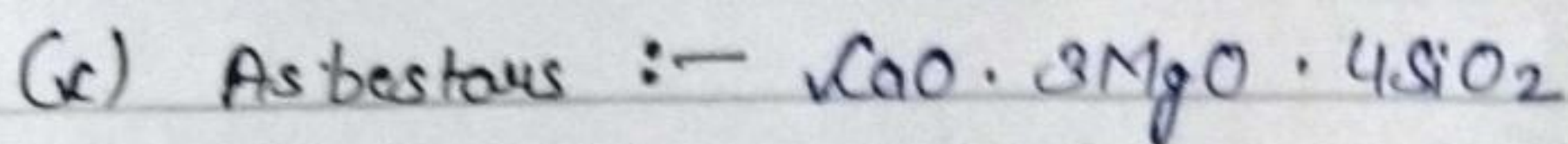
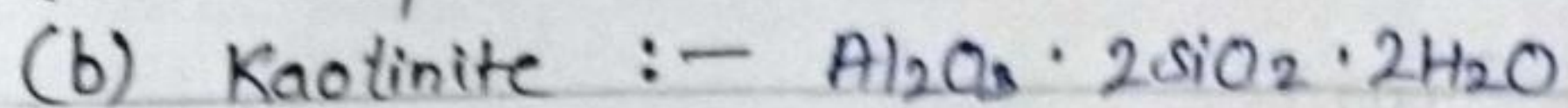
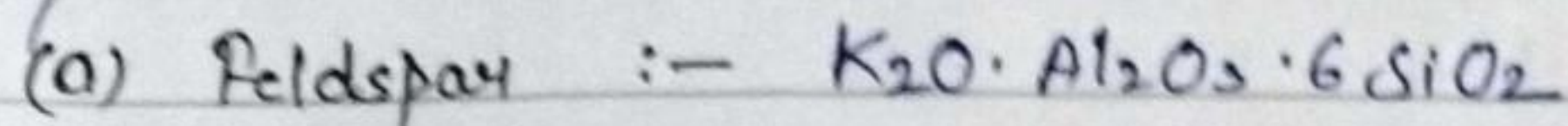
#### 5. SILICON :-

Silicon is the II<sup>nd</sup> most abundant (27.2%) element after oxygen (45.5%) in the earth's crust. It does not occur free in nature but in the combined state, it occurs widely in form of silica & silicates. All mineral rocks, clays &



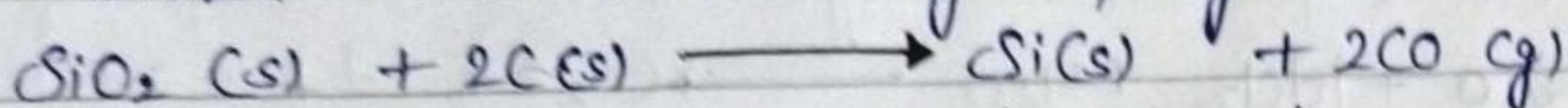
soils are built of silicates of magnesium, aluminium, potassium or iron. Aluminium silicate is however the most common constituent of rocks & clays.

Silica is found in the free state in sand, flint & quartz & in the combined state as silicates like:



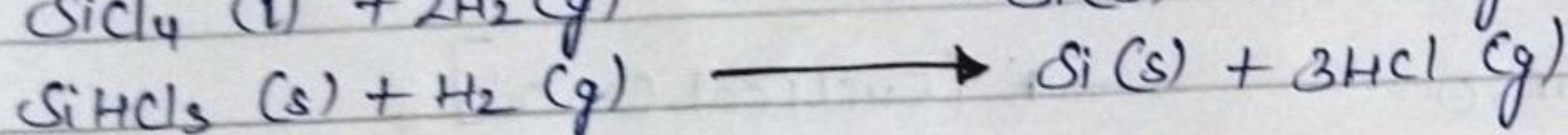
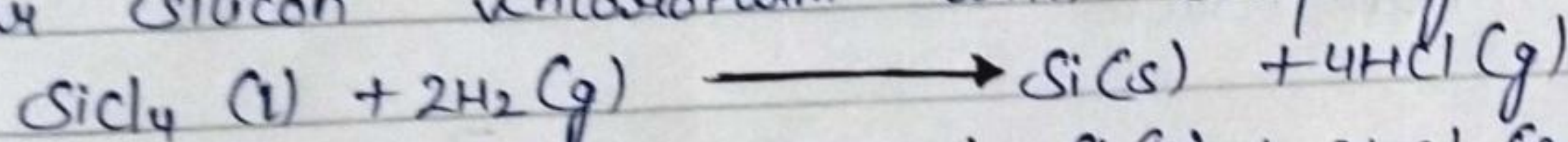
Preparation :-

(a) From silica (sand) :- Element silicon is obtained by the reduction of silica ( $SiO_2$ ) with high purity coke in an electric furnace.



(b) From silicon tetrachloride ( $SiCl_4$ ) or silicon chloroform ( $SiHCl_3$ ) :-

It is obtained by reduction of highly purified silicon tetrachloride or silicon chloroform with dihydrogen.



Physical properties :-

a) Elemental silicon is very hard having diamond like structure.

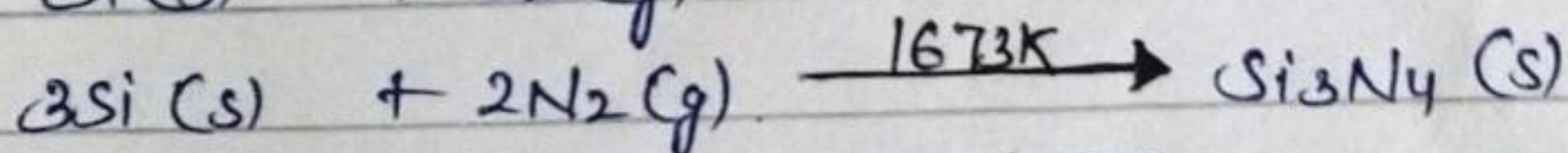
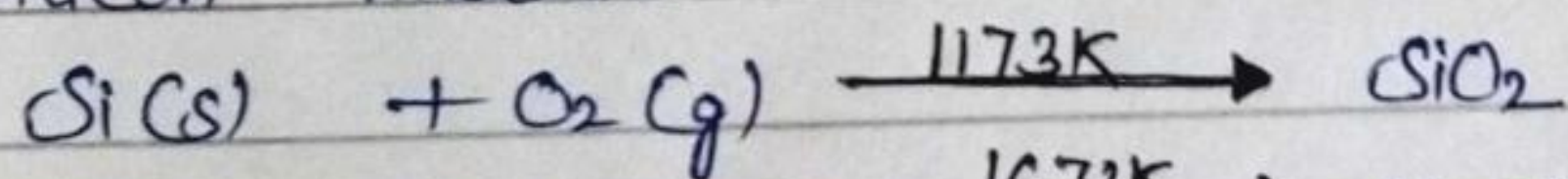
b) It has shining luster with a melting point of 1793K & boiling point of about 3550K.

c) Silicon exists in three properties (isotopes) i.e.,  $^{28}_{14}Si$  &  $^{30}_{14}Si$  &  $^{29}_{14}Si$  but  $^{28}_{14}Si$  is the most common isotope.

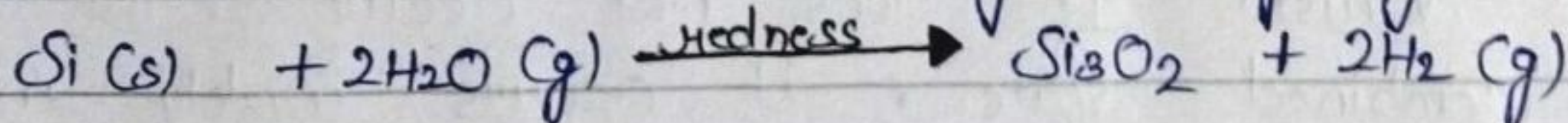
Chemical properties :-

Silicon is particularly unreactive at room temperature towards most of the elements except fluorine. Some important chemical reactions of silicon are discussed below.

(a) Action of air: Silicon reacts with oxygen of air at 1173K to form silicon dioxide & with nitrogen of air at 1673K to form silicon nitride.

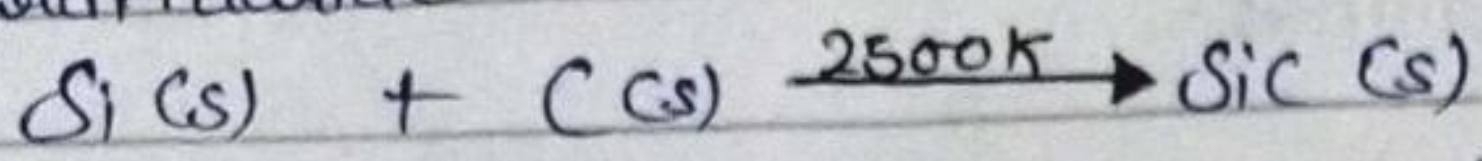


(b) Action of steam :- It is slowly attacked by steam when heated to redness liberating dihydrogen gas.





(c) Action with halogens :- It burns spontaneously in Fluorine gas at room temperature ~~dihydrogen gas~~ to form silicon tetrafluoride



Carborundum is an extremely hard substance next only to diamond. It is mainly used as an abrasive & as a refractory material.

Uses :-

(a) Silicon is added to steel as such or more usually in form of ferrosilicon (an alloy of Fe & Si) to make it acid resistant.

(b) High purity silicon is used as a semiconductor in electronic devices such as transistors.

(c) It is used in the preparation of alloys such as silicon-bronze, magnesium silicon bronze & ferrosilicon.

## 6. SILICATES :-

Silicates have basic unit of  $\text{SiO}_4^{4-}$ , each silicon atom is bonded with four oxide ions tetrahedrally.

There are following types of silicates.

