Long Answer Questions

Long Answer Questions (PYQ)

Q.1. Answer the following question :

Q. Account for the following:

[*CBSE (F) 2017*]

a. **BiH_3 is the strongest reducing agent in Group 15 elements hydrides.**
b. **Cl_2 acts as a bleaching agent.**
c. **Noble gases have very low boiling points.**

Ans. (a) On moving down the group atomic size increases, therefore, E–H bond strength decreases. Thus, Bi–H bond is the weakest amongst the hydrides of group 15 and hence BiH_3 is the strongest reducing agent.

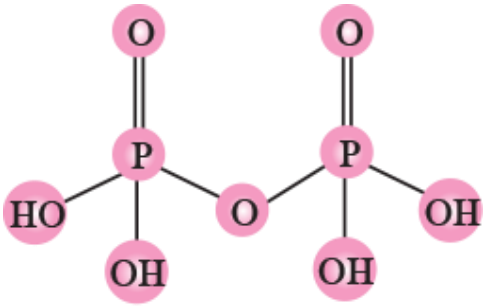
(b) In the presence of moisture or in aqueous solution, Cl_2 liberates nascent oxygen
$Cl_2 + H_2O \rightarrow 2HCl + [O]$
The bleaching action of Cl_2 is due to oxidation which is permanent.
Coloured substance + [O] → Colourless substance

(c) Noble gases being monoatomic have no interatomic forces except weak dispersion forces and therefore they have very low boiling points.

Q. Draw the structures of the following:

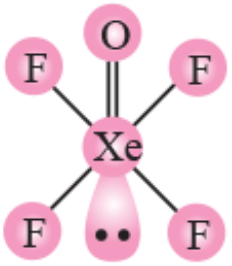
a. **$H_4P_2O_7$**
b. **$XeOF_4$**

Ans. (a)



Pyrophosphoric acid
($H_4P_2O_7$)

(b)



Square pyramidal
$XeOF_4$

Q.2. Answer the following question :

Q. Although nitrogen and chlorine have nearly same electronegativity yet nitrogen forms hydrogen bonding while chlorine does not. Why?

[*CBSE (F) 2017*]

Ans. Atomic size of nitrogen is smaller than chlorine. Due to this electron density per unit volume on nitrogen atom is higher than that of chlorine atom. Therefore, nitrogen form hydrogen bonds while chlorine does not although nitrogen and chlorine have nearly same electronegativity.

Q. What happens when F_2 reacts with water?

Ans. It oxidises H_2O to O_2.

$2F_2(g) + 2H_2O(l) \rightarrow 4H^+(aq) + 4F^-(aq) + O_2(g)$

Q. Write the name of the gas evolved when Ca_3P_2 is dissolved in water.

Ans. Phosphine (PH_3).

$Ca_3P_2 + 6H_2O \rightarrow 3Ca(OH)_2 + 2PH_3$

Q. Write the formula of a noble gas species which is isostructural with Br_2^- .

Ans. XeF_2.

IBr_2^- has 2 bond pairs and 3 lone pairs, therefore, it should be linear. Like IBr_2^- XeF_2 has 2 bond pairs and 3 lone pairs, therefore, it is also linear.

Q. Complete the equation:

$[Fe(H_2O)_6]^{2+}$ + NO →

Ans.

$$[Fe(H_2O)_6]^{2+} + NO \rightarrow \underset{(\text{Brown ring})}{[Fe(H_2O)_5NO]^{2+}} + H_2O$$

Q.3. Answer the following question :

Q. Complete the following chemical reaction equations:

a. **P_4 + $SOCl_2$ →**
b. **XeF_4 + H_2O →**

Ans. (a) $P_4 + 8SOCl_2 \rightarrow 4PCl_3 + 4SO_2 + 2S_2Cl_2$

(b) $6XeF_4 + 12H_2O \rightarrow 4Xe + 2XeO_3 + 24HF + 3O_2$

Q. Explain the following observations giving appropriate reasons:

a. **The stability of +5 oxidation state decreases down the group in Group 15 of the periodic table.**
b. **Solid phosphorus pentachloride behaves as an ionic compound.**
c. **Halogens are strong oxidising agents.**

[*CBSE Delhi 2010*]

Ans. (a) The stability of +5 oxidation state decreases down the group in Group 15 of the periodic table. The +3 oxidation state becomes more and more common on moving down the group from N to Bi. This is because of inert pair effect.

(b) Solid PCl_5 behaves as an ionic compound because it is a salt containing the tetrahedral cation $[PCl_4]^+$and octahedral anion $[PCl_6]^-$.

(c) Halogens are strong oxidising agents because they have high electron affinities, so, they pick up electrons from other substances.

