CHAPTER - 15

THE p-BLOCK ELEMENTS (Groups 13 - 18)

SYNOPSIS

The p-block of the periodic table is unique in terms of having all types of elements-metals, non-metals and metalloids. There are six groups of p-block elements in the periodic table numbering from 13 to 18. Their valence shell electronic configuration is ns^2np^{1-6} except for He. Difference in the inner core of their E. C. greatly influence their physical & chemical properties. As a consequence of this, a lot of variation in properties among the elements is observed. In addition to the group oxidation state, these elements show other oxidation states differing from the total number of valence e^- by unit of two. While the group oxidation state is the most stable for the lighter elements of the group, the lower oxidation state becomes progressively more stable for the heavier elements. The combined effect of size and availability of d-orbitals considerably influences the ability of these elements to form π-bonds, while the lighter elements form $p\pi - p\pi$ bonds, the heavier ones form $d\pi - p\pi$ or $d\pi - d\pi$ bonds. Absence of d-orbital in second period of elements limits their maximum covalence to four while heavier ones can exceed their limit.

Elements of group-13 (B, Al, Ga, In, Tl)

Boron is a typical non-metal and the other members are metals. The availability of three valence electrons for covalent bond formation using four orbitals (2s, $2p_x$, $2p_y$ and $2p_z$) leads to the so called electron deficiency in boron compounds. This deficiency makes them good electron accepter and thus boron compounds behave as Lewis acids. Boron forms covalent molecular compounds with dihydrogen as boranes, the simplest of which is diborane (B_2H_6). Diborane contains two bridging hydrogen atoms between two boron atoms. These bridge bonds are considered to be three-centre two electron bonds. The important compounds of boron are boric acid and borax. Boric acid, $B(OH)_3$ is a weak monobasic acid; it acts as Lewis acid by accepting electrons from hydroxyl ions. Borax is a white crystalline solid of the formula $Na_2[B_4O_5(OH)_4].8H_2O$. In borax bead test characteristic colours are produced by transition metals salts.

Aluminium exhibits +3 oxidation state. With heavier elements +1 oxidation state get progressively stabilised on goining down the group. This is a consequence of inert pair effect.

Elements of group-14 (C, Si, Ge, Sn, Pb)

Carbon is a typical non-metal forming covalent bonds employing all its four valence electrons. It shows the property of catenation, the ability to form chains or rings, not only with C – C single bonds but also with multiple bonds (C = C or $C \equiv C$). The tendency to catenation decreases as C >>Si > Ge $\approx$ Sn > Pb. Carbon provides one of the best examples of allotropy. Three important allotropes of carbon are diamond, graphite and fullerenes. The members of the carbon family mainly exhibit +4 and +2 oxidation states. Compounds in +4 oxidation state are generally covalent in nature. The tendency to show +2 oxidation state increases among heavier elements. Lead in +2 state is stable whereas in +4 oxidation state, it is a strong oxidising agent. Carbon also exhibits negative oxidation state. It forms two important oxides CO and CO_2. CO is neutral

whereas CO_2 is acidic in nature. CO having lone pair of electrons on carbon forms metal carbonyls. It is deadly poisonous due to higher stability of its haemoglobin complex as compared to that of oxyhaemoglobin complex. Increased content of CO_2 in the atmosphere is contributing to green house effect. Silica, silicates and silicones are important class of compounds and find applications in industry and Technology.

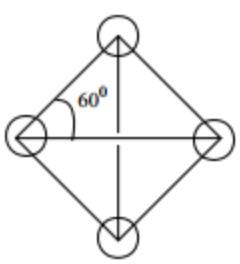
Elements of Group 15 (N, P, As, Sb, Bi)

