

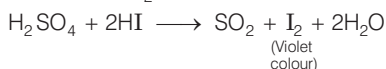
# p-Block Elements

## Multiple Choice Questions (MCQs)

**Q. 1** On addition of conc.  $\text{H}_2\text{SO}_4$  to a chloride salt, colourless fumes are evolved but in case of iodide salt, violet fumes come out. This is because

- (a)  $\text{H}_2\text{SO}_4$  reduces HI to  $\text{I}_2$  (b) HI is of violet colour  
(c) HI gets oxidised to  $\text{I}_2$  (d) HI changes to  $\text{HIO}_3$

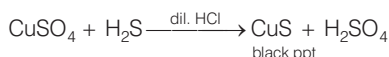
**Ans. (c)** Hydrogen iodide (HI) is more stronger oxidising agent than  $\text{H}_2\text{SO}_4$ . So, it reduces  $\text{H}_2\text{SO}_4$  to  $\text{SO}_2$  and itself oxidises to  $\text{I}_2$ . Colour of  $\text{I}_2$  is violet hence on adding conc.  $\text{H}_2\text{SO}_4$  to HI, it gets oxidised to  $\text{I}_2$ .



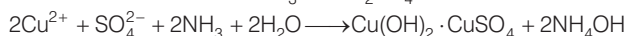
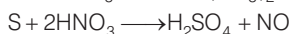
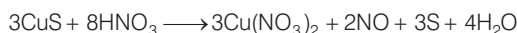
**Q. 2** In qualitative analysis when  $\text{H}_2\text{S}$  is passed through an aqueous solution of salt acidified with dil. HCl, a black precipitate is obtained. On boiling the precipitate with dil.  $\text{HNO}_3$ , it forms a solution of blue colour. Addition of excess of aqueous solution of ammonia to this solution gives .....

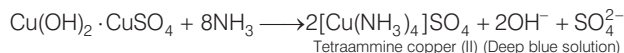
- (a) deep blue precipitate of  $\text{Cu}(\text{OH})_2$   
(b) deep blue solution of  $[\text{Cu}(\text{NH}_3)_4]^{2+}$   
(c) deep blue solution of  $\text{Cu}(\text{NO}_3)_2$   
(d) deep blue solution of  $\text{Cu}(\text{OH})_2 \cdot \text{Cu}(\text{NO}_3)_2$

**Ans. (b)** In qualitative analysis when  $\text{H}_2\text{S}$  is passed through an aqueous solution of salt acidified with dil. HCl a black ppt. of  $\text{CuS}$  is obtained.



On boiling  $\text{CuS}$  with dil.  $\text{HNO}_3$  it forms a blue coloured solution and the following reactions occur

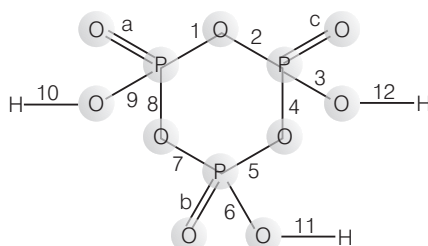




**Q. 3** In a cyclotrimetaphosphoric acid molecule, how many single and double bonds are present?

- (a) 3 double bonds; 9 single bonds
- (b) 6 double bonds; 6 single bonds
- (c) 3 double bonds; 12 single bonds
- (d) Zero double bond; 12 single bonds

**Ans. (c)** Cyclotrimetaphosphoric acid contains three double bonds and 9 single bonds as shown below



**Cyclotrimetaphosphoric acid ( $\text{HPO}_3$ )<sub>3</sub>**

a, b, c are three  $\pi$  bonds and numerics 1 to 12 are sigma ( $\sigma$ ) bonds.

**Q. 4** Which of the following elements can be involved in  $p\pi - d\pi$  bonding?

- (a) Carbon
- (b) Nitrogen
- (c) Phosphorus
- (d) Boron

**Ans. (c)** Among given four elements *i.e.*, carbon, nitrogen, phosphorus and boron. Only phosphorus has vacant *d*-orbit so only phosphorus has ability to form  $p\pi - d\pi$  bonding.

**Q. 5** Which of the following pairs of ions are isoelectronic and isostructural?

- (a)  $\text{CO}_3^{2-}$ ,  $\text{NO}_3^-$
- (b)  $\text{ClO}_3^-$ ,  $\text{CO}_3^{2-}$
- (c)  $\text{SO}_3^{2-}$ ,  $\text{NO}_3^-$
- (d)  $\text{ClO}_3^-$ ,  $\text{SO}_3^{2-}$

**Ans. (a)** Compounds having same value of total number of electrons are known as isoelectronic.

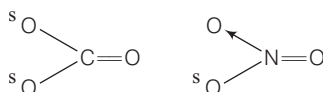
For  $\text{CO}_3^{2-}$

$$\begin{aligned} \text{Total number of electrons} &= 6 + 8 \times 3 + 2 \\ &= 6 + 24 + 2 \\ &= 32 \end{aligned}$$

For  $\text{NO}_3^-$

$$\begin{aligned} \text{Total number of electrons} &= 7 + 8 \times 3 + 1 \\ &= 7 + 25 \\ &= 32 \end{aligned}$$

Hence,  $\text{CO}_3^{2-}$  and  $\text{NO}_3^-$  are isoelectronic. These two ions have similar structure so they are isostructural.



Both have triangular planar structure as in both the species carbon and nitrogen are  $sp^2$  hybridised. Hence, (a) is the correct choice.

**Q. 6** Affinity for hydrogen decreases in the group from fluorine to iodine. Which of the halogen acids should have highest bond dissociation enthalpy?

- (a) HF (b) HCl (c) HBr (d) HI

**Ans. (a)** HF  
HCl  
HBr  
HI

On moving top to bottom

- Size of halogen atom increases
- H-X bond length increases
- Bond dissociation enthalpy decreases

**Q. 7** Bond dissociation enthalpy of E—H (E= element) bonds is given below. Which of the compounds will act as strongest reducing agent?

Compound	NH <sub>3</sub>	PH <sub>3</sub>	AsH <sub>3</sub>	SbH <sub>3</sub>
$\Delta_{\text{diss}} (E-H) / \text{kJ mol}^{-1}$	389	322	297	255

- (a) NH<sub>3</sub> (b) PH<sub>3</sub> (c) AsH<sub>3</sub> (d) SbH<sub>3</sub>

**Ans. (d)** On moving top to bottom, size of central atom increases. Bond length of X—H bond increases and bond dissociation energy decreases. Hence, reducing nature increases.

NH<sub>3</sub>  
PH<sub>3</sub>  
AsH<sub>3</sub>  
SbH<sub>3</sub>

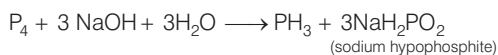
- Bond length increases
- Bond dissociation energy decreases
- Reducing character increases

Hence, SbH<sub>3</sub> is act as strongest reducing agent among these.

**Q. 8** On heating with concentrated NaOH solution in an inert atmosphere of CO<sub>2</sub>, white phosphorus gives a gas. Which of the following statement is incorrect about the gas?

- (a) It is highly poisonous and has smell like rotten fish  
(b) It's solution in water decomposes in the presence of light  
(c) It is more basic than NH<sub>3</sub>  
(d) It is less basic than NH<sub>3</sub>

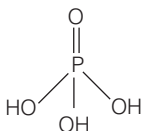
**Ans. (c)** White phosphorous on reaction with NaOH solution in the presence of inert atmosphere of CO<sub>2</sub> it produces phosphine gas which is less basic than NH<sub>3</sub>.