Q.4. Answer the following question :

Q. Give reasons for the following:

a. **Bond enthalpy of F_2 is lower than that of Cl_2.**
b. **PH_3 has lower boiling point than NH_3.**

Ans. (a) Bond dissociation enthalpy decreases as the bond distance increases from F_2 to I_2 because of the corresponding increase in the size of the atom as we move from F to I.

The F—F bond dissociation enthalpy is, however, smaller than that of Cl—Cl and even smaller than that of Br—Br. This is because F atom is very small and hence the three lone pairs of electrons on each F atom repel the bond pair holding the F-atoms in molecule resulting lower bond enthalpy than Cl_2.

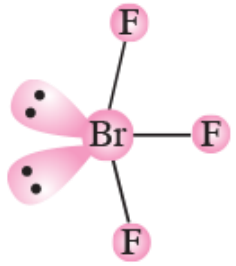
(b) Unlike NH_3, PH_3 molecules are not associated through hydrogen bonding in liquid state. That is why the boiling point of PH_3 is lower than NH_3.

Q. Draw the structures of the following molecules:

a. **BrF_3**
b. **$(HPO_3)_3$**
c. **XeF_4**

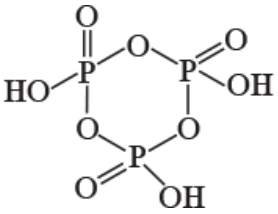
[CBSE Delhi 2013]

Ans. (*a*) BrF_3

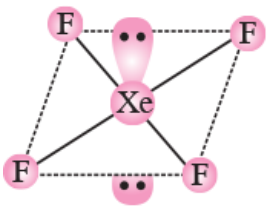


Slightly bent "T"

(*b*) $(HPO_3)_3$



(*c*) XeF_4



Square planar

Q.5. Answer the following question :

Q. Account for the following:

a. **Acidic character increases from HF to HI.**
b. **There is large difference between the melting and boiling points of oxygen and sulphur.**
c. **Nitrogen does not form pentahalide.**

Ans. (a) As the size of halogen atom increases from F to I, the bond dissociation enthalpy of H—X bond decreases from H—F to H—I. Due to this acidic character increases from HF to HI.

(b) Because of small size and high electronegativity oxygen forms pπ-pπ multiple bonds and exists as a diatomic, O_2 molecule. These molecules are held together by weak Van der Waal forces. Sulphur on the other hand due to its higher tendency for catenation and lower tendency for pπ-pπ multiple bond formation, forms octa-atomic, S_8 molecule. Because of bigger size of S_8 molecule than O_2molecule the force of attraction holding the S_8 molecules together are much stronger than O_2molecules. Hence, there is large difference between the melting and boiling points of oxygen and sulphur.

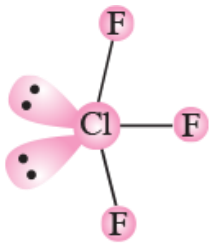
(c) Nitrogen with $n = 2$, has s and *p*-orbitals only. It does not have d-orbitals to expand its covalency beyond four. Due to this it does not form pentahalide.

Q. Draw the structures of the following:

a. **ClF_3**
b. **XeF_4**

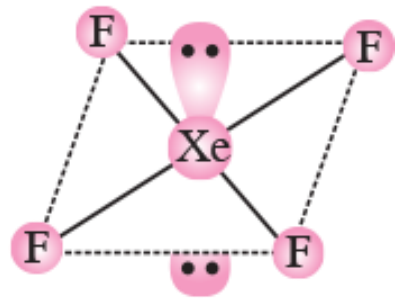
[*CBSE Delhi 2015*]

Ans. (a)



ClF_3: Slightly bent "T"

(b)



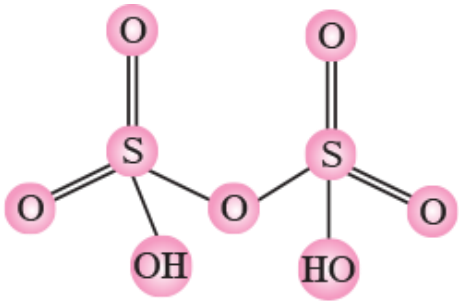
XeF_4: Square planar

Q.6. Answer the following question :

Q. Draw the structures of the following:

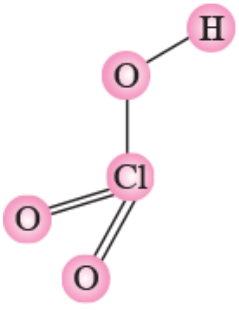
a. $H_2S_2O_7$
b. $HClO_3$

Ans. (*a*)



Pyrosulphuric acid (Oleum)
($H_2S_2O_7$)

(*b*)



Chloric acid
($HClO_3$)

Q. Give an explanation for each of the following observations:

a. **In the structure of HNO_3, the N—O bond (121 pm) is shorter than the N—OH bond (140 pm).**
b. **All the P—Cl bonds in PCl_5 are not equivalent.**
c. **ICl is more reactive than I_2.**

Ans. (a) Due to resonance, N—O bond length is the average of single and double bond whereas N—OH bond is purely single bond.