(a) Orthosilicates :- These silicates contain single discrete unit of  $\text{SiO}_4^{4-}$  tetrahedral. E.g. Willemite  $[\text{Zn}_2\text{SiO}_4]$ .

(b) Pyrosilicates :- These silicates contain two units of  $\text{SiO}_4^{4-}$  joined along a corner, containing oxygen atom. These are also called as island silicate.

E.g. :- Hemimorphite  $\text{Zn}_3(\text{Si}_2\text{O}_7)\text{Zn}(\text{OH})_2 \cdot \text{H}_2\text{O}$ , pyrosilicates  $\text{Si}_2\text{O}_7^{6-}$

(c) Cyclic Structure :- cyclic or ring silicate having general formula  $(\text{SiO}_3^{2-})_n$  or  $(\text{SiO}_3)_n^{2n-}$  structure & example of cyclic silicates containing  $\text{Si}_3\text{O}_6^{6-}$  &  $\text{Si}_6\text{O}_{18}^{12-}$  ions. E.g. :- Beryl  $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$

(d) Chain silicates :- chain silicates are formed by sharing two oxygen atoms by each tetrahedral. Anions of chain silicate have two general formula. 1)  $(\text{SiO}_3)_n^{2n-}$  2)  $(\text{Si}_4\text{O}_{11})_n^{6n-}$

(e) Two dimensional sheet silicates :- In such silicates, three oxygen atoms of each tetrahedral are shared with adjacent  $\text{SiO}_4^{4-}$  tetrahedral, such sharing form two dimensional sheet structure with general formula  $(\text{Si}_2\text{O}_5)_n^{2n-}$



(P) Three dimensional sheet silicates :- These silicates involve all four oxygen atoms in sharing with adjacent  $\text{SiO}_4^{4-}$  tetrahedral.  
E.g :- Quartz, Zeolites & Ultramarines.

## 7. SILANE :-

(a) Only these are found  $\text{SiH}_4$  &  $\text{Si}_2\text{H}_6$

(b) Higher molecules are not found so Si can't show catenation properties.

(c)  $\text{SiH}_4$  is more reactive than  $\text{CH}_4$  due to following reason.

(i)  $\text{Si}^{\delta+} - \text{H}^{\delta-}$  &  $\text{C}^{\delta-} - \text{H}^{\delta+}$

$\text{C}$  - electronegative than H

So less electronegative than H

So bond polarity is reversed when  $\text{Nu}^-$  attacks, so it faces repulsion in  $\text{C}$  but not in Si.

(ii) Silicon is having vacant d orbital which is not in case of Carbon.

(iii) Silicon is larger in size compared to  $\text{C}$ . By which the incoming  $\text{Nu}^-$  doesn't face any steric hindrance to attack at Si whereas  $\text{CH}_4$  is tightly held from all sides.

## 8. SILICONES :-

These are organosilicon polymers containing  $\text{R}_2\text{SiO}$  repeating units & empirical formula analogous to ketone ( $\text{R}_2\text{CO}$ ).

Alkyl substituted :- These are formed by hydrolysis of alkyl chlorosilanes & their polymerisation. The alkyl or aryl

substituted chlorosilanes are prepared by the reaction of Grignard reagent & silicon tetrachlorides.

Organic polymers containing silicon in them are called as silicones.

Uses :-

(a) They are used as greases, varnishes & resins.

(b) As they are water repellants, they are used for water-proofing.

(c) They are good electric insulators.



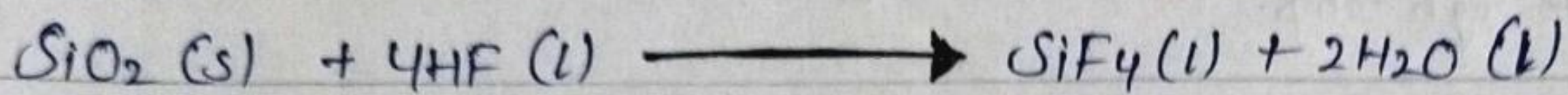
## 9. SILICA ( $\text{SiO}_2$ ) :-

Silica or silicon dioxide occurs in nature in the free state as sand, quartz & flint & in the combined state as silicates like Feldspar, Kaolinite etc.

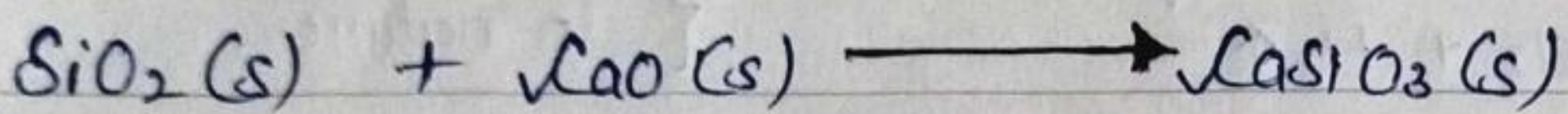
### Properties :-

(a) pure silica is colourless, but sand is usually coloured yellow or brown due to presence of Ferric oxide as an impurity.

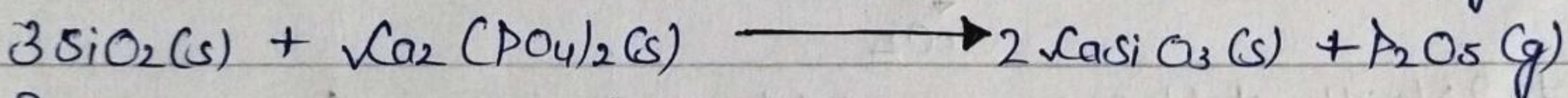
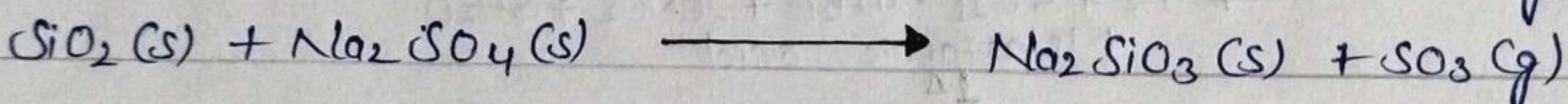
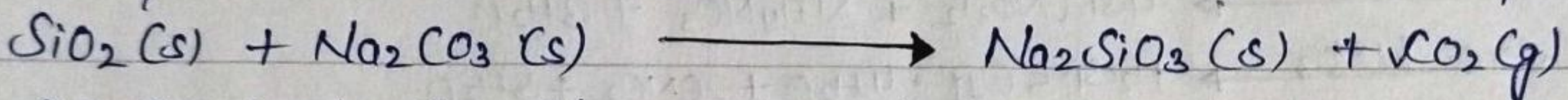
(b) Silicon dioxide is insoluble in water & all acids except hydrofluoric acid.



(c) It also combines with metallic oxides at high temperature giving silicates.



(d) When silica is heated strongly with metallic ion, silicates are formed & the volatile oxides are driven off as vapours.



The first two e.g. quoted here are important in glass making.

**Structure of Silica :-** Silica has a 3 dimensional network structure. In silica, silicon is  $\text{sp}^3$ -hybridized & is thus linked to four oxygen atoms & each atom is linked to two silicon atoms forming a three-dimensional giant molecule. This 3-dimensional network structure imparts stability to  $\text{SiO}_2$  crystal & hence a large amount of energy is required to break the crystal result in high melting point.

### Uses :-

(a) Sand is used in large quantities to make the cement.

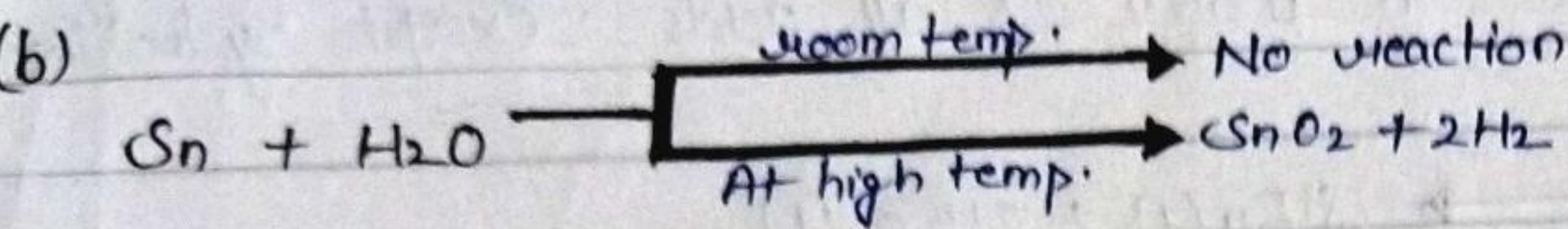
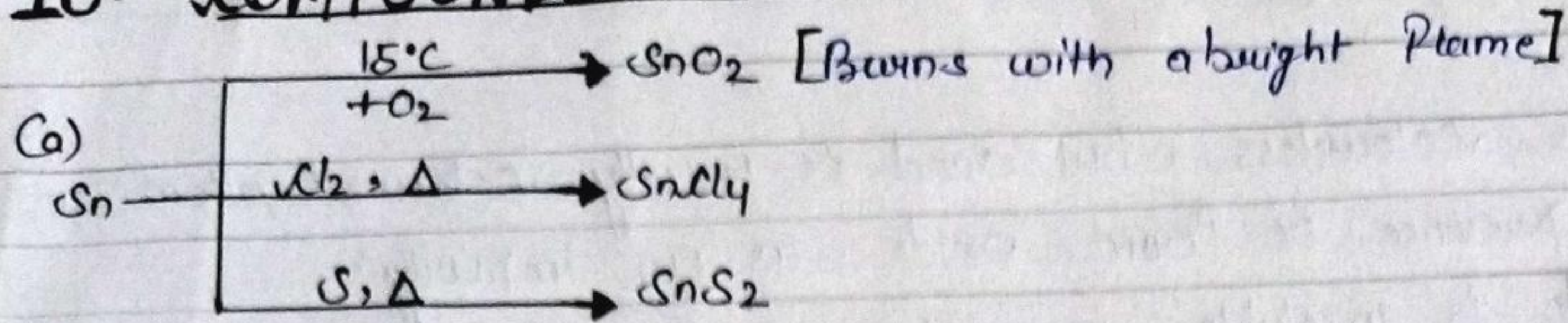
(b) Being transparent to ultra violet light, large crystal of quartz are used for making lenses for optical instruments & for controlling the frequency of radio-transmitters.

