Short Answer Questions-II

Short Answer Questions-II (PYQ)

Q.1. Complete the following chemical equations:

[*CBSE (F) 2011*]

Q. $P_4 + SO_2Cl_2$ →

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

Q. **$Fe^{3+} + SO_2 + H_2O$ →**

Ans.

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

Q.

$$XeF_6 + \underset{(\text{excess})}{H_2O} \rightarrow$$

Ans.

$$XeF_6 + \underset{(\text{excess})}{3H_2O} \rightarrow XeO_3 + 6\,HF$$

Q.2. Complete the following equations:

[*CBSE (F) 2013*]

Q. $PCl_3 + H_2O$ →

Ans. $PCl_3 + 3H_2O \rightarrow H_3PO_3 + 3HCl$

Q. $XeF_2 + PF_5$ →

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

Q.

$$NaN_3 \xrightarrow{\text{Heat}}$$

Ans.

$$2\,NaN_3 \xrightarrow{\text{Heat}} 2Na + 3N_2$$

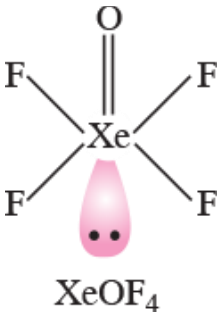
Q.3. Answer the following question :

[*CBSE Delhi 2014*]

Q. Draw the structures of the following molecules:

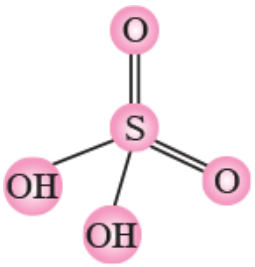
a. **$XeOF_4$**
b. **H_2SO_4**

Ans. (a)



$XeOF_4$

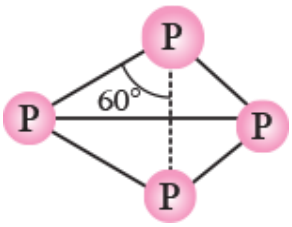
(b)



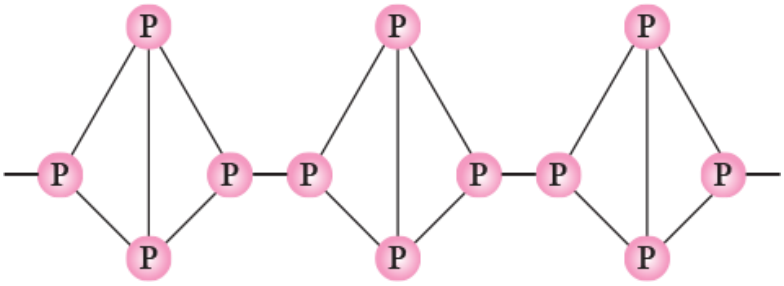
H_2SO_4

Q. Write the structural difference between white phosphorus and red phosphorus.

Ans. White phosphorus consists of discrete tetrahedral P_4 molecule with six P—P covalent bonds.



Red phosphorus has polymeric structure in which P_4 tetrahedra are linked together through P—P covalent bond to form chain.



Q.4. Give reasons for the following:

[*CBSE Guwahati 2015*]

Q. NH_3 has a higher boiling point than PH_3.

Ans. Due to small size and high electronegativity of N, NH_3 undergoes extensive intermolecular H-bonding and hence exist as an associated molecule. In contrast due to low electronegativity of P, PH_3 does not undergo H-bonding and thus exist as a discrete molecule. That is why, boiling point of NH_3 is higher than PH_3.

Q. H_2Te is more acidic than H_2S.

Ans. Bond dissociation enthalpy of H—Te bond is less than H—S bond as size of Te is larger than that of S. So, it is more acidic than H_2S.

Q. Chlorine water on standing loses its yellow colour.

Ans. $Cl_2 + H_2O \rightarrow HCl + HOCl$

Due to formation of hydrochloric acid and hypochlorous acid chlorine water loses yellow colour on standing.

