

UNIT 7

P-BLOCK ELEMENTS

Points to remember

The general valence shell electronic configuration of p-block elements ns^2np^{1-6}

GROUP 15 ELEMENTS

Group 15 elements: N, P, As, Sb & Bi

General electronic configuration: ns^2np^3

Physical Properties

Dinitrogen is a diatomic gas while all others are solids.

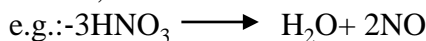
N & P are non-metals. As & Sb metalloids & Bi is a metal. This is due to decrease in ionization enthalpy and increase in atomic size.

Electro negativity decreases down the group.

Chemical properties

Common oxidation states: -3, +3 & +5.

Due to inert effect, the stability of +5 state decreases down the group & stability of +3 state increases in the case of nitrogen oxidation states from +1 to +4 tend to disproportionate in acid solution,



An anomalous behavior of Nitrogen:- due to its small size, high electro negativity, high ionization enthalpy and absence of d-orbital.

N_2 has unique ability to form $p\pi-p\pi$ multiple bonds whereas the heavier of this group do not form $p\pi-p\pi$ because their atomic orbitals are so large and diffuse that they cannot have effective overlapping.

Nitrogen exists as diatomic molecule with triple bond between the two atoms whereas other elements form single bonds in elemental state.

N cannot form $d\pi-p\pi$ due to the non availability of d-orbital whereas other elements can.

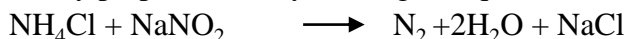
Trends in Properties

Stability-	$\text{NH}_3 > \text{PH}_3 > \text{AsH}_3 > \text{SbH}_3 > \text{BiH}_3$
Bond dissociation enthalpy-	$\text{NH}_3 > \text{PH}_3 > \text{AsH}_3 > \text{SbH}_3 > \text{BiH}_3$
Reducing character -	$\text{NH}_3 < \text{PH}_3 < \text{AsH}_3 < \text{SbH}_3 < \text{BiH}_3$
Basic character-	$\text{NH}_3 > \text{PH}_3 > \text{AsH}_3 > \text{SbH}_3 > \text{BiH}_3$
Acidic character-	$\text{N}_2\text{O}_3 > \text{P}_2\text{O}_3 > \text{As}_2\text{O}_3 > \text{Sb}_2\text{O}_3 > \text{Bi}_2\text{O}_3$

DINITROGEN

PREPARATION

- Commercial preparation- By the liquefaction & fractional distillation of air.
- Laboratory preparation- By treating an aqueous solution NH_4Cl with sodium nitrite.



- Thermal decomposition of ammonium dichromate Also give N_2 .



- Thermal decomposition of Barium or Sodium azide gives very pure N_2 .

PROPERTIES

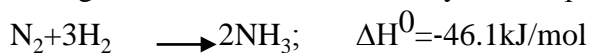
At high temperature nitrogen combines with metals to form ionic nitride (Mg_3N_2) & with non-metals, covalent nitride.

AMMONIA PREPARATION

Ammonia is prepared in the laboratory by heating ammonium salt with NaOH or lime.



In large scale it is manufactured by Haber's process



According to Le chatelier's principle the favorable conditions for the manufacture of NH_3 are :-
Optimum temperature: 700K High pressure: 200atm, Catalyst : Iron Oxides, Promoter : K_2O & Al_2O_3

PROPERTIES

Ammonia is a colorless gas with pungent odour. Highly soluble in water.

In solids & liquid states it exists as an associated molecule due to hydrogen bonding which accounts for high melting & boiling points of NH_3

NH_3 molecule is trigonal pyramidal shape. Aqueous solution of ammonia is weakly basic due to the formation of OH^- ion.



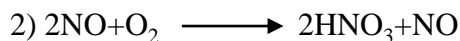
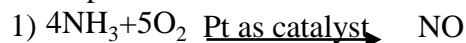
Ammonia can form coordinate bonds by donating its lone on nitrogen, ammonia forms complexes.



Name	Formula	Oxidation state	Chemical nature
Nitrous oxide	N_2O	+1	Neutral
Nitric oxide	NO	+2	Neutral
Dinitrogen trioxide	N_2O_3	+3	Acidic
Dinitrogen tetra oxide	N_2O_4 or NO_2	+4	Acidic
Dinitrogen penta oxide	N_2O_5	+5	Acidic

NITRIC ACID

PREPARATION: Ostwald's process— it is based upon catalytic oxidation of ammonia by atmospheric oxidation. The main steps are



PROPERTIES:

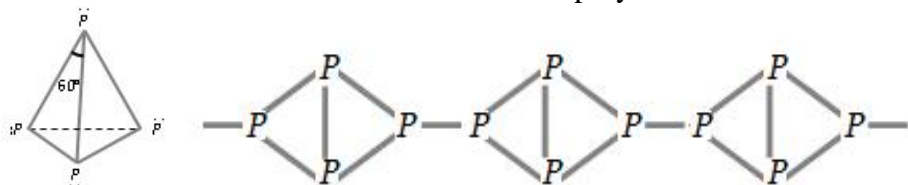
- I. Conc. HNO_3 is a strong oxidizing agent and attacks most metals gold & Pt.
- II. Cr & Al do not dissolve HNO_3 because of the formation of a positive film of oxide on the surface.
- III. It oxidizes non metals like I_2 to HIO_3 , C to CO_2 , S to H_2SO_4
- IV. Brown ring test is used to detect NO_3^- .

