p – block elements

The p-Block Elements, Important Questions long Answer Type [LA]

Question 1:

(a) Draw the structures of the following :

(i) $H_2S_2O_8$ (ii) $HClO_4$

(b) How would you account for the following :

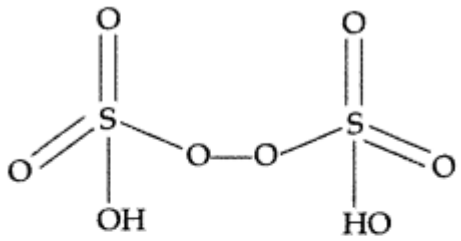
(i) NH_3 is a stronger base than PH_3

(ii) Sulphur has a greater tendency for catenation than oxygen.

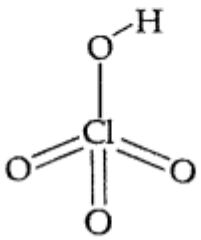
(iii) F_2 is a stronger oxidising agent than Cl_2.

Answer:

(a) (i) $H_2S_2O_8$ (Peroxodisulphuric acid) or Marshall's acid :



(*ii*) **$HClO_4$** (Perchloric acid) :



(b)(i) Since both P and N contain lone pairs of electrons but due to small size and high electronegativity of Nitrogen in NH_3, the electron density is much higher than PH_3, therefore it can easily donate electrons and acts as strong Lewis base than PH_3.

(ii) The greater catenation tendency of sulphur is due to two reasons :

(a) The lone pair of electrons feels more repulsion in 0-0 bond than S-S bond due to its small size and thus S-S forms strong bond.

(b) As the size of atom increases down the group from O – PO, the strength of bond increases and therefore catenation tendency also increases.

(iii) Due to low bond dissociation enthalpy and high electronegativity of Fluorine, it has strong tendency to accept electrons and thus get reduced.

$$F + e^- \rightarrow F^-$$

Therefore F_2 acts as strong oxidising agent, while Cl_2 is weak oxidising agent due to low electronegativity.

Question 2:

(a) Draw the structures of the following : (i) $H_2S_2O_7$ (ii) $HClO_3$

(b) Explain the following observations :

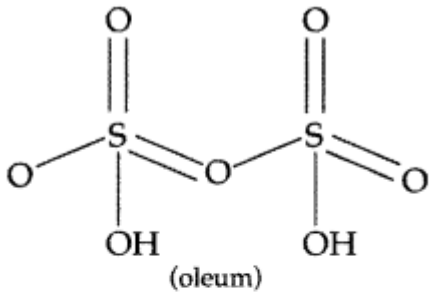
(i) In the structure of HNO_3 the N-O bond (121 pm) is shorter than the N- OH bond (140 pm).

(ii) All the P-Cl bonds in PCl_5 are not equivalent.

(iii) ICl is more reactive than I_2.

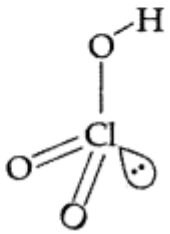
Answer:

(a) (i) $H_2S_2O_7$ (Pyrosulphuric acid) or oleum :



(oleum)

(*ii*) **$HClO_3$** (Chloric acid) :



(b) (i) The N-O bond has partial double bond character while the N-OH bond is a single bond in both resonance of HNO_3

(ii) All the P-Cl bonds in PCl_5 are not equivalent due to the fact that the axial bond pairs suffer more repulsion as compared to equatorial bond pairs.

(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 3:

(a) Draw the structures of the following : (i) H_3PO_2 (ii) BrF_3

(b) How would you account for the following observations :

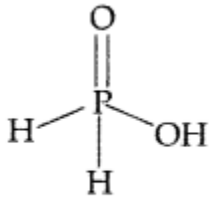
(i) Phosphorus has a greater tendency for catenation than nitrogen.

(ii) Bond dissociation energy of fluorine is less than that of chlorine.

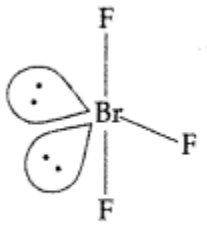
(iii) No chemical compound of helium is known.

Answer:

(a) (i) H_3PO_2 (Hypophosphorous acid)



(*ii*) **BrF_3** (SP^3d hybridization)



Shape : Bent T-shape

(b) (i) The bond strength of P-P is more than N-N, therefore phosphorous shows more tendency for catenation than nitrogen.

