

p-BLOCK ELEMENTS (HALOGEN & NOBLE GASES)

CONTENTS

Particular	Page No.
Theory	01 – 20
Exercise - 1	21 – 26
Part - I : Subjective Questions	
Part - II : Only One Option Correct Type	
Part - III : Match the Columns	
Exercise - 2	26 – 31
Part - I : Only One Option Correct Type	
Part - II : Single And Double Value Integer Type	
Part - III : One or More Than One Options Correct Type	
Part - IV : Comprehensions	
Exercise - 3	32 – 35
Part - I : JEE(ADVANCED) / IIT-JEE Problems (Previous Years)	
Part - II : JEE(MAIN) / AIEEE Problems (Previous Years)	
Answers	36 – 41
Additional Problems for self practice (APSP)	42 – 49
Part - I : PRACTICE TEST-1 (IIT-JEE (MAIN Pattern))	
Part - II : NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) STAGE-I	
Part - III : PRACTICE TEST-2 (IIT-JEE (ADVANCED Pattern))	
APSP Answers	50
APSP Solutions	51 – 54

JEE(Advanced) Syllabus

Isolation/preparation and properties of the following non-metals: Halogens Preparation and properties of the following compounds:

Halogens: Hydrohalic acids, oxides and oxyacids of chlorine, bleaching powder; Xenon fluorides.

JEE(Main) Syllabus

Group-17: Preparation, properties and uses of chlorine and hydrochloric acid; Trends in the acidic nature of hydrogen halides; Structures of interhalogen compounds and oxides and oxoacids of halogens.

Group-18: Occurrence and uses of noble gases; Structures of fluorides and oxides of xenon.



p-Block Elements (Halogen & Noble Gases)

Section (A) : Elements: Occurrence & Isolation

Introduction :

The five representative elements fluorine (F), chlorine (Cl), bromine (Br), iodine (I) and astatine (At) are members of Group 17. These are collectively known as the **halogens** (Greek halo means salt and genes means born i.e., salt producers). The halogens are highly reactive non-metallic elements. Like Groups 1 and 2, the elements of Group 17 show great similarity amongst themselves. That much similarity is not found in the elements of other groups of the periodic table.

GROUP 17 ELEMENTS : THE HALOGENS FAMILY

Occurrence :

All halogens are very reactive & do not occur in free state.

Element	Abundance	Source
F	544 ppm (13 th most abundant element)	<ul style="list-style-type: none"> Main Source : Fluorspar (CaF_2) or Fluorite Another Source : Fluoroapatite [$3\text{Ca}_3(\text{PO}_4)_2 \cdot \text{CaF}_2$] (Mainly source of P) Cryolite : Na_3AlF_6
Cl	126 ppm (20 th most abundant element)	<ul style="list-style-type: none"> Most abundant compound of Cl : NaCl (Sea water) Carnalite : $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$.
Br	2.5 ppm	<ul style="list-style-type: none"> Bromides occurs in sea water & brine lakes
I	0.46 ppm	<ul style="list-style-type: none"> Iodides occurs in low conc. in sea water. Better source : Natural brines Impurities (NaIO_3 & NaIO_4) in Chile salt petre (NaNO_3)
At	Radioactive & has a short half-life ($t_{1/2} = 7.2 \text{ Hr.}$)	<ul style="list-style-type: none"> Do not occur in nature

Allotropy :

All the elements of halogen family generally do not show allotropy.

Atomicity :

All halogens exist as diatomic (X_2) molecule.



Element Preparation

Fluorine

S.No.	Method	Process	Comments
1.	Moisson's Method (Electrolytic)	$\text{CaF}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + 2\text{HF}$ (Conc.)	
		$\text{KF} + \text{HF} \rightarrow \text{K}[\text{HF}_2]$	♦ $\text{K}[\text{HF}_2] \rightleftharpoons \text{K}^+[\text{F}-\text{H}-\text{F}]^-$
		Fluorine cell : Electrodes : Anode : Carbon Cathode : Steel Electrolyte : KHF_2 (1 part) + HF (5 part) Temperature of the both : -24°C Reaction : $\text{K}[\text{HF}_2] \longrightarrow \text{KF} + \text{HF}$ $\text{KF} \longrightarrow \text{K}^+ + \text{F}^-$ On electrolysis : At cathode : $\text{K}^+ + \text{e}^- \rightarrow \text{K}$ $\text{K} + \text{HF} \rightarrow \text{KF} + \text{H}$ $2\text{H} \rightarrow \text{H}_2(\text{g})$ At Anode : $\text{F}^- \rightarrow \text{F} + \text{e}^-$ $2\text{F} \rightarrow \text{F}_2$	♦ Anhydrous HF is only slightly ionized & is therefore a poor conductor of electricity. Thus a mixture of KF & HF in 1 : 13 mole ratio is electrolysed to increase the conductivity. Difficulties: ♦ HF is corrosive & also very toxic ♦ H_2O should not be present. Otherwise F_2 will oxidize H_2O to O_2 $2\text{F}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{HF} + \text{O}_2$ ♦ Graphite anodes must not be used, since graphite reacts with fluorine, forming a polymeric substance known as graphite fluoride.
		Modern method : Electrolyte : $\text{KF} : \text{HF} = 1 : 2$ Temperature : 72°C	
		Note : It is not possible to prepare fluorine by electrolysis of aqueous solution of NaF or KF . It is because when aqueous solution of KF is subjected to electrolysis, there will be following two oxidation in competition at anode, $\text{H}_2\text{O} \longrightarrow 1/2\text{O}_2 + 2\text{H}^+ + 2\text{e}^-$ $\text{SOP} = -1.23 \text{ V}$ and $\text{F}^- \longrightarrow 1/2\text{F}_2 + \text{e}^-$ $\text{SOP} = -2.87 \text{ V}$ As a matter of rule that substance will be oxidise whose SOP is higher therefore water gets oxidise at anode and not F^- .	
2.	Chemical Method	$2\text{KMnO}_4 + 2\text{KF} + 10\text{HF} + 3\text{H}_2\text{O}_2 \rightarrow 2\text{K}_2\text{MnF}_6 + 8\text{H}_2\text{O} + 3\text{O}_2$ $\text{K}_2[\text{MnF}_6] + 2 \text{SbF}_5 \longrightarrow 2\text{K} [\text{SbF}_6] + \text{MnF}_3 + \text{F}_2$ { via $\text{MnF}_4 \longrightarrow \text{MnF}_3 + \frac{1}{2}\text{F}_2$ }	♦ The stronger Lewis acid SbF_5 displaces the weaker one, MnF_4 from its salt. ♦ MnF_4 is unstable and readily decomposes to give MnF_3 and fluorine.

