

# The p-Block Elements (Group 15, 16, 17 & 18)

## CHAPTER

# 21

- In  $\text{XeF}_2$ ,  $\text{XeF}_4$ ,  $\text{XeF}_6$  the number of lone pairs on Xe are respectively [2002]
  - 2, 3, 1
  - 1, 2, 3
  - 4, 1, 2
  - 3, 2, 1.
- In case of nitrogen,  $\text{NCl}_3$  is possible but not  $\text{NCl}_5$  while in case of phosphorous,  $\text{PCl}_3$  as well as  $\text{PCl}_5$  are possible. It is due to [2002]
  - availability of vacant  $d$  orbitals in P but not in N
  - lower electronegativity of P than N
  - lower tendency of H-bond formation in P than N
  - occurrence of P in solid while N in gaseous state at room temperature.
- Number of sigma bonds in  $\text{P}_4\text{O}_{10}$  is [2002]
  - 6
  - 7
  - 17
  - 16.
- Oxidation number of Cl in  $\text{CaOCl}_2$  (bleaching power) is: [2002]
  - zero, since it contains  $\text{Cl}_2$
  - 1, since it contains  $\text{Cl}^-$
  - +1, since it contains  $\text{ClO}^-$
  - +1 and -1 since it contains  $\text{ClO}^-$  and  $\text{Cl}^-$
- What may be expected to happen when phosphine gas is mixed with chlorine gas? [2003]
  - $\text{PCl}_3$  and  $\text{HCl}$  are formed and the mixture warms up
  - $\text{PCl}_5$  and  $\text{HCl}$  are formed and the mixture cools down
  - $\text{PH}_3 \cdot \text{Cl}_2$  is formed with warming up
  - The mixture only cools down
- Concentrated hydrochloric acid when kept in open air sometimes produces a cloud of white fumes. The explanation for it is that [2003]
  - oxygen in air reacts with the emitted  $\text{HCl}$  gas to form a cloud of chlorine gas
  - strong affinity of  $\text{HCl}$  gas for moisture in air results in forming of droplets of liquid solution which appears like a cloudy smoke.
  - due to strong affinity for water, concentrated hydrochloric acid pulls moisture of air towards itself. This moisture forms droplets of water and hence the cloud.
  - concentrated hydrochloric acid emits strongly smelling  $\text{HCl}$  gas all the time.
- Which one of the following substances has the highest proton affinity? [2003]
  - $\text{H}_2\text{S}$
  - $\text{NH}_3$
  - $\text{PH}_3$
  - $\text{H}_2\text{O}$
- Which among the following factors is the most important in making fluorine the strongest oxidizing halogen? [2004]
  - Hydration enthalpy
  - Ionization enthalpy
  - Electron affinity
  - Bond dissociation energy
- Excess of  $\text{KI}$  reacts with  $\text{CuSO}_4$  solution and then  $\text{Na}_2\text{S}_2\text{O}_3$  solution is added to it. Which of the statements is **incorrect** for this reaction? [2004]
  - $\text{Na}_2\text{S}_2\text{O}_3$  is oxidised
  - $\text{CuI}_2$  is formed
  - $\text{Cu}_2\text{I}_2$  is formed
  - Evolved  $\text{I}_2$  is reduced
- Which one of the following statement regarding helium is **incorrect**? [2004]
  - It is used to produce and sustain powerful superconducting magnets
  - It is used as a cryogenic agent for carrying out experiments at low temperatures
  - It is used to fill gas balloons instead of hydrogen because it is lighter and non-inflammable
  - It is used in gas-cooled nuclear reactors
- The number of hydrogen atom(s) attached to phosphorus atom in hypophosphorous acid is [2005]

