

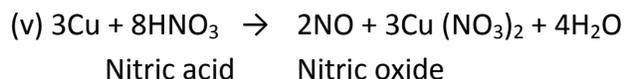
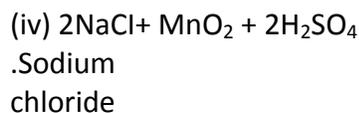
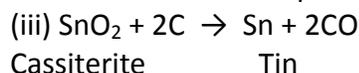
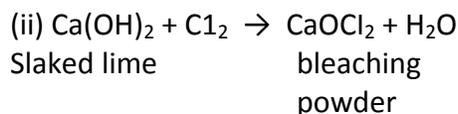
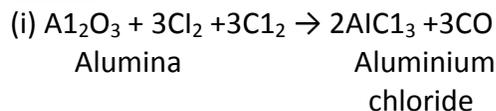
## The p block elements-solutions

### Sol 1.

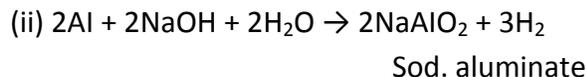
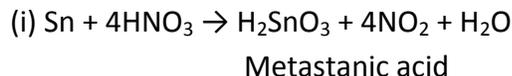
(i) HBr is a reducing agent and it reduces  $\text{H}_2\text{SO}_4$  to  $\text{SO}_2$

(ii) Acids turn blue litmus red, so HClO also turns blue litmus red. The colour of litmus is decolorized because HClO is also a strong oxidizing agent.

### Sol 2.



### Sol 3.

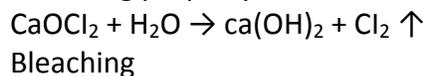


### Sol 4.

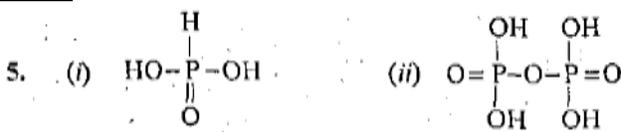
(Conc.  $\text{HNO}_3$  decomposes partially into  $\text{NO}_2$ .  $\text{NO}_2$  is reddish brown in colour and is soluble in conc  $\text{HNO}_3$ . So, it imparts colour to conc  $\text{HNO}_3$ .)

(ii)  $\because$  Mg can reduce  $\text{CO}_2$  to C so it continues to burn in  $\text{CO}_2$   
 $2\text{Mg} + \text{CO}_2 \rightarrow 2\text{MgO} + \text{C}$

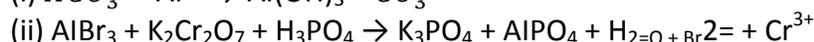
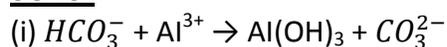
(iii) Bleaching action of bleaching powder is due to chlorine present in it. When it is kept in open bottle for long time it decomposes and chlorine is lost in atmosphere. Due to this it loses its bleaching property.



### Sol 5.



### **Sol 6.**



### **Sol 7.**

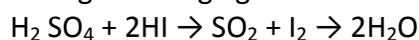
(i) Carbon exists in various allotropic forms like diamond, graphite, coal, etc. Diamond consists of a three-dimensional structure of  $\text{sp}^3$  hybridized carbon atoms bonded through very strong covalent bonds. It makes it hard and useful as an abrasive.

Graphite, on the other hand, is made up of a two-dimensional sheet-like structure made of  $\text{sp}^2$  hybridized carbon atoms. These layers of carbon atoms are held together by relatively weak van der Waals

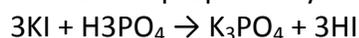
forces and can, therefore, slip over one another imparting lubricating properties to graphite.

(ii) Sulphur consists of  $\text{S}_8$  rings held together by weak van der Waals forces. As sulphur melts at  $119^\circ\text{C}$ , these van der Waals forces are overcome and  $\text{S}_8$  rings slip and roll over one another giving rise to a clear mobile liquid. Above  $160^\circ\text{C}$ , the  $\text{S}_8$  rings begin to open up and form long chains which get tangled with each other, thereby gradually increasing the viscosity.