Q.5. How would you account for the following:

[*CBSE (AI) 2010*]

Q. The electron gain enthalpy with negative sign is less for oxygen than that for sulphur.

Ans. This is due to smaller size of oxygen the electron cloud is distributed over a small region of space, making electron density high which repels the incoming electrons.

Q. Phosphorus shows greater tendency for catenation than nitrogen.

Ans. Because P—P bond is stronger than N—N bond.

Q. Fluorine never acts as the central atom in polyatomic interhalogen compounds.

Ans. Fluorine never acts as the central atom in polyatomic interhalogen compounds since it is the most electronegative element of the group.

Q.6. Account for the following:

[*CBSE (F) 2015*]

Q. Bond angle in NH_4^+ is higher than NH_3.

Ans. N atom both in NH_3 and NH_4^+ is sp^3 hybridised. In NH_4^+ all the four orbitals are bonded whereas in NH_3there is a lone pair on N , which is responsible for lone pair-bond pair repulsion in NH_3 reducing the bond angle from 109°28' to 107°.

Q. N atom both in NH_3 and NH+4 is sp^3 hybridised. In NH+4 all the four orbitals are bonded whereas in NH_3there is a lone pair on N , which is responsible for lone pair-bond pair repulsion in NH_3 reducing the bond angle from 109°28' to 107°.

Ans. Due to high electronegativity and small size of oxygen, H_2O undergoes extensive intermolecular H-bonding and exists as an associated molecule. On the other hand, due to low electronegativity of S, H_2S is unable to form effective H-bonds and exists as a discrete molecule which are held by weak Van der Waal forces. To overcome these forces only small amount of energy is required. Therefore H_2S has lower boiling point than H_2O.

Q. Reducing character decreases from SO_2 to TeO_2.

Ans. Because the stability of + 4 oxidation state increases from S to Te on moving down the group in group 16 due to inert pair effect.

Q.7. Give reasons for the following:

[*CBSE Chennai 2015*]

Q. Dinitrogen is a gas but phosphorus is a solid.

Ans. Nitrogen due to small size and high electronegativity forms pπ – pπ multiple bonds and exist as a diatomic molecule. These molecules are held together by weak Van der Waal forces and hence N_2 exist as a gas at room temperature. In contrast due to larger size and lower electronegativity P does not form pπ – pπ bond with itself rather it prefer to form single P–P bonds and exist as tetrahedral P_4 molecules. Due to bigger size, the force of attraction holding P_4 molecules are quite strong and cannot broken by the collision of molecules at room temperature and hence solid at room temperature.

Q. Bond angle decreases from H_2O to H_2Te.

Ans. As we move down the group from O to Te, the size of central atom goes on increasing and its electronegativity goes on decreasing. Consequently, the bond pairs of electrons tend to lie away from the central atom as we move from H_2O to Te. As a result of this the force of repulsion between the bond pairs decreases as we move from O to Te and hence the bond angle decreases in the same order.

Q. Halogens have the maximum negative electron gain enthalpy.

Ans. Halogens have one electron less than the nearest noble gas configuration. Therefore, they have a strong tendency to accept an additional electron to acquire nearest noble gas configuration and hence they have maximum negative electron gain enthalpy.

Q.8. Account for the following:

[*CBSE (F) 2014*]

Q. The molecules NH_3 and NF_3 have dipole moments which are of opposite directions.

Ans. This is because in NH_3 nitrogen is more electronegative than hydrogen while in NF_3, nitrogen is less electronegative than fluorine.

Q. Bi is a strong oxidising agent in the +5 state.

Ans. Due to inert pair effect Bi in +3 state is much more stable than in +5 state. Therefore, Bi in +5 state accepts two electrons and get reduced to more stable +3 state. Hence Bi is strong oxidising agent in +5 state.