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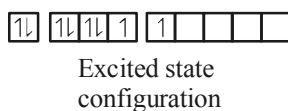
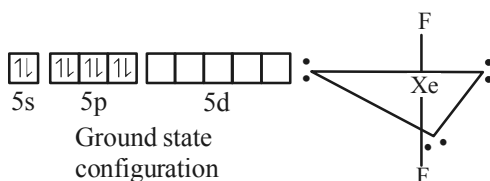
- (a) three (b) one  
(c) two (d) zero
12. The correct order of the thermal stability of hydrogen halides (H-X) is [2005]  
(a)  $\text{HI} > \text{HCl} < \text{HF} > \text{HBr}$   
(b)  $\text{HCl} < \text{HF} > \text{HBr} < \text{HI}$   
(c)  $\text{HF} > \text{HCl} < \text{HBr} > \text{HI}$   
(d)  $\text{HI} < \text{HBr} > \text{HCl} < \text{HF}$
13. Which of the following statements is true? [2006]  
(a)  $\text{HClO}_4$  is a weaker acid than  $\text{HClO}_3$   
(b)  $\text{HNO}_3$  is a stronger acid than  $\text{HNO}_2$   
(c)  $\text{H}_3\text{PO}_3$  is a stronger acid than  $\text{H}_2\text{SO}_3$   
(d) In aqueous medium HF is a stronger acid than HCl
14. The increasing order of the first ionization enthalpies of the elements B, P, S and F (Lowest first) is [2006]  
(a)  $\text{B} < \text{P} < \text{S} < \text{F}$  (b)  $\text{B} < \text{S} < \text{P} < \text{F}$   
(c)  $\text{F} < \text{S} < \text{P} < \text{B}$  (d)  $\text{P} < \text{S} < \text{B} < \text{F}$
15. What products are expected from the disproportionation reaction of hypochlorous acid? [2006]  
(a) HCl and  $\text{Cl}_2\text{O}$  (b) HCl and  $\text{HClO}_3$   
(c)  $\text{HClO}_3$  and  $\text{Cl}_2\text{O}$  (d)  $\text{HClO}_2$  and  $\text{HClO}_4$
16. Identify the incorrect statement among the following. [2007]  
(a)  $\text{Br}_2$  reacts with hot and strong NaOH solution to give NaBr and  $\text{H}_2\text{O}$ .  
(b) Ozone reacts with  $\text{SO}_2$  to give  $\text{SO}_3$ .  
(c) Silicon reacts with  $\text{NaOH}_{(\text{aq})}$  in the presence of air to give  $\text{Na}_2\text{SiO}_3$  and  $\text{H}_2\text{O}$ .  
(d)  $\text{Cl}_2$  reacts with excess of  $\text{NH}_3$  to give  $\text{N}_2$  and HCl.
17. Regular use of the following fertilizers increases the acidity of soil? [2007]  
(a) Ammonium sulphate  
(b) Potassium nitrate  
(c) Urea  
(d) Superphosphate of lime.
18. Which one of the following reactions of xenon compounds is not feasible? [2009]  
(a)  $3\text{XeF}_4 + 6\text{H}_2\text{O} \longrightarrow 2\text{Xe} + \text{XeO}_3 + 12\text{HF} + 1.5\text{O}_2$   
(b)  $2\text{XeF}_2 + 2\text{H}_2\text{O} \longrightarrow 2\text{Xe} + 4\text{HF} + \text{O}_2$   
(c)  $\text{XeF}_6 + \text{RbF} \longrightarrow \text{Rb}[\text{XeF}_7]$   
(d)  $\text{XeO}_3 + 6\text{HF} \longrightarrow \text{XeF}_6 + 3\text{H}_2\text{O}$
19. Which of the following has maximum number of lone pairs associated with Xe? [2011RS]  
(a)  $\text{XeF}_4$  (b)  $\text{XeF}_6$   
(c)  $\text{XeF}_2$  (d)  $\text{XeO}_3$
20. The molecule having smallest bond angle is: [2012]  
(a)  $\text{NCl}_3$  (b)  $\text{AsCl}_3$   
(c)  $\text{SbCl}_3$  (d)  $\text{PCl}_3$
21. Which among the following is the most reactive? [JEE M 2015]  
(a)  $\text{I}_2$  (b)  $\text{ICl}$   
(c)  $\text{Cl}_2$  (d)  $\text{Br}_2$
22. **Assertion:** Nitrogen and oxygen are the main components in the atmosphere but these do not react to form oxides of nitrogen.  
**Reason:** The reaction between nitrogen and oxygen requires high temperature. [JEE M 2015]  
(a) The assertion is incorrect, but the reason is correct  
(b) Both the assertion and reason are incorrect  
(c) Both assertion and reason are correct, and the reason is the correct explanation for the assertion  
(d) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
23. Which one has the highest boiling point? [JEE M 2015]  
(a) Kr (b) Xe  
(c) He (d) Ne
24. The pair in which phosphorous atoms have a formal oxidation state of +3 is: [JEE M 2016]  
(a) Orthophosphorous and hypophosphoric acids  
(b) Pyrophosphorous and pyrophosphoric acids  
(c) Orthophosphorous and pyrophosphorous acids  
(d) Pyrophosphorous and hypophosphoric acids
25. The reaction of zinc with dilute and concentrated nitric acid, respectively, produces: [2016]  
(a) NO and  $\text{N}_2\text{O}$  (b)  $\text{NO}_2$  and  $\text{N}_2\text{O}$   
(c)  $\text{N}_2\text{O}$  and  $\text{NO}_2$  (d)  $\text{NO}_2$  and NO
26. The products obtained when chlorine gas reacts with cold and dilute aqueous NaOH are: [2017]  
(a)  $\text{ClO}^-$  and  $\text{ClO}_3^-$  (b)  $\text{ClO}_2^-$  and  $\text{ClO}_3^-$   
(c)  $\text{Cl}^-$  and  $\text{ClO}^-$  (d)  $\text{Cl}^-$  and  $\text{ClO}_2^-$