(iii) **NOTE** : HI cannot be prepared by heating hydrogen iodide with conc.  $\text{H}_2\text{SO}_4$  because it is a strong reducing agent and reduces  $\text{H}_2\text{SO}_4$  to  $\text{SO}_2$  and is itself oxidized to iodine.



Hence HI is prepared by heating iodides with conc. phosphoric acid.



(iv) In  $\text{H}_3\text{PO}_4$  and  $\text{H}_3\text{PO}_3$  the P atom is attached to 3 and 2 OH groups respectively. The H atom of these P – OH bonds are ionisable. This clearly shows that  $\text{H}_3\text{PO}_4$  is tribasic and  $\text{H}_3\text{PO}_3$  is dibasic.

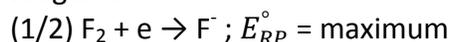
(v) Liquor ammonia possesses high vapour pressure at room temperature and thus before opening a bottle of liquor ammonia, it should be cooled to lower the pressure of  $\text{NH}_3$  inside the bottle, otherwise  $\text{NH}_3$  will bump out of the bottle.

(vi) Solid  $\text{CO}_2$  is technically known as dry ice because it sublimates without leaving any stain on surface.

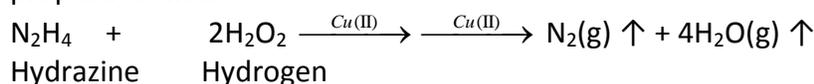
(vii) Anhydrous HCl, being a non-polar covalent compound, is a bad conductor however an aqueous solution of HCl is ionized (Fajan's rule) to give  $\text{H}^+$  and  $\text{Cl}^-$  ions and is a good conductor.

(viii) In graphite, out of four valence electrons, only three form covalent bonds ( $\text{sp}^2$  hybridization) with three other carbon atoms. This forms hexagonal rings as sheets of one atom thickness. These sheets are held together by weak attractive forces. One electron of each carbon atom is free and this enables these thin sheets to slide over one another. For this reason graphite is a soft material with lubricating properties.

(ix) The standard reduction potential of fluorine is highest and thus it cannot be oxidized by any reagent.

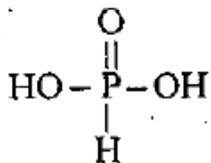


(x) The mixture of  $\text{N}_2\text{H}_4$  and  $\text{H}_2\text{O}_2$  (in presence of Cu (II) catalyst) is used as a rocket propellant because the reaction is highly exothermic and large volume of gases are evolved, which can propel a rocket.



## Peroxide

(xi) Orthophosphorus acid is a dibasic acid as it has 2 -OH groups in its formula :



(xii) In  $\text{MgCl}_2$ , Mg is  $sp$  hybridized while in  $\text{SnCl}_2$ , Sn is  $sp^2$  hybridized (hence the molecule is angular).

(xiii) **NOTE** : Oxygen is the 2nd most electronegative element after the, fluorine and thus invariably show negative oxidation state.

Further more, it has  $2s^2 2p^4$  configuration and thus requires only two electrons to complete its octet to show -2.oxidation state. Although sulphur also possess  $ns^2 np^4$  configuration but due to availability of d-orbitals in their outer most shell -2,+2, +4, +6 oxidation state-are also shown. Oxygen, however, shows only -2 oxidation state due to non-availability of d-orbitals in its outermost shell.

(xiv) **NOTE** :  $\text{H}_3\text{PO}_3$  is a dibasic acid because it contains two OH groups in its molecule.

In the two P-OH bonds, the hydrogen is ionisable. [For structure see part (xi)]

(xv) **NOTE** : As compared to P, N atom has higher electronegativity and small size and shows H - bonding.

Thus ammonia molecule show association where as phosphine does not.