(b) PCl_5 has trigonal bipyramidal structure in which the three equatorial P—Cl bonds are equivalent, while the two axial bonds are longer than equatorial bonds. This is due to the fact that axial bond pairs suffer more repulsion as compared to equatorial bond pairs.

(c) This is because I—Cl bond has lower bond dissociation enthalpy than I—I bond.

Q.7. Answer the following question :

Q. Which allotrope of phosphorus is more reactive and why?

Ans. White or yellow phosphorus is more reactive than the other allotropes because it is less stable due to angular strain in the P_4 molecule of white phosphorus where the angles are only 60°.

Q. How the supersonic jet aeroplanes are responsible for the depletion of ozone layers?

Ans. Nitrogen oxides (particularly nitric oxide) emitted from the exhaust system of supersonic jet aeroplanes are responsible for depletion of ozone layer.

$NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$

Q. F_2 has lower bond dissociation enthalpy than Cl_2. Why?

Ans. Bond dissociation enthalpy of F_2 is lower than Cl_2 due to small size of fluorine and relatively larger electron-electron repulsion among the lone pairs in F_2 molecule where they are much closer to each other than in case of Cl_2.

Q. Which noble gas is used in filling balloons for meteorological observations?

Ans. Helium, as it is non-inflammable and light gas.

Q. Complete the equation: $XeF_2 + PF_5 \rightarrow$

[*CBSE Delhi 2015*]

Ans. $XeF_2 + PF_5 \rightarrow [XeF]^+ [PF_6]^-$

Q.8. Answer the following question :

Q. Complete the following chemical reaction equations:

a. **$AgCl(s) + NH_3(aq) \rightarrow$**
b. **$P_4(s) + NaOH(aq) + H_2O(l) \rightarrow$**

Ans. (a) $AgCl + 2NH_3 \rightarrow [Ag(NH_3)_2]^+ Cl^-$

(b) $P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$

Q. Explain the following observations:

a. **H_2S is less acidic than H_2Te.**
b. **Fluorine is a stronger oxidising agent than chlorine.**
c. **Noble gases are the least reactive elements.**

[CBSE (F) 2010]

Ans. (a) This is because bond dissociation enthalpy of H—Te bond is less than H—S as the size of Te is larger than S.

(b) Fluorine is a stronger oxidising agent than chlorine due to low dissociation enthalpy of F—F bond and high hydration enthalpy of F– ions.

(c) Noble gases are the least reactive elements due to fully filled outermost shells, high ionisation enthalpy and positive electron gain enthalpy.

Q.9. Answer the following question :

Q. Complete the following reaction equations:

a. $\mathbf{XeF_2 + PF_5 \rightarrow}$

b. $Cl_2\,(g) + \underset{(\text{hot and conc.})}{NaOH\,(aq)} \rightarrow$

Ans.

a. $XeF_2 + PF_5 \rightarrow [XeF]^+ [PF_6]^-$

b. $3\,Cl_2\,(g) + \underset{(\text{Hot and conc.})}{6\,NaOH\,(aq)} \rightarrow 5NaCl + NaClO_3 + 3H_2O$

Q. Explain the following observations:

a. **+3 oxidation state becomes more and more stable from As to Bi in the group.**
b. **Sulphur in vapour state exhibits paramagnetism.**
c. **Fluorine does not exhibit any positive oxidation state.**

[*CBSE (F) 2009*]

Ans. (a) This is due to inert pair effect.

(b) In vapour state sulphur partly exists as S_2 molecule having two unpaired electrons in the anti bonding π* orbitals like O_2 and, hence exhibits paramagnetism.

(c) This is because fluorine is the most electronegative element and does not have d-orbitals in its valence shell.

Q.10. Answer the following question :

Complete the following reaction equations:

a. **$PCl_5 + H_2O$ (excess) →**
b. **$F_2 + H_2O$ →**

[*CBSE (F) 2009*]

Ans. (a) $PCl_5 + 4H_2O$ (excess) $\rightarrow H_3PO_4 + 5HCl$

(b) $2F_2(g) + 2H_2O(l) \rightarrow 4H^+(aq) + 4F^-(aq) + O_2(g)$

Q. Explain the following observations:

a. **No distinct chemical compound of helium is known.**
b. **Phosphorus has a greater tendency for catenation than nitrogen.**
c. **In solutions of H_2SO_4 in water, the second dissociation constant K_{a_2}, is less than the first dissociation constant K_{a_1}.**

Ans.

a. This is due to small size, high ionisation enthalpy and stable electronic configuration of helium.

b. This is because P–P single bond is stronger than N–N single bond.

c. $K_{a_2} << K_{a_1}$, because HSO_4^- ion has much less tendency to donate a proton to H_2O as compared to neutral H_2SO_4.