PHOSPHOROUS

ALLOTROPIC FORMS: White/yellow, red and Black (α -black & β -black).

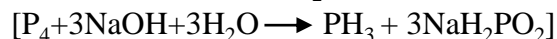
White phosphorous is more reactive red phosphorous because white P exists as discrete P_4 molecules.

In P several P_4 molecules are linked to form polymeric chain.



PHOSPHINE

Preparation: It is prepared in laboratory by heating white P with concentrated NaOH solution in an inert atmosphere of CO₂



PHOSPHOROUS HALIDES

Phosphorous forms two types of halides PX₃ & PX₅ (X=F,I,Br)

Trihalides have pyramidal shape and pentahalides have trigonal bipyramidal structure.

OXO ACIDS OF PHOSPHOROUS

1. The acids in +3 oxidation state disproportionate to higher & lower oxidation.
 $4H_3PO_3 \longrightarrow 3H_3PO_4 + PH_3$
2. Acids which contain P-H bond have strong reducing properties. EX: -H₃PO₂
3. Are ionisable and cause the basicity.
4. Hydrogen atoms which are attached with oxygen in P-OH form are ionisable

GROUP 16 ELEMENTS (CHALCOGENS)

Group 16 Elements: O, S, Se, Te, Po General electronic configuration: ns²np⁴

Element	Occurrence
Sulphur	As sulphates such as gypsum CaSO ₄ .2H ₂ O, Epsom salt MgSO ₄ .7H ₂ O and sulphides such as galena PbS, zinc blende ZnS, copper pyrites CuFeS ₂

As metal selenides and telluride in sulphide ores.

Se & Te as a decay product of thorium and uranium minerals.

ATOMIC & PHYSICAL PROPERTIES

- Ionization enthalpy decreases from oxygen to polonium.
- Oxygen atom has less negative electron gain enthalpy than S because of the compact nature of the oxygen atom. However from the S onwards the value again becomes less negative up to polonium.
- Electro negativity gradually decreases from oxygen to polonium, metallic character increases from oxygen to polonium.
- Oxygen & S are non-metals, selenium and tellurium are metalloids. Po is a radioactive metal.
- Oxygen is a diatomic gas while S, Se & Te are octatomic S₈, Se₈ & Te₈ molecules which has 'puckered' ring' structure.

CHEMICAL PROPERTIES

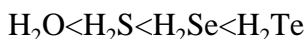
- Common oxidation state: -2, +2, +4 & +6.
- Due to inert effect, the stability of +6 decreases down the group and stability of +4 increases.

Oxygen exhibits +1 state in O₂F₂, +2 in OF₂.

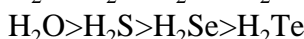
Anomalous behavior of oxygen- due to its small size, high electro negativity and absence of d-orbital.

TREND IN PROPERTIES

Acidic character-



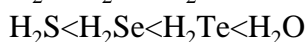
Thermal stability-



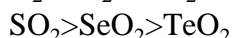
Reducing character-



Boiling point-



Reducing property of dioxides-



Stability of halides-



Halides

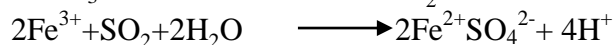
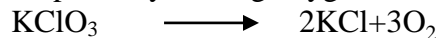
Dihalides: sp³ hybridisation but angular structure.

Tetra halides: sp³ hybridization-see-saw geometry

Hexa halides: sp³d², octahedral SF₆

DIOXYGEN

Prepared by heating oxygen containing salts like chlorates, nitrates



SO₂ molecule is angular.

OXIDES

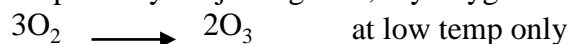
A binary compound of oxygen with another element is called oxide. Oxides can be classified on the basis of nature

- Acidic Oxides:- Non metallic oxides. Aqueous solutions are acids. Neutralize bases to form salts. Ex: SO₂, CO₂, N₂O₅ etc.
- Basic Oxides: metallic oxides. Aqueous solutions are alkalis. Neutralize acids to form salts. Ex: Na₂O, K₂O, etc.
- Amphoteric oxides:- Some metallic oxides exhibit a dual behavior. Neutralize both acids & bases to form salts.

Ex: Al₂O₃, SbO₂, SnO etc

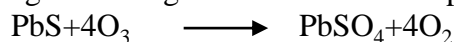
OZONE PREPARATION

Prepared by subjecting cold, dry oxygen to silent electric discharge.



PROPERTIES

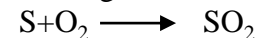
Due to the ease with which it liberates atoms of nascent oxygen, it acts as a powerful oxidizing agent. For eg: -it oxidizes lead sulphide to lead sulphate and iodide ions to iodine.