Chlorine

S.No.	Method	Process	Comments
1.	Laboratory Preparation	$\text{H}_2\text{SO}_4 + \text{NaCl} \rightarrow \text{HCl} + \text{NaHSO}_4$ $4\text{HCl} + \text{MnO}_2 \rightarrow \text{MnO}_2 + 2\text{H}_2\text{O} + \text{Cl}_2\uparrow$	♦ HCl is purified first passed through H_2O then through conc. H_2SO_4 to remove H_2O further dried by CaO & P_4O_{10}
2.	Commercially:		
(i)	By electrolysis of aq. NaCl solution in the manufacture of NaOH	$2\text{NaCl} + 2\text{H}_2\text{O} \xrightarrow{\text{Electrolyte}} 2\text{NaOH} + \text{Cl}_2 + 2\text{H}_2$ $2\text{NaCl} \xrightarrow{\text{Electrolyte}} 2\text{Na} + \text{Cl}_2$	



(ii)	Deacon's process	$4\text{HCl} + \text{O}_2 \xrightleftharpoons[440^\circ\text{C}]{\text{CuCl}_2 \text{ Catalyst}} 2\text{Cl}_2 + 2\text{H}_2\text{O} + \Delta$	<ul style="list-style-type: none"> Air is used to oxidize HCl instead MnO_2 Reaction is reversible Conversion 65%
(iii)	Electrolysis of Brine	Reactions: At Anode : $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$ At cathode : $\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$ $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$ Side reactions may also occur if the products mix: $2\text{NaOH} + \text{Cl}_2 \rightarrow \text{NaCl} + \text{NaOCl} + \text{H}_2\text{O}$ $2\text{OH}^- + \text{Cl}_2 \rightarrow 2\text{OCl}^- + \text{H}_2$ (Hypochlorite) At anode (small extent reaction) : $4\text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^-$	
3.	Miscellaneous Reactions	(a) $[\text{NaCl} + \text{HNO}_3 \rightarrow \text{NaNO}_3 + \text{HCl}] \times 3$ $\text{HNO}_3 + 3\text{HCl} \rightarrow \text{NOCl} + \text{Cl}_2 + 2\text{H}_2\text{O}$ $3\text{NaCl} + 4\text{HNO}_3 \rightarrow 3\text{NaNO}_3 + \text{NOCl} + \text{Cl}_2 + 2\text{H}_2\text{O}$ (nitrosyl chloride) $2\text{NOCl} + \text{O}_2 \rightarrow 2\text{NO}_2 + \text{Cl}_2$ $\text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_3$ (to be recycled) (b) $\text{Ca} \begin{matrix} \text{OCl} \\ \text{Cl} \end{matrix} + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{Cl}_2 + \text{H}_2\text{O}$ (c) $2\text{KMnO}_4 + 16\text{HCl} \rightarrow 2\text{KCl} + 2\text{MnCl}_2 + 5\text{Cl}_2 + 8\text{H}_2\text{O}$ (d) $\text{PbO}_2 + 4\text{HCl} \rightarrow \text{PbCl}_2 + \text{Cl}_2 + 2\text{H}_2\text{O}$ (e) When Cl_2 is used for the chlorination of hydrocarbon, the by-product is HCl. The HCl is catalytically oxidised into H_2O & Cl_2 using copper powder mixed with rare earth chlorides. $4\text{HCl} + \text{O}_2 \xrightarrow{\text{Cu powder} + \text{rare earth chloride}} 2\text{H}_2\text{O} + 2\text{Cl}_2$	<ul style="list-style-type: none"> These methods are exclusively used only for chlorine.

Bromine:

S.No.	Method	Process
1.	Extracted from sea water	<ul style="list-style-type: none"> Cl_2 gas passed through solution to oxidize Br^- to Br_2 $\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2$ ↓ Removed by steam of air & passed to solution of Na_2CO_3. Reactions : $3\text{Br}_2 + 3\text{Na}_2\text{CO}_3 \rightarrow 5\text{NaBr} + \text{NaBrO}_3 + 3\text{CO}_2$ $5\text{NaBr} + \text{NaBrO}_3 + 2\text{H}_2\text{SO}_4 \rightarrow 5\text{HBr} + \text{HBrO}_3 + 3\text{Na}_2\text{SO}_4$ $5\text{HBr} + \text{HBrO}_3 \rightarrow 3\text{Br}_2 + 3\text{H}_2\text{O}$ ↓ Pure Bromine
2.	Common method	$2\text{NaBr} + 3\text{H}_2\text{SO}_4 + \text{MnO}_2 \xrightarrow{\Delta} \text{Br}_2 + \text{MnSO}_4 + 2\text{NaHSO}_4 + 2\text{H}_2\text{O}$ (conc.)

**Iodine:**

S.No.	Method	Process	Comments
1.	Source : Chile saltpetre	<ul style="list-style-type: none"> Pure NaNO_3 is obtained by dissolving salt petre in H_2O & crystallizing NaNO_3 Iodate residues thus accumulated & concentrate in mother liquor Concentrate \rightarrow divided into 2 part 1^{st} part reduced with NaHSO_3 $2\text{IO}_3^- + 6\text{HSO}_3^- \rightarrow 2\text{I}^- + 6\text{SO}_4^{2-} + \text{OH}^-$ 2^{nd} part is mixed $3\text{I}^- + \text{IO}_3^- + 6\text{H}^+ \rightarrow 3\text{I}_2 + 3\text{H}_2\text{O}$ 	<ul style="list-style-type: none"> Chile salt petre is mainly NaNO_3 Contain traces of NaIO_3 (Sodium iodate) & NaIO_4 (Sodium periodate) Purified by sublimation
2.	Source: Natural blue	$2\text{I}^- + \text{Cl}_2 \rightarrow \text{I}_2 + 2\text{Cl}^-$ \downarrow blown out by air	
3.	From sea-weeds:	$2\text{NaI} + \text{MnO}_2 + 3\text{H}_2\text{SO}_4 \longrightarrow 2\text{NaHSO}_4 + \text{MnSO}_4 + \text{I}_2 + 2\text{H}_2\text{O}$	<ul style="list-style-type: none"> Liberated iodine is condensed in series of earthen ware known as aludels.
4.	Other Method	$\text{CuSO}_4 + 2\text{KI} \rightarrow \text{K}_2\text{SO}_4 + \text{CuI}_2$ $2\text{CuI}_2 \rightarrow \text{Cu}_2\text{I}_2 + \text{I}_2$	<ul style="list-style-type: none"> This I_2 gets dissolved into KI forming KI_3, since I_3^- ions are yellow, therefore solution develops yellow colour.

Section (B₁ + C₁ + D₁) : Periodic Trends, Properties of Elements and Chemical Bonding
Atomic & Physical Properties :

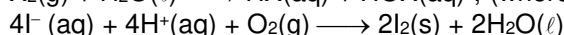
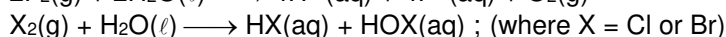
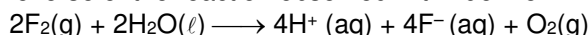
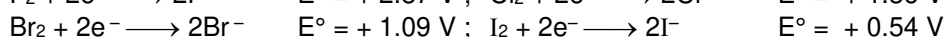
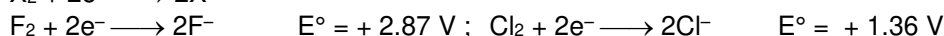
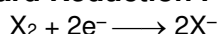
S.No.	Property	F	Cl	Br	I
1.	Atomic Number	9	17	35	53
2.	Atomic Mass/g mol ⁻¹	19	35.45	79.90	126.90
3.	Electronic configuration General electronic configuration = $(ns^2 np^5)$	[He] $2s^2 2p^5$	[Ne] $3s^2 3p^5$	[Ar] $3d^{10} 4s^2 4p^5$	[Kr] $4d^{10} 5s^2 5p^5$
4.	Covalent Radius / pm ($F < Cl < Br < I$)	64	99	114	133
5.	Ionic Radius X^- / pm ($F < Cl < Br < I$)	133	184	196	220
6.	Ionization enthalpy / (kJ mol ⁻¹) ($F > Cl > Br > I$)	1680	1256	1142	1008
7.	Electron gain enthalpy / (kJ mol ⁻¹) ($Cl > F > Br > I$)	<ul style="list-style-type: none"> Due to increase in atomic size, ionisation enthalpy decreases down the group. 			
		-333	-349	-325	-296
8.	Distance X - X/pm ($F_2 < Cl_2 < Br_2 < I_2$)	<ul style="list-style-type: none"> Maximum negative electron gain enthalpy in the corresponding period. Negative electron gain enthalpy of fluorine < chlorine: Due to small size of fluorine atom. As a result, there are strong inter-electronic repulsions in the relatively small 2p orbitals of fluorine and thus, the extra electron (incoming) does not experience much attraction. 			
		143	199	229	266
9.	Enthalpy of dissociation (X_2)/kJ mol ⁻¹ ($Cl - Cl > Br - Br > F - F > I - I$)	<ul style="list-style-type: none"> Smaller enthalpy of dissociation of F_2 is due to relatively larger electron-electron repulsion among the lone pairs in F_2 molecule. 			
		158.8	242.6	192.8	151.1
10.	Electronegativity ($F > Cl > Br > I$)	4	3.2	3.0	2.7
11.	Melting point / K ($F < Cl < Br < I$)	54.4	172	265.8	386.6