(xvi) It is due to self ionization of  $\text{NH}_3$ , the reaction is

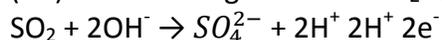


Thus on addition of  $\text{NH}_4\text{Cl}$  the concentration of  $\text{NH}_4^+$  radical increase and therefore  $\text{NH}_4\text{Cl}$  acts as an acid in liquid  $\text{NH}_3$ .

(xvii) In excess of  $\text{NaOH}$  the hydroxide of Al becomes soluble due to the formation of meta-aluminate.

(xviii) The repulsive forces between fluorine atoms are high due to its small size and high electronegativity. It makes dissociation of F – F bond easy. So bond dissociation energy of  $\text{F}_2$  is less than  $\text{Cl}_2$

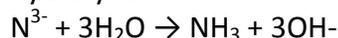
(xix) The reducing nature of  $\text{SO}_2$  is represented as



Hence with the increase of  $\text{OH}^-$  (alkalinity) the forward reaction is favored.

(xx) Nitrogen and fluorine both are small and have high electron density, they repel the bonded pair of electrons leading to larger bond length than expected.

(xxi)  $\text{N}^{3-}$  being smaller in size and high charge present on it make it more susceptible to hydrolysis :

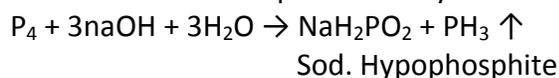


$\text{Cl}^-$  being a weak conjugate base does not undergo hydrolysis.  $\text{MgCl}_2$  is stronger electrolyte and so it is not hydrolyses

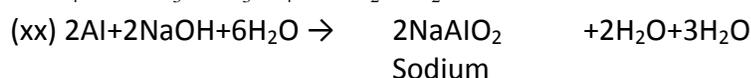
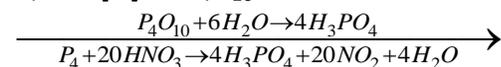
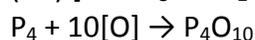
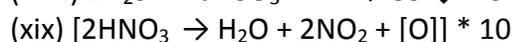
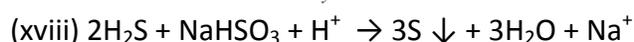
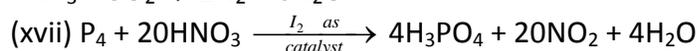
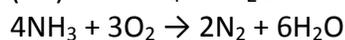
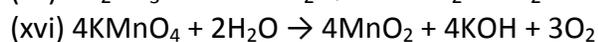
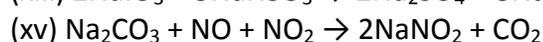
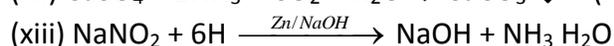
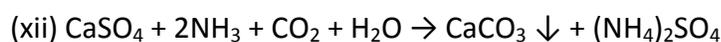
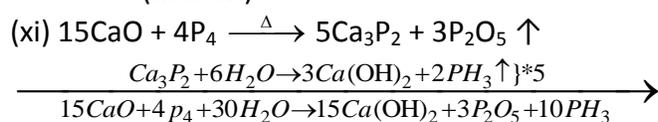
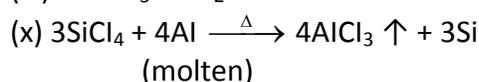
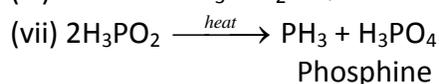
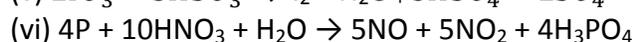
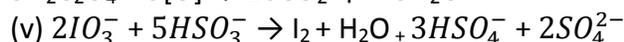
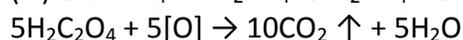
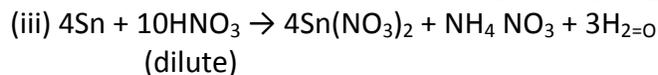
(xxii) In  $(\text{SiH}_3)_3\text{N}$ , lone pair of electrons on nitrogen is involved in  $\pi - \pi$ , back bonding is possible because of absence of d orbitals in carbon so  $(\text{CH}_3)_3\text{N}$  is more basic than  $(\text{SiH}_3)_3\text{N}$ .

