

# ACE

YOUR WAY **CBSE XII**



Series 4

## CHAPTERWISE PRACTICE PAPER : THE $p$ -BLOCK ELEMENTS (Group 15 to 18)

Time Allowed : 3 hours

Maximum Marks : 70

### GENERAL INSTRUCTIONS

- (i) All questions are compulsory.
- (ii) Q. no. 1 to 5 are very short answer questions and carry 1 mark each.
- (iii) Q. no. 6 to 10 are short answer questions and carry 2 marks each.
- (iv) Q. no. 11 to 22 are also short answer questions and carry 3 marks each.
- (v) Q. no. 23 is a value based question and carries 4 marks.
- (vi) Q. no. 24 to 26 are long answer questions and carry 5 marks each.
- (vii) Use log tables if necessary, use of calculators is not allowed.

1. Give a reaction to obtain dinitrogen in very pure state.
  2. Which halide ion gives most stable hexahalide with group 16 elements? What is the physical state of these hexahalides?
  3. Hydrogen fluoride is a liquid while other hydrogen halides are gases. Comment.
  4. State two properties of helium which make it suitable for filling balloons for meteorological observations.
  5. Give the resonance structures of  $N_2O_3$ .
  6. Write the balanced equations for the following :
    - (i) Reduction of nitrates with  $Fe^{2+}$  to form brown coloured complex.
    - (ii) Reaction of thionyl chloride with white phosphorus.
  7. Why are interhalogen compounds more reactive than halogens?
  8. (i) How is  $XeO_3$  prepared? Give chemical reaction.  
(ii) Draw the structure of  $XeO_3$ .
  9. Give reason : Bleaching of flowers by  $Cl_2$  is permanent while that with  $SO_2$  is temporary.
  10. Explain the following observations :
    - (i) Sugar gets charred on addition of concentrated sulphuric acid.
    - (ii) Thermal stability of  $H_2O$  is much higher than that of  $H_2S$ .
- OR**
- $H_2S$  acts only as reducing agent but  $SO_2$  acts both as reducing agent as well as an oxidising agent. Give reason.
11. Explain the following :
    - (i) Sulphur exhibits tendency for catenation but oxygen does not.
    - (ii)  $SF_6$  is not easily hydrolysed though thermodynamically it should be. Why?
  12. (i) Why HF acid is stored in wax coated glass bottles?  
(ii) Give two examples to show the anomalous behaviour of fluorine.
  13. (i) Xe forms compounds but Kr does not. Why?  
(ii) Why do noble gases form compounds with fluorine and oxygen only?  
(iii) Xenon does not form fluorides such as  $XeF_3$  and  $XeF_5$ .