Q. PCl_5 is known but NCl_5 is not known.

Ans. Nitrogen with n = 2, has *s* and *p* orbitals only. It does not have *d* orbitals to expand its covalency beyond four. Hence, NCl_5 is not known. PCl_5 is known as *P* has vacant

3*d* orbital to which 3*s* electrons can be excited to make available five half filled orbitals needed for the formation of five P—Cl bonds.

Q.9. Explain the following observations:

[*CBSE (AI) 2012*]

Q. H_2S is more acidic than H_2O.

Ans. Due to smaller size of O as compared to S, the bond dissociation enthalpy of O–H bond is higher than that of S–H bond. As a result, in aqueous solution, S–H bond can break more easily to form H^+ ion than O–H bond. Hence, H_2S is more acidic than H_2SO.

Q. Fluorine does not exhibit any positive oxidation state.

Ans. This is because fluorine is the most electronegative element and it does not have *d* orbitals.

Q. Helium forms no real chemical compound.

Ans. This is because the valence shell orbital of helium is completely filled ($1s^2$) and it has high ionisation enthalpy and more positive electron gain enthalpy.

Q.10. Give reasons:

[*CBSE Delhi 2017*]

Q. Thermal stability decreases from H_2O to H_2Te.

Ans. As the size of the element E increases down the group E–H bond dissociation enthalpy decreases therefore thermal stability decreases from H_2O to H_2Te.

Q. Fluoride ion has higher hydration enthalpy than chloride ion.

Ans. This is due to small size and high charge of fluoride ion, *i.e*., high charge density of fluoride ion.

Q. Nitrogen does not form pentahalide.

Ans. Nitrogen has only four (one *s* and three *p*) orbitals in its valence shell. It does not have *d* orbitals to expand its covalency beyond four. That is why it does not form pentahalides.

Q.11. Give reasons for the following:

[*CBSE (AI) 2017*]

Q. Red phosphorus is less reactive than white phosphorus.

Ans. Red phosphorus is less reactive than white phosphorus as the white phosphorus molecule possess angular strain in P_4 molecule where the bond angles are only 60°.

Q. Electron gain enthalpies of halogens are largely negative.

Ans. Halogens have one electron less than the nearest noble gas. Therefore, they readily accept one electron to attain nearest noble gas configuration and hence they have large negative values of electron gain enthalpies.

Q. N_2O_5 is more acidic than N_2O_3.

Ans. In N_2O_5, N is in +5 oxidation state whereas in N_2O_3 it is in +3 oxidation state. Higher the +ve oxidation state of the atom, more will be its acidic character.

Short Answer Questions-II (OIQ)

Q.1. Illustrate how copper and zinc give different products on reaction with HNO_3.

[*HOTS*]

Ans. With conc. HNO_3:

$$2\,HNO_3 \rightarrow H_2O + 2\,NO_2 + O$$
$$Cu + O \rightarrow CuO$$
$$CuO + 2\,HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$$
$$Cu + 4\,HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2\,NO_2$$

$$Zn + 2\,HNO_3 \rightarrow Zn(NO_3)_2 + 2H$$
$$HNO_3 + H \rightarrow H_2O + NO_2\,]\times 2$$
$$Zn + 4\,HNO_3 \rightarrow Zn(NO_3)_2 + 2H_2O + 2\,NO_2$$

With dil HNO_3:

$$2\,HNO_3 \rightarrow H_2O + 2NO + 3O$$
$$Cu + O \rightarrow CuO\,]\times 3$$
$$CuO + 2\,HNO_3 \rightarrow Cu(NO_3)_2 + H_2O]\times 3$$