**Q. 9** Which of the following acids forms three series of salts?

- (a) H<sub>3</sub>PO<sub>2</sub> (b) H<sub>3</sub>BO<sub>3</sub> (c) H<sub>3</sub>PO<sub>4</sub> (d) H<sub>3</sub>PO<sub>3</sub>

**Ans. (c)** Structure of H<sub>3</sub>PO<sub>4</sub> is



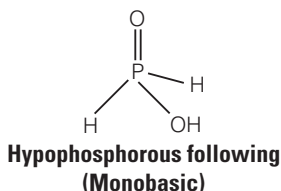
H<sub>3</sub>PO<sub>4</sub> has 3—OH groups i.e., has three ionisable H-atoms and hence forms three series of salts. These three possible series of salts for H<sub>3</sub>PO<sub>4</sub> are as follows



**Q. 10** Strong reducing behaviour of  $\text{H}_3\text{PO}_2$  is due to

- (a) low oxidation state of phosphorus
- (b) presence of two  $\text{—OH}$  groups and one  $\text{P—H}$  bond
- (c) presence of one  $\text{—OH}$  group and two  $\text{P—H}$  bonds
- (d) high electron gain enthalpy of phosphorus

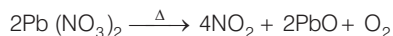
**Ans. (c)** Strong reducing behaviour of  $\text{H}_3\text{PO}_2$  is due to presence of two  $\text{P—H}$  bonds and one  $\text{P—OH}$  bond



**Q. 11** On heating lead nitrate forms oxides of nitrogen and lead. The oxides formed are .....

- (a)  $\text{N}_2\text{O}$ ,  $\text{PbO}$
- (b)  $\text{NO}_2$ ,  $\text{PbO}$
- (c)  $\text{NO}$ ,  $\text{PbO}$
- (d)  $\text{NO}$ ,  $\text{PbO}_2$

**Ans. (b)** On heating lead nitrate it produces brown coloured nitrogen dioxide ( $\text{NO}_2$ ) and lead (II) oxide.



**Q. 12** Which of the following elements does not show allotropy?

- (a) Nitrogen
- (b) Bismuth
- (c) Antimony
- (d) Arsenic

**Ans. (a)** Nitrogen does not show allotropy due to its weak  $\text{N—N}$  single bond. Therefore, ability of nitrogen to form polymeric structure or more than one structure or form become less. Hence, nitrogen does not show allotropy.

**Q. 13** Maximum covalency of nitrogen is .....

- (a) 3
- (b) 5
- (c) 4
- (d) 6

**Ans. (c)** Maximum covalency of nitrogen is 4 in which one electron is made available by s-orbital and 3 electrons are made available by p orbitals. Hence, total four electrons are available for bonding.

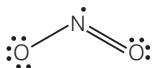
**Q. 14** Which of the following statements is wrong?

- (a) Single  $\text{N—N}$  bond is stronger than the single  $\text{P—P}$  bond.
- (b)  $\text{PH}_3$  can act as a ligand in the formation of coordination compound with transition elements.
- (c)  $\text{NO}_2$  is paramagnetic in nature.
- (d) Covalency of nitrogen in  $\text{N}_2\text{O}_5$  is four.

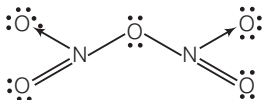
**Ans. (a)** True statement is that single  $\text{N—N}$  bond is weaker than the single  $\text{P—P}$  bond. This is why phosphorous show allotropy but nitrogen does not.

- (i)  $\text{PH}_3$  acts as a ligand in the formation of coordination compound due to presence of lone pair of electrons.

- (ii)  $\text{NO}_2$  is paramagnetic in nature due to presence of one unpaired electron.  
Structure of  $\text{NO}_2$  is



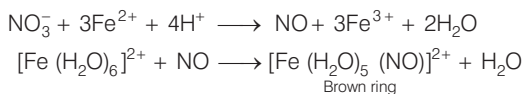
- (iii) Covalency of nitrogen in  $\text{N}_2\text{O}_5$  is 4.



**Q. 15** A brown ring is formed in the ring test for  $\text{NO}_3^-$  ion. It is due to the formation of

- (a)  $[\text{Fe}(\text{H}_2\text{O})_5(\text{NO})]^{2+}$  (b)  $\text{FeSO}_4 \cdot \text{NO}_2$   
(c)  $[\text{Fe}(\text{H}_2\text{O})_4(\text{NO})_2]^{2+}$  (d)  $\text{FeSO}_4 \cdot \text{HNO}_3$

**Ans. (a)** When freshly prepared solution of  $\text{FeSO}_4$  is added in a solution containing  $\text{NO}_3^-$  ion, it leads to formation of a brown coloured complex. This is known as brown ring test of nitrate.



**Q. 16** Elements of group- 15 form compounds in +5 oxidation state. However, bismuth forms only one well characterised compound in +5 oxidation state. The compound is

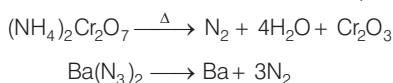
- (a)  $\text{Bi}_2\text{O}_5$  (b)  $\text{BiF}_5$   
(c)  $\text{BiCl}_5$  (d)  $\text{Bi}_2\text{S}_5$

**Ans. (b)** Stability of + 5 oxidation state decreases top to bottom and + 3 oxidation state increases top to bottom due to inert pair effect. Meanwhile compound having + 5 oxidation state of Bi is  $\text{BiF}_5$ . It is due to smaller size and high electronegativity of fluorine.

**Q. 17** On heating ammonium dichromate and barium azide separately we get

- (a)  $\text{N}_2$  in both cases  
(b)  $\text{N}_2$  with ammonium dichromate and NO with barium azide  
(c)  $\text{N}_2\text{O}$  with ammonium dichromate and  $\text{N}_2$  with barium azide  
(d)  $\text{N}_2\text{O}$  with ammonium dichromate and  $\text{NO}_2$  with barium azide

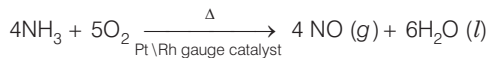
**Ans. (a)** On heating ammonium dichromate and barium azide it produces  $\text{N}_2$  gas separately.



**Q. 18** In the preparation of  $\text{HNO}_3$ , we get NO gas by catalytic oxidation of ammonia. The moles of NO produced by the oxidation of two moles of  $\text{NH}_3$  will be .....

- (a) 2 (b) 3 (c) 4 (d) 6

**Ans. (a)** Two moles of  $\text{NH}_3$  will produce 2 moles of NO on catalytic oxidation of ammonia in preparation of nitric acid.



**Q. 19** The oxidation state of central atom in the anion of compound  $\text{NaH}_2\text{PO}_2$  will be .....

- (a) + 3                      (b) + 5                      (c) + 1                      (d) - 3

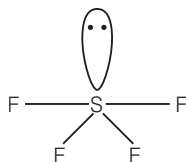
**Ans. (c)** Let oxidation state of P in  $\text{NaH}_2\text{PO}_2$  is  $x$ .

$$\begin{aligned} 1 + 2 \times 1 + x + 2 \times -2 &= 0 \\ 1 + 2 + x - 4 &= 0 \\ + x - 1 &= 0 \\ x &= +1 \end{aligned}$$

**Q. 20** Which of the following is not tetrahedral in shape?

- (a)  $\text{NH}_4^+$                       (b)  $\text{SiCl}_4$                       (c)  $\text{SF}_4$                       (d)  $\text{SO}_4^{2-}$

**Ans. (c)**  $\text{SF}_4$  has sea-saw shaped as shown below

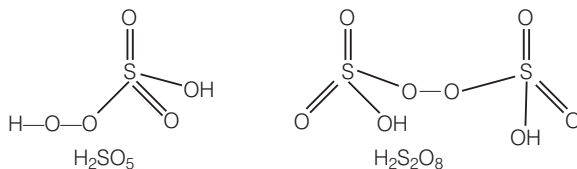


It has trigonal bipyramidal geometry having  $sp^3d$  hybridisation.