12.	Boiling point / K ($F < Cl < Br < I$) (State at room temp.)	84.9	239.0	332.5	458.2
		Gas	Gas	Liquid	Solid
13.	$\Delta_{\text{Hyd}}H(X^-) / \text{kJ mol}^{-1}$ ($F > Cl > Br > I$)	515	381	347	305
		♦ Smaller the ion, higher is the hydration energy.			
14.	$E^\circ / \text{V (SRP)} ; X_2(g) + 2e^- \rightarrow 2X^-(aq)$ ($F_2 > Cl_2 > Br_2 > I_2$) (Order of oxidising power)	2.87	1.36	1.09	0.54
		♦ More the value of the SRP, more powerful is the oxidising agent.			
15.	Colour (at room temp.)	Pale green yellow gas.	Greenish-yellow gas	Reddish brown liquid	Dark violet solid
16.	Oxidization state	-1	-1, +1, +3, +5, +7	-1, +1, +3, +5, +7	-1, +1, +3, +5, +7

CHEMICAL PROPERTIES :**Oxidation states and trends in chemical reactivity**

- (1) All the halogens exhibit -1 oxidation state. However, chlorine, bromine and iodine exhibit +1, +3, +5 and +7 oxidation states also.
- (2) The higher oxidation states of chlorine, bromine and iodine are realised mainly when the halogens are in combination with the small and highly electronegative fluorine and oxygen atoms e.g., in interhalogens, oxides and oxoacids.
- (3) The fluorine atom has no d orbitals in its valence shell and therefore cannot expand its octet. Being the most electronegative, it exhibits only -1 oxidation state.
- (4) All the halogens are highly reactive. They react with metals and non-metals to form halides. The reactivity of the halogens decreases down the group.
- (5) The ready acceptance of an electron is the reason for the strong oxidising nature of halogens. F_2 is the strongest oxidising halogen and it oxidises other halide ions in solution or even in the solid phase.
- (6) The decreasing oxidising ability of the halogens in aqueous solution down the group is evident from their standard electrode potentials.
- (7) Fluorine oxidises water to oxygen whereas chlorine and bromine react with water to form corresponding hydrohalic and hypohalous acids.
- (8) The reactions of iodine with water is non-spontaneous I^- can be oxidised by oxygen in acidic medium; just the reverse of the reaction observed with fluorine.

**Standard Reduction Potential (SRP)**

More the value of the SRP, more powerful is the oxidising agent. Hence the order of oxidising power is $F_2 > Cl_2 > Br_2 > I_2$

Since SRP is the highest for F_2 (among all elements of periodic table), it is a strongest oxidising agent.

Hydration energy of X^-

Smaller the ion, higher is the hydration energy.

Halide ion	F^-	Cl^-	Br^-	I^-
Hydration energy (in kJ/mol)	515	381	347	305

Anomalous behaviour of fluorine

- (1) The anomalous behaviour of fluorine is due to its small size, highest electronegativity, low F-F bond dissociation enthalpy, and non availability of d orbitals in valence shell.
- (2) Most of the reactions of fluorine are exothermic (due to the small and strong bond formed by it with other elements).
- (3) It forms only one oxoacid while other halogens form a number of oxoacids.
- (4) Hydrogen fluoride is liquid (b.p. 293 K) due to strong hydrogen bonding. Other hydrogen halides are gases.

**Reactivity towards oxygen :**

Oxidation State	F	Cl	Br	I
-1	OF ₂ , O ₂ F ₂	—	—	—
+1		Cl ₂ O	Br ₂ O	
+4		Cl ₂ O	BrO ₂	I ₂ O ₄
+5		—	—	I ₂ O ₅
+6		Cl ₂ O ₆ , ClO ₃	—	
+7		Cl ₂ O ₇		I ₂ O ₇

- Halogens form many oxides with oxygen but most of them are unstable.
- Fluorine forms two oxides OF₂ and O₂F₂. However, only OF₂ is the thermally stable at 298 K.
- These oxide are essentially oxygen fluorides because of the higher electronegativity of fluorine than oxygen. Both are strong fluorinating agents.
- O₂F₂ oxidises plutonium to PuF₆ and the reaction is used in removing plutonium as PuF₆ from spent nuclear fuel.
- Chlorine, bromine and iodine form oxides in which the oxidation states of these halogen vary from + 1 to + 7.
- A combination of kinetic and thermodynamic factors lead to the generally decreasing order of stability of oxides formed by halogens, I > Cl > Br. The higher oxides of halogens tend to be more stable than the lower ones.
- Chlorine oxides, Cl₂O, ClO₂, Cl₂O₆ and Cl₂O₇ are highly reactive oxidising agents and tend to explode. ClO₂ is used as a bleaching agent for paper pulp and textiles and in water treatment.
- The bromine oxides, Br₂O, BrO₂, BrO₃ are the least stable halogen oxides and exist only at low temperature. They are very powerful oxidising agents.
- The iodine oxides, I₂O₄, I₂O₅, I₂O₇ are insoluble solids and decompose on heating. I₂O₅ is very good oxidising agent and is used in the estimation of carbon monoxide.

S.No.	Reaction with Elements	General Reaction	Comments
1.	H ₂	$X_2 + H_2 \rightarrow 2HX \begin{cases} \rightarrow F_2 + H_2 \rightarrow 2HF \\ \rightarrow Cl_2 + H_2 \rightarrow 2HCl \\ \rightarrow Br_2 + H_2 \rightarrow 2HBr \\ \rightarrow I_2 + H_2 \rightarrow 2HI \end{cases}$ <p>The acidic strength of these acids increases in the order : HF < HCl < HBr < HI. The stability of these halides decreases down the group due to decrease in bond (H-X) dissociation enthalpy in the order : H - F > H - Cl > H - Br > H - I</p>	<ul style="list-style-type: none"> All the halogens Reactivity towards H₂ decrease down the group. F₂ → Violently react I₂ → Slow at room temp.
2.	Metal	$nX_2 + 2M \rightarrow 2MX_n \begin{cases} \rightarrow 2Na + Cl_2 \rightarrow 2NaCl \\ \rightarrow 2Al + 3Cl_2 \rightarrow 2AlCl_3 \\ \rightarrow 2Fe + 3Cl_2 \rightarrow 2FeCl_3 \\ \rightarrow Mg_{(s)} + Br_{2(l)} \rightarrow MgBr_{2(s)} \\ \rightarrow 2Ag + F_2 \rightarrow 2AgF \end{cases}$	<ul style="list-style-type: none"> Most metals form halides F the most vigorous <p>The ionic character of halides is MF > MCl > MBr > MI.</p>
3.	P	$\begin{aligned} 3X_2 + 2P &\rightarrow PX_3 \quad \begin{cases} \rightarrow P_4 + 6Cl_2 \rightarrow 4PCl_3 \\ \rightarrow P_4 + 6Br_2 \rightarrow 4PBr_3 \\ \rightarrow P_4 + 6I_2 \rightarrow 4PI_3 \end{cases} \\ 5X_2 + 2P &\rightarrow PX_5 \quad [2P + 5Cl_2 \rightarrow 2PCl_5] \end{aligned}$ <p>(Limited) (Excess)</p>	<ul style="list-style-type: none"> All the halogens form trihalides As } Also form trihalides Sb } Bi } F, Cl & Br form pentahalides AsF₅, SbF₅, BiF₅, SbCl₅
4.	S	$\begin{aligned} X_2 + 2S &\rightarrow S_2X_2 \quad [S_8 + 4Cl_2 \rightarrow 4S_2Cl_2] \\ 2Cl_2 + S &\rightarrow SCl_4 \\ 3F_2 + S &\rightarrow SF_6 \end{aligned}$ <p>(Limited) (excess)</p>	<ul style="list-style-type: none"> Cl and Br Cl only F only