SULPHURDIOXIDE

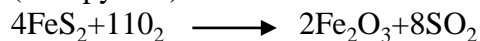
PREPARATION

Burning of S in air

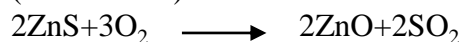


Roasting of sulphide minerals

(Iron pyrites)



(Zinc blende)



PROPERTIES

- Highly soluble in water to form solution of sulphurous acid
$$\text{SO}_2 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{SO}_3$$
- SO₂ reacts with Cl₂ to form sulphuryl chloride
$$\text{SO}_2 + \text{Cl}_2 \longrightarrow \text{SO}_2\text{Cl}_2$$
- It reacts with oxygen to form SO₃ in presence of V₂O₅ catalyst
$$2\text{SO}_2 + \text{O}_2 \longrightarrow 2\text{SO}_3$$
- Moist SO₂ behaves as a reducing agent. It converts Fe(III) ions to Fe(II) ions & decolorizes acidified potassium permanganate(VII) solution (It is the test for the gas).

SULPHURIC ACID:

PREPARATION

It is manufactured by **contact process** which involves 3 steps

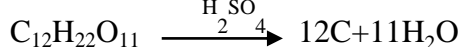
1. Burning of S or Sulphide ores in air to generate SO_2 .
2. Conversion of SO_2 to SO_3 in presence of V_2O_5 catalyst
3. Absorption of SO_3 in H_2SO_4 to give oleum.

PROPERTIES

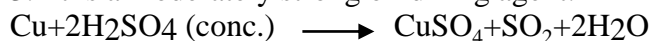
1. In aqueous solution it ionizes in 2 steps



2. It is a strong dehydrating agent Eg :-charring action of sugar



3. It is a moderately strong oxidizing agent.



GROUP 17 ELEMENTS (HALOGENS)

Group 17 elements: F, Cl, Br, I, At

General electronic configuration: $ns^2 np^5$

Element	Occurrence
Fluorine (F)	As in soluble fluorides (fluorspar CaF_2 , Cryolite and fluoroapatite)
Cl, Br, I	Sea water contains chlorides, bromides and iodides of Sodium, potassium magnesium and calcium, but is mainly sodium chloride solution (2.5% by mass). Certain form so f marine life (various sea weeds)

ATOMIC & PHYSICAL PROPERTIES

- i. Atomic & ionic radii increase from fluorine to iodine.
- ii. Ionization enthalpy gradually decreases from fluorine to iodine due to increase in atomic size.
- iii. Electron gain enthalpy of fluorine is less than that of chlorine. It is due to small size of fluorine & repulsion between newly added electron & electrons already present in its small 2 p orbital.
- iv. Electro negativity decreases from fluorine to iodine. Fluorine is the most electro negative element in the periodic table.
- v. The color of halogens is due to absorption of radiations invisible region which results in the excitation of outer electrons to higher energy level.
- vi. Bond dissociation enthalpy of fluorine is smaller than that of chlorine is due to electron-electron repulsion among the lone pair in fluorine molecules where they are much closer to each other than in case of chlorine. The trend: $\text{Cl-Cl} > \text{Br-Br} > \text{F-F} > \text{I-I}$.

CHEMICAL PROPERTIES

OXIDATION STATES: -1. However, chlorine, bromine & iodine exhibit +1, +3, +5, +7 oxidation states also.

Fluorine forms two oxides OF_2 and O_2F_2 . These are essentially oxygen fluorides because of the higher electro negativity of fluorine than oxygen.

Anomalous behavior of fluorine - due to its small size, highest electro negativity, low F-F bond dissociation enthalpy and absence of d-orbitals.

TRENDS IN PROPERTIES

Oxidizing property – $F_2 > Cl_2 > Br_2 > I_2$

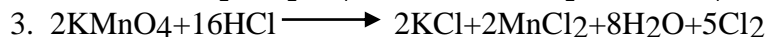
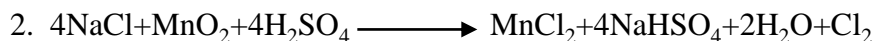
Acidic strength- $HF < HCl < HBr < HI$

Stability & bond dissociation enthalpy- $HF > HCl > HBr > HI$ Stability of oxides of halogens- $I > Cl > Br$

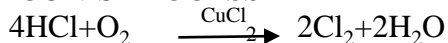
Ionic character of halides- $MF > MCl > MBr > MI$

CHLORINE

PREPARATION



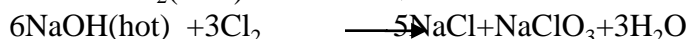
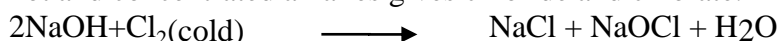
4. DEACON'S PROCESS



5. By electrolysis of brine solution. Cl_2 is obtained at a node.

PROPERTIES

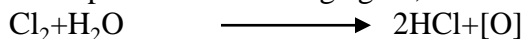
a) With cold and dilute alkalis Cl_2 produces a mixture of chloride and hypochlorite but with hot and concentrated alkalis gives chloride and chlorate.