(c) powdered powdered quartz is used for making silica bricks.

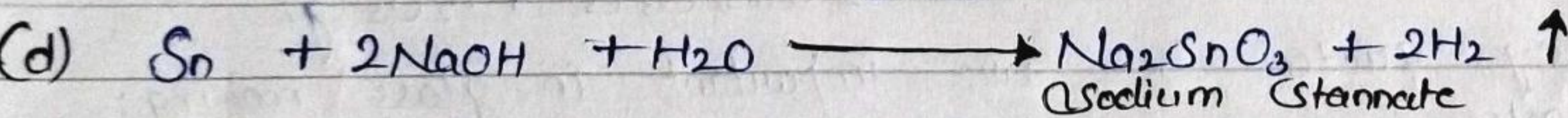
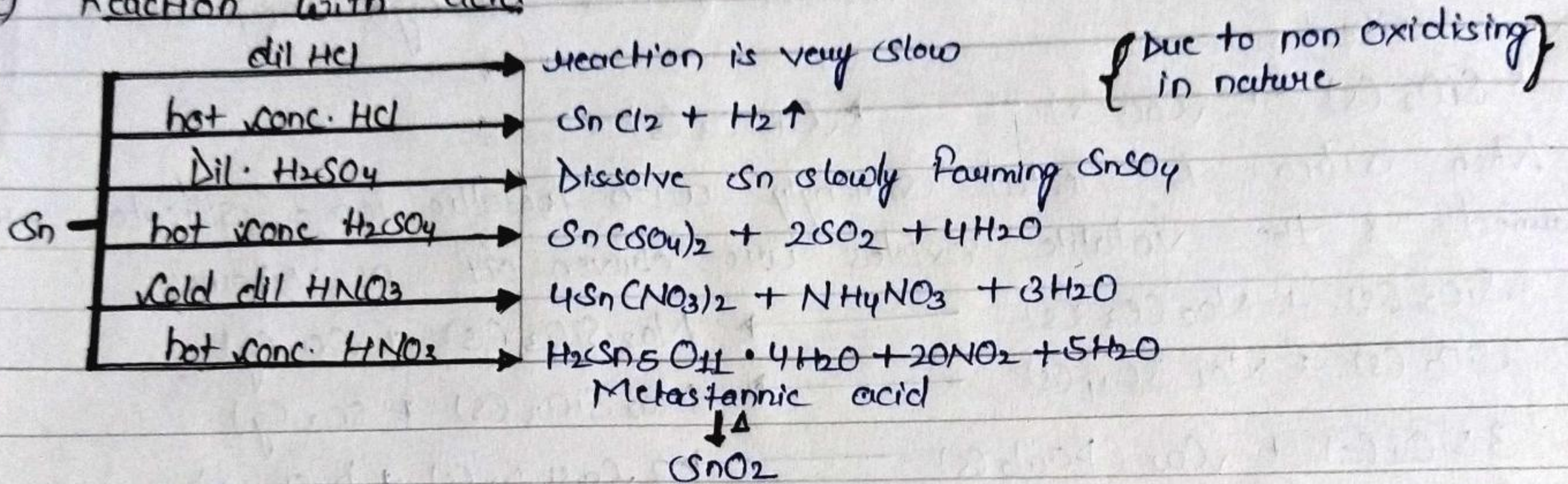


(d) Silica gel ( $\text{SiO}_2 \cdot x\text{H}_2\text{O}$ ) is used as a desiccant (For absorbing moisture) & as an adsorbant in chromatography.

## 10. COMPOUNDS OF Sn (TIN)/LEAD :-

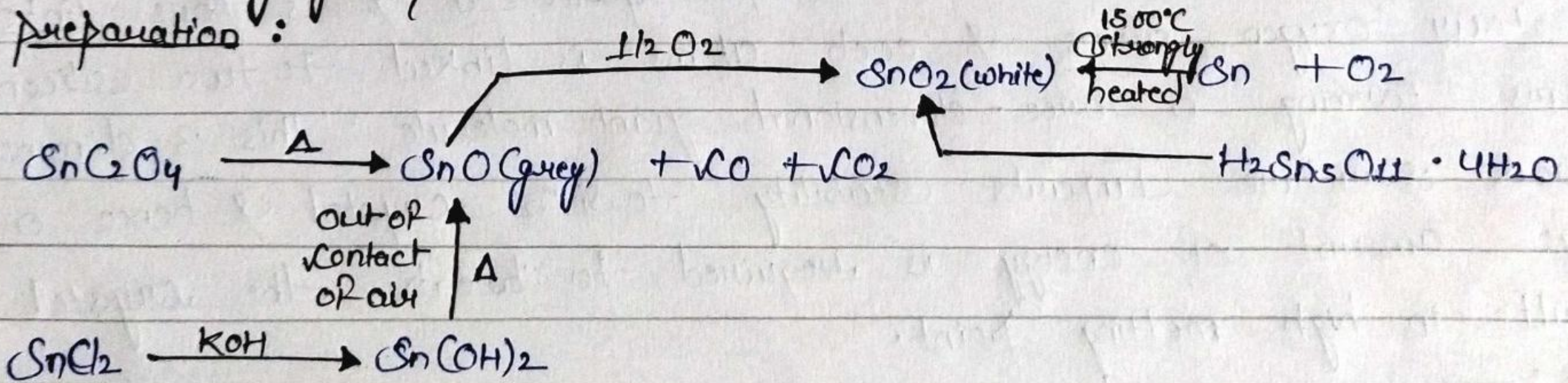


### (c) Reaction with acid :-

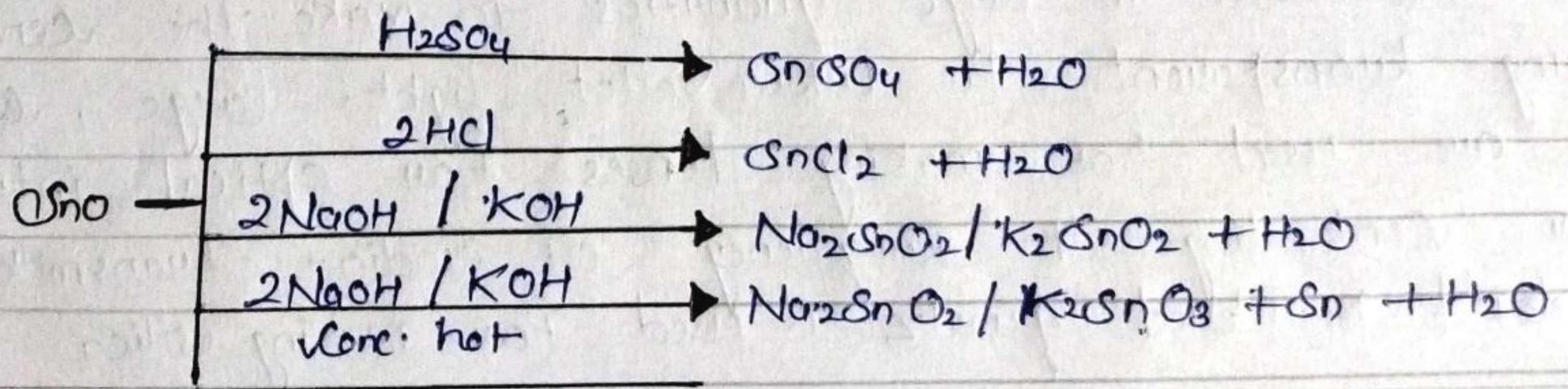


## 11. $\text{SnO}$ (grey) & $\text{SnO}_2$ (white) :-

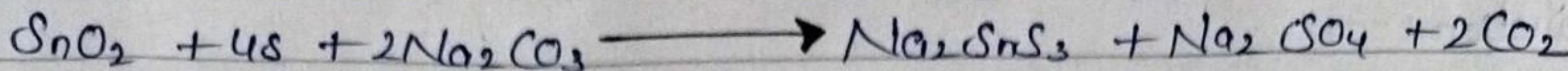
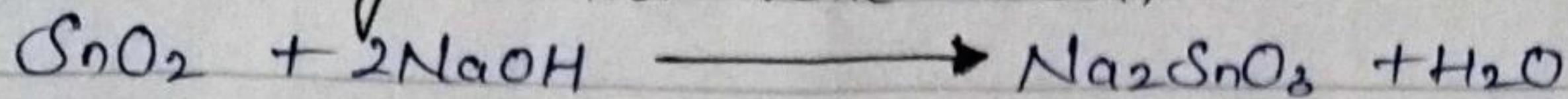
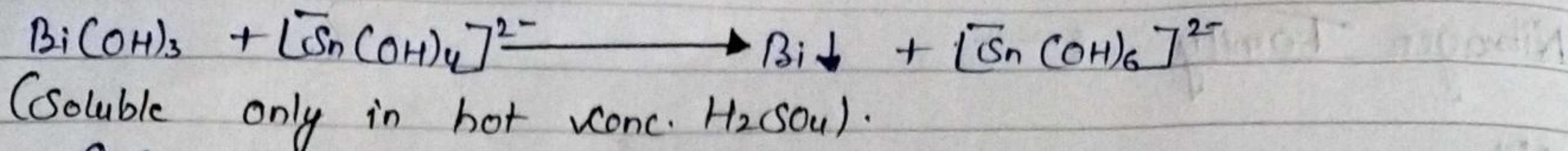
Preparation:



Properties: Both are amphoteric in nature

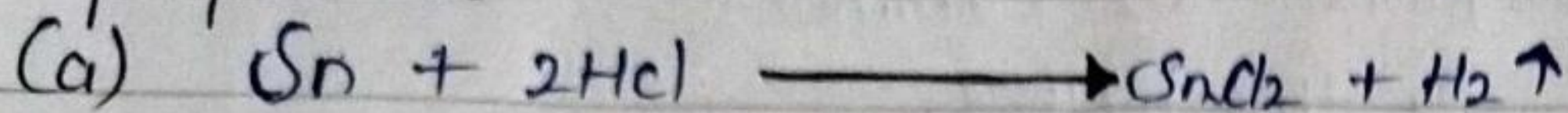




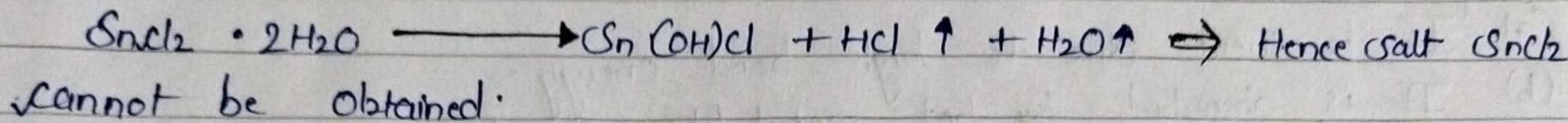


## 12. STANNOUS CHLORIDE ( $\text{SnCl}_2$ ) :-

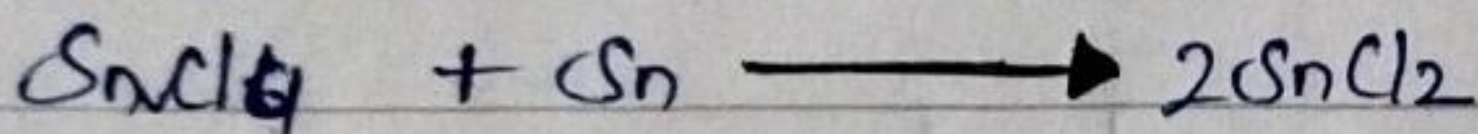
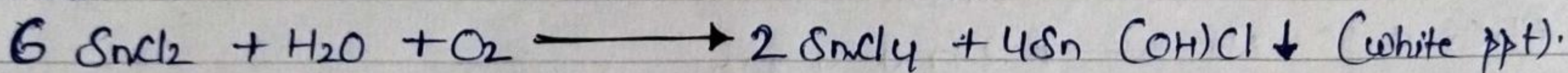
Preparation :-



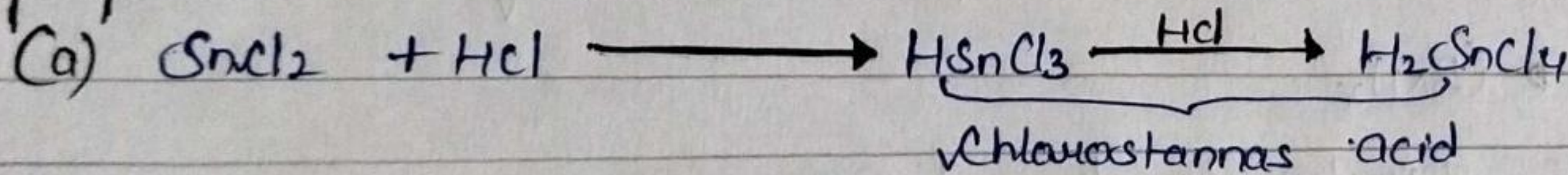
(b) Anhydrous salt cannot be obtained by heating the hydrated salt as it undergoes hydrolysis & a white solid of tin hydroxy chloride is formed.



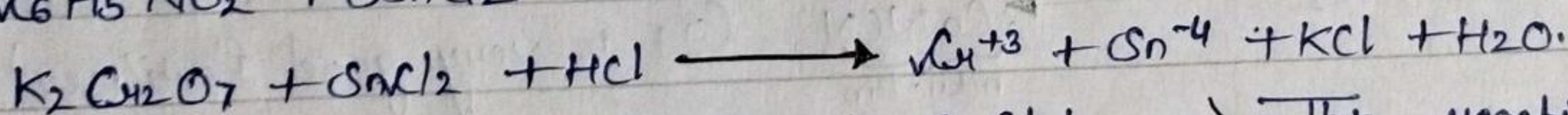
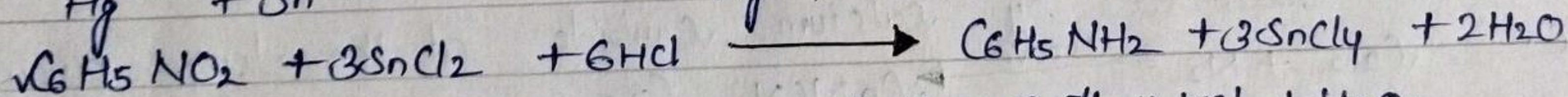
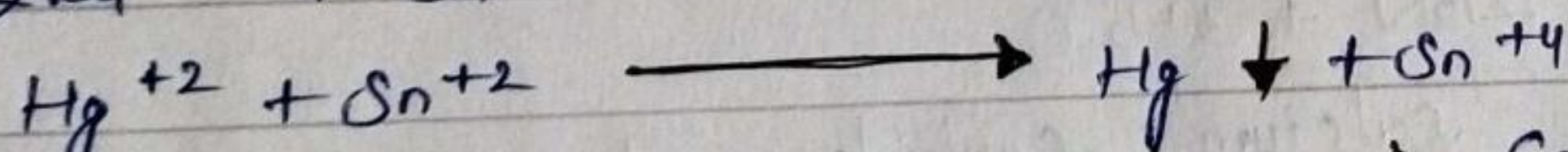
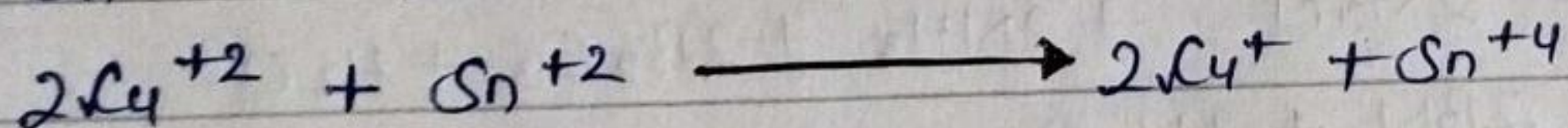
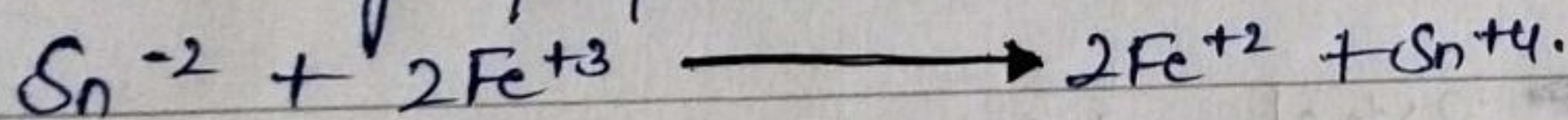
(c) A piece of Sn is always added to preserve a solution of  $\text{SnCl}_2$ .



Properties :-



(b) Reducing properties.



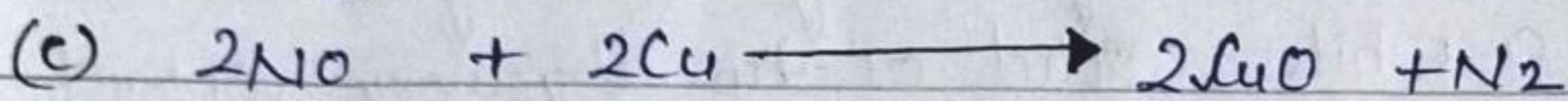
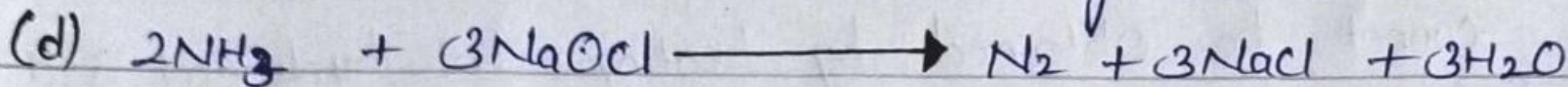
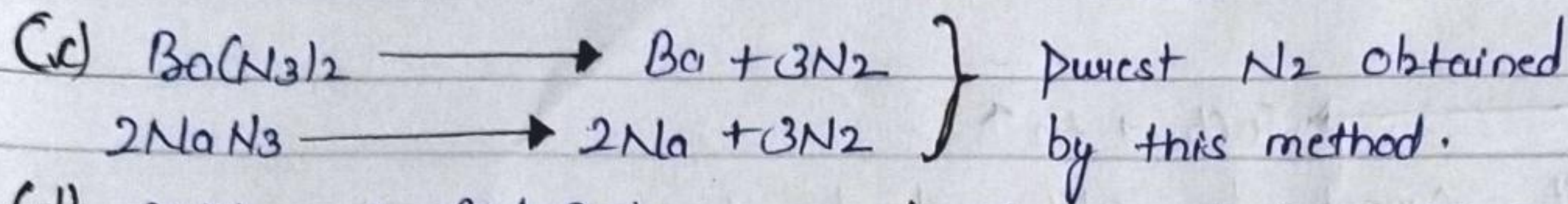
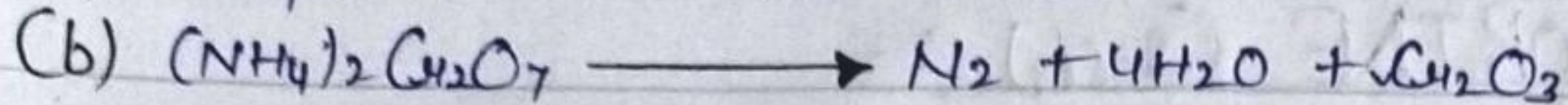
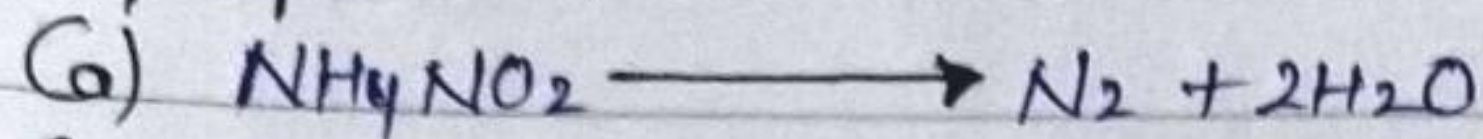
(c) Readily combines with  $\text{I}_2 \Rightarrow \text{SnCl}_2\text{I}_2 \Rightarrow$  This reaction is used to estimate tin.