5.	O ₂	$O_2 + F_2 \xrightarrow[\text{silent electric discharge}]{\text{only in presence of}} O_2F_2$	
6.	Other non-metals	$C + 2F_2 \rightarrow CF_4$ $2B + 3F_2 \rightarrow 2BF_3$	<ul style="list-style-type: none"> Wood, charcoal, phosphorous, arsenic, antimony, boron, silicon react with F₂ producing a flame.
7.	Other Halogens	$X_2 + X'_2 \rightarrow 2XX'$ $X_2 + X'_X \rightarrow XX'_3$	<ul style="list-style-type: none"> Halogens combine amongst themselves to form a number of compounds known as interhalogen of the types XX', XX'₃, XX'₅ and XX'₇ where X is a larger size halogen and X' is smaller size halogen.

S.No.	Reaction with Compounds	General Reaction	Comments
1.	H ₂ O	$2F_2 + 2H_2O \rightarrow 4HF + O_2$	<ul style="list-style-type: none"> Vigorous reaction with F.
		$X_2(g) + H_2O(l) \rightarrow HX(aq.) + HOX(aq.)$ X = Cl or Br	<ul style="list-style-type: none"> Cl > Br > I (F not at all)
		$4I^-(aq.) + 4H^+(aq.) + O_2 \rightarrow 2I_2(s) + 2H_2O(l)$	<ul style="list-style-type: none"> I reaction in reverse direction
2.	Base		
(i)	NH ₃	For F ₂ $2NH_3 + 3F_2 \rightarrow N_2 + 6HF$	<ul style="list-style-type: none"> It is the distinction from other halogens.
		For Cl ₂ and Br ₂ NH ₃ Excess $3X_2 + 8NH_3 \rightarrow N_2 + 6NH_4X$ $[3Cl_2 + 8NH_3 \rightarrow N_2 + 6NH_4Cl]$ X ₂ Excess $NH_3 + 3X_2 \rightarrow NX_3 + 3HX$ $[NH_3 + 3Cl_2 \rightarrow NCl_3 + 3HCl]$	<ul style="list-style-type: none"> NX₃ is explosive
		For I ₂ $NH_3(g) + I_2 \rightarrow \text{No Reaction}$ $NH_3(aq) + I_2(s) \xrightarrow[\text{A slurry is formed which can be dried and on hammering it explodes causing sound (crakers)}]{\text{Ammonia liquor}} \rightarrow \underbrace{NI_3 \cdot NH_3}_{\text{an explosive (Nitrogen triiodide ammoniated)}} + 3HI$ $8NI_3 \cdot NH_3 \rightarrow 5N_2 + 9I_2 + 6NH_4I$	
(ii)	NaOH	For F ₂ $2F_2 + 2NaOH \xrightarrow{\text{(dilute)}} OF_2(g) + 2NaF + H_2$ $2F_2 + 4NaOH \xrightarrow{\text{(concentrated)}} O_2(g) + 4NaF + 2H_2O$	<ul style="list-style-type: none"> Dilute alkali forms oxygen difluoride & with concentrated alkali liberates O₂.
		For Cl ₂ , Br ₂ , I ₂ $2NaOH + Cl_2 \rightarrow NaCl + NaOCl + H_2O$ (Cold & dil.) $6NaOH + 3Cl_2 \rightarrow 5NaCl + NaClO_3 + 3H_2O$ (hot & conc.)	<ul style="list-style-type: none"> These reactions are also given by Br₂ and I₂.
(iii)	Ca(OH) ₂ (Dry slaked lime)	$2Ca(OH)_2 + 2Cl_2 \rightarrow Ca(OCl)_2 + CaCl_2 + 2H_2O$ (Bleaching powder)	<ul style="list-style-type: none"> Composition of bleaching powder = Ca(OCl)₂·CaCl₂·Ca(OH)₂·2H₂O
3.	Acid	Generally no reaction is shown with acids.	
4.	H ₂ S	For F ₂ $H_2S + 4F_2 \rightarrow SF_6 + 2HF$	



		For $\text{Cl}_2, \text{Br}_2, \text{I}_2$ $\text{X}_2 + \text{H}_2\text{S} \rightarrow 2\text{HX} + \text{S}$ $[\text{Cl}_2 + \text{H}_2\text{S} \rightarrow 2\text{HCl} + \text{S}]$	<ul style="list-style-type: none"> Cl_2, Br_2 & I_2 oxidize S^{2-} to S It shows Cl has great affinity for hydrogen to form HCl
5.	SO_2	$\text{X}_2 + \text{SO}_2 \rightarrow \text{SO}_2\text{X}_2$ $[\text{SO}_2 + \text{Cl}_2 \rightarrow \text{SO}_2\text{Cl}_2]$	<ul style="list-style-type: none"> F & Cl
6.	CO	$\text{X}_2 + \text{CO} \rightarrow \text{COX}_2$ $[\text{CO} + \text{Cl}_2 \rightarrow \text{COCl}_2]$	<ul style="list-style-type: none"> Cl and Br form carbonyl halides

Other Reactions			
For F_2			
1.	Reaction with SO_3	$2\text{SO}_3 + \text{F}_2 \xrightarrow[\text{AgF}]{180^\circ\text{C}} \text{FSO}_2 \text{ OOSO}_2\text{F}$	
2.	Reaction with SiO_2	$\text{SiO}_2 (\text{s}) + 2\text{F}_2 (\text{g}) \rightarrow \text{SiF}_4 (\text{g}) + \text{O}_2 (\text{g})$	<ul style="list-style-type: none"> It attacks glass at about 100°C. The reaction is slow with dry F_2.
3.	Oxidising character	$\text{F}_2 + 2\text{NaX} \rightarrow 2\text{NaF} + \text{X}_2$; where $(\text{X} = \text{Cl}, \text{Br}, \text{I})$ (a) It can oxidise all other halide ions into halogen molecules (b) It can oxidise ClO_3^- into ClO_4^- and IO_3^- to IO_4^- $\text{F}_2 + \text{ClO}_3^- + \text{H}_2\text{O} \rightarrow 2\text{F}^- + \text{ClO}_4^- + 2\text{H}^+$ (c) It can oxidise HSO_4^- into $\text{S}_2\text{O}_8^{2-}$ $2\text{HSO}_4^- + \text{F}_2 \rightarrow 2\text{F}^- + \text{S}_2\text{O}_8^{2-} + 2\text{H}^+$	<ul style="list-style-type: none"> It is the most powerful oxidising agent.
For Cl_2			
	Oxidising and bleaching properties	Chlorine dissolves in water giving HCl and HOCl . Hypochlorous acid (HOCl) so formed, gives nascent oxygen which is responsible for oxidising and bleaching properties of chlorine.	
		$2\text{FeSO}_4 + \text{H}_2\text{SO}_4 + \text{Cl}_2 \rightarrow \text{Fe}_2(\text{SO}_4)_3 + 2\text{HCl}$ $\text{Na}_2\text{SO}_3 + \text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HCl}$ $\text{SO}_2 + 2\text{H}_2\text{O} + \text{Cl}_2 \rightarrow \text{H}_2\text{SO}_4 + 2\text{HCl}$ $\text{I}_2 + 6\text{H}_2\text{O} + 5\text{Cl}_2 \rightarrow 2\text{HIO}_3 + 10\text{HCl}$ $\text{X}^- + \text{Cl}_2 \rightarrow \text{X}_2 + 2\text{Cl}^-$	<ul style="list-style-type: none"> Oxidises ferrous to ferric, sulphite to sulphate, sulphur dioxide to sulphuric acid and iodine to iodic acid. Chlorine oxidises both Br^- and I^- to Br_2 and I_2 respectively.
	Bleaching action	$\text{Cl}_2 + \text{H}_2\text{O} \rightarrow 2\text{HCl} + \text{O}$ <u>Bleaching action of SO_2</u> $\text{SO}_2 + 2\text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 + 2\text{H}$ $\text{SO}_3^{2-} + \text{Coloured material} \rightarrow \text{SO}_4^{2-} + \text{Reduced Colourless material}$	<ul style="list-style-type: none"> It is a powerful bleaching agent bleaching action is due to oxidation. Coloured substance + $\text{O} \rightarrow$ Colourless substance It bleaches vegetable or organic matter in the presence of moisture. Bleaching effect of chlorine is permanent. The bleaching action of SO_2 is temporary because it takes place through reduction. $\text{Reduced Colourless material} \xrightarrow[\text{O}_2 \text{ of air}]{\text{Reduced}} \text{Colourless material} \rightarrow \text{Coloured material}$
For Br_2			
		$(\text{Br}_2 \cdot 8\text{H}_2\text{O}) \leftarrow$ Clathrate compound	<ul style="list-style-type: none"> Reddish brown liquid, fairly soluble in water. It also forms hydrate like Cl_2

