p – block elements

Question 104.

(a) Name the gas evolved on heating ammonium nitrate. Write the chemical reaction.

(b) Write two uses of ammonium nitrate.

Answer: The gas evolved on heating is Nitrous oxide

Chemical reaction : $NH_4NO_3 \xrightarrow{\Delta} \underset{\text{Nitrous oxide}}{N_2O} + 2H_2O$

(b) Uses of NH_4NO_3

- It is used in fertilizers.
- It is used in explosives.

Question 105.Account for the following :

(i) NF_3 is an exothermic compound but NCl_3 is an endothermic compound.

(ii) HF is not stored in glass bottles but is kept in wax-coated bottles.

(iii) Bleaching of flowers by Cl_2 is permanent while that of SO_2 is temporary.

Answer:

(i) F is more electronegative than Cl. The difference in the electronegativity between N and F is much more than the difference between electronegativity of N and Cl. So there is need of much more energy to break the N-F bond.

(ii) HF is highly corrosive and etches glass hence it is kept in wax-coated bottles.

(iii) Chlorine bleaches the material by oxidation hence it is permanent while SO_2 bleaches the material by reduction and as the material is exposed to air, it gets oxidised and the colour is restored, hence it is temporary.

Question 106.

(a). With the help of chemical equations explain the principle of contact process in brief for the manufacture of sulphuric acid by contact process.

(b) Bismuth is a strong oxidizing agent in the pentavalent state. Explain.

Answer:

(a) Contact Process : Burning sulphur in an excess of air

$$S + O_2 \rightarrow SO_2\ (g)$$

or, By heating sulphide ores like pyrites in an excess of air :

$$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$$

In either case, an excess of air is used so that the SO_2 produced is already mixed with oxygen for the next stage.

This is reversible reaction and the formation of SO_3 is exothermic in the presence of catalyst V_2O_5 at 720 K

$2SO_2 + O_2 \rightleftharpoons 2SO_3$ ΔH = -196 KJ/mol

This cannot be done by simply adding water to the S03. The reaction is so uncontrollable that it creates a fog of H2S04. Instead, the S03 is first dissolved in cone. H2S04.

$$H_2SO_4 + SO_3 \rightarrow H_2S_2O_7$$

The product is known as fuming sulphuric acid or oleum to which water is added to get H_2SO_4

$$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$$

(b) The stability of +5 oxidation state decreases and that of +3 state increases due to inert pair effect down the group therefore Bi (V) accepts two electrons and gets reduced to Bi (III). $Bi^{5+} + 2e^- \rightarrow Bi^{3+}$:

So, Bi(V) is more stronger oxidising agent.

Question 107. (a) Draw the structures of the following molecules :

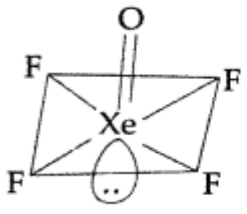
(i) $XeOF_4$ (ii) H_2SO_4

(b) Write the structural difference between white phosphorus and red phosphorus.

Answer:

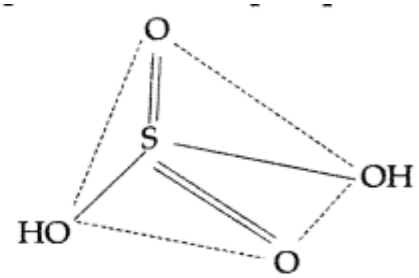
(a)

(*i*) **$XeOF_4$**



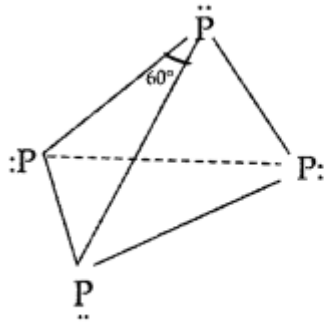
Shape : Square pyramidal

(*ii*) **H_2SO_4**

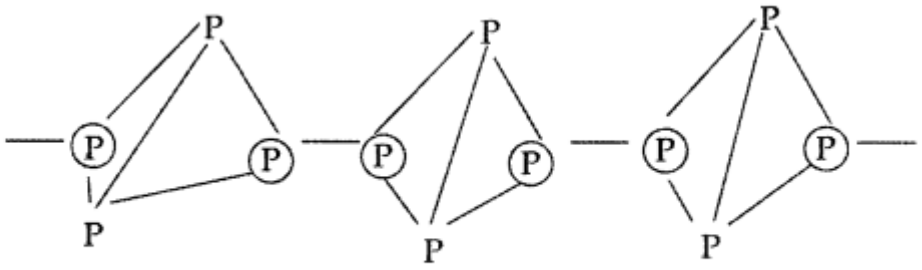


Shape : Tetrahedral structure

(b) White phosphorus exists as discrete P4 units with SP3 hybridized phosphorus atom, arranged tetrahedrally but in red phosphorus all P_4 tetrahedral units are linked with each other to form polymeric structure.



White phosphorus



Red phosphorus

Question 108.Account for the following :

(i) PCl_5 is more covalent than PCl_3.

(ii) Iron on reaction with HCl forms $FeCl_2$ and not $FeCl_3$.

(iii) The two 0-0 bond lengths in the ozone molecule are equal.