14. Nitric acid forms anhydride (A) with  $P_4O_{10}$ .
- Write the reaction involved.
  - What is the role of  $P_4O_{10}$ ?
  - Write resonating structures of the anhydride (A) formed.
15. Write balanced chemical equations for the following reactions :
- $Cl_2 + NaOH \longrightarrow$   
(Cold and dil.)
  - $NaBr + \text{conc. } H_2SO_4 \longrightarrow$
  - $Cl_2 + NaOH \longrightarrow$   
(Hot and conc.)
- OR**
- Name two poisonous gases which can be prepared from chlorine gas and write reactions for their synthesis.
  - What happens when chlorine is passed over dry slaked lime.
16. What happens when  $SO_2$  is passed through
- acidified solution of  $K_2Cr_2O_7$ ?
  - acidified solution of  $KMnO_4$ ?
  - an aqueous solution of Fe (III) salts?
17. (i) Explain why fluorine forms only one oxoacid, HOF.  
(ii) Give reason for the following :
- Ferric iodide is very unstable but ferric chloride is stable.
  - $ClF_3$  molecule has a T-shaped structure and not a trigonal planar one.
18. (i) A green coloured solution turns pink when ozone is bubbled through it. The pink colour further decolourises when zinc and dilute  $H_2SO_4$  are added to it. Identify the green and pink coloured compounds giving sequence of reactions.  
(ii) Write chemical reaction when  $PtF_6$  and xenon are mixed together.
19. (i) Why has it been difficult to study the chemistry of radon?  
(ii) Draw the structure of  $H_2SO_5$ .  
(iii) Give reactions in which xenon fluoride acts as :
- fluoride donor
  - fluoride acceptor.
20. Give reasons for the following :
- Phosphinic acid behaves as a monoprotic acid.
  - 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.
21. (i) Describe the favourable conditions for the manufacture of  
(a) ammonia by Haber's process  
(b) sulphuric acid by Contact process.  
(ii) Complete the following reaction :  
 $NH_3 + NaOCl \longrightarrow$
22. (i) How are  $XeF_2$  and  $XeF_4$  prepared?  
(ii) Complete the following reactions :  
(a)  $XeF_4 + O_2F_2 \longrightarrow$   
(b)  $XeF_4 + SbF_5 \longrightarrow$
23. In an adventurous sport, four teams have to cross a river. Team leader of one team carries a container having calcium carbide and calcium phosphide. He told his team members that in any emergency situation, pierce the bottom of container and throw into the river. This creates instantaneous fire and others will know that we need their help.  
(i) What values are displayed by the team leader?  
(ii) Which substance causes the instantaneous fire?  
(iii) Write the chemistry behind the fire.  
(iv) Write the chemical reaction for laboratory production of substance that causes instantaneous fire.
24. (A) is a translucent white waxy solid which on heating in inert atmosphere is converted to its allotropic form (B). When allotrope (A) reacts with very dilute, aqueous solution of KOH, it liberates a highly poisonous gas (C) having rotten fish smell. With excess of chlorine (C) forms (D) which hydrolyses to compound (E). Identify compounds (A) to (E).
- OR**
- What is the covalence of nitrogen in  $N_2O_5$ ?
  - How is nitric acid prepared in laboratory?
  - Ammonia is a stronger base than phosphine. Why?

- (iv) In the solid state,  $\text{PCl}_5$  behaves as an ionic species. Give reason.
- (v) Why does a nitric acid bottle appear yellow?
25. (i) Explain the following :
- $\text{O}_2$  and  $\text{F}_2$  both stabilize higher oxidation states of metals but  $\text{O}_2$  exceeds  $\text{F}_2$  in doing so.
  - Perchloric acid is a stronger acid than sulphuric acid.
  - The stability of +5 oxidation state decreases down the group in group 15 elements.
- (ii) Out of  $\text{PH}_3$  and  $\text{H}_2\text{S}$ , which is more acidic and why?
- (iii)  $\text{PCl}_5$  exists as  $[\text{PCl}_4]^+ [\text{PCl}_6]^-$  but  $\text{PBr}_5$  exists as  $[\text{PBr}_4]^+ [\text{Br}]^-$ . Explain

OR

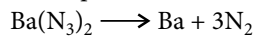
- (i) Explain the following :
- Structures of xenon fluorides cannot be explained by valence bond approach.
  - Despite having greater polarity, hydrogen fluoride boils at a lower temperature than water.
- (ii) State three important uses of neon gas.
26. (i) What is the difference between the nature of  $\pi$ -bonds present in  $\text{H}_3\text{PO}_3$  and  $\text{HNO}_3$  molecules?
- (ii) Give a chemical equation or name of the reaction to support the following statement :  
Sodium chlorate ( $\text{NaClO}_3$ ) is an oxidant.
- (iii) On being slowly passed through water,  $\text{PH}_3$  forms bubbles but  $\text{NH}_3$  dissolves. Why is it so?
- (iv) In interhalogen compounds of the type  $\text{AB}_5$  and  $\text{AB}_7$ , B is invariably fluorine. Why?
- (v) Phosphoric acid is a syrupy liquid. Explain.