Answer Key

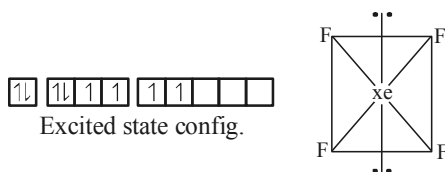
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(d)	(a)	(d)	(d)	(d)	(a)	(b)	(d)	(b)	(c)	(c)	(c)	(b)	(b)	(b)
16	17	18	19	20	21	22	23	24	25	26				
(d)	(a)	(d)	(c)	(c)	(b)	(c)	(b)	(c)	(c)	(c)				

SOLUTIONS

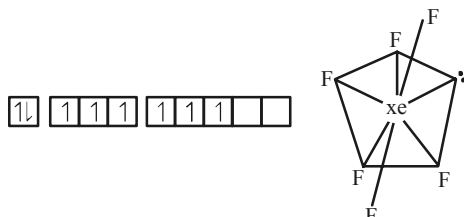
1. (d) In the formation of  $\text{XeF}_2$ ,  $sp^3d$  hybridisation occurs which gives the molecule a trigonal bipyramidal structure.



In the formation of  $\text{XeF}_4$ ,  $sp^3d^2$  hybridization occurs which gives the molecule an octahedral structure.



In the formation of  $\text{XeF}_6$ ,  $sp^3d^3$  hybridization occurs which gives the molecule a pentagonal bipyramidal structure.



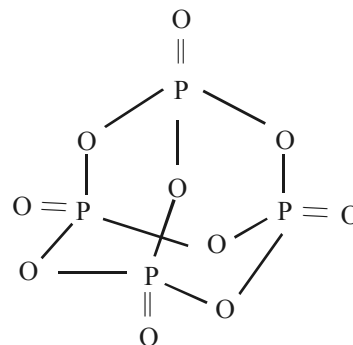
2. (a)  ${}_7\text{N} = 1s^2 2s^2 2p^3$ ;  ${}_{15}\text{P} = 1s^2 2s^2 2p^6 3s^2 3p^3$