**Q. 21** Which of the following are peroxyacids of sulphur?

- (a)  $\text{H}_2\text{SO}_5$  and  $\text{H}_2\text{S}_2\text{O}_8$                       (b)  $\text{H}_2\text{SO}_5$  and  $\text{H}_2\text{S}_2\text{O}_7$   
(c)  $\text{H}_2\text{S}_2\text{O}_7$  and  $\text{H}_2\text{S}_2\text{O}_8$                       (d)  $\text{H}_2\text{S}_2\text{O}_6$  and  $\text{H}_2\text{S}_2\text{O}_7$

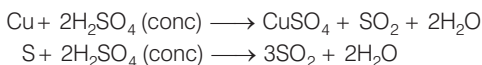
**Ans. (a)** Peroxyacids of sulphur must contain one  $\text{—O—O—}$  bond as shown below



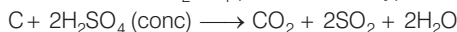
**Q. 22** Hot conc.  $\text{H}_2\text{SO}_4$  acts as moderately strong oxidising agent. It oxidises both metals and non-metals. Which of the following element is oxidised by conc.  $\text{H}_2\text{SO}_4$  into two gaseous products?

- (a) Cu                      (b) S                      (c) C                      (d) Zn

**Ans. (c)**  $\text{H}_2\text{SO}_4$  is a moderately strong oxidising agent which oxidises both metals and non-metals as shown below



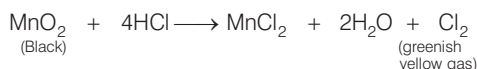
While carbon on oxidation with  $\text{H}_2\text{SO}_4$  produces two types of oxides  $\text{CO}_2$  and  $\text{SO}_2$ .



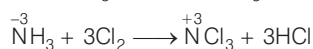
**Q. 23** A black compound of manganese reacts with a halogen acid to give greenish yellow gas. When excess of this gas reacts with  $\text{NH}_3$  an unstable trihalide is formed. In this process the oxidation state of nitrogen changes from ..... .

- (a) - 3 to + 3                      (b) - 3 to 0  
(c) - 3 to + 5                      (d) 0 to - 3

**Ans. (a)** Black coloured compound  $\text{MnO}_2$  reacts with  $\text{HCl}$  to produce greenish yellow coloured gas of  $\text{Cl}_2$



$\text{Cl}_2$  on further treatment with  $\text{NH}_3$  produces  $\text{NCl}_3$ .



$\text{NH}_3$  (– 3) changes to  $\text{NCl}_3$  (+3) in the above reaction. Hence, (a) is the correct choice.

**Q. 24** In the preparation of compounds of Xe, Bartlett had taken  $\text{O}_2^+ \text{Pt F}_6^-$  as a base compound. This is because

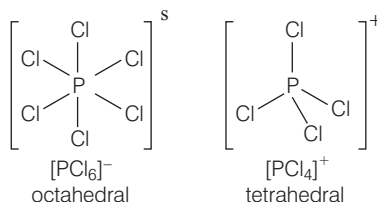
- (a) both  $O_2$  and Xe have same size.  
(b) both  $O_2$  and Xe have same electron gain enthalpy.  
(c) both  $O_2$  and Xe have almost same ionisation enthalpy.  
(d) both Xe and  $O_2$  are gases.

**Ans. (c)** Bertlett had taken  $\text{O}_2^+ \text{Pt F}_6^-$  as a base compound because  $\text{O}_2$  and Xe both have almost same ionisation enthalpy. The ionisation enthalpies of noble gases are the highest in their respective periods due to their stable electronic configurations.

**Q. 25** In solid state  $\text{PCl}_5$  is a .....

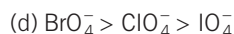
- (a) covalent solid  
(b) octahedral structure  
(c) ionic solid with  $[\text{PCl}_6]^+$  octahedral and  $[\text{PCl}_4]^-$  tetrahedral  
(d) ionic solid with  $[\text{PCl}_4]^+$  tetrahedral and  $[\text{PCl}_6]^-$  octahedral

**Ans. (d)** In solid state  $\text{PCl}_5$  exists as an ionic solid with  $[\text{PCl}_4]^+$  tetrahedral and  $[\text{PCl}_6]^-$  octahedral.



**Q. 26** Reduction potentials of some ions are given below. Arrange them in decreasing order of oxidising power.

Ion	$\text{ClO}_4^-$	$\text{IO}_4^-$	$\text{BrO}_4^-$
Reduction potential $E^\circ/\text{V}$	$E^\circ = 1.19 \text{ V}$	$E^\circ = 1.65 \text{ V}$	$E^\circ = 1.74 \text{ V}$



**Thinking Process**

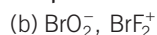
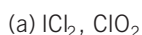
This problem is based on concept of standard reduction potential of species and oxidising property.

**Ans. (c)** Greater the SRP value of species higher will be its oxidising power.

Species	$E^\circ_{\text{cell}}$	
$\text{ClO}_4^-$	1.19V	<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">↓</div> <div>SRP of species increases. Oxidising power increase.</div> </div>
$\text{IO}_4^-$	1.65V	
$\text{BrO}_4^-$	1.74V	

Here, SRP = standard reduction potential.

**Q. 27** Which of the following is isoelectronic pair?



**Ans. (b)** Isoelectronic pair have same number of electrons

	$\text{BrO}_2^-$	$\text{BrF}_2^+$
Total number of electrons	$= 35 + 2 \times 8 + 1 = 52$	$= 35 + 9 \times 2 - 1 = 52$

Hence, (b) is the correct choice, while in another cases this value is not equal.

$\text{ICl}_2$	$\text{ClO}_2$
$53 + 2 \times 17 = 87$	$17 + 16 = 33$
$\text{ClO}_2$	$\text{BrF}$
$17 + 16 = 33$	$35 + 9 = 44$
$\text{CN}^-$	$\text{O}_3$
$= 6 + 7 + 1 = 14$	$= 8 \times 3 = 24$

Hence, only (b) is the correct choice.



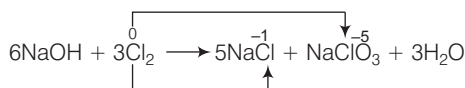
## Multiple Choice Questions (More Than One Options)

**Q. 28** If chlorine gas is passed through hot **NaOH** solution, two changes are observed in the oxidation number of chlorine during the reaction. These are ..... and .....

- (a) 0 to +5                      (b) 0 to +3                      (c) 0 to -1                      (d) 0 to +1

**Ans. (a, c)**

When chlorine gas is passed through hot NaOH solution it produces NaCl and NaClO<sub>3</sub>.



Oxidation state varies from 0 to -1 and 0 to +5.

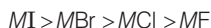
Hence, (a) and (c) are correct choices.

