Chemistry Study Materials for Class 12

(NCERT Intext and Exercise Questions –Answers)

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The p-Block Elements

Question 12: Nitrogen exists as diatomic molecule and phosphorus as P4. Why?

Solution 12: Nitrogen owing to its small size has a tendency to form $p\pi - p\pi$ multiple bonds with it. 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**.**

Question 13: Write main differences between the properties of white phosphorus and red phosphorus.

Solution 13:

White phosphorus	**Red phosphorus**
It is a soft and waxy solid. It possesses a garlic small	It is hard and crystalline solid, without any small.
It is poisonous.	It is non-poisonous.
It is insoluble in water but soluble in carbon disulphide	It is insoluble in both water and carbon disulphide.
It undergoes spontaneous combustion in air	It is relatively less reactive
It is both solid and vapour states, it exists as a p_4 molecule	.It exists as a chain of tetrahedral p_4 units

Question 14: Why does nitrogen show catenation properties less than phosphorus?

Solution 14: Catenation is much more common in phosphorous compounds than in nitrogen compounds. This is because of the relative weakness of the N-N single bond as compared to the P-P single bond. Since nitrogen atom is smaller, there is greater repulsion of electron density of two nitrogen atoms, thereby weakening the N-N single bond.

Question 15: Give the Disproportionation reaction of H_3PO_3 .

Solution 15: On heating, orthophosphorus acid disproportionates to give orthophosphoric acid (H_3PO_3), (H_3PO_4) and phosphine (PH_3)

The oxidation states of P in the various species involved in reaction are mentioned below. +3, +5 and +3

$$4H_3PO_3 \longrightarrow 3H_3PO_4 + PH_3$$

Question 16: Can PCl_5 act as an oxidizing as well as a reducing agent? Justify.

Solution 16: PCl_5 can only act as an oxidizing agent. The highest oxidation state that P can show is+5. In PCl_5, phosphorus is in its highest oxidation state (+5). However, it can decrease its oxidation state and act as an oxidizing agent.

Question 17: Justify the placement of O, S, Se, Te and Po in the same group of the periodic table in terms of electronic configuration, oxidation state and hydride formation.

Solution 17: The elements of group 16 are collectively called Chalcogens.

(i) Elements of group 16 have six valence electrons each. The general electronic configuration of these elements is $ns^2\ np^4$, where n varies from 2 to 6.

(ii) Oxidation state: As these elements have six valence electrons ($ns^2\ np^4$), they should display an oxidation state of-2. However, only oxygen predominantly shows the oxidation state of -2 owing to its high electronegativity. It also exhibits the oxidation state of -1 (H_2O_2) , zero (O_2), and +2 (OF_2). However, the stability of the -2 oxidation state decreases on moving down a group due to a decrease in the electronegativity of the elements.

(iii) The heavier elements of the group show an oxidation state of +2, +4, and +6 due to the availability of d-orbitals.

Question 18: Why is dioxygen a gas but sulphur a solid?

Solution 18: 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 O2 (O==O) molecule. Also, the intermolecular forces in oxygen are weak Vander Wall's, which cause it to exist as gas. On the other forces in oxygen are weak Vander Wall's, which cause it to exist as gas. On the other hand, sulphur does not form $p\pi - p\pi$ bonds but exists as a puckered structure held together by strong covalent bonds. Hence, it is a solid.

Question 19: 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 species and not O^-?(Hint: Consider lattice energy factor in the formation of compounds).

Solution 19: 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^{2-} ion. Hence, the oxide having O^{2-} ions are more stable than oxides having O^{2-}. Hence, we can say that formation of O^{2-} is energetically more favourable than formation of O^{2-}

Question 20: Which aerosols deplete ozone?

Solution 20: Freon's or chlorofluorocarbons (CFCs) are aerosols that accelerate the depletion of ozone. In the presence of ultraviolet radiations, molecules of CFCs break down to form chlorine- free radicals that combine with ozone to form oxygen.

Question 22: How is SO_2 an air pollutant?

Solution 22: Sulphur dioxide causes harm to the environment in many ways:

1. It combines with water vapour present in the atmosphere to form sulphuric acid. This causes acid rain. Acid rain damages soil, plants, and buildings, especially those made of marble.
2. Even in very low concentrations, SO_2 causes irritation in the respiratory tract. It causes throat and eye irritation and can also affect the larynx to cause breathlessness.
3. It is extremely harmful to plants. Plants exposed to sulphur dioxide for a long time lose colour from their leaves. This condition is known as chlorosis. This happens because the formation of chlorophyll is affected by the presence of sulphur dioxide.

Question 23: Why are halogens strong oxidising agents?

Solution 23: 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.

Question 24: Explain why fluorine forms only one oxoacid, HOF

Solution 24: Fluorine forms only one oxoacid i.e., HOF because of its high electronegativity, small size and non availability of d orbitals.

Question 25: Explain why inspite of nearly the same electronegativity, oxygen forms hydrogen bonding while chlorine does not.

Solution 25: Both chlorine and oxygen have almost the same electronegativity values, but chlorine rarely forms hydrogen bonding. This is because in comparison to chlorine, oxygen has a smaller size and as a result, a higher electron density per unit volume.

Question 26: **Write two uses of ClO_2**

Solution 26: Uses of ClO_2 **(i)** It is used for purifying water. (ii) It is used as a bleaching agent**.**

Question 27: Why are halogens coloured?

Solution 27: Almost all halogens are coloured. This is because halogens absorb radiations in the visible region. This results in the excitation of valence electrons to a higher energy region. Since the amount of energy required for excitation differs for each halogen, each halogen displays a different colour. F2- yellow Cl2- greenish yellow, Br2- red, I2- violet.

Question 28: Write the reactions of F_2 and Cl_2 with water.

Solution 28: **(i)** $\mathbf{Cl_2 + H_2O \longrightarrow HCl + HOCl}$

Hydrochloric acid Hypochlorous acid

(ii) $2F_{2(g)} + 2H_2O \longrightarrow O_{2(g)} + 4HF(aq)$

Question 29: **How can you prepare Cl_2 from HCl and HCl from Cl_2 ? Write reasons only**

Solution 29**:** *(i)* Cl_2 can be prepared from HCl by Deacon's process.

$$4HCl + O_2 \longrightarrow CaCl_2 + 2Cl_2 + 2H_2O$$

(ii) HCl can be prepared from Cl_2 on treating it with water.

$$\mathbf{Cl_2 + H_2O \longrightarrow HCl + HOCl}$$

Hydrochloric acid Hypochlorous acid

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