# Nitrogen Family :-

## Nitrogen :-

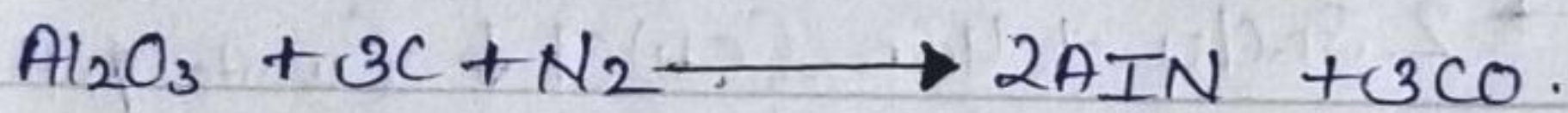
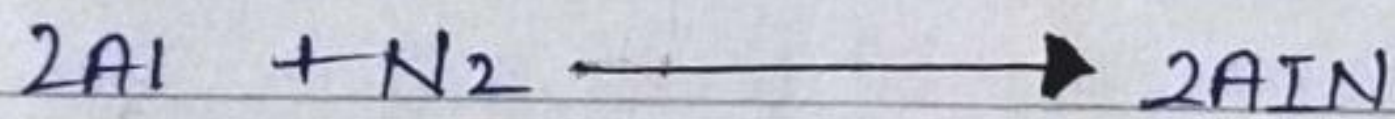
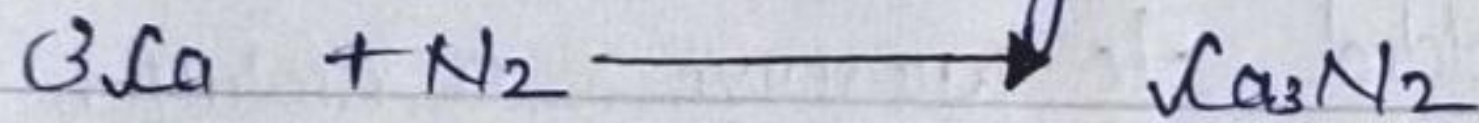
### Preparation :-



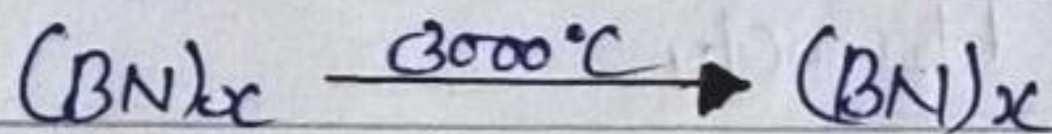
### Properties :-

(a) It is inert due to high bond energy.

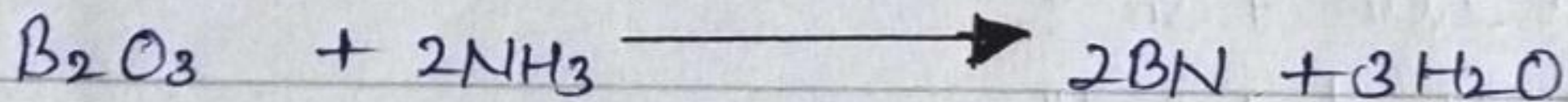
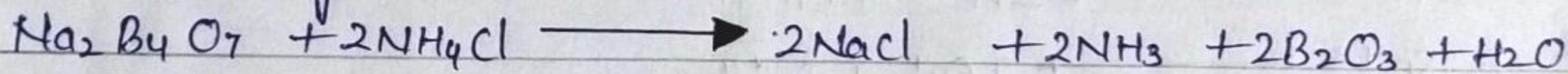
(b) It is absorbed by hot metal like Ca, Mg, Al etc.



Inorganic graphite  $(\text{BN})_x$ : White slippery solid having 2D-sheet structure.

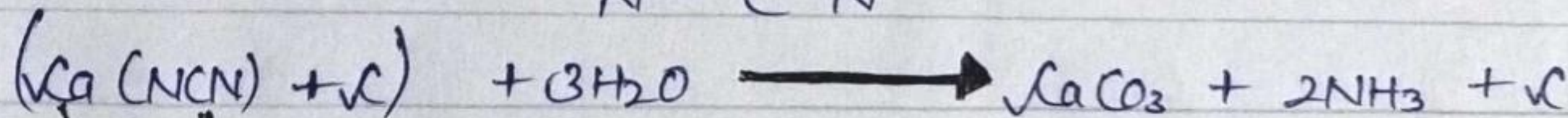
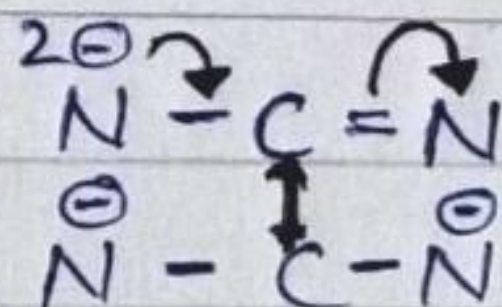


3-D network structure (similar to diamond (Barazan) which is harder than diamond cutting).

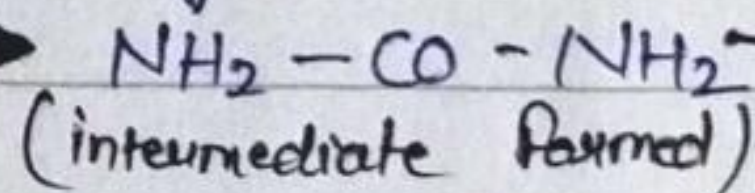


(c)  $\text{N}_2$  can be absorbed by calcium carbide at the temp around  $1000^\circ\text{C}$ .  
 $\text{CaC}_2 + \text{N}_2 \xrightarrow{1000^\circ\text{C}} \text{CaNCN}$  (It is very good Fertiliser)  
nitrolim