**Q. 29** Which of the following options are not in accordance with the property mentioned against them?

- (a)  $\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$                       Oxidising power  
 (b)  $\text{MI} > \text{MBr} > \text{MCl} > \text{MF}$                       Ionic character of metal halide  
 (c)  $\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$                       Bond dissociation enthalpy  
 (d)  $\text{HI} < \text{HBr} < \text{HCl} < \text{HF}$                       Hydrogen-halogen bond strength

**Ans. (b, c)**

$\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$  As ability to gain electron increases oxidising property increases. Here, F is the most electronegative element having highest value of SRP hence it has highest oxidising power.

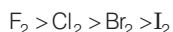


This is the incorrect order of ionic character of metal halide.

Correct order can be written as



As electronegativity difference between metal and halogen increases ionic character increases.



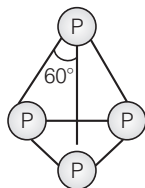
This is incorrect order of bond dissociation energy. Correct order is  $\text{Cl}_2 > \text{Br}_2 > \text{F}_2 > \text{I}_2$  due to electronic repulsion among lone pairs in  $\text{F}_2$  molecule.

**Q. 30** Which of the following is correct for  $\text{P}_4$  molecule of white phosphorus?

- (a) It has 6 lone pairs of electrons                      (b) It has six P — P single bonds  
 (c) It has three P — P single bonds                      (d) It has four lone pairs of electrons

**Ans. (b, d)**

Structure of  $\text{P}_4$  molecule can be represented as



It has total four lone pairs of electrons situated at each P-atom.

It has six P—P single bond.

**Q. 31** Which of the following statements are correct?

- (a) Among halogens, radius ratio between iodine and fluorine is maximum.
- (b) Leaving F — F bond, all halogens have weaker X — X bond than X — X' bond in interhalogens.
- (c) Among interhalogen compounds maximum number of atoms are present in iodine fluoride.
- (d) Interhalogen compounds are more reactive than halogen compounds.

**Ans. (a, c, d)**

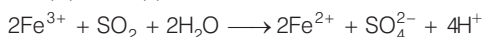
- (a) Among halogens, radius ratio between iodine and fluorine is maximum because iodine has maximum radius and fluorine has minimum radius.
- (b) It can be correctly stated as in general interhalogen compounds are more reactive than halogen. This is because X — X' bond in interhalogen is weaker than X — X bond in halogens except F—F bond.
- (c) Among interhalogen compounds maximum number of atoms are present in iodine fluoride because radius ratio of iodine and fluorine has maximum value.
- (d) Interhalogen compounds are more reactive than halogen due to weaker X — X' bond as compared to X — X of halogen compounds.

**Q. 32** Which of the following statements are correct for SO<sub>2</sub> gas?

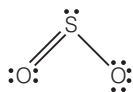
- (a) It acts as bleaching agent in moist conditions.
- (b) Its molecule has linear geometry.
- (c) Its dilute solution is used as disinfectant.
- (d) It can be prepared by the reaction of dilute H<sub>2</sub>SO<sub>4</sub> with metal sulphide.

**Ans. (a, c)**

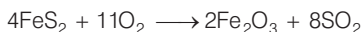
- (a) In moist condition SO<sub>2</sub> gas acts as a bleaching agent.  
e.g., it converts Fe (III) to Fe (II) ion and decolourises acidified KMnO<sub>4</sub> (VII).



- (b) is incorrect it has bent structure.



- (c) Its dilute solution is used as a disinfectant.
- (d) It can be prepared by the reaction of O<sub>2</sub> with sulphide ore,



while metal on treatment with H<sub>2</sub>SO<sub>4</sub> produces H<sub>2</sub>S.

Hence, options (a) and (c) are correct choices.

**Q. 33** Which of the following statements are correct?

- (a) All the three N — O bond lengths in HNO<sub>3</sub> are equal.
- (b) All P — Cl bond lengths in PCl<sub>5</sub> molecule in gaseous state are equal
- (c) P<sub>4</sub> molecule in white phosphorus have angular strain therefore white phosphorus is very reactive
- (d) PCl<sub>5</sub> is ionic in solid state in which cation is tetrahedral and anion is octahedral.



**Ans. (c, d)**

- (a) All the three N—O bond lengths in  $\text{HNO}_3$  are not equal.
- (b) All P—Cl bond lengths in  $\text{PCl}_5$  molecule in gaseous state are not equal. Axial bond is longer than equatorial bond.
- (c)  $\text{P}_4$  molecule in white phosphorous have angular strain therefore white phosphorous is very reactive.
- (d)  $\text{PCl}_5$  is ionic in solid state in which cation is tetrahedral and anion is octahedral.

Cation —  $[\text{PCl}_4]^+$

Anion —  $[\text{PCl}_6]^-$

**Q. 34** Which of the following orders are correct as per the properties mentioned against each?

(a)  $\text{As}_2\text{O}_3 < \text{SiO}_2 < \text{P}_2\text{O}_3 < \text{SO}_2$

Acid strength.

(b)  $\text{AsH}_3 < \text{PH}_3 < \text{NH}_3$

Enthalpy of vaporisation.

(c)  $\text{S} < \text{O} < \text{Cl} < \text{F}$

More negative electron gain enthalpy.

(d)  $\text{H}_2\text{O} > \text{H}_2\text{S} > \text{H}_2\text{Se} > \text{H}_2\text{Te}$

Thermal stability.

**Ans. (a, d)**

(a)  $\xrightarrow[\text{acidic strength increases}]{\text{As}_2\text{O}_3 < \text{SiO}_2 < \text{P}_2\text{O}_3 < \text{SO}_2}$

(b) Correct order is  $\xleftarrow[\text{enthalpy of vaporisation}]{\text{AsH}_3 > \text{PH}_3 > \text{NH}_3}$

(c)  $\text{S} < \text{O} < \text{Cl} < \text{F}$  More negative electron gain enthalpy

(d)  $\text{H}_2\text{O} > \text{H}_2\text{S} > \text{H}_2\text{Se} > \text{H}_2\text{Te}$  Thermal stability decreases on moving top to bottom due to increase in its bond length.

**Q. 35** Which of the following statements are correct?

(a) S—S bond is present in  $\text{H}_2\text{S}_2\text{O}_6$

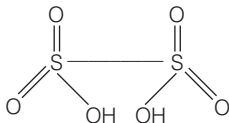
(b) In peroxosulphuric acid ( $\text{H}_2\text{SO}_5$ ) sulphur is in + 6 oxidation state

(c) Iron powder along with  $\text{Al}_2\text{O}_3$  and  $\text{K}_2\text{O}$  is used as a catalyst in the preparation of  $\text{NH}_3$  by Haber's process

(d) Change in enthalpy is positive for the preparation of  $\text{SO}_3$  by catalytic oxidation of  $\text{SO}_2$

**Ans. (a, b)**

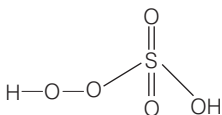
(a) Structure of  $\text{H}_2\text{S}_2\text{O}_6$  is as shown below



It contains one S—S bond.

(b) In peroxosulphuric acid ( $\text{H}_2\text{SO}_5$ ) sulphur is in + 6 oxidation state.

Structure of  $\text{H}_2\text{SO}_5$  is



Let oxidation state of S =  $x$

$$2 \times (+1) + x + 3 \times (-2) + 2 \times (-1) = 0$$

$$x - 6 = 0$$

$$x = 6$$

- (c) During preparation of ammonia, iron oxide with small amount of  $K_2O$  and  $Al_2O_3$  is used as a catalyst to increase the rate of attainment of equilibrium.
- (d) Change in enthalpy is negative for preparation of  $SO_3$  by catalytic oxidation of  $SO_2$ .