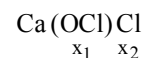
**NOTE** In phosphorous the 3d- orbitals

are available. Hence phosphorous can form pentahalides also but nitrogen can not form pentahalide due to absence of d-orbitals

3. (d)



4. (d)  $\text{CaOCl}_2$  — or it can also be written as

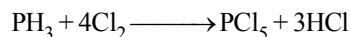


hence oxidation no of Cl in  $\text{OCl}^-$  is  
 $-2 + x_2 = -1$

$$x_2 = 2 - 1 = +1$$

now oxidation no. of another Cl is  $-1$  as it is present as  $\text{Cl}^-$ .

5. (d) On mixing phosphine with chlorine gas  $\text{PCl}_5$  and  $\text{HCl}$  forms. The mixture cools down.



6. (a)  $4\text{HCl} + \text{O}_2 \rightarrow 2\text{Cl}_2 + 2\text{H}_2\text{O}$

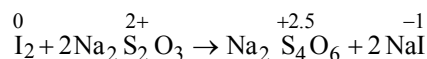
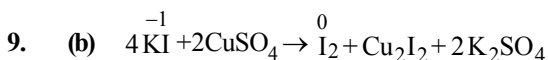
air                      cloud of white fumes

7. (b) Among the given compounds, the  $\text{NH}_3$  is most basic. Hence has highest proton affinity

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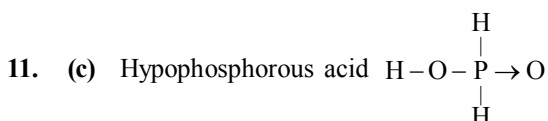
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8. (d) The fluorine has low dissociation energy of F - F bond and reaction of atomic fluorine is exothermic in nature



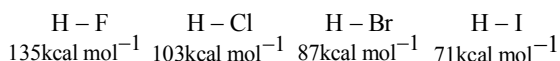
In this  $\text{CuI}_2$  is **not** formed.

10. (c) Helium is heavier than hydrogen although it is non-inflammable

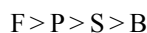


Two H-atoms are attached to P atom.

12. (c) The H-X bond strength decreases from HF to HI. i.e.  $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$ . Thus HF is most stable while HI is least stable. This is evident from their decomposition reaction: HF and HCl are stable upto 1473K, HBr decreases slightly and HI dissociates considerably at 713K. The decreasing stability of the hydrogen halide is also reflected in the values of dissociation energy of the H-X bond



13. (b) The  $\overset{+5}{\text{HNO}_3}$  is stronger than  $\overset{+3}{\text{HNO}_2}$ . The more the oxidation state of N, the more is the acid character.
14. (b) The correct order of ionisation enthalpies is

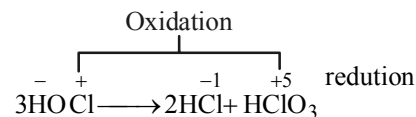


**NOTE** On moving along a period ionization enthalpy increases from left to right and decreases from top to bottom in a group. But this trend breaks up in case of

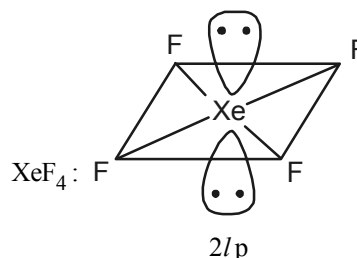
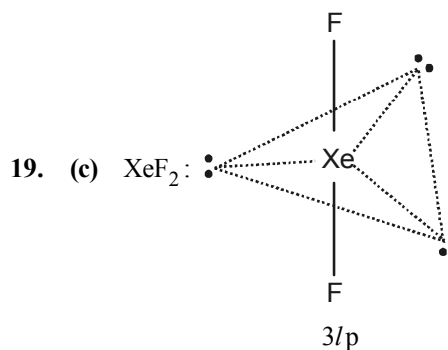
atom having fully or half filled stable orbitals.