### Cyanamide ion :-

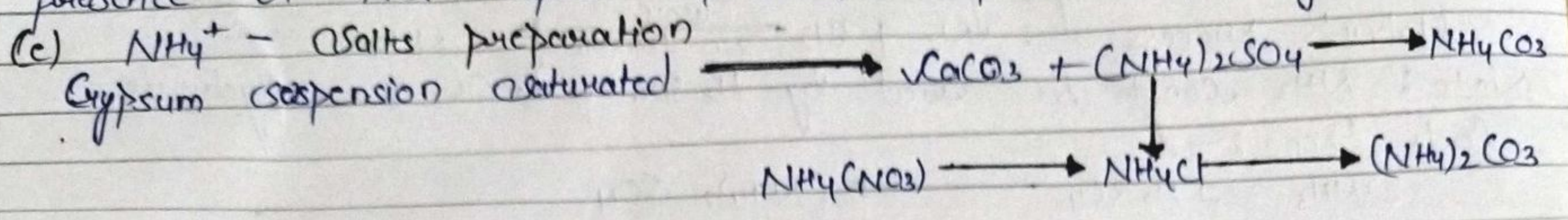


slowly decomposes

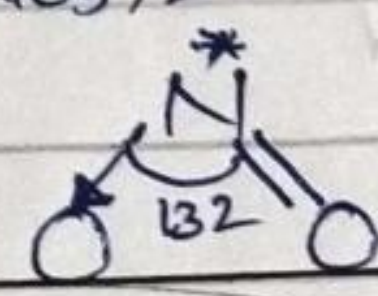
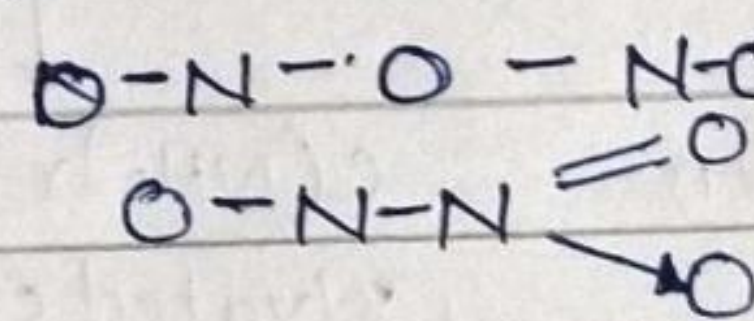
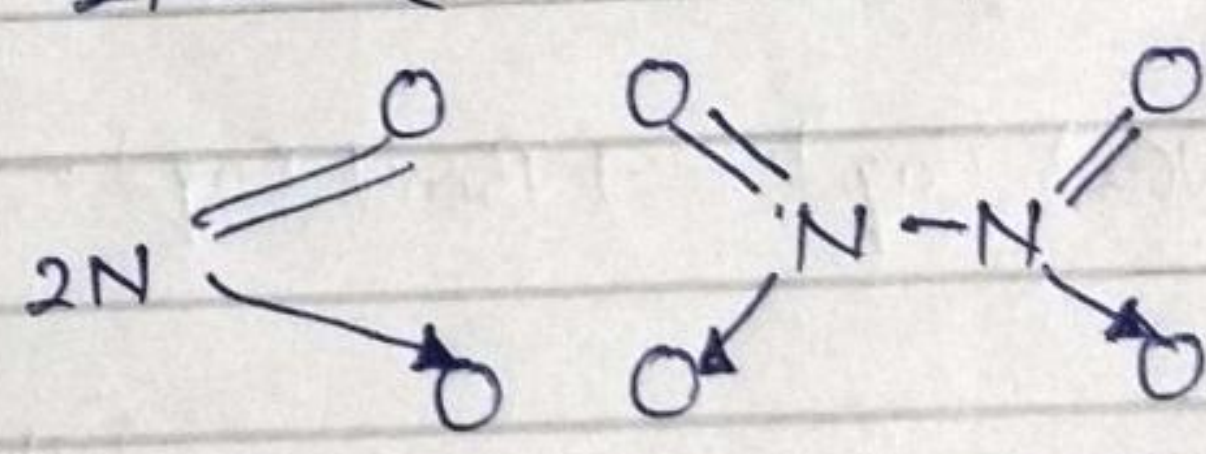
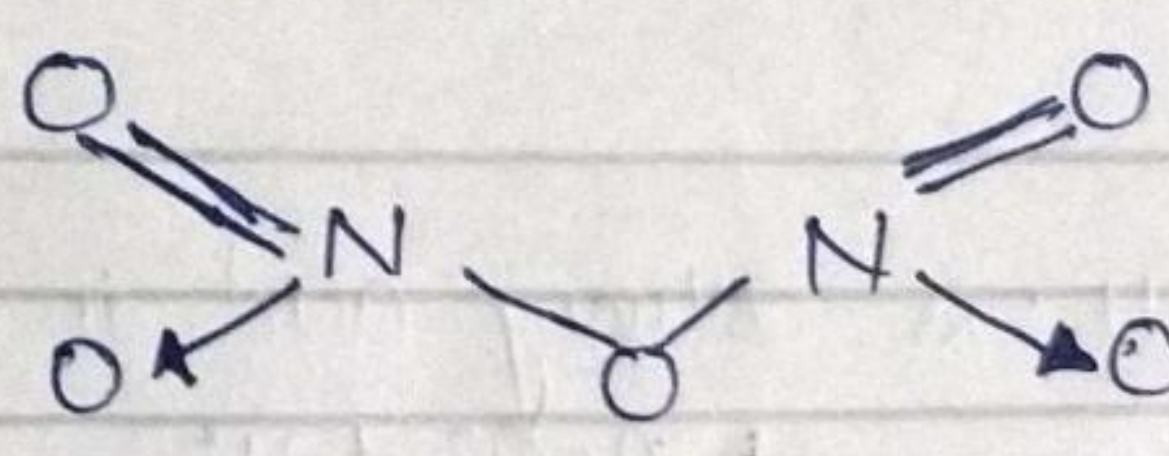




(d) Hydrolysis & Ammonolysis occurs in a same way.  
 $SiCl_4 + 4H_2O \rightarrow 4HCl + Si(OH)_4 \rightarrow Si_2O_2 + 2H_2O$   
 $SiCl_4 + 8NH_3 \rightarrow 4NH_4Cl + Si(NH_2)_4 \rightarrow Si_2N_2 + NH_3 \uparrow$   
 Rate of hydrolysis & Ammonolysis will be affected by the presence of HCl vapour &  $NH_4Cl$  vapour respectively.



Oxides of Nitrogen :-

Formula	Name	Preparation & Structure
$NO$	Dinitrogen monoxide (Nitrous oxide)	$NH_4NO_3 \rightarrow NO + 2H_2O$ $N=N \rightarrow O$ (sp linear polar)
$NO$	Laughing gas Nitrogen monoxide (Nitric oxide)	$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO$ $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
$NO_2$	Nitrogen dioxide Mixed anhydride	$Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 \uparrow$ 
$N_2O_3$	Dinitrogen trioxide	$NO + NO_2 \rightleftharpoons N_2O_3$ 
$N_2O_4$	Dinitrogen tetroxide	$2NO_2 \rightleftharpoons N_2O_4$ 
	Dinitrogen pentoxide	$2HNO_3 + P_2O_5 \rightarrow H_2O + N_2O_5$ $H_2O + P_2O_5 \rightarrow 2HPO_3$ 

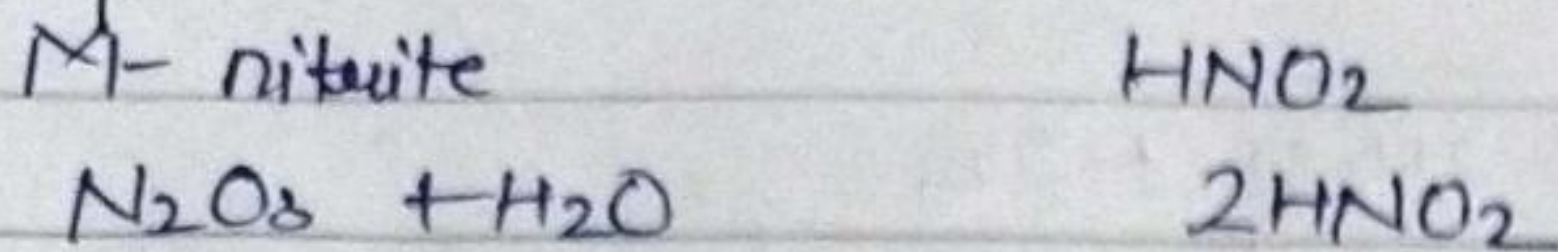






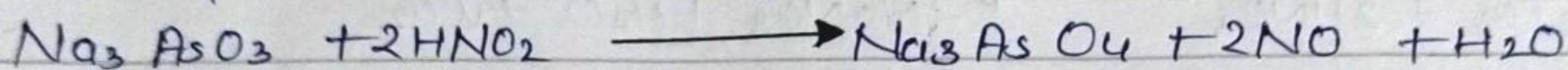
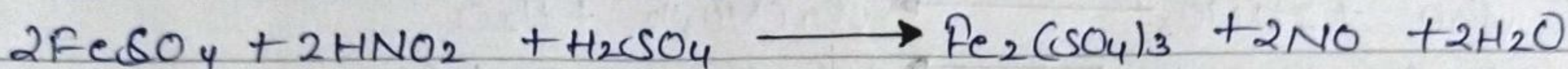
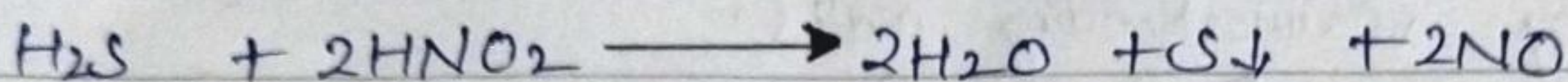
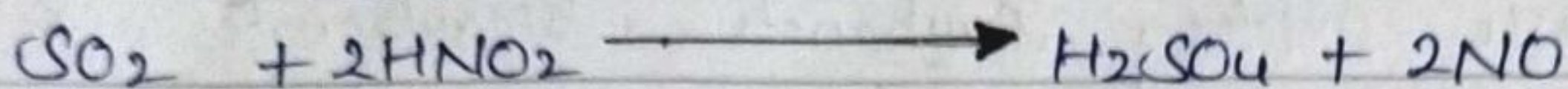
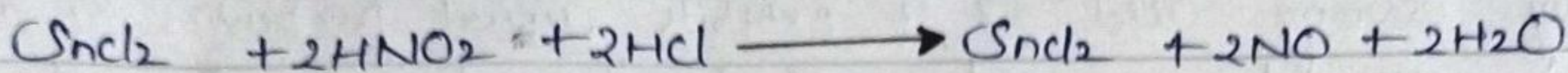
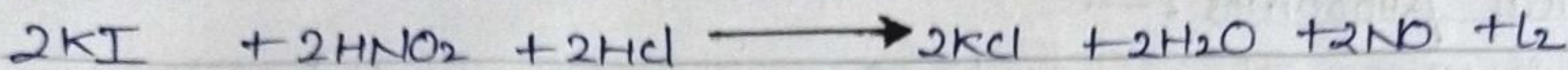
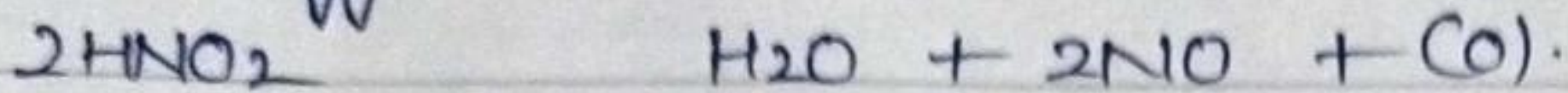
#### 4. NITROUS ACID (HNO<sub>2</sub>): -

Preparation: -

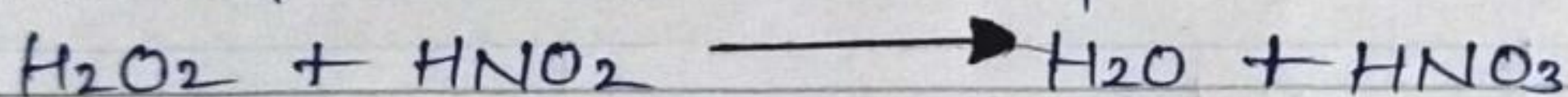
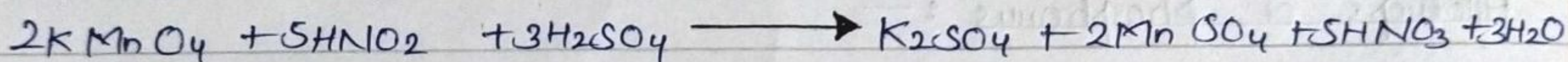
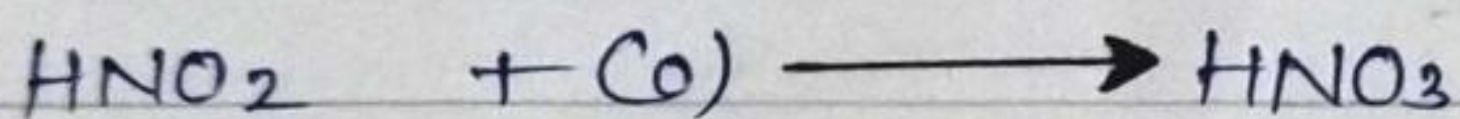