$$3Cu + 8\,HNO_3 \rightarrow 3\,Cu(NO_3)_2 + 4H_2O + 2\,NO$$

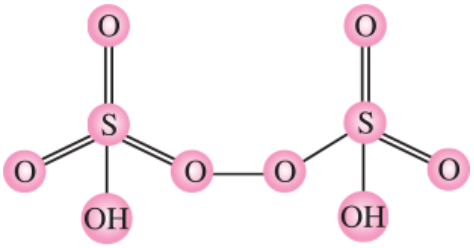
$$Zn + 2\,HNO_3 \rightarrow Zn(NO_3)_2 + 2H] \times 4$$
$$HNO_3 + 8H \rightarrow 3H_2O + NH_3$$
$$NH_3 + HNO_3 \rightarrow NH_4NO_3$$
$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

$$4Zn + 10\,HNO_3 \rightarrow 4\,Zn(NO_3)_2 + 5H_2O + N_2O$$

Q.2. Draw the structures of the following:

Q. $H_2S_2O_8$

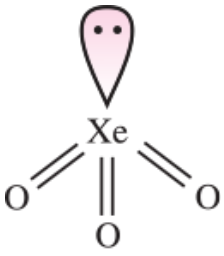
Ans.



Peroxodie sulphuric acid
($H_2S_2O_8$)

Q. XeO_3

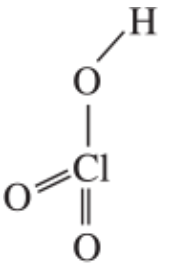
Ans.



Pyramidal
(XeO_3)

Q. $HOClO_2$

Ans.



Chloric acid

Q.3. Answer the following question :

[*CBSE Sample Paper 2016*]

Q. Write balanced chemical equations for the following:

a. **Complete hydrolysis of XeF_6.**
b. **Disproportionation reaction of orthophosphorus acid.**

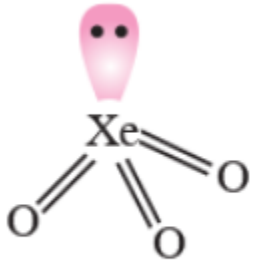
Ans.

a. $XeF_6 + 3H_2O \rightarrow XeO_3 + 6HF$

b. $4H_3PO_3 \xrightarrow{\Delta} 3H_3PO_4 + PH_3$

Q. Draw the structure of a noble gas species which is isostructural with BrO_3^-.

Ans. XeO_3 is isostructural with BrO_3^-.



Pyramidal

Q.4. Answer the following question :

Q. Complete the following chemical equations.

a. **NH_4Cl (*aq*) + $NaNO_2$ (*aq*) →**
b. **P_4 + 3NaOH + $3H_2O$ →**

Ans.

a. $NH_4Cl\,(aq) + NaNO_2\,(aq) \rightarrow N_2(g) + 2H_2O(l) + NaCl\,(aq)$

b. $P_4 + 3NaOH + 3H_2O \rightarrow \underset{\text{Phosphine}}{PH_3} + 3\,NaH_2PO_2$

Q.

Why is $K_{a_2} << K_{a_1}$ for H_2SO_4 in water?

Ans.

$K_{a_2} << K_{a_1}$, because HSO_4^- ion has much less tendency to donate a proton to H_2O as compared to $H2SO_4$.

Q.5. Explain the following observations giving appropriate reasons:

Q. Ozone is thermodynamically unstable with respect to oxygen.

Ans. $2O_3\,(g) \rightarrow 3O_2\,(g)$

Ozone is thermodynamically unstable with respect to oxygen as its decomposition into oxygen results in the liberation of heat (ΔH = –ve) and increase in entropy (ΔS = + ve). These two factors reinforce each other, resulting in large – ve ΔG (= $\Delta H - T\Delta S$) for its conversion into oxygen.

Q. The HEH bond angle of the hydrides of group 15 elements decreases as we move down the group.

Ans. As we move from NH_3 to BiH_3, the size of the central atom goes on increasing and its electronegativity goes on decreasing. Due to this, the bond pair of electrons tend to lie away from the central atom. As a result, the repulsion between the pairs decreases as we move from NH_3 to BiH_3. Consequently the bond angle decreases as we go down the group from NH3 to BiH_3.