b) With dry slaked lime it gives bleaching powder.



c) It is a powerful bleaching agent; bleaching action is due to oxidation



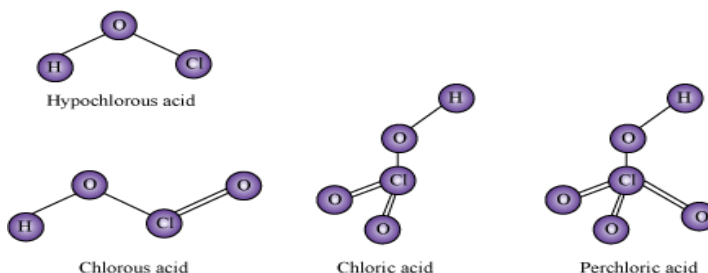
Colored substance + [O] colorless substance

d) Action of concentrated H_2SO_4 on $NaCl$ give HCl gas.



3:1 ratio of conc. HCl & HNO_3 is known as aquaregia & it is used for dissolving noble metals like Au and Pt .

OXO ACIDS OF HALOGENS



Inter halogen

Inter halogen compounds are prepared by direct combination of halogens. Ex: ClF , ClF_3 , BrF_5 , IF_7 . They are more reactive than halogens because $X-X'$ is weaker than $X-X$ bonds in halogens (except $F-F$).

TYPE	STRUCTURE
XX'_3	Bent T-shaped
XX'_5	Square pyramidal
XX'_7	Pentagonal bi pyramidal

GROUP 18 ELEMENTS

Group 18 elements: He, Ne, Ar, Kr, Xe & Rn

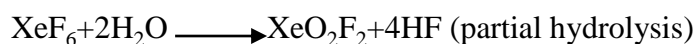
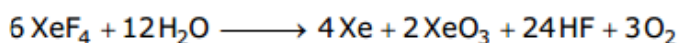
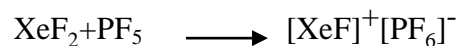
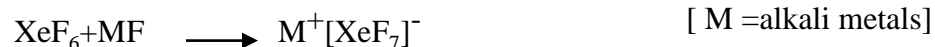
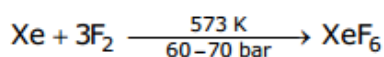
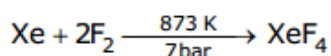
General electronic configuration: ns^2np^6

Atomic radii- large as compared to other elements in the periods in which it corresponds to Van der Waals radii.

Inert—due to complete octet of outer most shell, very high ionization enthalpy & electron gain enthalpies are almost zero.

The first noble compound prepared by Neil Bartlett was $XePtF_6$ & Xenon. $O_2^+PtF_6^-$ leads to the discovery of $XePtF_6$ since first ionization enthalpy of molecular oxygen (1175kJmol^{-1}) was almost identical with that of xenon (1170kJmol^{-1}).

PROPERTIES



VERY SHORT ANSWER TYPE QUESTION (1 marks)

- Nitrogen does not form pentahalide although it exhibits +5 oxidation state.**
Due to absence of d-orbitals N cannot extend its valency beyond four.
- NH_3 acts as Lewis base.**
Because N has a lone pair of electrons so NH_3 acts as a Lewis base.
- NH_3 is a stronger base than PH_3 .**
Due to the smaller size of nitrogen there is high electron density on nitrogen so the electron pair is easily available.
- All the five P-Cl bonds are not equal in PCl_5 .**
The two axial bonds suffer more repulsion from equatorial bonds and hence are elongated.
- H_3PO_3 is dibasic (diprotic) but H_3PO_4 is tribasic.**
In H_3PO_3 only two H atoms are linked to O which are ionisable; the third H is attached to P and not ionisable because P is less electronegative. In H_3PO_4 all the three H atoms are with O and ionisable.
- PCl_5 is ionic in solid state.**
It is due to the following conversion: $2PCl_5 \rightleftharpoons [PCl_4]^+[PCl_6]^-$
- Nitrogen shows little catenation but phosphorous distinctly shows catenation property.**
Due to the smaller size of N there is repulsion between the lone pairs and N-N single bond is weaker than P-P.
- +5 oxidation state of Bi is less stable than +3.**
Because the inert pair effect is very prominent in Bi, so +5 oxidation state is not stable.
15. Bi in +5 oxidation state is a strong oxidizing agent.
Because the inert pair effect is very prominent in Bi so Bi^{5+} can be easily converted into Bi^{3+} .
- N_2 is less reactive at room temperature.**

Due to having triple bond and hence high bond dissociation energy(946 kJ/mol

11. N exists as N₂ and gas form but P exists as P₄ and solid

Due to smaller size N can form pπ-dπ multiple bonding and exists as discrete N₂ molecule but P can not form pπ-pπ multiple bonding.