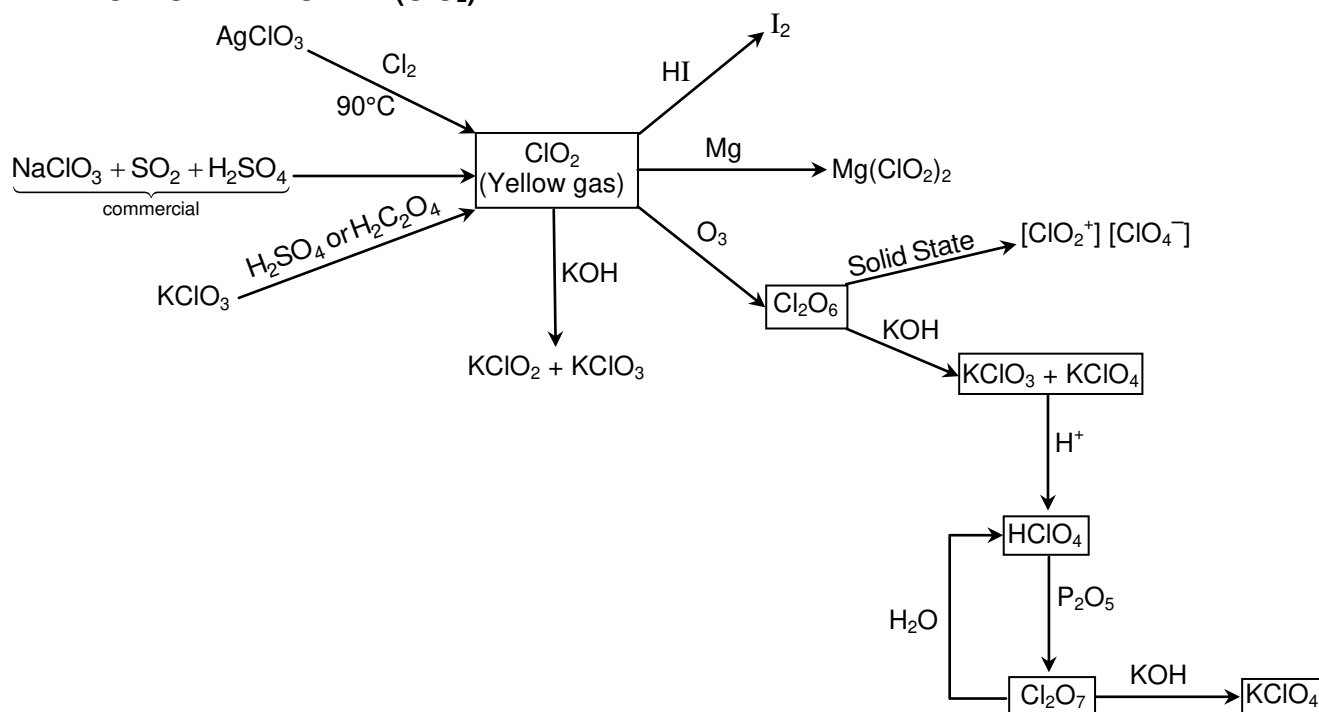
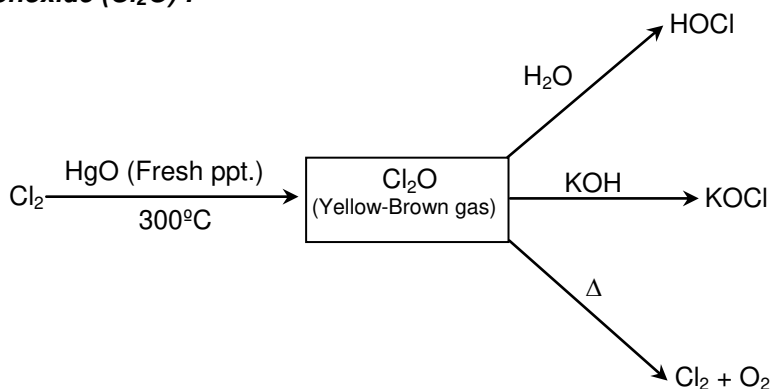




For I ₂			
1.	Reaction with Hypo	$\text{S}_2\text{O}_3^{2-} + \text{I}_2 \rightarrow \text{S}_4\text{O}_6^{2-} + 2\text{I}^-$ <p>(thiosulphate ions) (tetrathionate ions)</p>	♦ This reaction is the basis of iodometric titration, which is carried out for the estimation of iodine using starch indicator.
2.	Reaction with KClO ₃ or KBrO ₃	$2\text{KClO}_3 + \text{I}_2 \xrightarrow{\Delta} 2\text{KIO}_3 + \text{Cl}_2 ;$ $2\text{KBrO}_3 + \text{I}_2 \xrightarrow{\Delta} 2\text{KIO}_3 + \text{Br}_2$	

Section (E₁) : Oxides, Hydroxides & Oxyacids

OXIDES OF CHLORINE

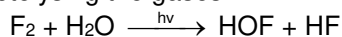
CHLORINE DIOXIDE (ClO₂) :Dichlorine Monoxide (Cl₂O) :

OXY-ACIDS OF HALOGENS

HOX SERIES :

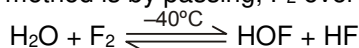
HYPO-FLUOROUS ACID [HOF] :

HOF has been prepared by trapping F₂ and H₂O in unreactive matrix of solid N₂ at very low temperature and photolysing the gases.





Recent method is by passing, F_2 over ice at $0^\circ C$ and removing the product into a cold trap.



- HOCl, HOBr and HOI are not very stable and are known only in aqueous solution.