Q. Bleaching effect of chlorine is permanent.

Ans.

$Cl_2 + H_2O \rightarrow [HCl + HOCl] \rightarrow 2HCl + [O]$

Coloured substance + [O] → Coloured substance

As the bleaching action of chlorine is due to oxidation, therefore, it is permanent.

Q.6. Give reasons for the following:

Q. ICl is more reactive than I_2.

Ans. ICl is more reactive than I_2 because I—Cl bond is weaker than I—I bond. Consequently, ICl breaks easily to form halogen atoms which readily bring about the reactions.

Q. Helium is used in diving apparatus.

Ans. Helium is used as a diluent for oxygen in modern diving apparatus because of its very low solubility in blood.

Q. H_2O is a liquid and H_2S is a gas.

Ans. Due to small size and high electronegativity of oxygen, molecules of water are associated through hydrogen bonding, resulting in its liquid state. On the other hand, H_2S molecules are not associated through H-bonding. Hence, it is a gas.

Q.7. Account for the following

Q. Chlorine water has both oxidising and bleaching properties.

Ans. Chlorine water produces nascent oxygen which is responsible for bleaching action and oxidation.

$Cl_2 + H_2O \rightarrow 2HCl + [O]$

Q. H_3PO_2 and H_3PO_3 act as good reducing agents while H_3PO_4 does not.

Ans. Both H_3PO_2 and H_3PO_3 have P—H bonds, so they act as reducing agents. H_3PO_4, has no P—H bond but has O—H bonds, so it cannot act as a reducing agent.

Q. On addition of ozone gas to KI solution, violet vapours are obtained

Ans. Ozone gas acts as a strong oxidising agent, so it oxidises iodide ions to iodine.

$2I^-(aq) + H_2O(l) + O_3(g) \rightarrow 2OH^- (aq) + I_2(g) + O_2(g)$

I_2 vapours evolved have violet colour.

Q.8. Give reasons for the following:

Q. Nitric oxide becomes brown when released in air.

Ans. Nitric oxide readily combines with O_2 of air to form nitrogen dioxide which is brown in colour.

$$\underset{\text{Nitric oxide}}{2\,NO} + O_2 \rightarrow \underset{\text{Nitrogen dioxide}}{2\,NO_2}$$
(Colourless) (Brown)

Q. Solid phosphorus pentachloride exhibits some ionic character.

Ans. Solid PCl_5 exists as $[PCl_4]^+$ $[PCl_6]^-$ and hence exhibits some ionic character.

Q. Ammonia acts as a ligand.

Ans. Due to the presence of lone pair of electrons on N, NH_3 acts as a ligand.

$$\underset{\text{Silver chloride}}{AgCl} + 2\,NH_3 \rightarrow \underset{\text{Diam min e silver (I) chloride}}{[Ag(NH_3)_2]\,Cl}$$

Q.9. Account for the following:

Q. Both NO and ClO_2 are odd electron species but NO dimerises while ClO_2 does not.

Ans. In NO, the odd electron on N is attracted by only one O-atom but in ClO_2, the odd electron on Cl is attracted by two O-atoms. Thus, the odd electron on N in NO is localised while the odd electron on Cl in ClO_2 is delocalised. Consequently, NO has a tendency to dimerise but ClO_2 does not.

Q. Bleaching of flowers by chlorine is permanent while that by sulphur dioxide is temporary.

Ans. Cl_2 bleaches coloured material by oxidation.

$Cl_2 + H_2O \rightarrow 2HCl + O$

Coloured material + [O] → Colourless

Hence, bleaching is permanent.

In contrast, SO_2 bleaches coloured material by reduction and hence bleaching is temporary since when the bleached colourless material is exposed to air, it gets oxidised and the colour is restored.