12. H₂S is acidic while H₂O is neutral.

H-S bond is weaker due to larger size of S so proton release easier in H₂S

13. Compound of F & O is fluoride of oxygen not oxide of fluorine .

F is more electronegative than O.

14. SCl₆ is not known but SF₆ is known

F is strongest oxidizing agent so it can oxidizes S to its maximum oxidation state +6 . Cl can not. Again Cl has larger size so steric repulsion is there in SCl₆

15. H₂O is liquid but H₂S is gas

O is electronegative so there is intermolecular H-bonding in water so it is liquid.

16. O₂ is gas but sulphur is solid

Due to smaller size O can form pπ-pπ multiple bond and exists as discrete diatomic molecule.

17. Group 16 elements are called chalcogens

Chalcogen means ore forming elements. They form several ores

18. Halogens have maximum negative electron gain enthalpy(Δ_{eg}H)

Because they have smallest size in their respective periods

19. F has less electron gain enthalpy than that of Cl but fluorine is stronger oxidizing agent than chlorine.

F has very small size so there is inter-electronic repulsion. F is stronger oxidizing agent due to its low bond dissociation energy and high hydration energy

20. F exhibits only -1 oxidation state , other halogen shows +1, +3, +5, +7 oxidation states

F is most electronegative element and due to absence of d-orbitals it can not expand its octet so it does not exhibit positive oxidation state.

21. Bond dissociation energy of F₂ is less than Cl₂

Due to very small size of F there is interelectronic repulsion in F₂ so it has low bond dissociation energy

22. HF has lower acid strength than HI

Due to larger size of I the H-I bond is weaker than H-F bond so HI is stronger

23. He, Ne do not form compound with F.

Due to high IE

24. Noble gases have very low b.pt

Because there is only weak dispersion force between their atoms.

25. Ne used as warning signal

Because Ne – light has high fog penetration power

26. Noble gases form compounds only with fluorine and oxygen

Because F & O are the most electronegative elements

27. Out of noble gases only Xe forms compounds

Because Xe has comparatively low IE and vacant orbitals for promotion of electrons

28. Noble gases are mostly inert

Because they have completely filled valence orbitals i.e octet configuration

29. He is used as diving apparatus .

Because it is less soluble in blood with compare to nitrogen

30. It is difficult to study the chemistry of Rn.

Because Rn is radioactive and hence very unstable

31. Noble gases have comparatively large atomic size.

They are mono atomic so their van der Waals radii measured which is longer than covalent/ionic or metallic radii.

32. Complete and balance the following reaction:

- (i) $\text{NH}_4\text{Cl} + \text{NaOH} \rightarrow 2\text{NH}_3 + 2\text{H}_2\text{O} + 2\text{Na}_2\text{SO}_4$
(ii) $2\text{FeCl}_3 + 3\text{NH}_4\text{OH} \rightarrow \text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}(\text{s}) + 3\text{NH}_4\text{Cl}$
(iii) $\text{Cu} + 2(\text{aq}) + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_4]^{+2}(\text{aq})$
(iv) $3\text{Cu} + \text{dil. HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO} + 4\text{H}_2\text{O}$
(v) $\text{Zn} + \text{dil. HNO}_3 \rightarrow 4\text{Zn}(\text{NO}_3)_2 + \text{NH}_4(\text{NO}_3) + 3\text{H}_2\text{O}$
(vi) $\text{Zn} + \text{conc. HNO}_3 \rightarrow \text{Zn}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$
(vii) $\text{XeF}_6 + 3\text{H}_2\text{O} \rightarrow \text{XeO}_3 + 6\text{HF}$
(viii) $\text{XeF}_6 + \text{H}_2\text{O} \rightarrow \text{XeOF}_4 + 2\text{HF}$
(ix) $\text{Ca}_3\text{P}_2 + 6\text{H}_2\text{O} \rightarrow 2\text{PH}_3 + \text{Ca}(\text{OH})_2$
(x) $\text{P}_4 + 3\text{KOH} + 3\text{H}_2\text{O} \rightarrow 3\text{KH}_2\text{PO}_2 + \text{PH}_3$

SHORT ANSWER TYPE QUESTION (2 marks)

1. Bond angle in PH_4^+ is higher than that in PH_3 . Why?

Sol: Both PH_4^+ and PH_3 involve sp^3 hybridization of P atom. In PH_4^+ all the four orbitals are bonded whereas in PH_3 there is a lone pair of electrons on P. In PH_4^+ the HPH bond angle is tetrahedral angle of 109.5° . But in PH_3 the lone pair-bond pair repulsion is more than bond pair-bond pair repulsion so that bond angle becomes less than normal tetrahedral angle of 109.5° . The bond angle in PH_3 has been found to be 93.6° .

2. H_2O is a liquid and H_2S is a gas. Explain why.

Sol: In H_2O hydrogen is bonded to highly electronegative element oxygen. Therefore there is strong intermolecular H-bonding in water. As, a result molecules exist as associated water is a liquid at room temperature. Whereas in case of H_2S there is negligible hydrogen bonding because of low electro negativity of Sulphur. Hence, H_2S is a gas at room temperature.