Q.11. Answer the following question :

Q. What happens when

a. **chlorine gas is passed through a hot concentrated solution of NaOH?**
b. **sulphur dioxide gas is passed through an aqueous solution of a Fe(III) salt?**

Ans.

a. $3\,Cl_2 + \underset{(\text{Hot and conc.})}{6\,NaOH} \rightarrow 5NaCl + NaClO_3 + 3H_2O$

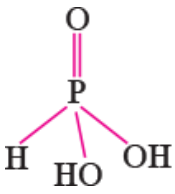
b. $2Fe^{3+} + SO_2 + 2H_2O \rightarrow 2Fe^{2+} + SO_4^{2-} + 4H^+$

Q. Answer the following:

a. **What is the basicity of H_3PO_3 and why?**
b. **Why does fluorine not play the role of a central atom in interhalogen compounds?**
c. **Why do noble gases have very low boiling points?**

[*CBSE (AI) 2011*]

Ans. (a)



Two, as the structure of H_3PO_3 has two P—OH bonds.

(b) This is due to smaller size and absence of d orbitals in the valence shell of fluorine.

(c) Noble gases being monoatomic gases have no interatomic forces except weak dispersion forces, therefore they have low boiling points.

Q.12. Answer the following question :

Q. Account for the following:

a. **Ozone is thermodynamically unstable.**
b. **Solid PCl_5 is ionic in nature.**
c. **Fluorine forms only one oxoacid HOF.**

Ans. (a) Ozone is thermodynamically unstable with respect to oxygen as its decomposition into oxygen results in the liberation of heat (DH is –ve) and an increase

in entropy (DS is +ve). These two effects reinforce each other, resulting in large negative Gibbs energy change (DG) for its conversion into oxygen.

(b) In solid state, PCl_5 exists as $[PCl_4]^+$ $[PCl_6]^-$ and conducts electricity on melting.

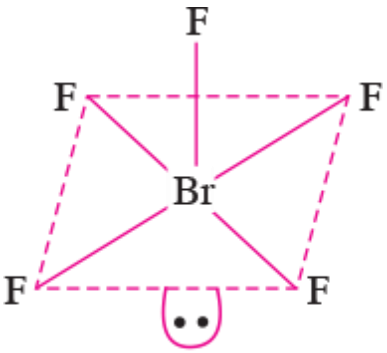
(c) Due to small size and high electronegativity, fluorine, forms only one oxoacid HOF.

Q. Draw the structures of

a. **BrF_5**
b. **XeF_4**

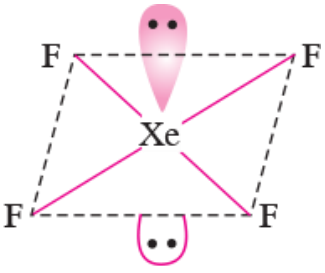
[*CBSE Delhi 2016*]

Ans. (a)



Square pyramidal

(b)



Square planar

Q.13. Answer the following question :

Q. Complete the following chemical reaction equations:

a. **$P_4 + SO_2Cl_2 \rightarrow$**
b. **$XeF_6 + H_2O \rightarrow$**

Ans. (a) $P_4 + 10SO_2Cl_2 \rightarrow 4PCl_5 + 10SO2$

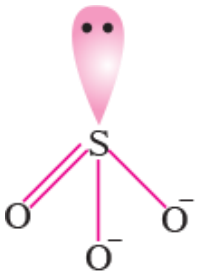
(b) $XeF6 + 3H_2O \rightarrow XeO_3 + 6HF$

Q. Predict the shape and the asked angle (90° or more or less) in each of the following cases:

a. SO_3^{2-} and the angle O—S—O

b. ClF_3 and the angle F—Cl—F

c. XeF_2 and the angle F—Xe—F



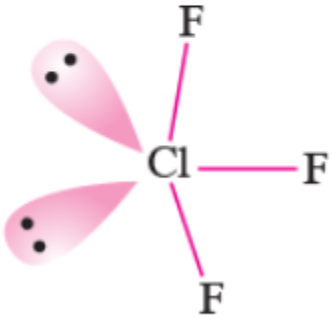
SO_3^{2-}

[*CBSE Delhi 2012*]

Ans.

