CBSE Class 12 physics
Important Questions
Chapter 7
The p-Block Elements

3 Marks Questions

1. Write three differences between white and red phosphorous.

Ans.

White phosphorous	Red phosphorous
1. It is translucent waxy solid	1. It has iron grey Lustre.
2. It is poisonous and glows in dark	2. It is non poisonous and does not glow in dark.
3. It is less stable and more reactive.	3. It is more stable and less reactive.

2. Why does NO_2 dimerise?

Ans. NO_2 contains odd number of valence electrons. It behaves as a typical odd molecule. On demerisation, it is converted to stable N_2O_4 molecule with even number of electrons.

3. Mention the conditions required to maximise the yield of ammonia.

Ans. Ammonia is prepared using the Haber's process. The yield of ammonia can be maximized under the following conditions:

(i) High pressure $\left(\propto \frac{1}{4} 200 \text{ atm} \right)$

(ii) A temperature of $\propto \frac{1}{4} 700 \text{ K}$

(iii) Use of a catalyst such as iron oxide mixed with small amounts of K_2O and Al_2O_3

4. What happens when H_3PO_3 is heated?

Ans. H_3PO_4,on heating, undergoes disproportionation reaction to form PH_3 and H_3PO_4. The oxidation numbers of P in H_3PO_4, PH_3, and H_3PO_4 are +3, - 3, and +5 respectively. As the oxidation number of the same element is decreasing and increasing during a particular reaction, the reaction is a disproportionation reaction.

$$\underset{\text{Orthophosphorous acid}}{\underset{(+3)}{4H_3PO_3}} \xrightarrow{\Delta} \underset{\text{Orthophosphorous acid}}{\underset{(+3)}{3H_3PO_4}} + \underset{\text{Phosphine}}{\underset{(-3)}{PH_3}}$$

5. How is O_3 estimated quantitatively?

Ans. Quantitatively, ozone can be estimated with the help of potassium iodide. When ozone is made to react with potassium iodide solution buffered with a borate buffer (pH 9.2), iodine is liberated. This liberated iodine can be titrated against a standard solution of sodium thiosulphate using starch as an indicator. The reactions involved in the process are given below.

$$\underset{\text{Iodide}}{2I^-} + H_2O + \underset{\text{Ozone}}{O_3} \rightarrow 2OH^- + \underset{\text{Iodine}}{I_2} + O_2$$

$$I_2 + \underset{\text{Sodium thiosulphate}}{2Na_2S_2O_3} \rightarrow \underset{\text{Sodium tetrathionate}}{Na_2S_4O_6} + 2NaI$$

6. How is the presence of SO_2 detected?

Ans. SO_2 is a colourless and pungent smelling gas.

It can be detected with the help of potassium permanganate solution. When SO_2 is passed through an acidified potassium permanganate solution, it decolonizes the solution as it reduces MnO_4^- ions to Mn^{2+} ions.

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

7. Mention three areas in which H_2SO_4 plays an important role.

Ans. Sulphuric acid is an important industrial chemicaland is used for a lot of purposes.

Some important uses of sulphuric acid are given below.

(i) It is used in fertilizer industry. It is used to make various fertilizers such as ammonium sulphate and calcium super phosphate.

(ii) It is used in the manufacture of pigments, paints, and detergents.

(iii) It is used in the manufacture of storage batteries.

8. Write the conditions to maximize the yield of H_2SO_4 by Contact process.

Ans. Manufacture of sulphuric acid by Contact process involves three steps.

1. Burning of ores to form SO_2

2. Conversion of SO_2 to SO_3 by the reaction of the former with O_2

(V_2O_5 is used in this process as a catalyst.)

3. Absorption of SO_3 in H_2SO_4 to give oleum $(H_2S_2O_7)$

The key step in this process is the second step. In this step, two moles of gaseous reactants combine to give one mole of gaseous product. Also, this reaction is exothermic. Thus, in accordance with Le Chatelier's principle, to obtain the maximum amount of SO_3 gas, temperature should be low and pressure should be high.