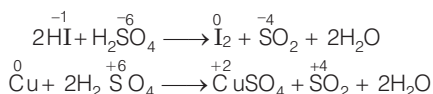
**Q. 36** In which of the following reactions conc.  $H_2SO_4$  is used as an oxidising reagent?

- (a)  $CaF_2 + H_2SO_4 \longrightarrow CaSO_4 + 2HF$
- (b)  $2HI + H_2SO_4 \longrightarrow I_2 + SO_2 + 2H_2O$
- (c)  $Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$
- (d)  $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$

**Ans. (b, c)**

In the above given four reactions, (b) and (c) represent oxidising behaviour of  $H_2SO_4$ . As we know that oxidising agent reduces itself as oxidation state of central atom decreases.

Here,



**Q. 37** Which of the following statements are true?

- (a) Only type of interactions between particles of noble gases are due to weak dispersion forces.
- (b) Ionisation enthalpy of molecular oxygen is very close to that of xenon.
- (c) Hydrolysis of  $XeF_6$  is a redox reaction.
- (d) Xenon fluorides are not reactive.

**Ans. (a, b)**

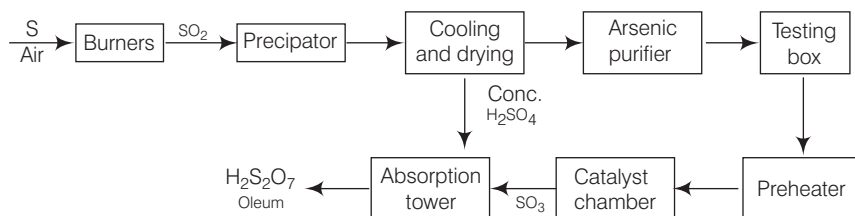
- (a) Only one type of interactions between particles of noble gases are due to weak dispersion forces.
- (b) Ionisation enthalpy of molecular oxygen is very close to that of xenon. This is the reason for the formation of xenon oxides.
- (c) Hydrolysis of  $XeF_6$  ( $\overset{+6}{Xe}\overset{-1}{F}_6 + 3H_2\overset{+1}{O} \longrightarrow \overset{+6}{Xe}\overset{-2}{O}_3 + 3H\overset{+1}{F}$ ) is not a redox reaction.
- (d) Xenon fluorides are highly reactive hydrolysis readily even by traces of water.

## Short Answer Type Questions

**Q. 38** In the preparation of  $\text{H}_2\text{SO}_4$  by Contact process, why is  $\text{SO}_3$  not absorbed directly in water to form  $\text{H}_2\text{SO}_4$ ?

**Ans.** In Contact process  $\text{SO}_3$  is not absorbed directly in water to form  $\text{H}_2\text{SO}_4$  because the reaction is highly exothermic, acid mist is formed. Hence, the reaction becomes difficult to handle.

**Note**

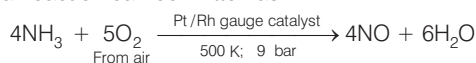


**Flow chart of Contact process**

**Q. 39** Write a balanced chemical equation for the reaction showing catalytic oxidation of  $\text{NH}_3$  by atmospheric oxygen.

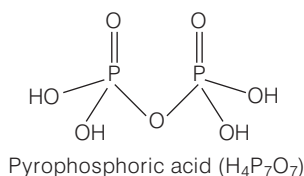
**Ans.** Ammonia ( $\text{NH}_3$ ) on catalytic oxidation by atmospheric oxygen in presence of Rh/Pt gauge at 500K under pressure of 9 bar produces nitrous oxide.

Balanced chemical reaction can be written as



**Q. 40** Write the structure of pyrophosphoric acid.

**Ans.** Molecular formula of pyrophosphoric acid is  $\text{H}_4\text{P}_2\text{O}_7$  and its structure is as follows

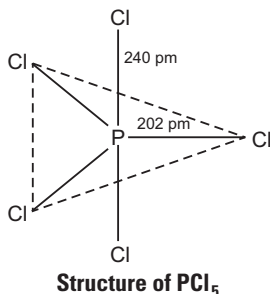


**Q. 41**  $\text{PH}_3$  forms bubbles when passed slowly in water but  $\text{NH}_3$  dissolves. Explain why?

**Ans.** Dissolution of  $\text{NH}_3$  and  $\text{PH}_3$  in water can be explained on the basis of H-bonding.  $\text{NH}_3$  forms H-bond with water so it is soluble but  $\text{PH}_3$  does not form H-bond with water so it remains as gas and forms bubble in water.

**Q. 42** In  $\text{PCl}_5$ , phosphorus is in  $\text{sp}^3\text{d}$  hybridised state but all its five bonds are not equivalent. Justify your answer with reason.

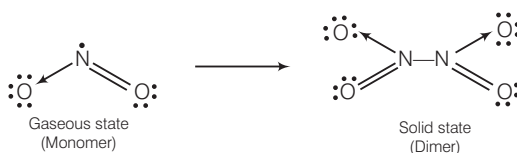
**Ans.** It has trigonal bipyramidal geometry, in which two Cl atoms occupy axial position while three occupy equatorial positions. All five P—Cl bonds are not identical. There are two types of bond lengths (i) Axial bond lengths (ii) Equatorial bond lengths



Thus, difference in bond length is due to fact that axial bond pairs suffer more repulsion as compared to equatorial bond pairs.

**Q. 43** Why is nitric oxide paramagnetic in gaseous state but the solid obtained on cooling it is diamagnetic?

**Ans.** In gaseous state,  $\text{NO}_2$  exists as a monomer which has one unpaired electron but in solid state, it dimerises to  $\text{N}_2\text{O}_4$  so no unpaired electron left. Therefore,  $\text{NO}_2$  is paramagnetic in gaseous state but diamagnetic in solid state.

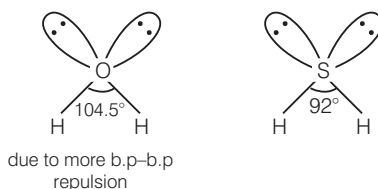


**Q. 44** Give one reason to explain why  $\text{ClF}_3$  exists but  $\text{FCl}_3$  does not exist?

**Ans.** Existence of  $\text{ClF}_3$  and  $\text{FCl}_3$  can be explained on the basis of size of central atom. Because fluorine is more electronegative as compared to chlorine and has smaller size. Thus, one large Cl atom can accommodate three smaller F atoms but reverse is not true.

**Q. 45** Out of  $\text{H}_2\text{O}$  and  $\text{H}_2\text{S}$ , which one has higher bond angle and why?

**Ans.** Bond angle of  $\text{H}_2\text{O}$  ( $\text{H} - \text{O} - \text{H} = 104.5^\circ$ ) is larger than that of  $\text{H}_2\text{S}$  ( $\text{H} - \text{S} - \text{H} = 92^\circ$ ) because oxygen is more electronegative than sulphur therefore, bond pair electron of O—H bond will be closer to oxygen and there will be more bond pair—bond pair repulsion between bond pairs of two O—H bonds.



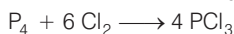
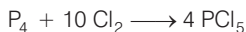
**Q. 46**  $\text{SF}_6$  is known but  $\text{SCl}_6$  is not. Why?