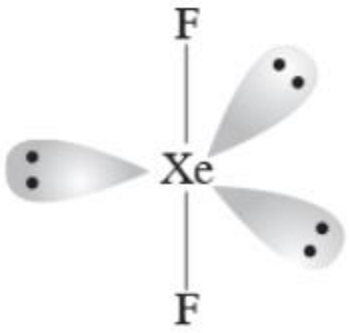
a. There are three bond pairs and one lone pair of electrons around S atoms in SO_3^{2-}. Therefore, according to VSEPR theory, SO_3^{2-} should be pyramidal. The angle O—S—O is greater than 90°.

b. There are three bond pairs and two lone pairs of electrons around Cl atom in ClF_2. Therefore, according to VSEPR theory, ClF_3 should be bent T-shaped. The angle F—Cl—F is less than 90°.



ClF_3

c. There are two bond pairs and three lone pairs of electrons around Xe atoms in XeF_2. Therefore according to VSEPR theory, XeF_2 should be linear. The angle F—Xe—F is greater than 90°.



XeF_2

Q.14. Answer the following question :

Q. Complete the following chemical equations:

a. **$XeF_4 + SbF_5 \rightarrow$**
b. **$Cl_2 + F_2$(excess) $\rightarrow$**

Ans.

a. $XeF_4 + SbF_5 \rightarrow [XeF_3]^+[SbF_6]^-$

b. $Cl_2 + 3F_2(\text{excess}) \xrightarrow{573K} 2ClF_3$

Q. Explain each of the following:

a. **Nitrogen is much less reactive than phosphorus.**

b. **The stability of +5 oxidation state decreases down group 15.**

c. **The bond angles (O—N—O) are not of the same value in NO_2^- and NO_2^+**

[CBSE Delhi 2012]

Ans.

a. As N≡N triple bond $(941.4\ kJ\ mol^{-1})$ is much stronger than P—P single bond $(213\ kJ\ mol^{-1})$, therefore nitrogen is much less reactive than phosphorus.

b. Due to inert pair effect stability of +5 oxidation decreases down the group 15.

c. In NO_2^-, nitrogen has a lone pair of electrons. As lone pair-bond pair repulsion is greater than bond pair-bond pair repulsion, thus O—N—O bond angle in NO_2^- is less then NO_2^+.

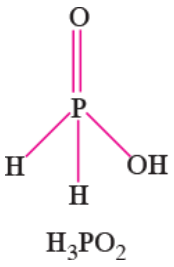
Q.15. Answer the following question :

Q. Draw the structures of the following molecules:

(a) H_3PO_2

(b) ClF_3

Ans. (a)



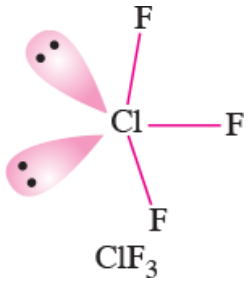
H_3PO_2

(b) No. of electron pairs around central atom Cl = 5

No. of bond pairs = 3

No of lone pairs = 2

The shape would be slightly bent T



ClF_3

Q. Explain the following observations:

a. **Oxygen is a gas but sulphur a solid.**
b. **Despite having greater polarity, hydrogen fluoride boils at a lower temperature than water.**
c. **The halogens are coloured.**

[*CBSE (AI) 2012*]

Ans. (a) Because of its small size, oxygen is capable of forming ρπ–ρπ bond and exists as diatomic O_2molecule. The intermolecular forces in oxygen are weak van der Waals force, due to which it is a gas at room temperature. On the other hand, sulphur, due to its larger size prefers to form S–S single bond and exist as octaatomic S_8 molecule having puckered ring structure. Because of larger size the force of attraction holding the S_8 molecules together are much stronger. Hence sulphur is a solid at room temperature.

(b) This is because in H_2O hydrogen bond formed is three dimensional whereas in H–F it is linear.

(c) All halogens are coloured. This is due to absorption of radiation in visible region which results in the excitation of outer electrons to higher energy level while the remaining light is transmitted. The colour of the halogen is the colour of transmitted light.