1. N_2 is the major component (78% v/v) of atmospheric air, but in the mineral form it occurs as $NaNO_3$ and KNO_3 only, in the earth's crust. (Relative abundance is 33rd/78 for N_2).
2. Phosphorus occurs in the mineral apatite $Ca_9(PO_4)_6$. CaX_2 (X = F, Cl, OH) and as phosphate in bones. (Relative abundance is 11th/78 for phosphorus)
3. They have $ns^2 sp^3$ configuration.
4. They show +3, +5 and –3 oxidation states. Bi shows a stable positive oxidation state of +3 only (inert pair effect) N has oxidation states from –3 to +5. Bi shows –3 oxidation state in compounds with metals.
5. They have exceptionally high ΔiH_1 (compared with group 14 and group 16) except Bi
6. Nitrogen is a diatomic gas, whereas other elements are tetraatomic solids.
7. Reactivity : N_2 is least reactive at room temperature due to a high bond-enthalpy of $N \equiv N$ (941 kJ mol^{-1}) white phosphorus is the most reactive at room temperature due to a greater angular strain in P_4 - tetraheral structure.
8. They form oxides of the formulae E_2O_3 and E_2O_5. Their oxides show acidic character and acidity decreases from top to bottom in the group
9. They form halides of the formulae EX_3 and EX_5. Nitrogen does not form a pentahalide due to absence of d-orbitals. Among the halides of nitrogen, only NF_3 is stable.
10. They form binary compounds with metals, exhibiting –3 oxidation state. (eg: Ca_3P_2, Zn_3P_2, Li_3N, Mg_3N_2, Na_3As_2, Zn_3Sb_2, Mg_3Bi_2 etc)
11. They form hydrides of formula EH_3.
    - Thermal stability : Decreases from NH_3 to BiH_3
    - Reducing property : Increases from NH_3 to BiH_3
    - H – E - H bond angle : Decreases from NH_3 to BiH_3
    - Bond - enthalpy : Decreases from NH_3 to BiH_3
    - Boiling point : $PH_3 < AsH_3 < NH_3 < SbH_3 < BiH_3$
    - Melting point : $PH_3 < AsH_3 < SbH_3 < NH_3$
    - Lewis base character : Decreases from NH_3 to BiH_3
12. NH_3 has a higher boiling point than PH_3 and AsH_3 due to strong hydrogen bonding.
13. NH_3 has a larger bond angle due to high electronegativity of N. As electronegativity of central atom decreases bond angle decreases.

VI. Phosphorus : Phosphorus is extracted from rock phosphate $Ca_3(PO_4)_2$

The important allotropes of phosphorus are white, red and black.

White phosphorus : It is a white waxy solid, isoluble in water and soluble in CS_2. It has phosphorescence in the dark. White phosphorus has tetrahedral molecular structure.



Reaction with hot NaOH

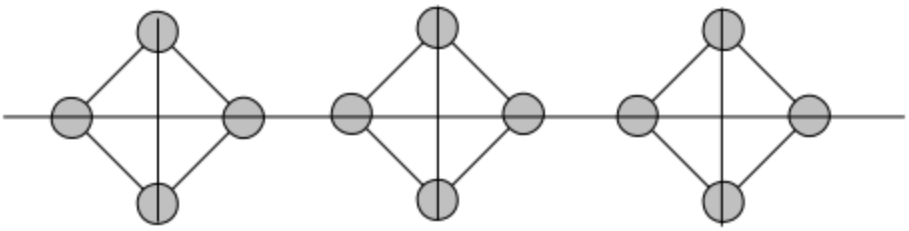
It dissolves in boiling aq. NaOH in an inert atmosphere of CO_2 forming phosphine (PH_3) (preparation of PH_3)

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

It burns in excess of air to form P_4P_{10}

$$P_4 + 5O_2 \longrightarrow P_4O_{10}$$

Red phosphorus : When white phosphorus is heated in an inert atmosphere at 573 K for seven days in a sealed cast-iron tube, red phosphorus is formed.
It is odourlss, non poisonous, insoluble in CS_2 or H_2O, less reactive, dense and polymeric.



Black phosphorus : It has two forms namely α and β. α -black phosphorus is formed when red p-is heated in a sealed tube at 803 K. It is opaque having monoclinic or rhombohedral crystals.

It does not oxidise in air. β-black P is formed by heating white P at 473 K under high pressure. It does not burn in air when heated upto 673K.

Elements of Group 16 (O, S, Se, Te, Po)

1. Occurrence : The most abundant element in the earths crust is oxygen. The second most abundant element of group 16 is sulphur. Elements of group 16 are collectively called chalcogens since they are associated with ores (minerals). Se and Te form binary compounds with metals and they are found along with sulphides of copper and silver. Po occurs as a radioactive decay product.
2. Electronic configuration : $ns^2\ np^4$
3. Atomic and ionic radii : Increase from top to bottom in the group.
4. Ionisation enthalpy : Decreases from top to bottom in the group. I.E. of group 16 is less than expected.
5. Electron gain enthalpy : Oxygen has the lowest negative electron gain enthalpy in this group. Sulphur has the highest negative ΔegH.
6. Electronegativity : Oxygen is the second most electronegative element in the periodic table. E.N. decreases from O to Po.
7. Physical state : O and S are non metals. Se and Te are metalloids. Po is a radioactive metal with a half life period of 13.8 days. O_2 is a diatomic gas whereas other elements form octa atomic molecules.
8. Chemical properties : They show +2, +4 and +6 oxidation states in addition to –2. Oxygen does not show +4 and +6 oxidation states. Stability of +6 oxidation state decreases from S to Po.
9. Hydrides : All elements of group 16 form hydrides of formula H_2E. Stability of hydrides decreases from H_2O to H_2Po