### Sol 8.

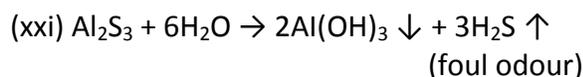
(i) Phosphine gas (PH<sub>3</sub>) is evolved when white phosphorus is boiled with aqueous NaOH or alcoholic solution of potassium hydroxide.



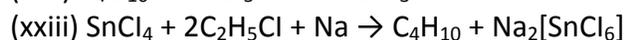
(ii) This is a method used to prepare I<sub>2</sub>.



Melta-aluminate

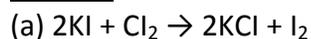


Foul odour, on damping of Al<sub>2</sub>S<sub>3</sub> is due to formation of H<sub>2</sub>S gas, which smells like rotten eggs.





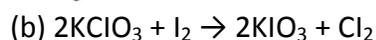


**Sol 22.**

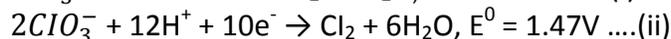
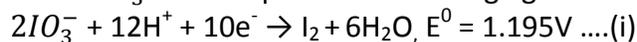
Since  $Cl_2$  is more powerful oxidizing agent than  $I_2$ ,  $Cl_2$  is able to displace  $I^-$  to form  $I_2$ .



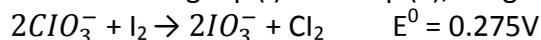
On subtracting eq. (i) from eq. (ii), we get



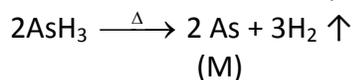
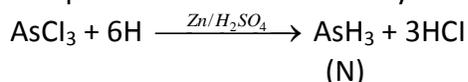
Here  $ClO_3^-$  is more powerful oxidizing agent than  $IO_3^-$ , so Cl is displaced by I.



On subtracting eq. (i) from eq. (ii), we get

**Sol 23.**

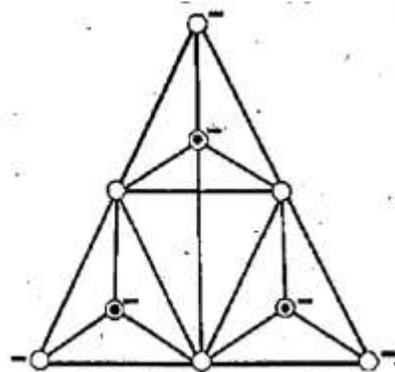
The poisonous element M may be As. So on the basis of the given facts,



Hence M = As; N = AsH<sub>3</sub>

**Sol 24.**

In cyclic  $Si_3O_9^{6-}$ , three tetrahedral of  $SiO_4^{2-}$  are joined together sharing two oxygen atoms per tetrahedron.

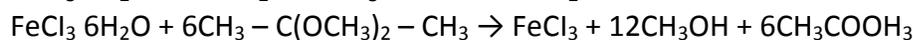


Structure of  $Si_3O_9^{6-}$  :

Dark circle represents Si and  
open circle represents oxygen atom/ion

**Sol 25.**

Thionyl chloride

**Sol 26.**

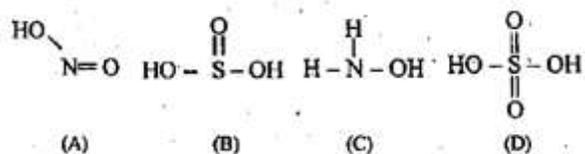
**Sol 27.**

The reaction is



(A)            (B)            (C)            (D)

The structures of A, B, C and D are as follows.

**Sol 28.**

Sulphur trioxide produced in the contact process is absorbed by sulphuric acid forming  $\text{H}_2\text{S}_2\text{O}_7$ .