**Ans.** Fluorine atom is smaller in size so, six  $\text{F}^-$  ions can surround a sulphur atom. The case is not so with chlorine atom due to its large size. So,  $\text{SF}_6$  is known but  $\text{SCl}_6$  is not known due to interionic repulsion between larger  $\text{Cl}^-$  ions.

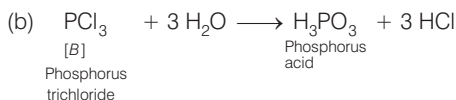
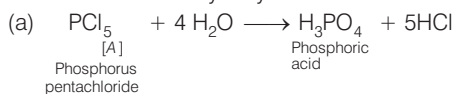
**Q. 47** On reaction with  $\text{Cl}_2$ , phosphorus forms two types of halides 'A' and 'B'. Halide 'A' is yellowish-white powder but halide 'B' is colourless oily liquid. Identify A and B and write the formulae of their hydrolysis products.

**Ans.** Phosphorus on reaction with  $\text{Cl}_2$  forms two types of halides A and B.

'A' is  $\text{PCl}_5$  and 'B' is  $\text{PCl}_3$ .

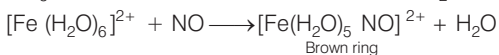


When 'A' and 'B' are hydrolysed



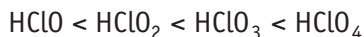
**Q. 48** In the ring test of  $\text{NO}_3^-$  ion,  $\text{Fe}^{2+}$  ion reduces nitrate ion to nitric oxide, which combines with  $\text{Fe}^{2+}$  (aq) ion to form brown complex. Write the reactions involved in the formation of brown ring.

**Ans.**  $\text{NO}_3^- + 3\text{Fe}^{2+} + 4\text{H}^+ \longrightarrow \text{NO} + 3\text{Fe}^{3+} + 2\text{H}_2\text{O}$

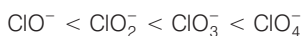


This test is known as brown ring test of nitrates generally used to identify the presence of nitrate ion in given solution.

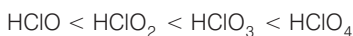
**Q. 49** Explain why the stability of oxoacids of chlorine increases in the order given below.



**Ans.** Oxygen is more electronegative than chlorine, therefore dispersal of negative charge present on chlorine increases from  $\text{ClO}^-$  to  $\text{ClO}_4^-$  ion because number of oxygen atoms attached to chlorine is increasing. Therefore, stability of ions will increase in the order given below



Due to increase in stability of conjugate base, acidic strength of corresponding acid increases in the same order



**Q. 50** Explain why ozone is thermodynamically less stable than oxygen?

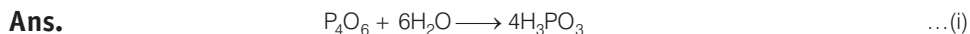
**Ans.** Ozone is thermodynamically less stable than oxygen because its decomposition into oxygen results in the liberation of heat ( $\Delta H$  is negative) and an increase in entropy ( $\Delta S$  is positive). These two effects reinforce each other, resulting in large negative Gibbs energy change ( $\Delta G$ ) for its conversion into oxygen.



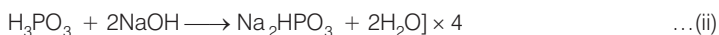
- Q. 51**  $P_4O_6$  reacts with water according to equation  $P_4O_6 + 6H_2O \longrightarrow 4H_3PO_3$ . Calculate the volume of 0.1 M NaOH solution required to neutralise the acid formed by dissolving 1.1 g of  $P_4O_6$  in  $H_2O$ .

**Thinking Process**

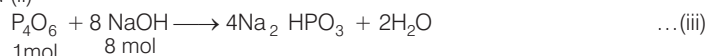
*This problem includes conceptual mixing of chemical properties of oxides of phosphorus, mole concept and stoichiometry.*



Neutralisation



Adding Eqs. (i) and (ii)



Number of moles of  $P_4O_6$ ,

$$n = \frac{m}{M} = \frac{1.1}{220} = \frac{1}{200} \text{ mol}$$

(Molar mass of  $P_4O_6$  =  $(4 \times 31) + (6 \times 16) = 220$ )

$\therefore$  Product formed by 1 mole of  $P_4O_6$  is neutralised by 8 moles NaOH

$\therefore$  Product formed by  $\frac{1}{200}$  moles of  $P_4O_6$  will be neutralised by NaOH

$$= 8 \times \frac{1}{200} = \frac{8}{200} \text{ mole NaOH}$$

Given, Molarity of NaOH = 0.1 M = 0.1 mol/L

$$\text{Molarity} = \frac{\text{Number of moles}}{\text{Volume in litres}}$$

$$\text{Volume} = \frac{\text{Number of moles}}{\text{Molarity}} = \frac{8}{200} \times \frac{1}{0.1} = 0.4 \text{ L or } 400 \text{ mL}$$

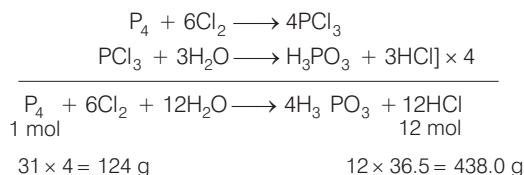
$\therefore$  400 mL NaOH is required.

- Q. 52** White phosphorus reacts with chlorine and the product hydrolyses in the presence of water. Calculate the mass of HCl obtained by the hydrolysis of the product formed by the reaction of 62 g of white phosphorus with chlorine in the presence of water.

**Thinking Process**

*This problem is based on concept of chemical reaction of phosphorus and stoichiometry. Write balanced chemical reaction and then calculate the amount of HCl produced.*

**Ans.** Equations for the reactions



$\therefore$  124 g of white phosphorus produces HCl = 438 g

$\therefore$  62 g of white phosphorus will produces

$$HCl = \frac{438}{124} \times 62 = 219.0 \text{ g HCl}$$



**Q. 53** Name three oxoacids of nitrogen. Write the disproportionation reaction of that oxoacid of nitrogen in which nitrogen is in + 3 oxidation state.

**Ans.** Three oxoacids of nitrogen having oxidation state + 3 are

- (a)  $\text{HNO}_2$ , nitrous acid
- (b)  $\text{HNO}_3$ , nitric acid
- (c) Hyponitrous acid,  $\text{H}_2\text{N}_2\text{O}_2$

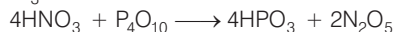
In  $\text{HNO}_2$ , N is in + 3 oxidation state

Disproportionation reaction

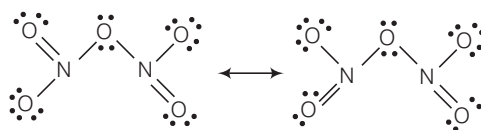


**Q. 54** Nitric acid forms an oxide of nitrogen on reaction with  $\text{P}_4\text{O}_{10}$ . Write the reaction involved. Also write the resonating structures of the oxide of nitrogen formed.

**Ans.**  $\text{P}_4\text{O}_{10}$  being a dehydrating agent, on reaction with  $\text{HNO}_3$  removes a molecule of water and forms anhydride of  $\text{HNO}_3$ .



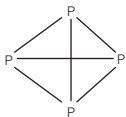
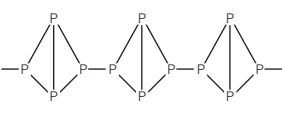
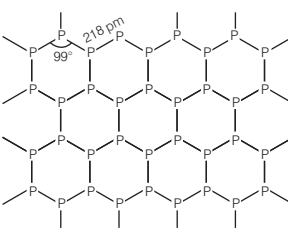
Resonating structures of  $\text{N}_2\text{O}_5$  are



**Q. 55** (i) white phosphorus (ii) red phosphorus and (iii) black phosphorus. Write the difference between white red and black phosphorus on the basis of their structure and reactivity.