   H_2S has unexpectedly low MP and BP whereas H_2O has the highest MP and BP among the hydrides. Bond angle decreases from H_2O to H_2Te.
10. Oxides : They form oxides of formulae EO_2 and EO_3 except O_2 (oxygen has no oxide). SO_2 and SO_3 are gases. SeO_2 is a solid. Reducing property decreases from SO_2 to TeO_2. (SO_2 is a reducer whereas TeO_2 is an oxidiser). Their trioxides are more acidic than dioxides.

11. Halides : They form halides of the type EX_2, EX_4 and EX_6 except O_2.
Among hexahalides, hexafluorides are stable. All hexafluorides are gases with octahedral structure.
Among the tetrafluorides, SF_4 is a gas, SeF_4 is a liquid and TeF_4 is a solid. They have see-saw geometry with sp^3d hybridisation of the central atom.
They form dichlorides and dibromides, except oxygen . Their monohalides undergo dimerisation and tend to disporportionate (eg : $2S_2Cl_2 \longrightarrow SCl_4 + 3S$)

12. Oxides : Oxides are classified into simple oxides and mixted oxides. In simple oxides the element forming the oxide has only one oxidation state.
Eg : Na_2O, MgO, Al_2O_3 etc
In mixed oxides the ox. states of the central atom are more than one.

Eg : $Fe_3O_4 \rightleftharpoons FeO + Fe_2O_3$

Simple oxides are further classified into acidic, basic neutral and amphoteric oxides CO, NO and N_2O are neutral oxides.

P_4O_{10}	SO_3	Cl_2O_7	etc	are acidic oxides
ZnO	Al_2O_3	BeO	etc	are amphoteric oxides
Na_2O	CaO	BaO	etc	basic oxides

13. Ozone (O_3) : It is an allotrope of oxygen. In the upper atmosphere O_3 is formed by the action of UV radiation.

$3O_2 \overset{h\upsilon}{\rightleftharpoons} 2O_3$

Preparation : O_3 is prepared by subjecting pure dry O_2 to a silent electric discharge. O_2 containing about 10% (v/v) O_3 is formed.

$3O_2 \rightleftharpoons 2O_3.\ \Delta H = +142\ kJ/mol$

Properties : O_3 is thermodynamically unstable. It is a pale-blue gas with a characteristic smell. It liquefies to give a dark blue liquid and solidifies to form violet-black solid.
It acts as a powerful oxidiser:

$PbS + 4O_{3(g)} \longrightarrow PbSO_4 + 4O_{2(g)}$

$2KI + H_2O + O_3 \longrightarrow 2KOH + I_2 + O_2$

Nitric oxide reacts with ozone forming NO_2 and O_2

$NO + O_3 \longrightarrow NO_2 + O_2$

In this way NO causes depletion of O_3
Ozone has an angular geometry with a bond angle of 117°.
Ozone is estimated by reacting with excess KI solution buffered with a borate and liberated I_2 is quantitatively estimated using standard sodium thiosulphate solution.
Uses : Used as a germicide, disinfectant, for sterilising theatres and water, for bleaching oils, ivory, starch and in the oxidation of K_2MnO_4.

14. Sulphur : Sulphur has many isotopes, namely α, β, γ etc.

α -sulphur or Rhombic sulphur : It is the stable allotrope of sulphur at room temperature. At 369 K it transforms into β-sulphur

β-sulphur or monoclinic sulphur. It is stable above 369 K

Properties	α – sulphur	β – sulphur
Molecular structure	S_8	S_8
M.P.	385.8 K	393 K
SP. gravity	2.06	1.98
Solubility in CS_2	Soluble	Soluble

Note : At about 1000 K, sulphur vapours contain S_2 molecules. Which are paramagnetic like O_2.