OR

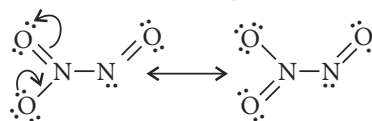
- (i) Two elements of the same group combine to form the compounds of the type  $\text{AA}'$ ,  $\text{AA}'_3$  and  $\text{AA}'_5$ . Draw the structure of each type, showing number of lone pairs and bond pairs?
- (ii) Explain :
- Hydrides of oxygen family are acidic in nature and acidic character increases down the group.
  - $\text{CN}^-$  is known but  $\text{CP}^-$  is not known.

## SOLUTIONS

1. Very pure nitrogen can be obtained by thermal decomposition of barium azide.



2. Fluoride ion ( $\text{F}^-$ ) gives most stable hexahalide with group 16 elements and these hexahalides are gaseous in nature.
3. Strong intermolecular hydrogen bonding exists in HF due to high electronegativity of fluorine which causes HF to exist as a liquid.
4. Helium is a non-inflammable and light gas which make it suitable for filling balloons.
5. Resonance structures of  $\text{N}_2\text{O}_3$  are

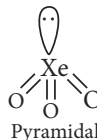


6. (i)  $\text{NO}_3^- + 3\text{Fe}^{2+} + 4\text{H}^+ \longrightarrow \text{NO} + 3\text{Fe}^{3+} + 2\text{H}_2\text{O}$   
Nitrate
- $[\text{Fe}(\text{H}_2\text{O})_6]^{2+} + \text{NO} \longrightarrow [\text{Fe}(\text{H}_2\text{O})_5(\text{NO})]^{2+} + \text{H}_2\text{O}$   
(Brown)

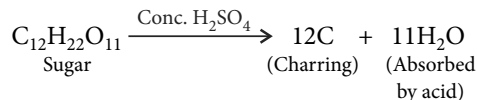
- (ii)  $\text{P}_4 + 8\text{SOCl}_2 \longrightarrow 4\text{PCl}_3 + 4\text{SO}_2 + 2\text{S}_2\text{Cl}_2$   
White Thionyl  
phosphorus chloride

7. Interhalogen compounds are generally more reactive than halogens since  $\text{X}-\text{X}'$  bond between two dissimilar electronegative elements is weaker than  $\text{X}-\text{X}$  bond between two similar elements except  $\text{F}-\text{F}$  bond. This is due to the reason that overlapping of orbitals of two dissimilar atoms is less effective than that of two similar atoms.

8. (i) Complete hydrolysis of  $\text{XeF}_6$  gives  $\text{XeO}_3$ .
- $$\text{XeF}_{6(s)} + 3\text{H}_2\text{O}_{(l)} \longrightarrow \text{XeO}_{3(s)} + 6\text{HF}_{(aq)}$$



9. Chlorine bleaches by oxidation while sulphur dioxide bleaches by reduction. The reduced product when exposed to air gets oxidised again and the colour returns. That is why bleaching action of  $\text{Cl}_2$  is permanent while bleaching action of  $\text{SO}_2$  is temporary.
10. (i) Sulphuric acid removes water from organic compounds and brings about charring.



- (ii) As we move down the group, the size of the central atom in  $\text{H}_2\text{M}$  increases, the  $\text{H}-\text{M}$  bond becomes weaker and breaks easily on heating. That is why thermal stability of  $\text{H}_2\text{O}$  is much higher than that of  $\text{H}_2\text{S}$ .

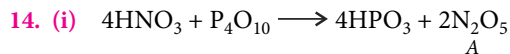
OR

Sulphur atom can have maximum oxidation state of +6 and minimum oxidation state of -2. In  $\text{SO}_2$ , the oxidation state of S is +4 therefore, it can get reduced to oxidation state of -2 as well as oxidised to oxidation state of +6 to act as oxidising agent and reducing agent respectively.