Long Answer Questions (OIQ)

Q.1. Answer the following question :

Q. When conc. H_2SO_4 was added into an unknown salt present in a test tube, a brown gas (A) was evolved. This gas intensified when copper turnings were also added into this test tube. On cooling, the gas (A) changed into a colourless gas (B).

a. **Identify the gases A and B.**
b. **Write the equations for the reactions involved.**

Ans.

$$A = NO_2(g), \qquad B = N_2O_4\ (g)$$

$$MNO_3 + H_2SO_4 \xrightarrow{\text{Heat}} MHSO_4 + HNO_3$$

$$4\,HNO_3 \xrightarrow{\text{Heat}} \underset{\substack{\text{Nitrogen dioxide}\\ (\text{Brown gas})}}{4\,NO_2} + 2H_2O + O_2$$

$$\underset{\text{Copper turnings}}{Cu} + 4\,HNO_3 \xrightarrow{\text{Heat}} Cu(NO_3)_2 + 2H_2O + 2\,NO_2$$

$$\underset{(\text{Brown gas})}{2\,NO_2} \underset{\text{Heat}}{\overset{\text{Cool}}{\rightleftharpoons}} \underset{(\text{Colourless})}{N_2O_4}$$

Q. Arrange the following in order of property indicated for each set:

a. **F_2, Cl_2, Br_2, I_2 —increasing bond dissociation enthalpy.**
b. **HF, HCl, HBr, HI—increasing acid strength.**
c. **NH_3, PH_3, AsH_3, SbH_3, BiH_3—increasing base strength.**

[HOTS]

Ans. (a) $I_2 < F_2 < Br_2 < Cl_2$

Bond dissociation enthalpy decreases with increase in the size of the atom as we move from Cl to I. The low F—F bond dissociation enthalpy is due to the fact that F atom is very small in size and hence the three lone pair of electrons on each F atom repel the bond pair of F—F bond very strongly.

(b) As the size of atom increases from F to I, the bond dissociation enthalpy of H—X bond decreases from H—F to H—I. Therefore, the acid strength increases in the opposite order:

HF < HCl < HBr < HI.

(c) As we move from NH_3 to BiH_3, the size of the central atom increases. Consequently, the electron density on the central atom decreases and hence the basic strength decreases as we move from $NH_3$to BiH_3.
Therefore, the basic strength increases in the order:

$BiH_3 < SbH_3 < AsH_3 < PH_3 < NH_3$.

Q.2. Account for the following :

Q. a. When NaBr is heated with conc. H_2SO_4, Br_2 is produced but when NaCl is heated with conc. H_2SO_4, HCl is produced.

(b) H_2S acts only as a reducing agent but SO_2 acts both as a reducing agent as well as an oxidising agent.

(c) The acid strength decreases in the order: HCl > H_2S > PH_3 .

Ans.

(a) When NaBr is heated with conc. H_2SO_4, HBr is first produced which being a reducing agent reduces H_2SO_4 to SO_2 while HBr itself gets oxidised to Br_2.

$NaBr + H_2SO_4 \rightarrow NaHSO_4 + HBr$
$2HBr + H_2SO_4 \rightarrow 2H_2O + SO_2 + Br_2$

As a result, only Br_2 is produced.

Similarly, NaCl reacts with conc. H_2SO_4 to form HCl. Since HCl does not act as a reducing agent, it does not get oxidised to Cl_2.

$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$
$HCl + H_2SO_4 \rightarrow$ No action

As a result, only HCl is produced.

(b) The minimum oxidation number (O.N) of S is –2 while its maximum O.N is +6. In SO_2, the O.N of sulphur is +4, hence, it cannot only increase its O.N by losing electrons but also reduce its O.N by gaining electrons. Thus, it acts both as a reducing agent as well as an oxidising agent.
In contrast, in H_2S, S has an O.N of –2. Thus, it can only increase its O.N by losing electrons and hence acts only as a reducing agent.

(c) Greater the polarity of the H–A bond, more easily the bond break and hence greater is the acid strength. As the electronegativity of atom A decreases in the order; Cl > S > P, therefore the polarity of the bond decreases in the order HCl > H–S > H–P and hence the acid strength decreases in the same order HCl > H_2S > PH_3.

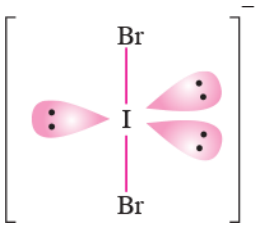
Q. Give the formula and describe the structure of a noble gas species which is isostructural with IBr_2^-.

[*HOTS*]

Ans. Total number of electron pairs around central atom I

$= 5e^- \begin{cases} b.p = 2 \\ l.p = 3 \end{cases}$

Therefore, according to VSEPR theory, IBr_2^- should be linear.



Now a noble gas compound having 10 electrons in the valence shell of central atom is XeF_2 (8 + 2 × 1 = 10). As it has 2 bond pairs and 3 lone pairs around Xe therefore like IBr_2^- XeF_2 is also linear.