HYPO-CHLOROUS ACID [HClO] :

PREPARATION :

- (i) The acid is known only in solution, It is obtained by shaking precipitate of HgO with chlorine water.
 $2HgO + 2Cl_2 + H_2O \longrightarrow Hg_2 OCl_2$ (Oxychloride of mercury) + $2HClO$
- (ii) Commercially, it is obtained by passing CO_2 through suspension of bleaching powder and then distilling.
 $2CaOCl_2 + H_2O + CO_2 \longrightarrow CaCl_2 + CaCO_3 + 2HClO$
- Maximum concentration obtained is 25% as in the process of distillation, the acid decomposes into its anhydrides, Cl_2O .
 $2HOCl \longrightarrow H_2O + Cl_2O$

PROPERTIES :

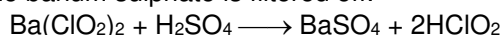
- (i) It is a weak acid. Its concentrated solution is yellow in colour while dilute solution is colourless. It is unstable and decomposes.
 $2HClO \longrightarrow 2HCl + O_2$
- (ii) It dissolves magnesium with evolution of hydrogen.
 $Mg + 2HClO \longrightarrow Mg(ClO)_2 + H_2$
- (iii) With alkalis, it forms salts called hypochlorites.
- (iv) It acts as a powerful oxidising and bleaching agent. This is due to release of nascent oxygen easily.
 $HClO \longrightarrow HCl + O$

HXO₂ SERIES :

CHLOROUS ACID [HClO₂] :

PREPARATION :

It is obtained in aqueous solution when barium chlorite suspension in water is treated with H_2SO_4 . The insoluble barium sulphate is filtered off.



PROPERTIES:

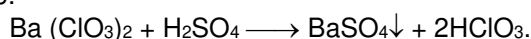
- (i) The freshly prepared solution is colourless but it soon decomposes to ClO_2 which makes the solution yellow.
 $5HClO_2 \longrightarrow 4ClO_2 + HCl + 2H_2O$
- (ii) Salts of $HClO_2$ are called chlorite and prepared by one of the following methods.
 $2ClO_2 + 2NaOH \longrightarrow NaClO_2 + NaClO_3 + H_2O$
 $2ClO_2 + Na_2O_2 \longrightarrow 2NaClO_2 + O_2$
- Chlorites are used as bleaching agents. They are stable in alkaline solution even when boiled, but in acid solution they disproportionate, particularly when heated.
 $5HClO_2 \longrightarrow 4ClO_2 + HCl + 2H_2O$ and $4HClO_2 \longrightarrow 2ClO_2 + HClO_3 + HCl + H_2O$
- (iii) The acid liberates iodine from KI.
 $4KI + HClO_2 + 2H_2O \longrightarrow 4KOH + HCl + 2I_2$

HXO₃ SERIES

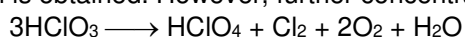
CHLORIC ACID [HClO₃] :

PREPARATION :

This acid is only known in solution. The acid is prepared by the action of the dilute H_2SO_4 on barium chlorate.



After reaction, $BaSO_4$ is removed by filtration, and the filtrate is evaporated in vacuum till 40 percent solution is obtained. However, further concentration by evaporation leads to decomposition.



$HBrO_3$ can be prepared by similar method using $Ba(BrO_3)_2$.

**PROPERTIES :**

- (i) Concentrated acid is colourless and pungent smelling liquid. It decomposes in light. However, it is stable in dark.
- (ii) It acts as a strong oxidising and bleaching agent in light.
- (iii) Organic substances like paper, cotton, wool, etc., catch fire in contact with the acid.
- (iv) HClO_3 oxidises SO_2 to SO_3 : $\text{HClO}_3 + 3\text{SO}_2 \longrightarrow \text{HCl} + 3\text{SO}_3$
- (v) HClO_3 when evaporates to dryness decomposes giving ClO_2 .

$$4\text{HClO}_3 \longrightarrow 4\text{ClO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g}) + \text{O}_2(\text{g})$$
- (vi) HBrO_3 is not very stable, but is known in solution, and as salts.
- (vii) HIO_3 is formed by oxidation of I_2 with concentrated HNO_3 or O_3 .

$$8\text{H}^+ + 10\text{NO}_3^- + \text{I}_2 \longrightarrow 2\text{IO}_3^- + 10\text{NO}_2 + 4\text{H}_2\text{O}$$
- (viii) IO_3^- oxidises I^- to I_2 : $\text{IO}_3^- + 5\text{I}^- + 6\text{H}^+ \longrightarrow 3\text{I}_2 + 3\text{H}_2\text{O}$
- (ix) Iodic acid is reasonably stable and exists as a white solid.
- (x) $2\text{KClO}_3 \xrightarrow[\text{MnO}_2]{150^\circ\text{C}} 2\text{KCl} + 3\text{O}_2$
- (xi) $4\text{KClO}_3 \xrightarrow{\text{low temperature}} 3\text{KClO}_4 + \text{KCl}$ (in absence of catalyst)
- (xii) $2\text{Zn}(\text{ClO}_3)_2 \xrightarrow{\Delta} 2\text{ZnO} + 2\text{Cl}_2 + 5\text{O}_2$
- (xiii) Chlorates are used in fire work.

HXO₄ SERIES**PERCHLORIC ACID [HClO_4] :****PREPARATION:**

- (i) It is the most stable oxy-acid of chlorine. Anhydrous HClO_4 is obtained by doing distillation of KClO_4 (potassium perchlorate), with 96-97.5% H_2SO_4 under low pressure at $90-160^\circ\text{C}$.

$$\text{KClO}_4 + \text{H}_2\text{SO}_4 \longrightarrow \text{KHSO}_4 + \text{HClO}_4$$
- (ii) An aqueous solution of the acid is obtained by reacting barium perchlorate with calculated quantity of dilute H_2SO_4 . The insoluble barium sulphate is removed by filtration.

$$\text{Ba}(\text{ClO}_4)_2 + \text{H}_2\text{SO}_4 \longrightarrow \text{BaSO}_4 + 2\text{HClO}_4$$
- (iii) $\text{NaClO}_3 + \text{H}_2\text{O} \xrightarrow{\text{Electrolysis}} \text{ClO}_4^- + 2\text{H}^+ + 2\text{e}^-$
- (iv) $\text{NH}_4\text{ClO}_4 + \text{HNO}_3 \longrightarrow \text{HClO}_4 + \text{NH}_4\text{NO}_3$
- (v) $4\text{ClO}_3^- \xrightarrow{\Delta} 3\text{ClO}_4^- + \text{Cl}^-$
- (vi) $\text{HClO}_4 \cdot 2\text{H}_2\text{O} + 2\text{H}_2\text{S}_2\text{O}_7 \longrightarrow \text{HClO}_4$ (obtained as anhydrous HClO_4) + $2\text{H}_2\text{SO}_4$

PROPERTIES:

- (i) Anhydrous HClO_4 is a colourless liquid which turns dark on keeping. It fumes in moist air.
- (ii) It is one of the strongest acid and ionises as follows :

$$\text{HClO}_4 \longrightarrow \text{H}^+ + \text{ClO}_4^-$$
- (iii) It dissolves most of the metals.

$$\text{Zn} + 2\text{HClO}_4 \longrightarrow \text{Zn}(\text{ClO}_4)_2 + \text{H}_2$$
- (iv) Hot concentrated acid (73%) behaves as a remarkable oxidising agent :

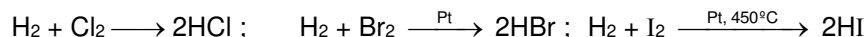
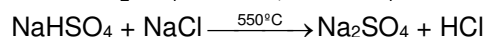
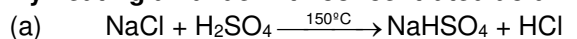
$$4\text{HClO}_4 \longrightarrow 2\text{Cl}_2 + 7\text{O}_2 + 2\text{H}_2\text{O}$$
- (v) $2\text{HClO}_4 + \text{P}_2\text{O}_5 \longrightarrow 2\text{HPO}_3 + \text{Cl}_2\text{O}_7$
- $\text{Mg}(\text{ClO}_4)_2$ is used in dry batteries and is also an effective desiccant called **anhydron**. KClO_4 is used in fire works and flares.