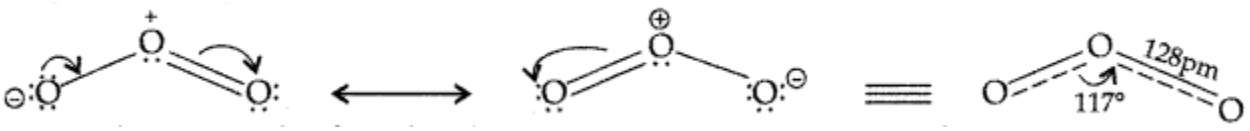
Answer:

(i) In PCl_5, phosphorus has +5 oxidation state and has less tendency to loose electrons than in +3 of PCl_3.

Therefore, PCl_5 has more tendency to share e^{-1}s than PCl_3.

(ii) Because HCl on reaction with iron liberates H_2 gas which prevents the formation of ferric chloride.

(iii) Due to resonance the two oxygen atoms have partial double bond character and thus have same bond length i.e. 128 pm



Question 109.Account for the following :

(i) Bi(V) is a stronger oxidizing agent than Sb(V).

(ii) N – N single bond is weaker than P – P single bond.

(iii) Noble gases have very low boiling points.

Answer:

(i) Bi(V) is a stronger oxidizing agent than Sb(V) due to inert pair effect as the stability of lower oxidation state (+3) increases down the group.

(ii) Due to smaller size of Nitrogen, their lone pairs repel the bond pair of N – N bond while P – P due to bigger size does not show more repulsion.
(iii) Due to presence of weak Van der waal forces of attraction, noble gases have very low boiling point.

Question 110.Account for the following :
(i) Sulphur in vapour form exhibits paramagnetic behaviour.
(ii) $SnCl_4$ is more covalent than $SnCl_2$.
(iii) H_3PO_2 is a stronger reducing agent than H_3PO3.
Answer:
(i) In vapour state sulphur partly exists as S2 molecule which has two unpaired electrons in the antibonding II orbitals and hence exhibits paramagnetism.
(ii) Sn^{+4} in $SnCl_4$ has more polarising power than $SnCl_2$
(iii) H_3PO_2 contains two P-H bonds while H_3PO_3 contains only one P-H bond therefore H_3PO_2 is stronger reducing agent.

Question 111.
Give reasons for the following :
(i) $(CH_3)_3$ P = O exists but $(CH_3)_3$ N = O does not.
(ii) Oxygen has less electron gain enthalpy with negative sign than sulphur.
(iii) H_3PO_2 is a stronger reducing agent than H_3PO_3.
Answer:
(i) $(CH_3)_3P$ = 0 exists due to presence of empty d-orbitals and thus can expand its covalency upto 6 but $(CH_3)_3$ N = O cannot expand its covalency due to absence of d-orbitals.
(ii) The least negative electron gains enthalpy of oxygen is due to small size and more interelectronic repulsion with coming electron.
(iii) H_3PO_2 contains two P-H bonds while H_3PO_3 contains only one P-H bond therefore H_3PO_2 is a stronger reducing agent.

Question 112.Give reasons:
(i) SO_2 is reducing while TeO_2 is an oxidizing agent.
(ii) Nitrogen does not form pentahalide.
(iii) ICl is more reactive than I_2.

Answer:

(i) SO_2 is reducing while TeO_2 is an oxidising agent because sulphur can expand its covalency upto +6 from +4 due to presence of empty d-orbital but as we move down the group the stability of +6 oxidation state decreases and of +4 oxidation state increases due to inert pair effect. Hence SO_2 acts as reducing agent while TeO_2 acts as an oxidising agent.

(ii) Due to absence of empty d-orbitals, N_2 does not form pentahalides.

(iii) Because ICl bond is weaker than I -I bond as a result of which ICl breaks easily to form halogen atoms which readily bring about the reaction, hence more reactive.

Question 113.Give reasons:

(i) Thermal stability decreases from H_2O to H_2Te.

(ii) Fluoride ion has higher hydration enthalpy than chloride ion.

(iii) Nitrogen does not form pentahalide.

Answer:

(i) Thermal stability decreases from H_2O to H_2Te due to weakening of bond between hydrogen and the atom from O to T_e as size is increasing down the group.

(ii) Fluoride ion has higher hydration enthalpy than chloride ion due to stronger attractions of smaller in size fluoride ion.

(iii) Nitrogen does not contain'd' orbitals.

Question 114.Give reasons for the following:

(a) Red phosphorus is less reactive than white phosphorus.

(b) Electron gain enthalpies of halogens are largely negative.

(c) N_2O_5 is more acidic than N_2O_3.

Answer: a) Red phosphorus is less reactive than white phosphorus because white phosphorus possess angle strain where long angles are only 60° making it more reactive. Also, red phosphorus being polymeric is less reactive than white phosphorus which has discrete tetrahedral structure.

(b) Electron gain enthalpies of halogens are largely negative due to high effective nuclear charge and smaller size among period. They readily accept an electron to attain noble gas configuration.

(c) N_2O_5 is more acidic than N_2O_3 because higher the oxidation state, higher will be acidic character. N_2O_5 has +5 oxidation state and N_2O_3 has +3 oxidation state.

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