3. Why is BiH_3 the strongest reducing agent among all the hydrides of group 15?

Sol: Among the hydride of group 15 BiH_3 is least stable because Bi has largest size in the group and has least tendency to form covalent bonds with small hydrogen atom. Therefore it can readily lost H atom and hence has strongest tendency to act as reducing agent.

4. Fluorine shows anomalous behavior among Halogens. Give instances.

Sol: (i) Since fluorine is the most electronegative element, it shows only a negative oxidation state of -1. It does not show any positive oxidation state. On the other hand, other Halogens show positive oxidation states also such as, +1, +3, +5, +6 and +7.

(ii) Maximum covalency of Fluorine is 1 because it cannot expand its valence shell. On the other hand, other elements can exercise covalencies up to 7 because of availability of vacant d-orbitals.

6. Why H_2S is less acidic than H_2Te ?

Sol: In H_2Te the size of central Te is more than that of S in H_2S and therefore the distance between the central atom and the hydrogen atom in Te-H is more than that of S-H. As a result of large bond length, the bond disassociation enthalpy of Te-H is less than that of S-H and bond cleavage of H_2Te is easy. Hence, H_2Te is more acidic than H_2S .

7. What do you mean by Clathrates?

Sol: A compound formed by physical trapping of molecules of one substance in holes in the crystal lattice of another. Clathrates are produced by crystallizing a mixture of two substances. Quinol, for example, has holes in its lattice and can hold noble gases, oxygen methane, etc. Ice can form clathrate compounds with argon, krypton and xenon. In such compounds no chemical bond is formed between the host compound and the trapped molecule.

8. Fluorine does not undergo disproportionation reaction but other Halogens do. Why?

Sol: Disproportionation means simultaneous oxidation-reduction. Fluorine being most electronegative element undergoes only reduction but not oxidation. As a result it only shows -1 oxidation state while other halogens show both negative (-1) and positive (+1,+3,+5,+7) oxidation states. Thus, Fluorine does not show disproportionation reaction while other halogens do.

9. Why interhalogens are more reactive than halogens?

Sol: This is because the bond in interhalogens (X-X') is weaker than (X-X). This is on account of less effective overlapping between orbital of dissimilar atoms than those of similar atoms. Hence, the X-X' bond can be broken easily and therefore Interhalogens are more reactive than halogens.

10. Helium and Neon doesn't form compounds with fluorine as Xenon does. Why?

Sol: Helium and Neon does not contain d-orbital in their valence shell and hence their electrons cannot be promoted to higher energy levels like that in Xenon to form bonds. Therefore Helium and Neon does not form bond with fluorine whereas Xenon does.

11. Give reasons for inertness shown by the Noble gases.

Sol: (i) The noble gases have completely filled $ns^2 np^6$ electronic configuration in their valence shell.

(ii) The noble gases have high ionization energy.

(iii) The electron affinities of noble gases are almost zero.

Q12. Explain why ClF_3 exists whereas FCl_3 does not.

Ans. Electronic configuration of Cl is $1s^2 2s^2 2p^6 3s^2 3p_x^2 3p_y^2 3p_z^1$. An electron from 3p can jump to 3d orbitals. So it can show an oxidation state of 3 and combine with the more electronegative fluorine. Electronic configuration of F is $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^1$. No d-orbital is available for excitation of electron. Moreover it is most electronegative element. So it shows an oxidation state of -1 only.

SHORT ANSWER QUESTIONS (3MARKS)

1. Arrange the following:

(i) F_2, Cl_2, Br_2, I_2 . Increasing bond disassociation enthalpy.

(ii) HF, HBr, HCl, HI. Increasing acid strength.

(iii) $NH_3, PH_3, AsH_3, SbH_3, BiH_3$. Increasing base strength.

Sol: (i) $I_2 < F_2 < Br_2 < Cl_2$.

(ii) $HF < HCl < HBr < HI$.

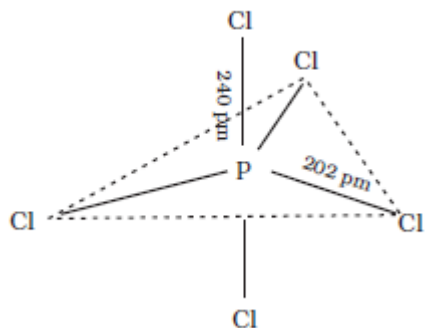
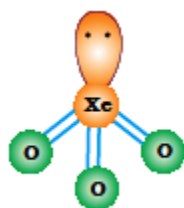
(iii) $BiH_3 < SbH_3 < AsH_3 < PH_3 < NH_3$.