Some important orders :

- (a) Acidic strength :
 (i) $\text{HI} > \text{HBr} > \text{HCl} > \text{HF}$ (ii) $\text{HOCl} > \text{HOBr} > \text{HOI}$ (iii) $\text{HClO}_4 > \text{HClO}_3 > \text{HClO}_2 > \text{HClO}$
- (b) Oxidising powder
 (i) $\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$
 (ii) $\text{BrO}_4^- > \text{IO}_4^- > \text{ClO}_4^-$ (According to electrode potential)
- (c) Order of disproportionations
 $3\text{XO}^- \longrightarrow 2\text{X}^- + \text{XO}_3^-$ (hypohalite ion) ; $\text{IO}^- > \text{BrO}^- > \text{ClO}^-$

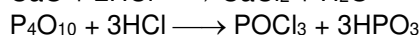
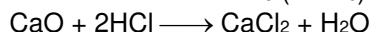
**Section (Fi) :****HALOGEN ACIDS (HCl, HBr & HI)**

- ♦ Pure anhydrous HX compounds refer as hydrogen halides.
- ♦ Their aqueous solutions as hydrohalic acids.

Preparation :**(1) By direct combination of elements :****(2) By heating a halide with concentrated acid :**

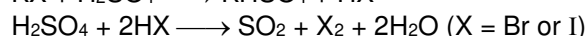
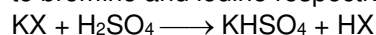
This method is called as salt cake method as it involves the formation of NaHSO_4 (salt cake).

HCl cannot be dried over P_2O_5 (P_4O_{10}) or quick lime since they react with gas chemically.

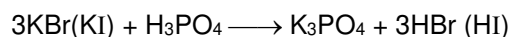
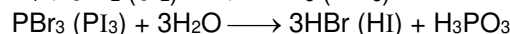
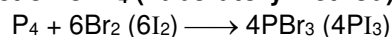
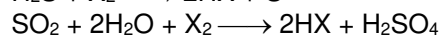
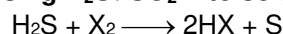


HCl is, hence dried by passing through concentrated H_2SO_4 .

- (b) HBr (or HI) cannot be prepared by heating bromide (iodide) with concentrated H_2SO_4 because HBr and HI are strong reducing agents and reduce H_2SO_4 to SO_2 and get themselves oxidised to bromine and iodine respectively.



Hence, HBr and HI are prepared by heating bromides and iodides respectively with concentrated H_3PO_4 .

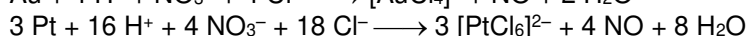
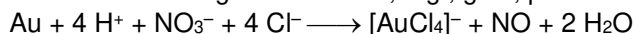
**(3) By reaction of P_4 (Laboratory Method) :****(4) By passing H_2S / SO_2 into solutions of halogens :****(5) PROPERTIES :**

- These are colourless, pungent smelling gases with acidic tastes.
- These are neither combustible nor supporter of combustion.
- When perfectly dry, they have no action on litmus, but in presence of moisture, they turn blue litmus red, showing acidic nature. Among HX, HI is the strongest and HF is the weakest acid.
- These are quite soluble in water.

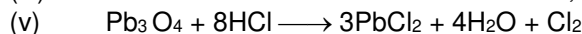
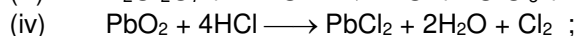
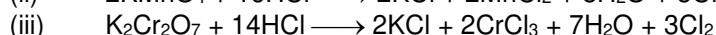
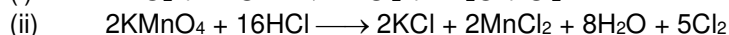
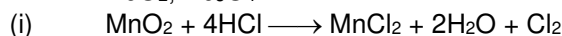
HCl ionises as below : $\text{HCl}(\text{g}) + \text{H}_2\text{O}(\ell) \longrightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{Cl}^-(\text{aq}) ; K_a = 10^7$

It's aqueous solution is called hydrochloric acid. High value of dissociation constant (K_a) indicates that it is a strong acid in water.

- (v) When three parts of concentrated HCl and one part of concentrated HNO_3 are mixed, aqua regia is formed which is used for dissolving noble metals, e.g., gold, platinum.

**(6) Reducing property and stability of hydrazids :**

HCl : It is quite stable and hence is oxidised by strong oxidising agents like MnO_2 , KMnO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$, PbO_2 , Pb_3O_4 .

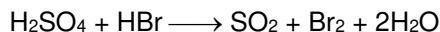


Therefore, HCl is a weak reducing agent.

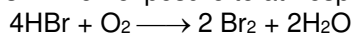


HBr : It is not very stable and hence more easily oxidised or acts as a strong reducing agents.

- (i) In addition to above reducing properties of HCl, it also reduces H_2SO_4 to SO_2 which is not done by HCl.

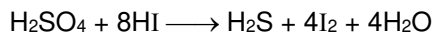
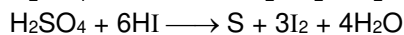


- (ii) Aqueous HBr on exposure to atmospheric oxygen is oxidised to bromine (yellow)



HI : It is least stable hydrogen halide. It is readily oxidised and thus acts as a powerful reducing agent. In addition to reaction shown by HCl, it shows following reactions also.

- (i) $\text{H}_2\text{SO}_4 + 2\text{HI} \longrightarrow \text{SO}_2 + \text{I}_2 + \text{H}_2\text{O}$



- (ii) $2\text{HNO}_3 + 2\text{HI} \longrightarrow 2\text{NO}_2 + \text{I}_2 + 2\text{H}_2\text{O}$

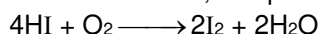
- (iii) $2\text{HNO}_2 + 2\text{HI} \longrightarrow 2\text{NO} + \text{I}_2 + 2\text{H}_2\text{O}$

- (iv) $\text{HIO}_3 + 5\text{HI} \longrightarrow 3\text{I}_2 + 2\text{H}_2\text{O}$

- (v) $\text{K}_2\text{S}_2\text{O}_8 + 2\text{HI} \longrightarrow \text{K}_2\text{SO}_4 + \text{I}_2 + \text{H}_2\text{SO}_4$

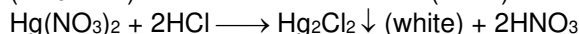
- (vi) $2\text{FeCl}_3 + 2\text{HI} \longrightarrow 2\text{FeCl}_2 + \text{I}_2 + 2\text{HCl}$

- (vii) Aqueous solution of acid, if exposed to O_2 is oxidised to iodine.



(7) Detection of cation:

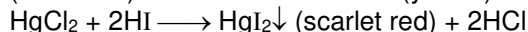
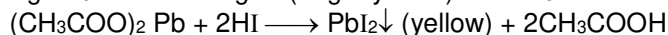
HCl : $\text{AgNO}_3 + \text{HCl} \longrightarrow \text{AgCl} \downarrow (\text{white}) + \text{HNO}_3$



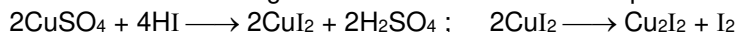
HBr : $\text{AgNO}_3 + \text{HBr} \longrightarrow \text{AgBr} \downarrow (\text{pale yellow}) + \text{HNO}_3$



HI : $\text{AgNO}_3 + \text{HI} \longrightarrow \text{AgI} \downarrow (\text{bright yellow}) + \text{HNO}_3$



HI reacts with CuSO_4 liberating iodine via the formation of cupric iodide (not by HCl or HBr).



USES :

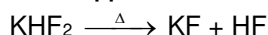
- (i) HCl is used in preparation of Cl_2 , chlorides, aqua regia, glucose (from corn starch), medicines, laboratory as reagents, cleaning metal surfaces before soldering or electroplating. It is also used for extracting glue from bones and purifying bone black.
- (ii) HBr is used as laboratory reagent for preparing bromo derivatives like sodium bromides and potassium bromide.
- (iii) HI is used as reducing agent in organic chemistry.