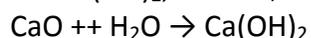
It is not dissolved in water as it gives a dense fog of sulphuric acid particle.

The catalyst used in the contact process is vanadium pent oxide.

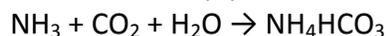
**Sol 29.**

In such a case

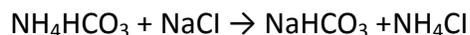
A =  $\text{Ca}(\text{OH})_2$ , B =  $\text{NH}_4\text{HCO}_3$ , C =  $\text{Na}_2\text{CO}_3$ , D =  $\text{NH}_4\text{Cl}$  and E =  $\text{CaCl}_2$



(A)



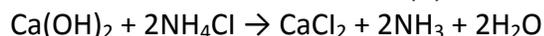
Sod. Bicarbonate(B)



Amin. Chloride(D)



Sod. Carbonate (C)

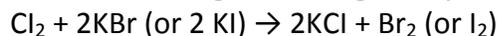


Can be

used again

**Sol 30.**

More electronegative halogen displaced lesser electronegative halogen from its halide. Thus,

**Sol 31.**

Use the formula

H(hybridization),  $H = 1/2 (V + M - C + A)$  where

V = number of electron in valence shell of central atom

M = number of monovalent atoms surrounding the central atom

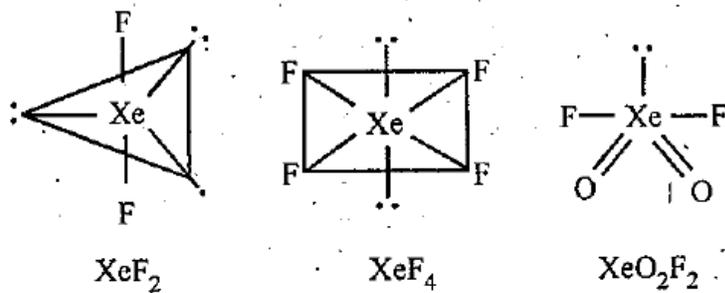
C = Charge on cation

A = Charge on anion

$\text{XeF}_2$  :  $H = 1/2 (8 + 2 - 0 + 0) = 5$  Hence hybridization is  $sp^3d$ , and thus its structure is linear.

$\text{XeF}_4$  :  $H = 1/2 (8 + 4 - 0 + 0) = 6$ , Hence hybridization is  $sp^3d^2$  and thus its structure is square planar.

$\text{XeO}_2\text{F}_2$  :  $H = 1/2 (8 + 2 - 0 + 0) = 5$ , Hence hybridization is  $sp^3d$  and shape is see saw.



### Sol 32.

Elemental nitrogen exists as a diatomic molecule because nitrogen can form  $p\pi - p\pi$  multiple bonds which is not possible in case of phosphorus due to repulsion between, non-bonded electrons of the inner core. There is no such repulsion in case of smaller nitrogen atoms as they have only  $1s^2$  electrons in their inner core.

### Sol 33.

Since  $\text{B}_2\text{O}_3$  is formed by reaction of (Y) with air, (Y) therefore should be  $\text{B}_2\text{H}_6$  in which % of hydrogen is 21.72. The compound (X) on reduction with  $\text{LiAlH}_4$  gives  $\text{B}_2\text{H}_6$ . Thus it is boron trihalide. The reactions are shown as:

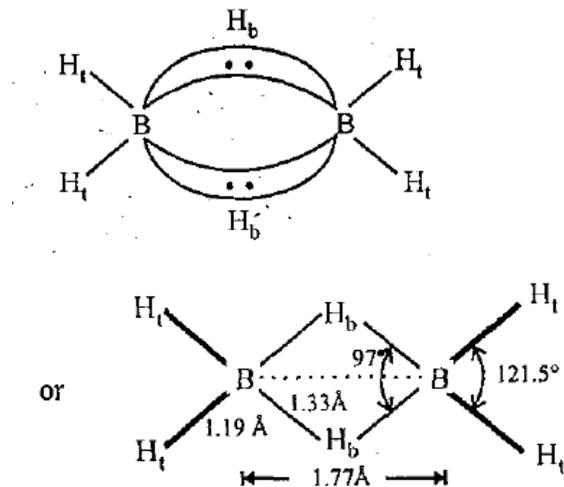


(X)                      (Y)                      (X = Cl or Br)