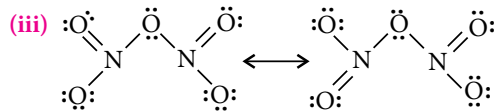
In  $\text{H}_2\text{S}$ , the oxidation state of S is -2 which is the minimum oxidation state of S hence, it can only increase its oxidation state by losing electrons and acts only as a reducing agent.

11. (i) Single  $\text{O}-\text{O}$  bond is weaker than  $\text{S}-\text{S}$  bond because of high interelectronic repulsions between the lone pair and bond pair of  $\text{O}-\text{O}$  bond, as a result catenation property is weaker in oxygen.
- (ii) In  $\text{SF}_6$  molecule, sulphur is surrounded by six fluorine atoms which protect it from attack by reagents to such an extent that even thermodynamically most favourable reactions like hydrolysis do not occur. So,  $\text{H}_2\text{O}$  cannot attack  $\text{SF}_6$  easily.
12. (i)  $\text{HF}$  does not attack wax but attacks sodium silicate which is the main constituent of glass. As a result, the glass bottles are slowly corroded or eaten up.
- $$\text{Na}_2\text{SiO}_3 + 6\text{HF} \longrightarrow \text{Na}_2\text{SiF}_6 + 3\text{H}_2\text{O}$$
- (ii) Fluorine shows only a negative oxidation state of -1 in its compounds. Other members exhibit both negative and positive oxidation states. Fluorine does not form any oxoacid while other members form a number of oxoacids.
13. (i) It is because Xe has lower ionisation enthalpy than Kr.
- (ii) Fluorine and oxygen are the most electronegative elements hence, they are very reactive and form compounds with noble gases, particularly with xenon.

- (iii) All the filled orbitals of Xe have paired electrons. The promotion of one, two or three electrons from the  $5p$ -filled orbitals to the  $5d$ -vacant orbitals will give rise to two, four and six half-filled orbitals. Therefore, Xe can combine with even number of F atoms but not odd. Thus, it cannot form  $\text{XeF}_3$  and  $\text{XeF}_5$ .



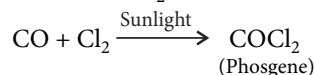
- (ii)  $\text{P}_4\text{O}_{10}$  is the dehydrating agent.



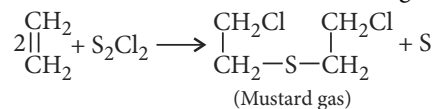
15. (i)  $\text{Cl}_2 + 2\text{NaOH} \longrightarrow \text{NaOCl} + \text{NaCl} + \text{H}_2\text{O}$   
(Cold and dil.)
- (ii)  $2\text{NaBr} + 3\text{H}_2\text{SO}_4 \longrightarrow 2\text{NaHSO}_4 + \text{Br}_2 + \text{SO}_2 + 2\text{H}_2\text{O}$   
(Conc.)
- (iii)  $3\text{Cl}_2 + 6\text{NaOH} \longrightarrow 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O}$   
(Hot and conc.)

OR

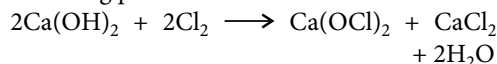
- (i) (a) **Phosgene** : It is formed by addition reaction of  $\text{Cl}_2$  and  $\text{CO}$ .



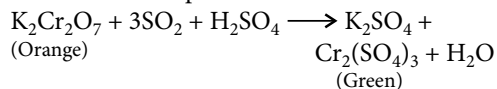
- (b) **Mustard gas** : When  $\text{Cl}_2$  is passed through boiling sulphur,  $\text{S}_2\text{Cl}_2$  is formed.  $\text{S}_2\text{Cl}_2$  is treated with ethene to form mustard gas.