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

Ans. $H_2SO_{4(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + HSO^-_{4(aq)};\ K_{a_1} > 10$

$HSO^-_{4(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + SO^-_{4(aq)};\ K_{a_2} = 1.2 \times 10^2$

It can be noticed that $K_{a_1} >> K_{a_2}$

This is because a neutral H_2SO_4 has a much higher tendency to lose a proton than the negatively charged HSO_4^-. Thus, the former is a much stronger acid than the latter.

10. Considering the parameters such as bond dissociation enthalpy, electron gain

enthalpy and hydration enthalpy, compare the oxidising power of F_2 and Cl_2.

Ans. Fluorine is a much stronger oxidizing agent than chlorine. The oxidizing power depends on three factors.

1. Bond dissociation energy

2. Electron gain enthalpy

3. Hydration enthalpy

The electron gain enthalpy of chlorine is more negative than that of fluorine. However, the bond dissociation energy of fluorine is much lesser than that of chlorine. Also, because of its small size, the hydration energy of fluorine is much higher than that of chlorine. Therefore, the latter two factors more than compensate for the less negative electron gain enthalpy of fluorine. Thus, fluorine is a much stronger oxidizing agent than chlorine.

11. Illustrate how copper metal can give different products on reaction with HNO_3.

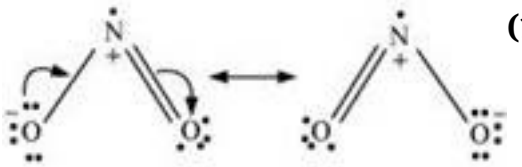
Ans. Concentrated nitric acid is a strong oxidizing agent. It is used for oxidizing most metals. The products of oxidation depend on the concentration of the acid, temperature, and also on the material undergoing oxidation.

$$3Cu + 8HNO_{3(dilute)} \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

$$Cu + 4HNO_{3(conc.)} \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$$

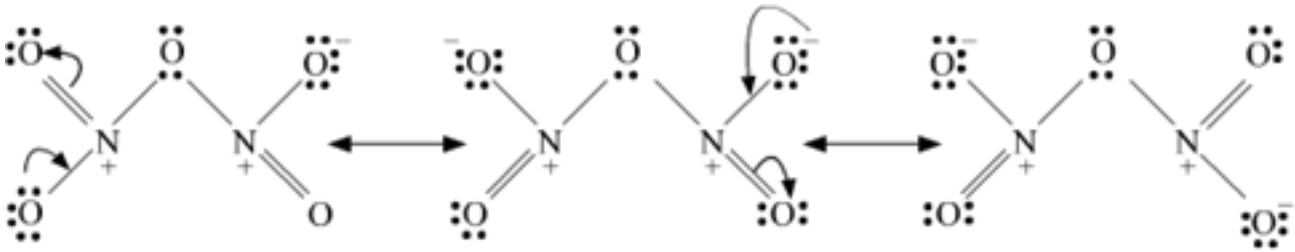
12. Give the resonating structures of NO_2 and N_2O_5.

Ans.



(1)

(2)



13. The HNH angle value is higher than HPH, HAsH and HSbH angles. Why? [Hint: Can be explained on the basis of sp^3 hybridisation in NH_3 and only *s-p* bonding between hydrogen and other elements of the group].

Ans. Hydride $NH_3\ PH_3\ AsH_3\ SbH_3$

H-M-H angle $107°92°91°90°$

The above trend in the H-M-H bond angle can be explained on the basis of the electronegativity of the central atom. Since nitrogen is highly electronegative, there is high electron density around nitrogen. This causes greater repulsion between the electron pairs around nitrogen, resulting in maximum bond angle. We know that electronegativity decreases on moving down a group. Consequently, the repulsive interactions between the electron pairs decrease, thereby decreasing the H-M-H bond angle.

14. Explain why NH_3 is basic while BiH_3 is only feebly basic.

Ans. NH_3 is distinctly basic while BiH_3 is feebly basic.

Nitrogen has a small size due to which the lone pair of electrons is concentrated in a small region. This means that the charge density per unit volume is high. On moving down a group, the size of the central atom increases and the charge gets distributed over a large area decreasing the electron density. Hence, the electron donating capacity of group 15 element hydrides decreases on moving down the group.