Preparation: -

# Oxidising property: Becoz of its easy oxidation to liberate nasent oxygen, it acts as a strong oxidant.



# Reducing properties: Nitrous acid also act as a reducing agent as it can be oxidised into nitric acid.

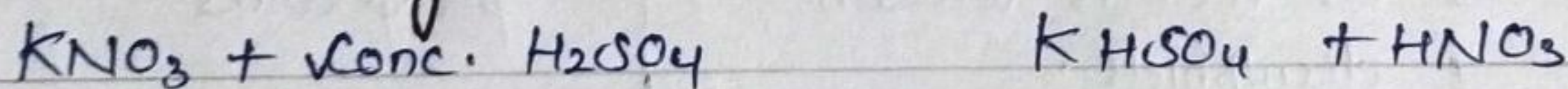


#### 5. NITRIC ACID (HNO<sub>3</sub>): -

It was named aqua Fortis (means strong water) by alchemists.

Preparation: -

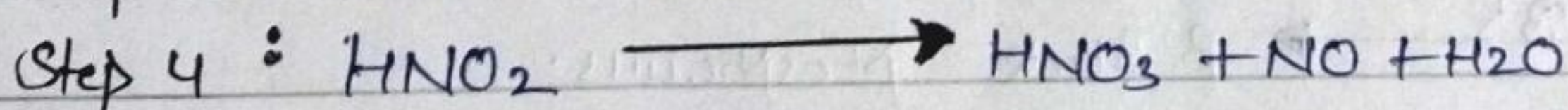
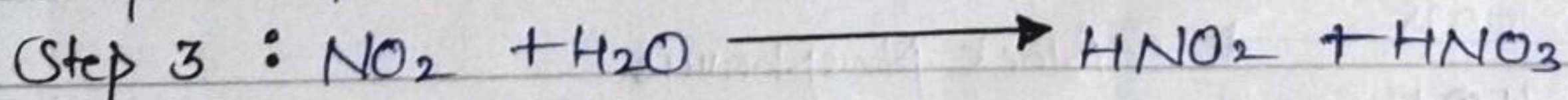
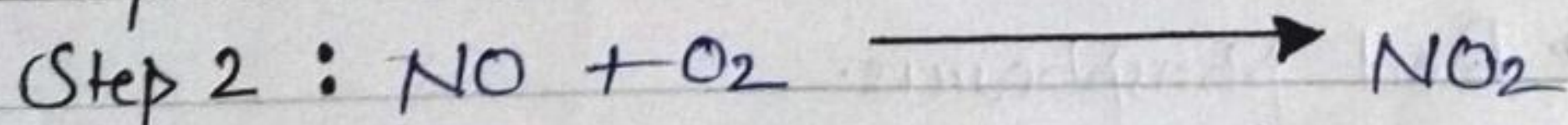
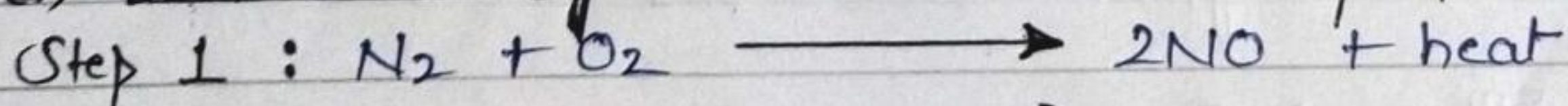
(a) Laboratory Method: -



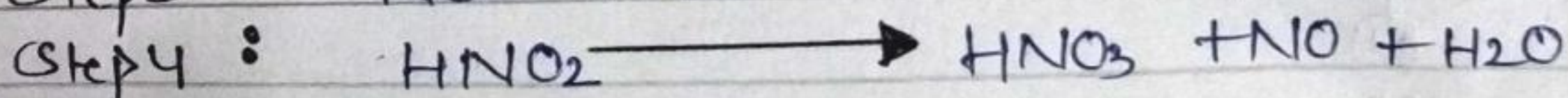
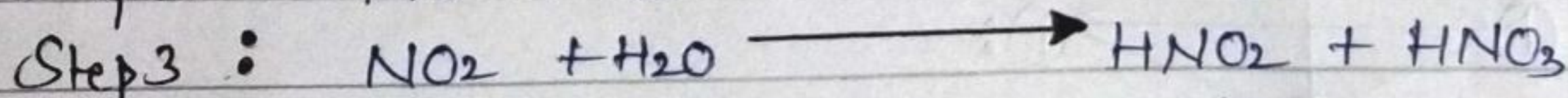
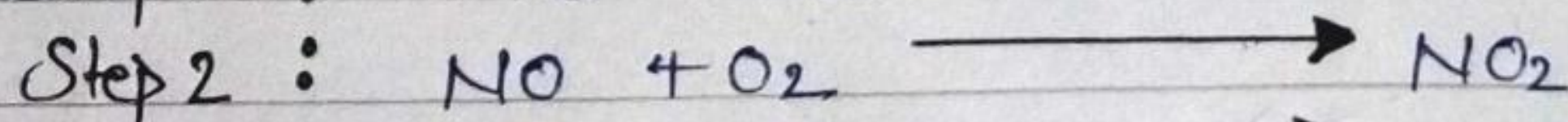
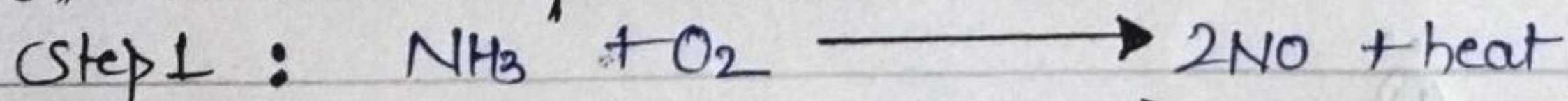
Vapours of nitric acid evolved are condensed in a glass receiver.

(b) Industrial preparation: -

(i) Birkeland Ede process or arc process: -



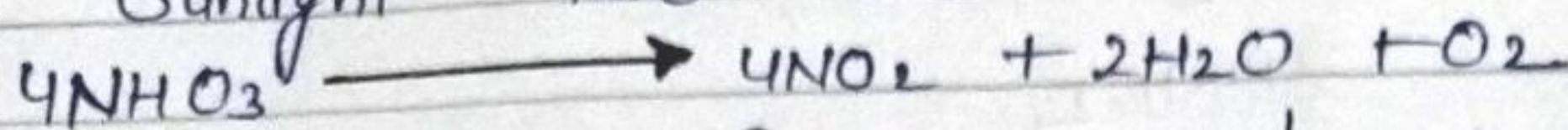
(ii) Ostwald's process: -





### Physical properties :-

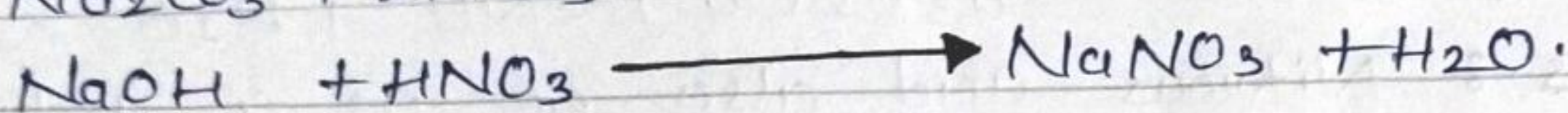
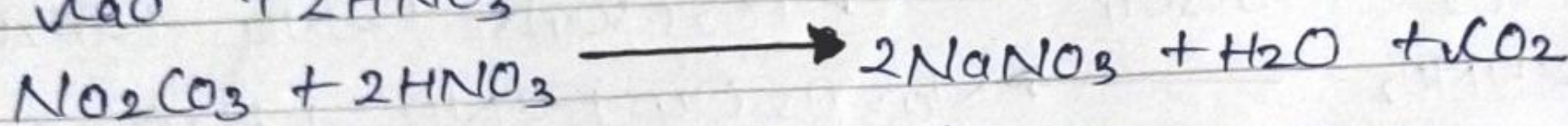
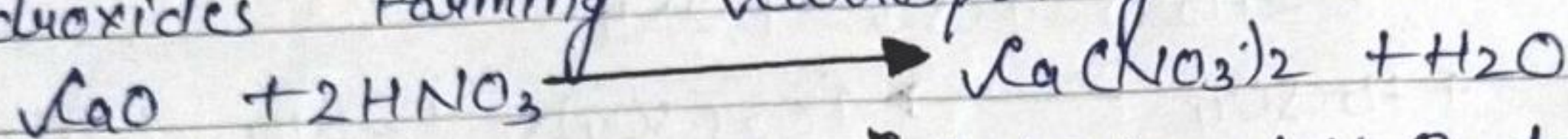
- Nitric acid usually acquires yellow colour due to its decomposition by sunlight into  $\text{NO}_2$ .



# The yellow colour of the acid can be removed by warming it to  $60-80^\circ\text{C}$  & bubbling dry air through it. It has extremely corrosive action on the skin & causes painful sores.


### Chemical properties :-

- It is very strong acid & it exhibits usual properties of acids.
- It reacts with basic oxides, carbonates, bicarbonates & hydroxides forming corresponding salts.