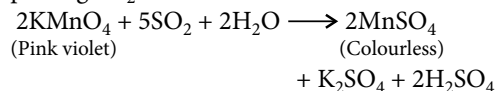
- (ii) When chlorine is passed over dry slaked lime bleaching powder is formed.



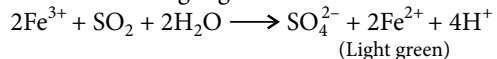
16. (i) Acidified  $\text{K}_2\text{Cr}_2\text{O}_7$  turns green due to formation of chromium sulphate.



- (ii) Acidified  $\text{KMnO}_4$  solution turns colourless on passing  $\text{SO}_2$ .

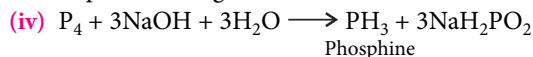


- (iii)  $\text{Fe}^{3+}$  salts are reduced to  $\text{Fe}^{2+}$  by  $\text{SO}_2$  and solution turns light green.

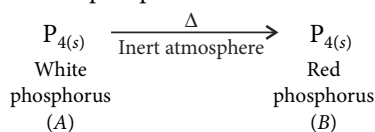




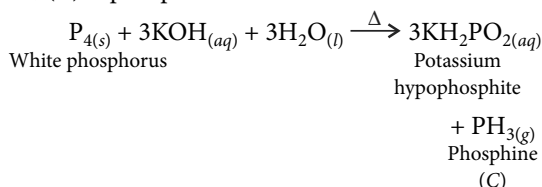
23. (i) Team leader showed responsibility and alertness.  
 (ii) Phosphine,  $\text{PH}_3$  causes the instantaneous fire.  
 (iii) Calcium phosphide ( $\text{Ca}_3\text{P}_2$ ) reacts with water to give  $\text{PH}_3$  which catches fire instantaneously. Also, calcium carbide ( $\text{CaC}_2$ ) on reaction with water produces acetylene which burns strongly to produce a signal.



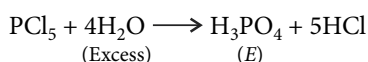
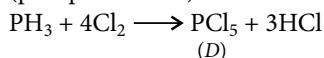
24. Since (A) is a translucent white waxy solid, which on heating in inert atmosphere is converted to its allotropic form (B) so, 'A' is white phosphorus and 'B' is red phosphorus.



When white phosphorus (A) reacts with very dilute, aqueous solution of KOH, it liberates phosphine gas which is very poisonous and has rotten fish smell. So, (C) is phosphine.

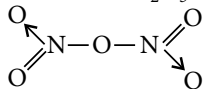


Phosphine with excess of  $\text{Cl}_2$  forms  $\text{PCl}_5$ , which hydrolyses to  $\text{H}_3\text{PO}_4$ . So, D is  $\text{PCl}_5$  and E is  $\text{H}_3\text{PO}_4$  (phosphoric acid).



**OR**

- (i) The structure of  $\text{N}_2\text{O}_5$  is



From the structure of  $\text{N}_2\text{O}_5$ , it is evident that covalence of nitrogen is four.

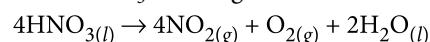
- (ii) Nitric acid in laboratory is prepared by heating  $\text{NaNO}_3$  and conc.  $\text{H}_2\text{SO}_4$  in a glass retort.  
 $\text{NaNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HNO}_3$   
 (iii) Due to the presence of lone pairs of electrons on the central atom both  $\text{NH}_3$  and  $\text{PH}_3$  are Lewis bases. When  $\text{NH}_3$  or  $\text{PH}_3$  accept a proton, an additional N—H or P—H bond is formed.



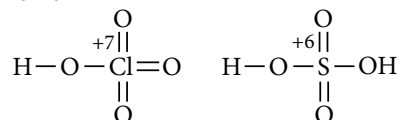
Due to smaller size of N than P, N—H bond thus formed is much stronger than P—H bond. As a result  $\text{NH}_3$  has more tendency than  $\text{PH}_3$  to accept a proton. Therefore,  $\text{NH}_3$  is stronger base than  $\text{PH}_3$ .