Elements of group 17 Halogens (F, Cl, Br, I and At)

a. They form salts and so they are collectively called halogens (means salt producers)

b. All halogens occur in the combined state and fluorine is the most abundant halogen in the earth's crust. Cl_2 is the second most abundant halogen. Sea water contains chlorides, bromides and iodides.

c. They have diatomic molecues. F_2 and Cl_2 are gases Br_2 is a liquid and I_2 is a sublimable solid at room temperature.

d. They are strongly electronegative

e. They have the shortest atomic radii in their respective periods due to high effective nuclear charge.

f. They have the highest -ve ΔegH_1 in their respective periods. The highly -ve ΔegH_1 is due to attainment of stable electronic configuration after accepting one more electron by the atom. F has a lower -ve ΔegH_1 than Cl due to a higher electron-density of valence shell.

g. Bond dissociation enthalpy is in the order : Cl – Cl > Br–Br > F–F > I–I

Low bond dissociation enthalpy of F_2 is due to strong $\ell p - \ell p$ repulsion between the two F atoms bonded by a shorter bond. (143 pm)

Low bond-enthalpy, high electronegativity and higher hydration enthalpy of F^- make F_2 more reactive among the non metals.

h. Electornic configuration : $ns^2\ np^5$

i. Oxidation state : +1, +3, +5, +7 and –1. Fluorine shows –1 oxidation state only at room temperature.

Chemical properties

(a) Reaction with Hydrogen : They form hydrogen halides (HX) and reactivity towards hydrogen decreases from F_2 to I_2.

Variation of acidity : HF < HCl < HBr < HI due to weakening of basic strength of halide ions in the order F^- > Cl^- > Br^- > I^- (when the conjugate base is strong the acid is weak.)

Variation of b.p of HX : HF > HI > HBr > HCl. HF has a high b.p. due to strong intermolecular hydrogen bonding and HI has the second highest b.p. due to strong vander waal's force

Variation of M.P. : HI > HF > HBr > HCl

(b) Reaction with O_2 : Most of the oxides of halogens are unstable. OF_2 is a fluoride of O_2 and act as a strong fluorinating agent. Another fluoride of O_2, namely O_2F_2 is used to produce PuF_6.

Cl_2, Br_2 and I_2 form oxides in +1, +3, +5 and +7 oxidation states. The stability of oxides is in the order I > Cl > Br and oxides in higher oxidation state are more stable than in lower oxidation state.

Oxides of Cl_2 (Cl_2O, Cl_2O_6 and Cl_2O_7) are highly reactive oxidisers having explosive character. ClO_2 is used to bleach paper - pulp and cotton and in water treatment.

Oxides of bromine are least stable and exist only at low temperatures. (middle row anomaly). (p-block element from Ga to Kr and d-block element from Y to Cd show anomalous properties due to a higher

effective nuclear charge resulting from the filling up of 3d and this is known as middle row-anomaly).

I_2O_5 is an oxidising agent and it is used in the estimation of CO.

Reaction with metals : They form halide with metals. Ionic character varies in the order.

MF > MCl > MBr > MI

Halides in higher O.S. are more covalent than the ones in lower O.S.

Eg : $SnCl_4$, $PbCl_4$, $SbCl_5$ and UF_6 are more covalent than $SbCl_4$, $PbCl_4$, $SbCl_5$ and UF_6 respectively

Elements of group 18 (He, Ne, Ar, Kr, Xe and Rn)

Occurrence : All elements of group 18 except Rn occurs in the atmosphere. The most abundant noble gas in the universe is He and in the earth's atmosphere Ar is the most abundant noble gas. He is found associated with radioactive minerals and Rn is a decay product of Ra (226).

Electronic configuration : $ns^2 sp^6$ except He

ΔiH_1 : Highest in the period

ΔegH : Highly positive

Physical properties: They are monoatomic gases. They are odourless, colourless and tasteless. They have very low MP and BP due to weak interatomic forces. Helium has the lowest B.P. among all known substances (4.2 K). Liquid helium can diffuse through glass rubber or plastics.

Chemical properties : They are chemically inert due to a *saturated valence shell electronic configuration.*

Compounds of Noble-gases : The first compound of any noble gas element prepared was $XePtF_6$ (Neil Bartlet)

Xenon forms XeF_2, XeF_4 and XeF_6 by direct combination with F_2 under proper conditions.