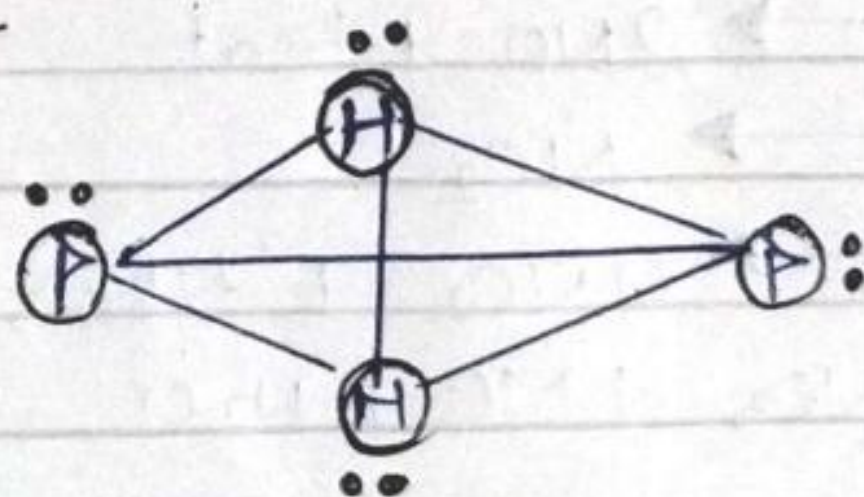
## 6. PHOSPHORUS :-

### Allotrops of phosphorus :-

S.No.	White phosphorus	Red Phosphorus	Black Phosphorus
(1)	waxy solid having soapy touch.	Iron-grey lustre Hard polymer	
(2)	poisonous, cut with knife	Non-poisonous can't cut	2 types, properties same as Red phosphorus.
(3)	Insoluble in water	Insoluble in water & $\text{CS}_2$	
(4)	But soluble in carbon-disulphide.	as well as carbon-disulphide.	
(5)	Glow in dark (chemical-uminescence)	Does not glow in dark	
(6)	Garlic-like odour	No typical odour	

- White phosphorus  $\xrightarrow[573\text{K}]{\text{inert atmosphere}}$  Red phosphorus.
- Red phosphorus  $\xrightarrow{803\text{K}}$   $\alpha$  Black phosphorus
- Red phosphorus  $\xrightarrow{473\text{K}}$   $\beta$  Black phosphorus.

- White phosphorus :-  
structure :-





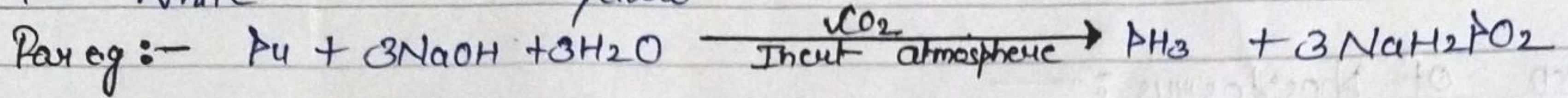
## Properties: —

1. Most reactive & less stable phosphorus.
2. Catch fire in air.
3. React with  $X$  with pop sound NTP.

hybridisation =  $sp^3$

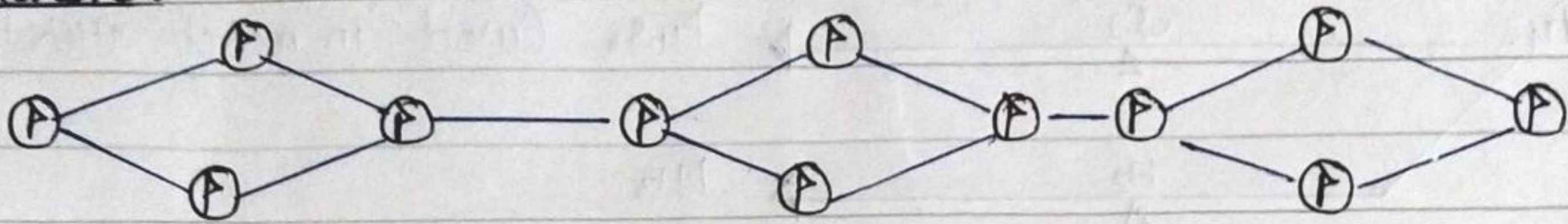
Bond angle =  $63^\circ$

4. White  $\xrightarrow{\text{air}}$  yellow



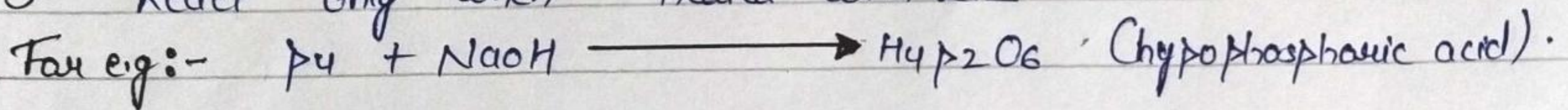
## 2. Red phosphorus: —

### Structure: —



### Properties: —

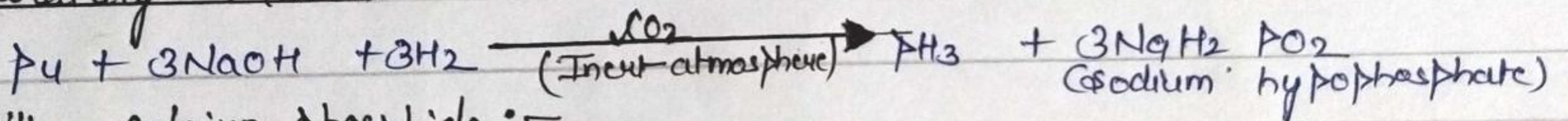
1. Less reactive & more stable
2. Polymeric structure & not strained
3. React only when heated with  $Cl_2$



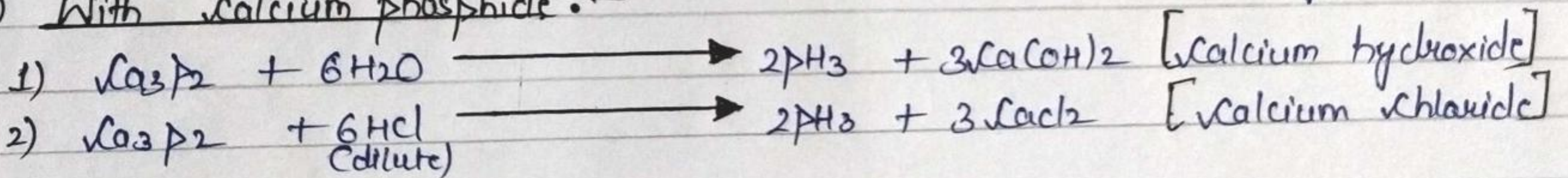
## 3. Phosphine: — ( $PH_3$ )

### Preparation: —

#### (a) Laboratory Method: —



#### (b) With calcium phosphide: —

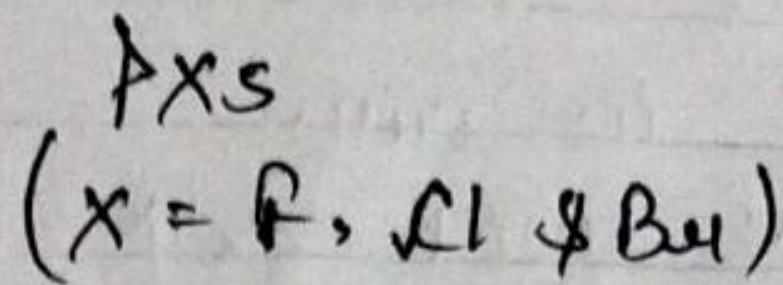
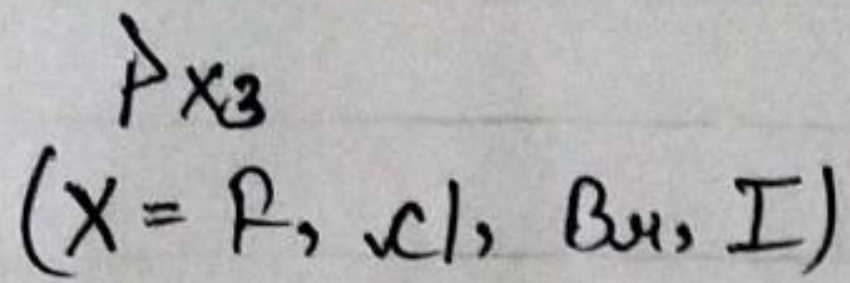


### Properties: —

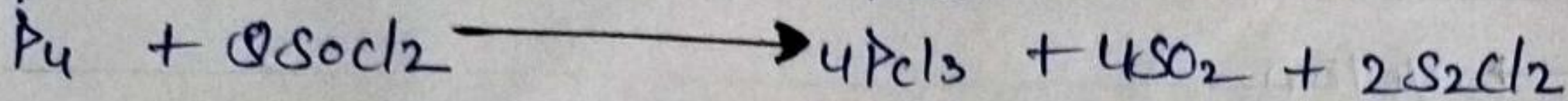
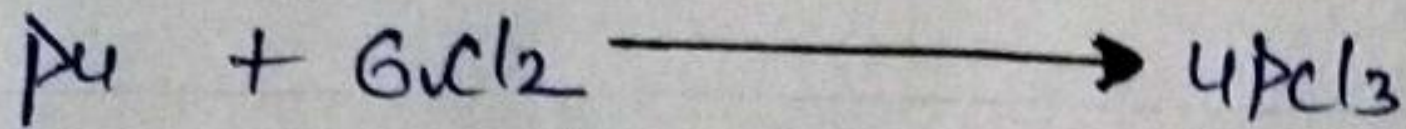
- a) Colourless gas
- b) Rotten fish smell
- c) Highly poisonous
- d) Slightly soluble in water.
- e) Weakly basic in nature.
- f) Due to the presence of lone pair phosphine act as Lewis base.



## # Halide of Phosphorus :-



### • Trihalides :-



## # Rxn of Phosphorus :-