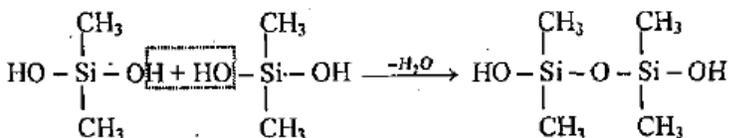
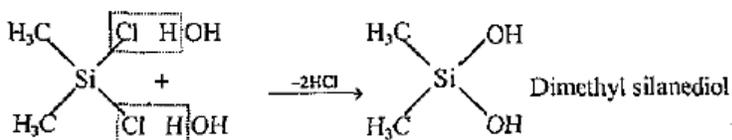
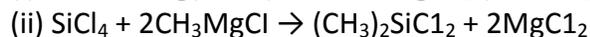
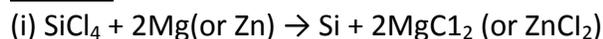
(Y)

Structure of  $\text{B}_2\text{H}_6$  is as follows:

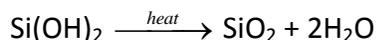
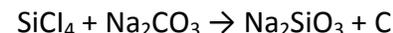
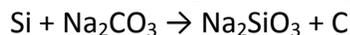
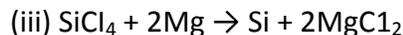


Thus the diborane molecule has four two-centre-two-electron bonds ( $2c - 2e$  bonds) also called usual bonds and two three-centre-two-electron bonds ( $3c - 2e$ ) also called banana bonds. Hydrogen attached to usual and banana bonds are called  $\text{H}_t$  (terminal H) and  $\text{H}_b$  (bridge H) respectively.

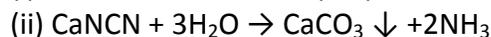
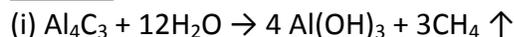
### Sol 34.



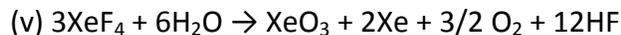
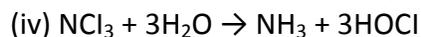
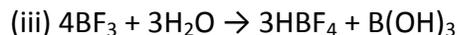
Polymerization continues on both ends to give linear silicone.



### Sol 35.

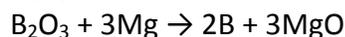
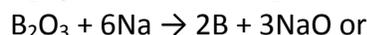
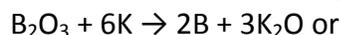


Ammonia formed dissolves in water to form  $\text{NH}_4\text{OH}$

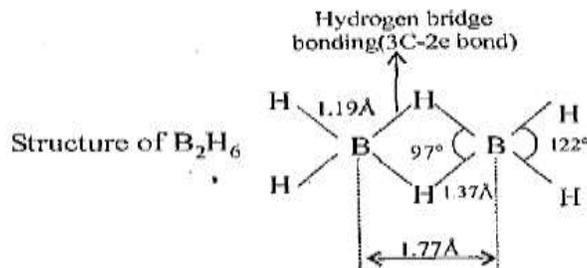


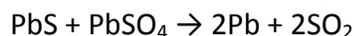
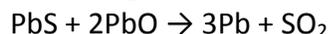
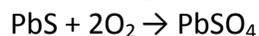
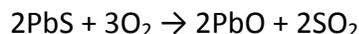
### Sol 36.

**NOTE :** When hot concentrated HCl is added to borax ( $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ ) the sparingly soluble  $\text{H}_3\text{BO}_3$  is formed which on subsequent heating gives  $\text{B}_2\text{O}_3$  which is reduced  $\text{Na}_2\text{B}_4\text{O}_7$  (anhydrous) + 2HCl(hot, conc.)