$$\underset{(\text{excess})}{Xe} + F_2 \xrightarrow[(\text{Nickel container})]{673K,\ 1bar} XeF_2(s)$$

$$\underset{(1\ \text{part})}{Xe} + \underset{(5\ \text{parts})}{2F_2} \xrightarrow[(\text{Ni-container})]{873K,\ 7\ bar} XeF_4(s)$$

$$\underset{(1\ \text{part})}{Xe} + \underset{(20\ \text{parts})}{3F_2} \xrightarrow[(\text{Ni-container})]{573K,\ 60-70\ bar} XeF_6(s)$$

$$XeF_4 + O_2F_2 \xrightarrow{143\ K} XeF_6 + O_2$$

They are colourless crystalline solids and sublime readily at 298 K. They are strong fluorinating agents. They undergo hydrolysis.

$$2XeF_2 + 2H_2O \longrightarrow 2Xe + 4HF + O_2$$

$$6XeF_4 + 12H_2O \longrightarrow 4Xe + 2XeO_3 + 24HF + 3O_2$$

$$XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF$$

$$XeOF_4 + H_2O \longrightarrow XeO_2F_2 + 2HF$$

$XeO_2F_2 + H_2O \longrightarrow XeO_3 + 2HF$

XeO_3 is a a colourless explosive solid.

Compounds	Hybridisation state	Geometry
XeF_2	sp^3d	linear
XeF_4	sp^3d^2	square planar
XeF_6	sp^3d^3	distorted octahedral
XeO_3	sp^3	pyramidal
$XeOF_4$	sp^3d^2	square pyramidal

Xenon fluorides combine with fluoride ion acceptors to form cationic species.

Eg : $XeF_2 + PF_5 \longrightarrow [XeF]^{\oplus}\ [PF_6]^{\ominus}$ and fluoride ion donors to form fluoroanions.

Eg : $XeF_6 + KF \longrightarrow K^{\oplus}\ [XeF_7]^{\ominus}$

Uses : Helium is used to inflate balloons, to produce very low temperature for cryogenic experiments, to dilute O_2 for SCUBA to eliminate BENDS of deep sea divers. Also used to sustain powerful super conducting magnets used in MRI scanners.

Neon is used to produce red light in discharge tubes and sign-boards.

Argon is used to produce inert atmosphere in metallurgical processes and to fill incandescent bulbs. Xe and Kr are used in sign-boards.

PART-I (JEE MAIN)

SECTION-I- Straight objective type questions

1. Which of the following statements is false?

   1) Boron has unusually high melting point due to very strong crystalline lattice

   2) Gallium with unusually low melting point can exist as a liquid during summer

   3) Radius of indium and thallium are comparable because thallium has noble gas plus 14 f-electrons plus 10 d-electron core

   4) In group 13, electronegativity of the elements steadily decreases from boron to thallium

2. The stability of +1 oxidation state for group 13 elements increases in the sequence

   1) $Tl < In < Ga < Al$ 2) $In < Tl < Ga < Al$ 3) $Ga < In < Al < Tl$ 4) $Al < Ga < In < Tl$

3. The element that is used in high temperature thermometer is

   1) Al 2) Hg 3) Ga 4) Pb

4. Which of the following lead halides does not exist?

   1) PbF_4 2) $PbCl_4$ 3) $PbBr_4$ 4) PbI_4

5. Bond energy is highest for the bond

   1) $Sn - Sn$ 2) $C - C$ 3) $Si - Si$ 4) $Ge - Ge$

6. Which one of the following is not correct for the allotropic forms of carbon?

   1) C_{60} molecule has a shape like soccer ball and its structure contains twenty six-membered rings and twelve five-membered rings

   2) Graphite is thermodynamically the most stable allotrope of carbon

   3) Graphite has a layered structure. Each layer is composed of hexagonal rings of carbon atoms

   4) In diamond, each carbon atom is sp^2 hybridised where as in graphite and fullerene, all the carbon atoms are sp^3 hybridised

7. Which of the following statements is not correct for group 15 elements?

   1) Except nitrogen all elements show allotropy

   2) The N-N single bond is stronger than P-P single bond, thus catenation capacity is greater for nitrogen

   3) Both black phosphorus and red phosphorus are less reactive than white phosphorus

   4) Boiling point increases from top to bottom upto antimony but melting point increases up to arsenic and then decreases

8. Which of the following is an acidic oxide?

   1) As_2O_3 2) P_2O_3 3) Bi_2O_3 4) Sb_2O_3

9. The correct order of ease of formation of hydrides is

   1) $NH_3 > PH_3 > AsH_3 > BiH_3$ 2) $BiH_3 > AsH_3 > PH_3 > BiH_3$

   3) $NH_3 > AsH_3 > PH_3 > BiH_3$ 4) $BiH_3 > PH_3 > AsH_3 > NH_3$

10. Which of the following options correctly represent the variation in the indicated properties for the group16 hydrides?