Q.3. Answer the following question :

Q. Arrange the following in the order of property indicated against each set:

a. **HF, HCl, HBr, HI — increasing bond dissociation enthalpy**
b. **H_2O, H_2S, H_2Se, H_2Te — increasing acidic character**

Ans. (a) Shorter the bond length, higher is the bond dissociation enthalpy of hydrogen halide. As the atomic size increases down the group the E–H (E = F, Cl, Br, I) bond length increases and hence the bond dissociation enthalpy increases in the reverse order *i.e.*,
HI < HBr < HCl < HF

(b) $H_2O < H_2S < H_2Se < H_2Te$
The increase in acidic character from H_2O to H_2Te is due to decrease in bond enthalpy for dissociation of H—E (E = O, S, Se, Te) bond down the group.

Q. X_2 is a greenish yellow gas with pungent smell and used in purification of water. On dissolving water it gives a solution which turns blue litmus red. When it is passed through NaBr solution Br_2 is obtained.

a. **Identify the gas.**
b. **What are products obtained when X_2 reacts with ammonia? Give chemical equations.**
c. **What happens when X_2 reacts with cold and dilute NaOH solution? Write chemical equation and give the name of reaction.**

Ans.

a. $X_2 = Cl_2$

b. $8\,NH_3 + 3\,Cl_2 \rightarrow 6\,NH_4Cl + N_2$
(excess)

$NH_3 + 3\,Cl_2 \rightarrow NCl_3 + 3\,HCl$
(excess) (oxidation)

c. $2\,NaOH + Cl_2 \rightarrow NaCl + NaOCl + H_2O$, Disproportionation reaction
(cold and dil.)

Q.4. Explain the following:

[*CBSE Sample Paper 2016*]

Q. Hydrogen fluoride is a weaker acid than hydrogen chloride in aqueous solution.

Ans. It is due to

- **a.** Higher H—F bond dissociation energy than H—Cl.
- **b.** Stronger H-bonding of F – ion with H_3O^+ than Cl^-,

Q. PCl_5 is ionic in nature in the solid state.

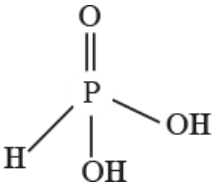
Ans. This is because in solid state PCl_5 exists as $[PCl_4]^+ [PCl_6]^-$ in which cation is tetrahedral and the anion is octahedral. On melting, these ions become free to move and hence it conducts electricity.

Q. SF_6 is inert towards hydrolysis.

Ans. In SF_6, S atom is sterically protected by six F atoms and does not allow water molecules to attack the S atom. Further, F does not have d-orbitals to accept the electrons donated by H_2O molecules. Due to these reasons, SF_6 is kinetically an inert substance.

Q. H_3PO_3 is diprotic.

Ans.



Since it contains only two ionisable H-atoms which are present as OH-groups, it is diprotic.

Q. Out of noble gases only xenon is known to form established chemical compounds.

Ans. Except radon which is radioactive, xenon has least ionization enthalpy among noble gases hence it forms compounds particularly with O_2 and F_2.

Q.5. Answer the following question :

Q. Account for the following:

a. **$SnCl_4$ is more covalent than $SnCl_2$.**
b. **Tendency to form pentahalides decreases down the group in group 15 of the periodic table.**

Ans. (a) The oxidation states of central atom Sn in $SnCl_4$ and $SnCl_2$ are +4 and +2 respectively. +4 state of Sn has higher polarising power which, inturn, increase the covalent character of bond formed between the central atom and the other atoms.

(b) This is due to inert pair effect. The stability of +5 oxidation state decreases down the group in group 15.

Q. Complete the following chemical equations:

a. $P_4 + SO_2Cl_2 \rightarrow$

b. $XeF_2 + H_2O \rightarrow$

c. $I_2 + \underset{(\text{conc})}{HNO_3} \rightarrow$

Ans. (a) $P_4 + 10SO_2Cl_2 \rightarrow 4PCl_5 + 10SO_2$

(b) $2XeF_2 + 2H_2O \rightarrow 2Xe + 4HF + O_2$

(c) $2HNO_3$ (conc.) $\rightarrow H_2O + 2NO_2 + (O)] \times 5$

$$I_2 + 5(O) \rightarrow I_2O_5$$
$$I_2O_5 + H_2O \rightarrow 2HIO_3$$
$$\overline{I_2 + 10HNO_3\,(\text{conc.}) \rightarrow 2HIO_3 + 10NO_2 + 4H_2O}$$

Q.6. An element 'A' exists as a yellow solid in standard state. It forms a volatile hydride 'B' which is a foul smelling gas and is extensively used in qualitative analysis of salts. When treated with oxygen, 'B' forms an oxide 'C' which is a colourless, pungent smelling gas. This gas when passed through acidified $KMnO_4$ solution, decolourises it. 'C' gets oxidised to another oxide 'D' in the presence of a heterogeneous catalyst. Identify 'A', 'B', 'C', 'D' and also give the chemical equation of reaction of 'C' with acidified $KMnO_4$ solution and for conversion of 'C' to 'D'.