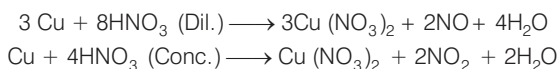
Phosphorus has three allotropic forms —

**Ans.**

White phosphorus	Red phosphorus	Black phosphorus
1. It is less stable form of P	More stable than white P.	It is most stable form of P
2. It is highly reactive. 	Less reactive than white P. 	It is least reactive. 
3. It has regular tetrahedron structure.	It has polymeric structure.	It has a layered structure.

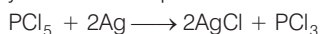
**Q. 56** Give an example to show the effect of concentration of nitric acid on the formation of oxidation product.

**Ans.** Effect of concentration of nitric acid on the formation of oxidation product can be understood by its reaction with conc  $\text{HNO}_3$ . Dilute and concentrated nitric acid give different oxidation products on reaction with copper metal.

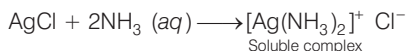


**Q. 57**  $\text{PCl}_5$  reacts with finely divided silver on heating and a white silver salt is obtained, which dissolves on adding excess aqueous  $\text{NH}_3$  solution. Write the reactions involved to explain what happens.

**Ans.**  $\text{PCl}_5$  on reaction with finely divided silver produced silver halide.

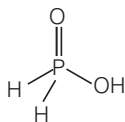


$\text{AgCl}$  on further reaction with aqueous ammonia solution produces a soluble complex of  $[\text{Ag}(\text{NH}_3)_2]^+ \text{Cl}^-$



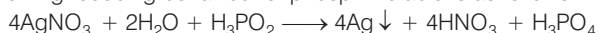
**Q. 58** Phosphorus forms a number of oxoacids. Out of these oxoacids, phosphinic acid has strong reducing property. Write its structure and also write a reaction showing its reducing behaviour.

**Ans.** Among various forms of oxoacids, phosphinic acid has stronger reducing property.



**Structure of phosphinic acid**

Reaction showing reducing behaviour of phosphinic acid is as follows



## Matching The Columns

**Q. 59** Match the compounds given in Column I with the hybridisation and shape given in Column II and mark the correct option.

Column I	Column II
A. $\text{XeF}_6$	1. $sp^3d^3$ -distorted octahedral
B. $\text{XeO}_3$	2. $sp^3d^2$ -square planar
C. $\text{XeOF}_4$	3. $sp^3$ -pyramidal
D. $\text{XeF}_4$	4. $sp^3d^2$ -square pyramidal

**Codes**

A B C D  
(a) 1 3 4 2  
(c) 4 3 1 2

A B C D  
(b) 1 2 4 3  
(d) 4 1 2 3

Ans. (a) A.  $\rightarrow$  (1)    B.  $\rightarrow$  (3)    C.  $\rightarrow$  (4)    D.  $\rightarrow$  (2)

S. No.	Compound	Hybridisation
A.		$sp^3d^3$ -distorted octahedral
B.		$sp^3$ -pyramidal
C.		$sp^3d^2$ -square pyramidal
D.		$sp^3d^2$ -square planar

**Q. 60** Match the formulas of oxides given in Column I with the type of oxide given in Column II and mark the correct option.

Column I	Column II
A. $Pb_3O_4$	1. Neutral oxide
B. $N_2O$	2. Acidic oxide
C. $Mn_2O_7$	3. Basic oxide
D. $Bi_2O_3$	4. Mixed oxide

**Codes**

A	B	C	D
(a) 1	2	3	4
(c) 3	2	4	1

A	B	C	D
(b) 4	1	2	3
(d) 4	3	1	2

Ans. (b) A.  $\rightarrow$  (4)    B.  $\rightarrow$  (1)    C.  $\rightarrow$  (2)    D.  $\rightarrow$  (3)

	Formulas of the compound	Type of oxide
A.	$Pb_3O_4$ ( $PbO \cdot Pb_2O_3$ )	Mixed oxide
B.	$N_2O$	Neutral oxide
C.	$Mn_2O_7$	Acidic oxide
D.	$Bi_2O_3$	Basic oxide

$Mn_2O_7$  on dissolution in water produces acidic solution.

$Bi_2O_3$  on dissolution in water produces basic solution.

**Q. 61** Match the items of Columns I and II and mark the correct option.

Column I	Column II
A. $\text{H}_2\text{SO}_4$	1. Highest electron gain enthalpy
B. $\text{CCl}_3\text{NO}_2$	2. Chalcogen
C. $\text{Cl}_2$	3. Tear gas
D. Sulphur	4. Storage batteries

**Codes**

A B C D

(a) 4 3 1 2

(c) 4 1 2 3

A B C D

(b) 3 4 1 2

(d) 2 1 3 4

**Ans. (a)** A.  $\rightarrow$  (4) B.  $\rightarrow$  (3) C.  $\rightarrow$  (1) D.  $\rightarrow$  (2)

A.  $\text{H}_2\text{SO}_4$  is used in storage batteries.

B.  $\text{CCl}_3\text{NO}_2$  is known as tear gas.

C.  $\text{Cl}_2$  has highest electron gain enthalpy.

D. Sulphur is a member of chalcogen i.e., ore producing elements.

**Q. 62** Match the species given in Column I with the shape given in Column II and mark the correct option.

Column I	Column II
A. $\text{SF}_4$	1. Tetrahedral
B. $\text{BrF}_3$	2. Pyramidal
C. $\text{BrO}_3^-$	3. Sea-saw shaped
D. $\text{NH}_4^+$	4. Bent T-shaped

**Codes**

A B C D

(a) 3 2 1 4

(c) 1 2 3 4

A B C D

(b) 3 4 2 1

(d) 1 4 3 2

**Ans. (b)** A.  $\rightarrow$  (3) B.  $\rightarrow$  (4) C.  $\rightarrow$  (2) D.  $\rightarrow$  (1)

	Species	Shape	Structure
A.	$\text{SF}_4$	Sea-saw shaped	
B.	$\text{BrF}_3$	Bent T-shaped	
C.	$\text{BrO}_3^-$	Pyramidal	
D.	$\text{NH}_4^+$	Tetrahedral	

**Q. 63** Match the items of Columns I and II and mark the correct option.

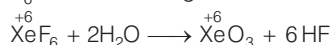
Column I	Column II
A. Its partial hydrolysis does not change oxidation state of central atom.	1. He
B. It is used in modern diving apparatus.	2. $\text{XeF}_6$
C. It is used to provide inert atmosphere for filling electrical bulbs.	3. $\text{XeF}_4$
D. Its central atom is in $sp^3d^2$ hybridisation.	4. Ar

**Codes**

A	B	C	D	A	B	C	D
(a) 1	4	2	3	(b) 1	2	3	4
(c) 2	1	4	3	(d) 1	3	2	4

**Ans. (c)** A.  $\rightarrow$  (2)    B.  $\rightarrow$  (1)    C.  $\rightarrow$  (4)    D.  $\rightarrow$  (3)

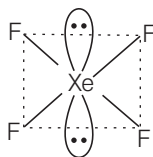
(A) Partial hydrolysis of  $\text{XeF}_6$  does not change oxidation state of central atom.