    i) $H_2O < H_2S < H_2Se < H_2Te$: Acidic strength

    ii) $H_2O > H_2S > H_2Se > H_2Te$: Reducing nature

    iii) $H_2O > H_2S > H_2Se > H_2Te$: Thermal stability

    iv) $H_2Te > H_2O > H_2Se > H_2S$: Boiling point

    1) ii, iii and iv 2) ii, and iii 3) i and iii 4) i, ii, iii and iv

11. Which of the following acids contain peroxy linkage?

I. $H_2S_2O_7$ II. $H_2S_2O_8$ III. H_2SO_5 IV. H_2SO_3

1) I and II only 2) II and III only 3) I,II and III only 4) II, III and IV only

12. The correct order of decreasing stability of hexafluorides of group 16 elements is :

1) $TeF_6 > SeF_6 > SF_6$ 2) $SF_6 > TeF_6 > SeF_6$ 3) $SF_6 > SeF_6 > TeF_6$ 4) $TeF_6 > SF_6 > SeF_6$

13. Which of the following sets of compounds cannot be hydrolysed easily?

1) $SiCl_4$, NCl_3 and TeF_6 2) CCl_4, NF_3 and SF_6 3) $GeCl_4$,PCl_3 and TeF_6 4) $SnCl_4$, PCl_5 and TeF_6

14. Which of the following reactions is non spontaneous?

1) $Cl_2+H_2O \rightarrow HCl+HOCl$ 2) $2I_2 + 2H_2O \rightarrow 4HI+O_2$

3) $Br_2+H_2O \rightarrow HBr+HOBr$ 4) $2F_2+2H_2O \rightarrow 4HF+O_2$

15. The high oxidising power of F_2 is due to its

1) high electron affinity

2) low enthalpy of hydration and high enthalpy of dissociation

3) high enthalpy of hydration and low enthalpy of dissociation

4) high enthalpy of hydration and high enthalpy of dissociation

16. The correct order of boiling point of hydrogen halides is

1) HF>HI>HBr>HCl 2) HF>HCl>HI>HBr 3) HF>HCl>HBr>HI 4) HI>HF>HBr>HCl

17. Match the following :

Column-I	**Column-II**
A) $I_2<Br_2<Cl_2<F_2$	P) pKa
B) $Cl_2>Br_2>F_2>I_2$	Q) Standard reduction potential
C) HI<HBr<HCl<HF	R) Bond energy
D) HI>HF>HBr>HCl	S) Melting point

1) A-R, B-Q, C -P, D- S 2) A-Q, B-R, C - P, D - S

3) A-Q, B-R, C-S, D - P 4) A -R, B-Q, C-S, D - P

18. Which of the following is not true about helium?

1) It has the lowest boiling point of any known substance

2) It has the highest first ionization energy

3) It can diffuse through rubber, glass and plastic material

4) It is the least abundant element of the group

19. Match List I with List II and select the correct answer using the codes given below the list

List-I (Compound)	**List-II (Molecular shape)**
A. XeF_4	1. Distorted octahedral
B. XeF_6	2. Square pyramidal
C. XeO_3	3. Square planar
D. $XeOF_4$	4. Pyramidal

1) $A \rightarrow 1; B \rightarrow 2; C \rightarrow 3; D \rightarrow 4$

2) $A \rightarrow 3; B \rightarrow 1; C \rightarrow 4; D \rightarrow 2$

3) $A \rightarrow 1; B \rightarrow 3; C \rightarrow 2; D \rightarrow 4$

4) $A \rightarrow 2; B \rightarrow 4; C \rightarrow 1; D \rightarrow 3$

20. If XeF_2 and XeF_6 are hydrolysed separately, then

1) Both give out O_2

2) XeF_6 gives O_2 but XeF_2 does not

3) XeF_2 alone gives out O_2

4) Neither of them gives HF

SECTION-II - Numerical Type Questions

21. The atomic number of an element with highest first ionisation enthalpy in group 13 is .....

22. Lead is a strong oxidising agent in the oxidation state of .....

23. The P–P–P bond angle in white phosphorous is close to ..... °

24. The total number of P-H bond(s) in H_3PO_2 is .....

25. How many of the following do(es) not exist?

$[SiF_6]^{2-}$, $[GeCl_6]^{2-}$, $[SiCl_6]^{2-}$, $[BF_6]^{3-}$, $[Al(H_2O)_6]^{3+}$, $[Al(OH)_4]^-$