[*HOTS*]

Ans.

'A' = Sulphur, 'B' = H_2S gas, 'C' = SO_2 gas, 'D' = SO_3 gas

Reactions are:

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O] \times 2$$
$$SO_2 + 2H_2O \rightarrow SO_4^{2-} + 4H^+ + 2e^-] \times 5$$
$$2MnO_4^- + 5SO_2 + 2H_2O \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 4H^+$$

$$\underset{\text{Sulphur dioxide}}{2SO_2(g)} + O_2(g) \xrightarrow{V_2O_5(s)} \underset{\text{Sulphur trioxide}}{2SO_3(g)}$$

(C) *(D)*

Q.7. On heating compound (A) gives a gas (B) which is a constituent of air. This gas when treated with 3 mol 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.

[*NCERT Exemplar*] [*HOTS*]

Ans.

A = NH_4NO_2 , B = N_2, C = NH_3, D = HNO_3

Equations of all the steps involved:

i. $\underset{(A)}{NH_4NO_2} \rightarrow \underset{(B)}{N_2} + 2H_2O$

ii. $\underset{(B)}{N_2} + 3H_2 \rightarrow \underset{(C)}{2NH_3}$

iii. $\underset{(C)}{4NH_3} + 5O_2 \rightarrow 4NO + 6H_2O$

$2NO + O_2 \rightarrow 2NO_2$

$3NO_2 + H_2O \rightarrow \underset{(D)}{2HNO_3} + NO$

Q.8. 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', 'C' and also write reactions involved and draw the structures of 'B' and 'C'.

[*NCERT Exemplar*] [*HOTS*]

Ans.

$$2Pb(NO_3)_2 \xrightarrow[673\ K]{\Delta} 2PbO + \underset{(A)}{4NO_2} + O_2$$

(Brown colour)

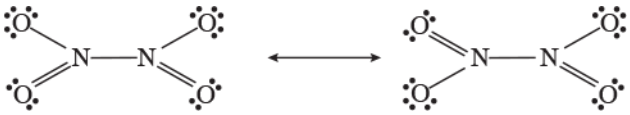
$$2NO_2 \underset{\text{On heating}}{\overset{\text{On cooling}}{\rightleftharpoons}} \underset{(B)}{N_2O_4}$$

(Colourless solid)

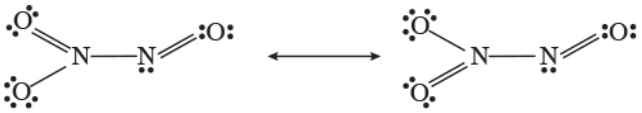
$$2NO + N_2O_4 \xrightarrow[250\ K]{\Delta} \underset{(C)}{2N_2O_3}$$

(Blue solid)

Structure if N_2O_4



Structure if N_2O_3



Q.9. A translucent white waxy solid (A) on heating in an inert atmosphere is converted to its allotropic form (B). Allotrope (A) on reaction with very dilute aqueous KOH liberates a highly poisonous gas (C) having rotten fish smell. With excess of chlorine it forms (D) which hydrolyses to compound (E). Identify compounds (A) to (E).

[*HOTS*]

Ans. A = White phosphorus B = Red phosphorus

C = Phosphine (PH_3) D = Phosphorus pentachloride (PCl_5)

E = Phosphoric acid (H_3PO_4)

Reactions are:

$$\underset{\text{White phosphorus}}{\underset{(A)}{P_4(s)}} \xrightarrow[\text{Inert gas}]{\Delta} \underset{\text{Red phosphorus}}{\underset{(B)}{P_4(s)}}$$

$$\underset{\text{White phosphorus}}{\underset{(A)}{P_4(g)}} + 3\,KOH\,(aq) + 3H_2O \xrightarrow{\Delta} \underset{\text{Potassium hypophosphite}}{3\,KH_2PO_2\,(aq)} + \underset{\text{Phosphine}}{\underset{(C)}{PH_3\,(g)}}$$

$$\underset{\text{Phosphine}}{\underset{(C)}{PH_3\,(g)}} + 4\,Cl_2\,(g) \rightarrow \underset{\text{Phosphorus pentachloride}}{\underset{(D)}{PCl_5\,(g)}} + 3\,HCl\,(g)$$

$$\underset{\text{Phosphorus pentachloride}}{\underset{(D)}{PCl_5\,(g)}} + 4H_2O\,(l) \rightarrow \underset{\text{Phosphoric acid}}{H_3PO_4\,(aq)} + 5\,HCl\,(aq)$$