- (iv)  $\text{PCl}_5$  is ionic in the solid state because it exists as  $[\text{PCl}_4]^+ [\text{PCl}_6]^-$  in which the cation is tetrahedral and anion is octahedral.

- (v) The yellow colour of the concentrated nitric acid bottle is due to the partial decomposition of the  $\text{HNO}_3$  to nitrogen dioxide.



25. (i) (a) This is due to the ability of oxygen to form multiple bonds with metal atoms.  
 (b) The oxidation state of Cl in perchloric acid is +7 while that of S in sulphuric acid is +6



Thus,  $\text{ClO}_3$  part of  $\text{HClO}_4$  can break the O—H bond more easily to liberate a proton than the  $\text{SO}_2$  part in  $\text{H}_2\text{SO}_4$ . Therefore, perchloric acid is a stronger acid than sulphuric acid.

- (c) In group 15 elements, the stability of +5 oxidation state decreases down the group due to inert pair effect *i.e.*, reluctance of *s*-electrons to participate in bond formation. As a result +3 oxidation state becomes more stable down the group.

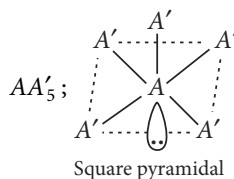
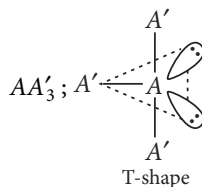
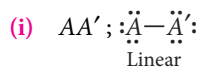
- (ii)  $\text{H}_2\text{S}$  is more acidic than  $\text{PH}_3$  because H—S bond is more polar due to higher electronegativity of sulphur.
- (iii) The splitting of  $\text{PBr}_5$  is different from  $\text{PCl}_5$  because Br atoms are large and six atoms of Br cannot be easily accommodated around smaller P atom.

OR

- (i) (a) According to the valence bond approach, orbitals containing unpaired electrons only take part in covalent bond formation. Xenon has no unpaired electrons. Hence, structure of its fluorides cannot be explained by valence bond approach.
- (b) Higher boiling point of  $\text{H}_2\text{O}$  is due to the extensive H-bonding than HF.
- (ii) (a) Neon is used in discharge tubes and fluorescent bulbs for display in advertisements.
- (b) Neon bulbs are used in botanical gardens and in green houses.
- (c) Neon is used in voltage regulators and indicators.
26. (i) In  $\text{H}_3\text{PO}_3$ , there is  $p\pi - d\pi$  bond whereas in  $\text{HNO}_3$ , there is  $p\pi - p\pi$  bond.
- (ii)  $\text{I}_2 + 2\text{NaClO}_3 \longrightarrow 2\text{NaIO}_3 + \text{Cl}_2$
- (iii)  $\text{NH}_3$  dissolves in water because it forms H-bonds whereas  $\text{PH}_3$  does not, therefore it is insoluble in water.
- (iv) Fluorine is the strongest oxidising agent therefore, it can form interhalogen compounds with other halogens in +5 and +7 oxidation states as it can provide energy for excitation of valence electrons.

- (v) Phosphoric acid is a syrupy liquid due to intermolecular H-bonding.

OR



- (ii) (a) Hydrides of oxygen family are weakly acidic in nature and acidic character increases as :  
 $\text{H}_2\text{O} < \text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te}$   
 This can be explained on the basis of the size of the central atom. As the size of central atom increases, bond length ( $E-H$ ) increases and bond dissociation enthalpy decreases which further increases the acidic character of hydrides.
- (b) This is due to the reason that nitrogen can form multiple bonds ( $:\text{C}\equiv\text{N}:$ ) while phosphorus cannot.

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