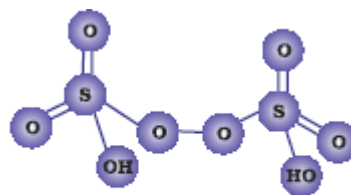
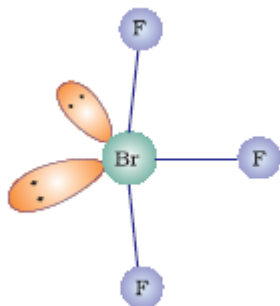
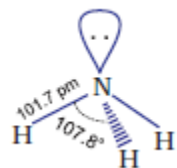
2. Draw the structure of followings and name the geometry

1. XeO_3, PCl_5

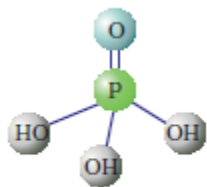
2. NH_3, ClF_3

3. $H_2S_2O_8, H_3PO_4$





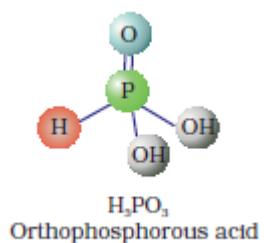
Peroxodisulphuric acid
($\text{H}_2\text{S}_2\text{O}_8$)



H_3PO_4
Orthophosphoric acid

Q.3. Draw the structure of followings and name the geometry

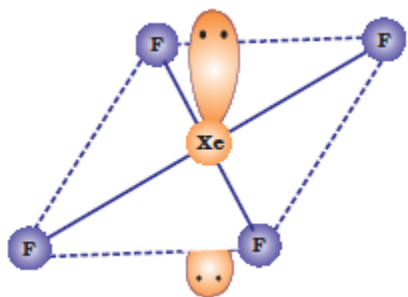
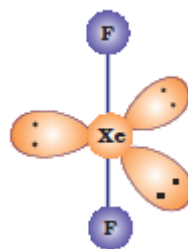
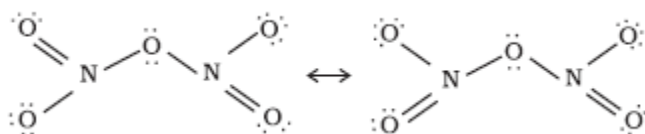
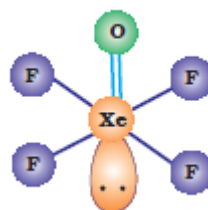
1. H_3PO_3 , H_2SO_4
2. XeOF_4 , N_2O_5
3. XeF_2 , XeF_4



H_3PO_3
Orthophosphorous acid



Sulphuric acid
(H_2SO_4)



4. Explain why (i) He is used in diving apparatus?
 (ii) Noble gases have very low boiling points. Why?
 (iii) Why is ICl more reactive than I₂?

Ans- (i) It is not soluble in blood even under high pressure.
 (ii) Being monoatomic they have weak dispersion forces.
 (iii) I-Cl bond is weaker than I-I bond

5. Account for the following.

- (i) SF₆ is less reactive than.
 (ii) of the noble gases only xenon chemical compounds.
 (iii) NO₂ is coloured and readily dimerises

Ans- (i) In SF₆ there is less repulsion between F atoms than in SF₄.
 (ii) Xe has low ionisation enthalpy & high polarising power due to larger atomic size.
 (iii) NO₂ contains odd number of valence electrons. It behaves as a typical odd molecule. On dimerization, it is converted to stable N₂O₄ molecule with even number of electrons.

6. Complete the following equations.

- (i) XeF₄ + H₂O →
 (ii) Ca₃P₂ + H₂O →
 (iii) AgCl_(s) + NH₃ (aq) →

Ans- (i) 6XeF₄ + 12H₂O → 4Xe + 2XeO₃ + 24HF + 3O₂
 (ii) Ca₃P₂ + 6H₂O → 3Ca(OH)₂ + 2PH₃
 (iii) AgCl_(s) + 2NH₃ (aq) → [Ag(NH₃)₂]Cl_(aq)

7. (i) How is XeOF₄ prepared? Draw its structure.
 (ii) When HCl reacts with finely powdered iron, it forms ferrous chloride and not ferric chloride, Why?

Ans- (i) Partial hydrolysis of XeOF₄

$$\text{XeF}_6 + \text{H}_2\text{O} \rightarrow \text{XeOF}_4 + 2\text{HF}$$
 Structure-square pyramidal.
 (ii) Its reaction with iron produces H₂

$$\text{Fe} + 2\text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2$$
 Liberation of hydrogen prevents the formation of ferric chloride.

LONG ANSWER TYPE QUESTION (5marks)

1. Account for the following.

- (i) Noble gas form compounds with F₂ & O₂ only.
 (ii) Sulphur shows paramagnetic behavior.
 (iii) HF is much less volatile than HCl.
 (iv) White phosphorous is kept under water.
 (v) Ammonia is a stronger base than phosphine.

Ans- (i) F₂ & O₂ are best oxidizing agents.
 (ii) In vapour state sulphur partly exists as S₂ molecule which has two unpaired electrons in the antibonding pi* orbitals like O₂ and, hence, exhibit paramagnetism.
 (iii) HF is associated with intermolecular H bonding.
 (iv) Ignition temperature of white phosphorous is very low (303 K). Therefore on exposure to air, it spontaneously catches fire forming P₄O₁₀. Therefore to protect it from air, it is kept under water.
 (v) Due to the smaller size of N, lone pair of electrons is readily available.