**[NOTE :** Normally this reaction takes place in the presence of Lewis acid ( $\text{AlCl}_3$ )

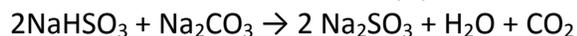


**Sol 37.**

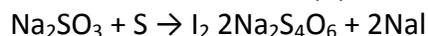
Oxidation number of Pb in litharge (PbO) is + 2

**Sol 38.**

(A)



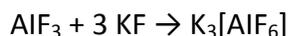
(B)



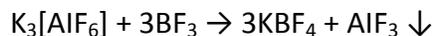
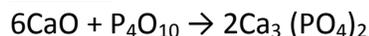
Oxidation states of 'S' are ; +4 in (A), (+6) in B and +2 in (C), +2.5 in (D)

**Sol 39.**

HF is weakly dissociated, while KF is highly dissociated giving a high concentration of  $\text{F}^-$  which leads to the formation of soluble  $\text{AlF}_6^{3-}$



Since  $\text{BF}_3$  is more acidic than  $\text{AlF}_3$ , it pulls out  $\text{F}^-$  from  $\text{AlF}_6^{3-}$  reprecipitating  $\text{AlF}_3$ .

**Sol 40.**

$$\text{Moles of } \text{P}_4\text{O}_{10} = 852/284 = 3$$

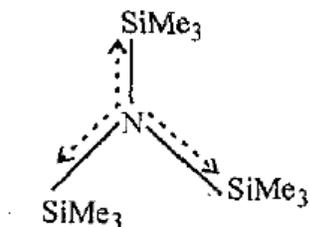
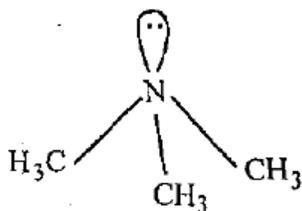
$$\text{Moles of CaO} = 3 * 6 = 18$$

$$\text{Wt. of CaO} = 18 * 56 = 1008 \text{ g}$$

For structure of  $\text{P}_4\text{O}_{10}$  : See question 20 of this Section.

**Sol 41.**

$(\text{CH}_3)_3\text{N}$  and  $(\text{Me}_3\text{Si})_3\text{N}$  are not is structural, the former is pyramidal while the latter is trigonal planar. Silicon has vacant d orbitals which can accommodate lone pair of electrons from N (back bonding) leading to planar shape..

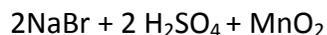


### Sol 42.

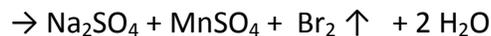
A. Conc.  $\text{H}_2\text{SO}_4$  B.  $\text{Br}_2$

c.  $\text{NO}_2^+$

Reaction involved are



(A)



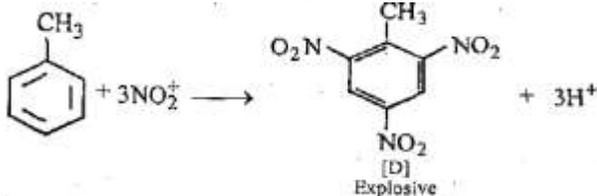
[B]

Brown fumes

and pungent smell



[C]



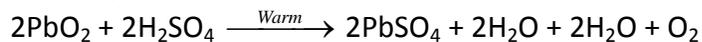
(C)  $\text{O}_2^- \sigma 1s^2, \sigma^* 1s^2; \sigma 2s^2, \sigma^* 2s^2; \sigma 2p_x^2, \pi 2p_y^2 = \pi 2p_z^2, \pi^* 2p_y^2 = \pi^* 2p_z^2$

Bond order = 1.5 paramagnetic

(D)  $\text{O}_2 \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_x^2, \pi 2p_y^2 = \pi 2p_z^2, \pi^* 2p_y^2 = \pi^* 2p_z^2$

Bond order = 2 paramagnetic

4. (d) (P)



(Q)

