The p-Block Elements

Que 1: Which is the element present in group 15 of periodic table showing oxidation state from -3 to +5? ***Marks :(1)***

Ans: Nitrogen

Que 2: How ammonia is prepared in laboratory? What is the chemical change happening when ammonium hydroxide solution is added drop wise to excess into a copper sulphate solution? (Give equations wherever necessary.) ***Marks :(4)***

Ans: Ammonia is prepared in laboratory by treating ammonium salts with caustic soda or calcium hydroxide. $2NH_4Cl + Ca(OH)_2 \rightarrow 2NH_3 + 2H_2O + CaCl_2$

When ammonium hydroxide is added to copper sulphate solution, initially a blue precipitate is formed due to the formation of copper hydroxide.

$CuSO_4 + 2NH_4OH \rightarrow Cu(OH)_2$ (Blue) $+ (NH_4)_2SO_4$

When excess is added, the blue color changes to deep blue color due to the formation of tetramine copper ion.

$Cu^{2+}{}_{(aq)}$ (blue) $+ 4NH_{3(aq)} \rightarrow [Cu(NH_3)_4]^{2+}{}_{(aq)}$(deep blue)

Que 3: phosphorous is the second element in the 15 th group of the periodic table.

1. **Which are the two important halides of phosphorous?**
2. **How they are prepared?**
3. **Explain with equations, their action with moisture.** ***Marks :(4)***

Ans:

1. PCl_3 and PCl_5.
2. PCl_3 is obtained by passing dry chlorine over heated white phosphorus.

$P_4 + 6Cl_2 \rightarrow 4PCl_3$

Phosphorus pentachloride is prepared by the reaction of white phosphorus with excess of dry chlorine.

$P_4 + 10Cl_2 \rightarrow 4PCl_5$

3. PCl_3 hydrolyses in the presence of moisture

$PCl_3 + 3H_3O \rightarrow H_3PO_3 + 3HCl$

PCl_5 is a yellowish white powder and in moist air, it hydrolyses to $POCl_3$ and finally gets converted to phosphoric acid

$PCl_5 + H_2O \rightarrow POCl_3 + 2HCl$

$POCl_3 + 3H_2O \rightarrow H_3PO_3 + 3HCl$

Que 4: How ozone is prepared? Give any two oxidizing reactions of ozone. ***Marks :(3)***

Ans: Ozone is prepared by passing a slow dry stream of oxygen through a silent electrical discharge.

$3O_2 \rightarrow 2O_3$, $\Delta H^{\emptyset}$ (298 K) = +142 kJ mol^{-1}

1.$PbS_{(s)} + 4O_{3(g)} \rightarrow PbSO_{4(s)} + 4O_{2(g)}$

2.$NO_{(g)} + O_{3(g)} \rightarrow NO_{2(g)} + O_{2(g)}$

Que 5: The most important oxoacid of nitrogen is Nitric acid.

1. Name the other two oxoacids of nitrogen.

2. With the help of balanced chemical equations, explain the reaction of Cu with dilute and concentrated nitric acids. ***Marks :(3)***

Ans: 1. Hyponitrous acid($H_2N_2O_2$) and Nitrous acid (HNO_2)

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

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

Que 6: Heating white phosphorous with concentrated NaOH in an inert atmosphere of CO_2 gives a compound used in Holme's signals. Name the compound. Write the balanced equation showing the reaction. ***Marks :(2)***

Ans: Phosphine.

$$P_4 + 3\,NaOH + 3\,H_2O \longrightarrow PH_3 + 3\,NaH_2PO_2$$

Que 7: An oxide of nitrogen which is brown in color and paramagnetic, on cooling becomes another oxide which is diamagnetic liquid or solid. Identify the two oxides and write the equation showing the change. ***Marks :(2)***

Ans: The two oxides are NO_2 and N_2O_4.

The equation is $2NO_2 \rightleftarrows N_2O_4$

Que 8: Why the first element in groups 15, 16, 17 and 18 of the periodic table show abnormal properties compared to rest of the members? ***Marks :(1)***

Ans: This is due to the small size, high electronegativity, high ionization enthalpy and non-availability of d orbitals.

Que 9: Which inter halogen compound is used in the production of UF_6 , a compound that is used in the enrichment of U^{235}. ***Marks :(1)***

Ans: ClF_3

Que 10: Deacon's process is used for the manufacture of ---------- . ***Marks :(1)***

Ans: Chlorine

Que 11: Name the process used for the large-scale preparation of Nitric acid. ***Marks :(1)***

Ans: Ostwald's process

Que 12: Name the compound of phosphorus which is used in Holme's signal. ***Marks :(1)***

Ans: Phosphine

Que 13: The compound of 15^{th} group element which is used as a refrigerant is-----. ***Marks :(1)***

Ans: Ammonia

Que 14: The strongest hydrohalic acid is ---------- . ***Marks :(1)***

Ans: Hydriodic acid

Que 15: Name the important oxoacids of nitrogen and write their chemical formulae. ***Marks :(1)***

Ans: 1. Nitrous acid : HNO_2

2. Nitric acid : HNO_3

3. Hyponitrous acid : $H_2N_2O_2$

Que 16: Nitrogen does not form pentahalides. Why? ***Marks :(1)***

Ans: Nitrogen has no vacant d-orbital

Que 17: Why dinitrogen (N_2) is inert at room temperature? ***Marks :(2)***

Ans: Due to high bond dissociation enthalpy of N-N triple bond

Que 18: Explain the manufacture of ammonia? ***Marks :(4)***

Ans: Ammonia is manufactured by Haber's process. In this nitrogen gas is mixed with hydrogen gas. High Pressure and low temperature favours the formation of ammonia. Hence ammonia is manufactured at a pressure of ~200 atm (200×10^5 Pa) and at an optimum temperature of 700K in presence of catalyst like iron oxide with small amount of K_2O and Al_2O_3

$N_2 + 3\ H_2 \rightarrow 2\ NH_3 + \text{heat}$

Que 19: Write a method to prepare very pure nitrogen (N_2) in the laboratory ***Marks :(2)***

Ans: By the thermal decomposition of Barium azide or sodium azide

$Ba(N_3)_2 \rightarrow Ba + 3\ N_2$

Que 20: Thermal stability of hydrides of group 15 elements decreases from NH_3 to BiH_3. Why? ***Marks :(2)***

Ans: Down the group from N to Bi atomic size increases and bond dissociation enthalpy of M-H bond decreases. Hence thermal stability decreases.

Que 21: Write three anomalous properties of nitrogen compared to other elements of group 15 ***Marks :(3)***

Ans: 1. Nitrogen can form stable p pi - p pi multiple bonds

2. Nitrogen is diatomic gas while others are polyatomic solids

3. Catenation tendency in nitrogen is weaker than other elements

Que 22: In group 15 stability of +5 oxidation state decreases down the group. Give reason ***Marks :(2)***

Ans: It is due to Inert pair effect. Inert pair effect increases down the group and +3 oxidation state becomes more stable down the group

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Que 24: First ionisation enthalpy of Nitrogen is higher than Oxygen. Why? ***Marks :(2)***

Ans: due to the stable outer ns^2np^3 electronic configuration of nitrogen, s level is fully filled and p level is exactly half filled

Que 25: Which allotropic form of phosphorous is more reactive? ***Marks :(1)***

Ans: White phosphorus

Que 26: What are the products obtained by the thermal decomposition of sodium azide. ***Marks :(2)***

Ans: Thermal decomposition of sodium azide gives dinitrogen gas and metallic sodium

$2NaN_3 \rightarrow 2Na + 3N_2$