2. Arrange the following in the increasing order of the property mentioned.

(i) HOCl, HClO₂, HClO₃, HClO₄ (Acidic strength)

(ii) As₂O₃, ClO₂, GeO₂, Ga₂O₃ (Acidity)

(iii) NH₃, PH₃, AsH₃, SbH₃ (HEH bond angle)

(iv) HF, HCl, HBr, HI (Acidic strength)

(v) MF, MCl, MBr, MI (ionic character)

Ans- (i) Acidic strength: HOCl < HClO₂ < HClO₃ < HClO₄

(ii) Acidity: Ga₂O₃ < GeO₂ < As₂O₃ < ClO₂

(iii) Bond angle: SbH₃ < AsH₃ < PH₃ < NH₃

(iv) Acidic strength: HF < HCl < HBr < HI

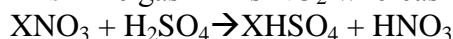
(v) Ionic character: MI < MBr < MCl < MF

3. When Conc. H₂SO₄ was added to an unknown salt present in a test tube, a brown gas (A) was evolved. This gas intensified when copper turnings were added in to test tube. On cooling gas (A) changed in to a colourless gas (B).

(a) Identify the gases 'A' and 'B'

(b) Write the equations for the reactions involved

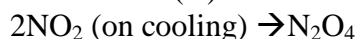
Ans- The gas 'A' is NO₂ whereas 'B' is N₂O₄.



Salt (conc.)



Blue Brown (A)



Colourless (B)

4. Account for the following.

(i) Noble gas form compounds with F₂ & O₂ only.

(ii) Sulphur shows paramagnetic behavior.

(iii) HF is much less volatile than HCl.

(iv) White phosphorous is kept under water. (v) Ammonia is a stronger base than phosphine.

Ans: (i) F₂ & O₂ are best oxidizing agents.

(ii) In vapour state sulphur partly exists as S₂ molecule which has two unpaired electrons in the anti bonding pi*π orbitals like O₂ and, hence, exhibit paramagnetism.

(iii) HF is associated with intermolecular H bonding.

(iv) Ignition temperature of white phosphorous is very low (303 K). Therefore on exposure to air, it spontaneously catches fire forming P₄O₁₀. Therefore to protect it from air, it is kept under water.

(v) Due to the smaller size of N, lone pair of electrons is readily available.

VALUE BASED QUESTIONS

1. Ammonium nitrate is used as a high nitrogen fertilizer in agriculture. It is also used in instant cold packs. It is mixed with fuel oil and used as explosive. Due to its various uses its production cannot be banned.

(a) What are cold packs?

(b) What steps Indian government has taken to avoid the misuse of ammonium nitrate by terrorists?

(c) What values are needed by an individual while handling such chemicals?

Ans: (a) They contain ammonium nitrate and water . Endothermic reaction gives cooling effect and relieves pain

(b) Only authorized dealers can sell ammonium nitrate

(c) Proper knowledge about the properties of the chemicals, misuse should be avoided, Chemical should be used only for the welfare of mankind

2. In recent years, the excessive uses of some aerosol propellants and refrigerants have depleted the ozone layer.

(a) Name two chemicals which deplete the ozone layer in the stratosphere.

(b) What is the importance of ozone in the stratosphere?

(c) Suggest some measures for minimizing global warming.

Ans.(a) NO, CFC'S

(b) Prevents entry of harmful ultraviolet radiations in earth's atmosphere.

(c) Minimising the usage of CFC'S, fossil fuels etc.

3. Student accidentally spills concentrated H_2SO_4 on his hand. Before the teacher gets to know, his friend washed his hands with water and also with soap but the burning sensation on hand was still going on. The friend then rubs solid sodium bicarbonate on his hand and then washed with water; finally the burning sensation is relieved.

(i) Mention the values shown by student's friend.

(ii) Can you recommend any other substance available in the laboratory which can be used instead of sodium bicarbonate?

Ans.(i) Concern and care for others and application of scientific knowledge

(ii) Slaked lime

4. India's top court ruled that authorities must regulate the sale of acid used in a spate of attacks on women. An acid called "Tezaab", which is designed to clean rusted tools but is often used in the attacks, can currently be bought across the counter. But the judges said the buyer of such acids should in future have to provide a photo identity card to any retailer when they make a purchase. The retailers must register the name and address of the buyer.

(a) Why are acid burns harmful?

(b) What are the values associated with the above discussion?

(c) What are responsibilities of the citizens in this regard?

Ans(a) Stringent measures to prevent misuse of acid

(b) They are highly corrosive.

(c) Help in preventing such incidences and helping victims , bringing to the notice of authorities such incidences

5. In a paper industry hydrogen peroxide is used bleaching agent. Satish asked his friend about using chlorine as bleaching agent. His friend told that using hydrogen peroxide was better.

(a) What is the disadvantage of using chlorine as bleaching agent?

(b) Why is use of hydrogen peroxide better?

Ans: (a) HCl is the bye product in case Cl is used as a bleaching agent

(b) Water is the bye product.