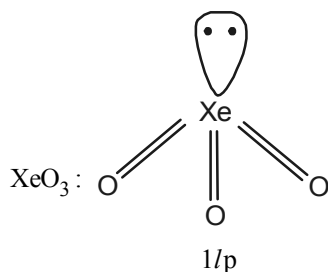
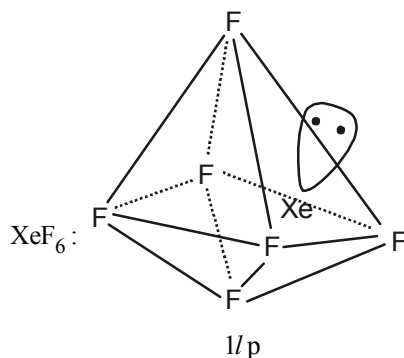
In this case P has a stable half filled electronic configuration hence its ionisation enthalpy is greater in comparison to S. Hence the correct order is  $\text{B} < \text{S} < \text{P} < \text{F}$ .

15. (b) During disproportionation same compound undergo simultaneous oxidation and reduction.



16. (d) Chlorine reacts with excess of ammonia to produce ammonium chloride and nitrogen.
17. (a)  $(\text{NH}_4)_2\text{SO}_4 + 2\text{H}_2\text{O} \longrightarrow 2\text{H}_2\text{SO}_4 + \text{NH}_4\text{OH}$   
 $\text{H}_2\text{SO}_4$  is strong acid and increases the acidity of soil.
18. (d) The products of the concerned reaction react each other forming back the reactants.  
 $\text{XeF}_6 + 3\text{H}_2\text{O} \longrightarrow \text{XeO}_3 + 6\text{HF}$





Hence XeF<sub>2</sub> has maximum no. of lone pairs of electrons.

20. (c) All the members form volatile halides of the type

AX<sub>3</sub>. All halides are pyramidal in shape. The bond angle decreases on moving down the group due to decrease in bond pair-bond pair repulsion.

NCl <sub>3</sub>	PCl <sub>3</sub>	AsCl <sub>3</sub>
107°	94°	92°

21. (b) ICl Order of reactivity of halogens  
Cl<sub>2</sub> > Br<sub>2</sub> > I<sub>2</sub>  
But, the interhalogen compounds are generally more reactive than halogens (except F<sub>2</sub>), since the bond between two dissimilar electronegative elements is weaker than the bond between two similar atoms i.e. X–X
22. (c) Nitrogen and oxygen in air do not react to form oxides of nitrogen in atmosphere because the reaction between nitrogen and oxygen requires high temperature.
23. (b) Xe. As we move down the group, the melting and boiling points show a regular increase due to corresponding increase in the magnitude of their van der waal forces of attraction as the size of the atom increases.
24. (c) Phosphorous acid contain P in +3 oxidation state.

Acid	Formula	Oxidation state of Phosphorus
Pyrophosphorous acid	H <sub>4</sub> P <sub>2</sub> O <sub>5</sub>	+3
Pyrophosphoric acid	H <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	+5
Orthophosphorous acid	H <sub>3</sub> PO <sub>3</sub>	+3
Hypophosphoric acid	H <sub>4</sub> P <sub>2</sub> O <sub>6</sub>	+4

25. (c) Reaction of Zn with dil. HNO<sub>3</sub>  

$$4\text{Zn} + 10\text{HNO}_3(\text{dil}) \longrightarrow 4\text{Zn}(\text{NO}_3)_2 + 5\text{H}_2\text{O} + \text{N}_2\text{O}$$
 (Zn reacts differently with very dilute HNO<sub>3</sub>)

Reaction of Zn with conc. HNO<sub>3</sub>  

$$\text{Zn} + 4\text{HNO}_3(\text{conc.}) \longrightarrow \text{Zn}(\text{NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{NO}_2$$

26. (c)  $\text{Cl}_2 + \text{NaOH} \rightarrow \text{NaCl} + \text{NaClO} + \text{H}_2\text{O}$   
[cold and dilute]