(ii) Due to smaller size of F than Cl as a result of which electron-electron repulsions between the lone pairs of electrons are very large than that of Cl, hence bond dissociation energy of F_2 is less than that of Cl_2.

(iii) Because the ionization energy of Helium is very high and the empty d-orbitals are also absent in it.

Question 4:(a) Draw the structures of the following :(i) N_2O_5 (ii) $XeOF_4$

(b) Explain the following observations :

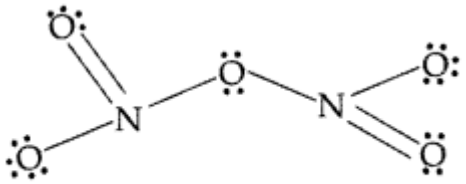
(i) The electron gain enthalpy of sulphur atom has a greater negative value than that of oxygen atom.

(ii) Nitrogen does not form pentahalides.

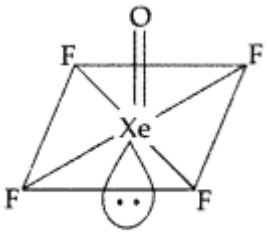
(iii) In aqueous solutions HI is a stronger acid than HCl. (All India 2009)

Answer:

(a) (i) N_2O_5 (ii) $XeOF_4$



Planar



Shape : Square pyramidal

(b) (i) Because enthalpy of dissociation of S-S bond is higher than 0-0 bond and the hydration energy of S^{2-} is less than that of O^{2-} ion.

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

(iii) Due to lower bond dissociation energy and higher degree of ionization, HI acts as stronger acid than HCl in aqueous solution.

Question 5:

(a) Draw the structures of the following : (i) XeF_4 (ii) $H_2S_2O_7$

(b) Explain the following observations :

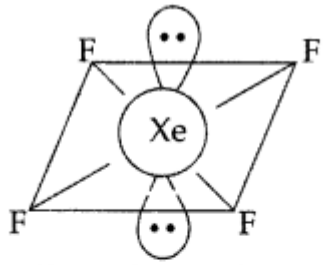
(i) Phosphorus has a greater tendency for catenation than nitrogen.

(ii) The negative value of electron gain enthalpy is less for fluorine than that for chlorine.

(iii) Hydrogen fluoride has a much higher boiling point than hydrogen chloride.

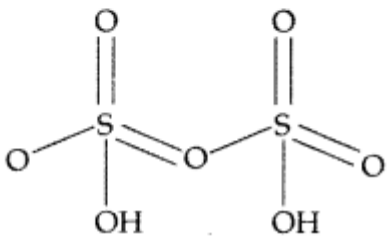
Answer:

(a) (i) XeF_4 :



Shape : Square planar

(*ii*) **$H_2S_2O_7$:**



(b) (i) The bond strength of P-P is more than N-N, therefore phosphorous shows more tendency for catenation than nitrogen.

(ii) Because of small size of flourine atom and strong electron-electron repulsions in its compact 2p orbitals.

(iii) Hydrogen fluoride (HF) has higher boiling point than HC1 due to extensive intermolecular hydrogen bonding while HCl doesn't show this H-bonding.

Question 6:

(a) Draw the structures of the following :(i) PCl_5(s) (ii) SO_3^{2-}

(b) Explain the following observations :

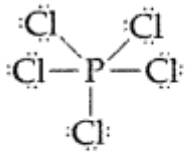
(i) Ammonia has a higher boiling point than phosphine.

(ii) Helium does not form any chemical compound.

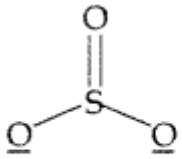
(iii) Bi (V) is a stronger oxidising agent than Sb (V).

Answer:

(a) (i) PCl_5 (s)



(*ii*) $\mathbf{SO_3^{2-}}$



(Sulphite) ion :

Shape : Pyramidal

Angle: The angle O – S – O is greater than 90°

(b) (i) Due to intermolecular H-bonding in NH_3 it has higher boiling point than PH_3 which does not have any H-bonding.

(ii) Because the ionization energy of Helium is very high and very high positive electrons gain enthalpy.

(iii) 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 (v). $Bi^{5+} + 2e^- \rightarrow Bi^{3+}$

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