$SO_2 + 2H_2O \rightarrow H_2SO_4 + 2H$

Coloured material + H → Colourless material $\underset{\text{oxidation}}{\overset{\text{aerial}}{\rightarrow}}$ Colourless material

Q. Sulphur exhibits greater tendency for catenation than selenium.

Ans. As we move from S to Se, the atomic size increases and hence the strength of E—E bond decreases. Thus, S—S bond is much stronger than Se—Se bond. Consequently, S shows greater tendency for catenation than selenium.

Q.10. Assign appropriate reasons for each of the following statements:

Q. Metal fluorides are more ionic in nature than metal chlorides.

Ans. According to Fajan's rule, a bigger anion is more easily polarised than a smaller anion. As a result, same metal cation can polarise a bigger Cl^- ion more easily than the smaller F^- ion. In other words, for the same metal, the metal fluoride is more ionic than metal chloride. So, in general, we can easily say that metal fluorides are more ionic than metal chlorides.

Q. Addition of Cl_2 to KI solution gives it a brown colour but excess of Cl_2 turns it colourless.

Ans. Cl_2 being a stronger oxidising agent than I_2 first oxidises KI to give I_2 which imparts brown colour to the solution.

$$2\,KI\,(aq) + Cl_2\,(g) \quad \rightarrow \quad 2\,KCl\,(aq) + \underset{\text{Brown}}{I_2\,(s)}$$

If Cl_2 is passed in excess, the I_2 thus formed gets further oxidised to iodic acid (HIO_3) which is colourless.

$$5\,Cl_2 + I_2 + 6H_2O \quad \rightarrow \quad 10HCl + \underset{(\text{ Colourless })}{2\,HIO_3}$$

Q. Perchloric acid is a stronger acid than sulphuric acid.

Ans. The oxidation state of Cl in perchloric acid is +7 while that of S in sulphuric acid is +6. Greater the oxidation state of central atom, more readily the O–H bond breaks and hence stronger is the acid.

Q.11. Give reasons for the following:

Q. Noble gases are mostly inert.

Ans. Noble gases are mostly inert because of the following reasons:

a. They have completely filled ns^2np^6 electronic configurations in their valence shells.
b. Electron gain enthalpies of noble gases are positive.
c. They have high ionisation enthalpies.

Q. Noble gases form compounds with fluorine and oxygen only.

Ans. Fluorine and oxygen are the most electronegative elements and hence are very reactive. So, they form compounds with noble gases, particularly xenon.

Q. Neon is generally used for warning signals.

Ans. Neon lights are visible from long distances even in fog and mist and hence neon is generally used for warning signals.

Q.12. A colourless inorganic salt A decomposes at about 250°C to give only two products B and C leaving no residue. The oxide C is a liquid at room temperature and is neutral to litmus paper while B is neutral oxide. White phosphorus burns in excess of B to produce strong dehydrating agent. Give balanced equations for above processes.

[*HOTS*]

Ans. A = NH_4NO_3 (Ammonium nitrate), B = N_2O (Nitrous oxide), C = H_2O

Reactions involved:

$$\underset{\text{Ammonium nitrate}}{\underset{(A)}{NH_4NO_3}} \xrightarrow{250^\circ C} \underset{\text{Nitrous oxide}}{\underset{(B)}{N_2O}} + \underset{(C)}{2H_2O}$$

$$\underset{(B)}{10N_2O} + P_4 \rightarrow 10N_2 + \underset{\text{Phosphorus pentoxide}}{\underset{(\text{dehydrating agent})}{P_4O_{10}}}$$

Q.13. On reaction with 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 formulas of their hydrolysis products.

[*NCERT Exemplar*]

Ans. A = PCl_5 (Yellowish white powder)

$P_4 + 10Cl_2 \rightarrow 4PCl_5$

B = PCl_3 (Colourless oily liquid)

$P_4 + 6Cl_2 \rightarrow 4PCl_3$

Hydrolysis products are formed as follows:

$PCl_3 + 3H_2O \rightarrow H_3PO_3 + 3HCl$

$PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$