(B) He is used in modern diving apparatus.

(C) Ar is used to provide inert atmosphere for filling electrical bulbs

(D) Central atom (Xe) of  $\text{XeF}_4$  is in  $sp^3d^2$  hybridisation.



**Square planar geometry**

## Assertion and Reason

*In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct answer out of the following choices.*

- Both Assertion and Reason are correct statements, and Reason is the correct explanation of the Assertion.
- Both Assertion and Reason are correct statements, and Reason is not the correct explanation of the Assertion.
- Assertion is correct, but Reason is wrong statement.
- Assertion is wrong but Reason is correct statement.
- Both Assertion and Reason are wrong statements.

**Q. 64** Assertion (A)  $\text{N}_2$  is less reactive than  $\text{P}_4$ .

Reason (R) Nitrogen has more electron gain enthalpy than phosphorus.

**Ans. (c)** Assertion is true, but reason is false.

$N_2$  is less reactive than  $P_4$  due to high value of bond dissociation energy which is due to presence of triple bond between two N-atoms of  $N_2$  molecule.

**Q. 65** Assertion (A)  $HNO_3$  makes iron passive.

Reason (R)  $HNO_3$  forms a protective layer of ferric nitrate on the surface of iron.

**Ans. (c)** Assertion is true, but reason is false.

$HNO_3$  makes iron passive due to formation of passive form of oxide on the surface. Hence, Fe does not dissolve in conc  $HNO_3$  solution.

**Q. 66** Assertion (A) HI cannot be prepared by the reaction of KI with concentrated  $H_2SO_4$ .

Reason (R) HI has lowest H—X bond strength among halogen acids.

**Ans. (b)** Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.

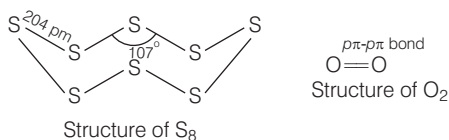
HI cannot be prepared by the reaction of KI with concentrated  $H_2SO_4$  because HI is converted into  $I_2$  on reaction with  $H_2SO_4$ .

**Q. 67** Assertion (A) Both rhombic and monoclinic sulphur exist as  $S_8$  but oxygen exists as  $O_2$ .

Reason (R) Oxygen forms  $p\pi - p\pi$  multiple bond due to small size and small bond length but  $p\pi - p\pi$  bonding is not possible in sulphur.

**Ans. (a)** Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.

Both rhombic and monoclinic sulphur exist as  $S_8$  but oxygen exists as  $O_2$ , because oxygen forms  $p\pi - p\pi$  multiple bond due to its small size and small bond length. But  $p\pi - p\pi$  bonding is not possible in sulphur due to its bigger size as compared to oxygen.

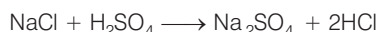


**Q. 68** Assertion (A)  $NaCl$  reacts with concentrated  $H_2SO_4$  to give colourless fumes with pungent smell. But on adding  $MnO_2$  the fumes become greenish yellow.

Reason (R)  $MnO_2$  oxidises  $HCl$  to chlorine gas which is greenish yellow.

**Ans. (a)** Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.

$NaCl$  reacts with concentrated  $H_2SO_4$  to give colourless fumes with pungent smell. Pungent smell is due to formation of  $HCl$ .



But on adding  $MnO_2$  the fumes become greenish yellow due to formation of chlorine gas.

**Q. 69** Assertion (A)  $\text{SF}_6$  cannot be hydrolysed but  $\text{SF}_4$  can be.

Reason (R) Six F-atoms in  $\text{SF}_6$  prevent the attack of  $\text{H}_2\text{O}$  on sulphur atom of  $\text{SF}_6$ .

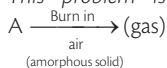
**Ans. (a)** Assertion and reason both are true and reason is the correct explanation of assertion.  $\text{SF}_4$  can be hydrolysed but  $\text{SF}_6$  can not because six F-atoms in  $\text{SF}_6$  prevent the attack of  $\text{H}_2\text{O}$  on sulphur atoms of  $\text{SF}_6$ .

## Long Answer Type Questions

**Q. 70** An amorphous solid "A" burns in air to form a gas "B" which turns lime water milky. The gas is also produced as a by-product during roasting of sulphide ore. This gas decolourises acidified aqueous  $\text{KMnO}_4$  solution and reduces  $\text{Fe}^{3+}$  to  $\text{Fe}^{2+}$ . Identify the solid "A" and the gas "B" and write the reactions involved.

### Thinking Process

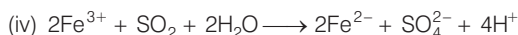
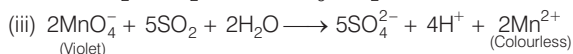
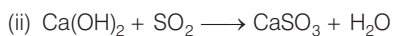
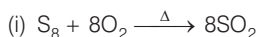
*This problem is based on concept of properties of sulphur and its oxide.*



*Amorphous solid A gives B is a gas which turns lime water milky and also produced as a by product during roasting of sulphide ore. This gas decolourises acidified aqueous  $\text{KMnO}_4$  solution and reduces  $\text{Fe}^{3+}$  to  $\text{Fe}^{2+}$ . Hence, compound B (g) must be  $\text{SO}_2$ .*

**Ans.** Since, the by-product of roasting of sulphide ore is  $\text{SO}_2$ , so A is  $\text{S}_8$  'A' =  $\text{S}_8$ ; 'B' =  $\text{SO}_2$

### Reactions



**Q. 71** On heating lead (II) nitrate gives a brown gas "A". The gas "A" on cooling changes to colourless solid "B". Solid "B" on heating with NO changes to a blue solid 'C'. Identify 'A', 'B' and 'C' and also write reactions involved and draw the structures of 'B' and 'C'.

### Thinking Process

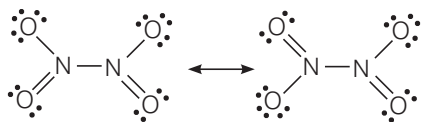
*This problem is based on preparation and properties of  $\text{NO}_2$ .*

**Ans.**  $\text{Pb(NO}_3)_2$  on heating produces a brown coloured gas which may be  $\text{NO}_2$ . Since, on reaction with  $\text{N}_2\text{O}_4$  and on heating it produces  $\text{N}_2\text{O}_3$  and  $\text{N}_2\text{O}_4$  respectively.

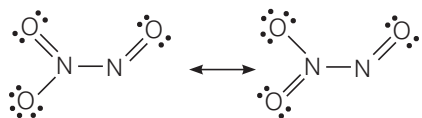


### Structures

(i)  $N_2O_4$

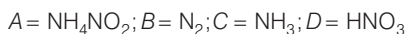


(ii)  $N_2O_3$



**Q. 72** On heating compound (A) gives a gas (B) which is a constituent of air. This gas when treated with 3 moles of hydrogen ( $H_2$ ) in the presence of a catalyst gives another gas (C) which is basic in nature. Gas C on further oxidation in moist condition gives a compound (D) which is a part of acid rain. Identify compounds (A) to (D) and also give necessary equations of all the steps involved.

**Ans.** The main constituents of air are nitrogen (78%) and oxygen (21%). Only  $N_2$  reacts with three moles of  $H_2$  in the presence of a catalyst to give  $NH_3$  (ammonia) which is a gas having basic nature. On oxidation,  $NH_3$  gives  $NO_2$  which is a part of acid rain. So, the compounds A to D are as



Reactions involved can be given, as