15. Nitrogen exists as diatomic molecule and phosphorus as P_4. Why?

Ans. Nitrogen owing to its small size has a tendency to form $p\pi - p\pi$ multiple bonds with itself. Nitrogen thus forms a very stable diatomic molecule, N_2. On moving down a group,

the tendency to form $p\pi - p\pi$ bonds decreases (because of the large size of heavier elements). Therefore, phosphorus (like other heavier metals) exists in the P_4 state.

16. Why is dioxygen a gas but sulphur a solid?

Ans. Oxygen is smaller in size as compared to sulphur. Due to its smaller size, it can effectively form $p\pi - p\pi$ bonds and form O_2 (O==O) molecule. Also, the intermolecular forces in oxygen are weak van der Wall's, which cause it to exist as gas. On the other hand, sulphur does not form M_2 molecule but exists as a puckered structure held together by strong covalent bonds. Hence, it is a solid.

17. Knowing the electron gain enthalpy values for $O \rightarrow O^-$ and $O \rightarrow O^{2-}$ as -141 and $702 kJ\,mol^{-1}$ respectively, how can you account for the formation of a large number of oxides having O^{2-} species and not O^-?

(Hint: Consider lattice energy factor in the formation of compounds).

Ans. Stability of an ionic compound depends on its lattice energy. More the lattice energy of a compound, more stable it will be.

Lattice energy is directly proportional to the charge carried by an ion. When a metal combines with oxygen, the lattice energy of the oxide involving O^{2-} ion is much more than the oxide involving O-ion. Hence, the oxide having O^{2-} ions are more stable than oxides having O^-. Hence, we can say that formation of O^{2-} is energetically more favourable than formation of O^-.

18. Why are halogens strong oxidising agents?

Ans. The general electronic configuration of halogens is np^5, where n = 2-6. Thus, halogens need only one more electron to complete their octet and to attain the stable noble gas configuration. Also, halogens are highly electronegative with low dissociation energies and high negative electron gain enthalpies. Therefore, they have a high tendency to gain an electron. Hence, they act as strong oxidizing agents.

19. How are xenon fluorides XeF_2, XeF_4 and XeF_6 obtained?

Ans. XeF_2, XeF_4 and XeF_6 are obtained by a direct reaction between Xe and F_2. The condition under which the reaction is carried out determines the product.

$$\underset{\text{(Excess)}}{Xe_{(g)}} + F_{2(g)} \xrightarrow{673K, 1bar} XeF_{2(s)}$$

$$\underset{\text{(1:5 ratio)}}{Xe_{(g)}} + 2F_{2(g)} \xrightarrow{873K, 7bar} XeF_{4(s)}$$

$$\underset{\text{(1:20 ration)}}{Xe_{(g)}} + 3F_{2(g)} \xrightarrow{573K, 60-70bar} XeF_{6(s)}$$

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

(i) F_2, Cl_2, Br_2, I_2 **increasing bond dissociation enthalpy.**

(ii) HF, HCl, HBr, HI - increasing acid strength.

(iii) $NH_3, PH_3, AsH_3, SbH_3, BiH_3$ **– increasing base strength.**

Ans. (i) Bond dissociation energy usually decreases on moving down a group as the atomic size increases. However, the bond dissociation energy of F_2 is lower than that of Cl_2 and Br_2. This is due to the small atomic size of fluorine. Thus, the increasing order for bond dissociation energy among halogens is as follows:

$$I_2 < F_2 < Br_2 < Cl_2$$

(ii) HF < HCl < HBr < HI

The bond dissociation energy of H-X molecules where X = F, Cl, Br, I, decreases with an increase in the atomic size. Since H-I bond is the weakest, HI is the strongest acid.

(iii) $BiH_3 \leq SbH_3 < AsH_3 < PH_3 < NH_3$

On moving from nitrogen to bismuth, the size of the atom increases while the electron density on the atom decreases. Thus, the basic strength decreases.

21. List the uses of Neon and argon gases.

Ans. Uses of neon gas:

(i) It is mixed with helium to protect electrical equipments from high voltage.

(ii) It is filled in discharge tubes with characteristic colours.

(iii) It is used in beacon lights.

Uses of Argon gas:

(i) Argon along with nitrogen is used in gas-filled electric lamps. This is because Ar is more inert than N.

(ii) It is usually used to provide an inert temperature in a high metallurgical process.

(iii) It is also used in laboratories to handle air-sensitive substances.