HYDROFLUORIC ACID [H_2F_2 , HF] :

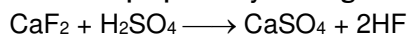
PREPARATION :

H_2 and F_2 combine with each other very violently (even in dark) to form HF. So simple reaction cannot be used for its preparation, special methods are employed for its preparation.

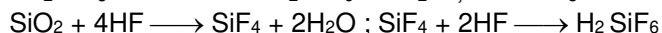
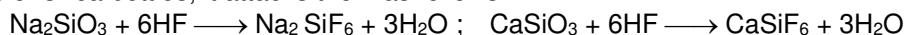
- (1) **Laboratory Method** : Anhydrous HF is obtained by heating dry potassium hydrogen fluoride in a copper retort connected with copper condenser.



- (2) **Industrial Method** : HF is prepared by heating fluorspar (CaF_2) with concentrated H_2SO_4 .



- (3) Aqueous HF being corrosive to glass, is stored in wax lined bottles or vessel made of copper or monel. In glass or silica bottles, it attacks them as follows:



This action of HF on silica (silicates) is used for etching glass. The glass surface to be etched is coated with wax, the design, is scratched on glass through wax coating and this is then treated with 40% solution.

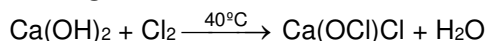
**PROPERTIES :**

- (i) It is colourless, corrosive liquid with pungent smell with high boiling point due to hydrogen bonding.
- (ii) Dry HF does not attack metals under ordinary conditions (except K), but in presence of water it dissolves metals with liberation of hydrogen gas.
- (iii) It is a weak dibasic acid (due to strong HF bond) and forms two series of salt.
 $\text{NaOH} + \text{H}_2\text{F}_2 \longrightarrow \text{NaHF}_2 + \text{H}_2\text{O}$; $\text{NaHF}_2 + \text{NaOH} \longrightarrow 2\text{NaF} + \text{H}_2\text{O}$
- (iv) HF also reacts with CCl_4 to form freons.
 $\text{CCl}_4 + \text{HF} \longrightarrow \text{CFCl}_3 + \text{HCl}$; $\text{CFCl}_3 + \text{HF} \longrightarrow \text{CF}_2\text{Cl}_2 + \text{HCl}$.

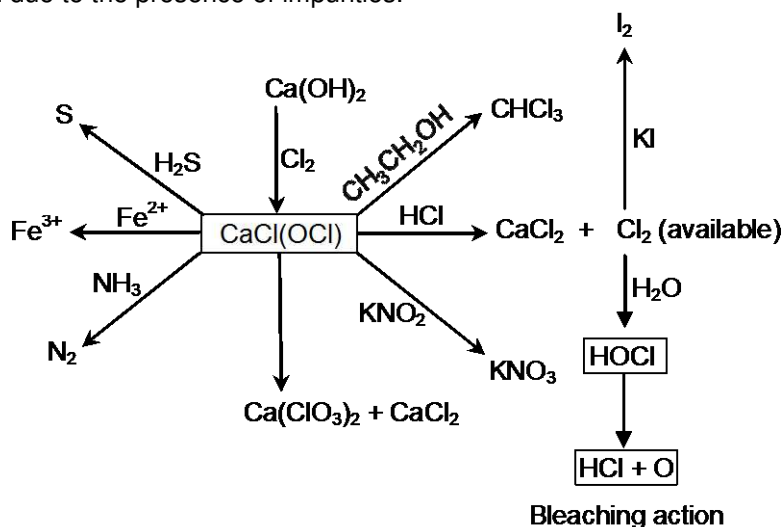
Section (H₁) : Other compounds (Inter halogens, Bleaching powder, Pseudo halides & Poly halides)**BLEACHING POWDER :**

Bleaching powder is also called calcium chlorohypochlorite because it is considered as a mixed salt of hydrochloric acid and hypochlorous acid.

The composition of bleaching powder is $\text{Ca}(\text{OCl})_2 \cdot \text{CaCl}_2 \cdot \text{Ca}(\text{OH})_2 \cdot 2\text{H}_2\text{O}$.

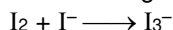
PREPARATION:**Properties**

It is a pale yellow powder. It has a strong smell of chlorine. It is soluble in water but a clear solution is never formed due to the presence of impurities.

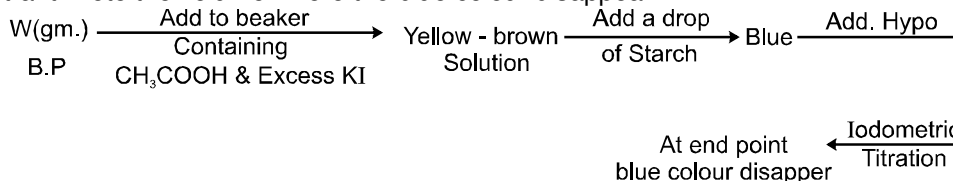
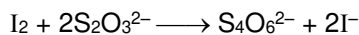
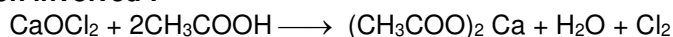
**ESTIMATION OF AVAILABLE CHLORINE :**

Let the weight of sample of bleaching powder be W g.

Add into a beaker containing acetic acid solution and excess KI. A yellow brown solution is formed (I_3^-)



Now few drops of starch solution is added into it. An intensive blue color is observed. Now hypo is used as the titrant. Note the volume where the blue colour disappear.

**Reaction involved :**

$$\text{Calculation : } \% \text{Cl} = \frac{[\text{M}_{\text{hypo}} \times \text{V}_{\text{hypo}}] \times \frac{1}{2} \times 71}{W} \times 100$$



**INTERHALOGEN COMPOUNDS :**

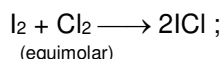
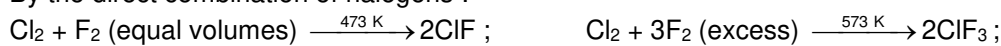
We know that halogen atoms have different electronegativity. Due to this difference in electronegativity the halogen atoms combine with each other and give rise to the formation of binary covalent compounds, which are called interhalogen compounds. These are of four types XX' , XX'_3 , XX'_5 and XX'_7 where X is a larger size halogen and X' is smaller size halogen.

Some Properties of Interhalogen Compounds

Type	Formula	Physical state and colour	Structure
XX'_1	ClF	Colourless gas	—
	BrF	pale brown gas	—
	IF ^a	detected spectroscopically gas	—
	BrCl ^b	ruby red solid (α -form)	—
	ICl	brown red solid (β -form)	—
	IBr	black solid	—
XX'_3	ClF ₃	colourless gas	Bent T- shaped
	BrF ₃	yellow green liquid	Bent T- shaped
	IF ₃	yellow powder	Bent T- shaped
	ICl ₃	orange solid	Bent T- shaped
XX'_5	IF ₅	colourless gas but solid below 77 K	Square pyramidal
	BrF ₅	colourless liquid	Square pyramidal
	ClF ₅	colourless liquid	Square pyramidal
XX'_7	IF ₇	colourless gas	Pentagonal bipyramidal

PREPARATION :

- (i) By the direct combination of halogens :



- (ii) Diluted with water :
- $\text{Br}_2 \text{ (g)} + 3\text{F}_2 \longrightarrow 2\text{BrF}_3$

- (iii)
- F_2
- is diluted with
- N_2
- :
- $\text{I}_2 + 3\text{F}_2 \xrightarrow{-78^\circ\text{C}} 2\text{IF}_3$

- (iv)
- F_2
- is taken in freon :
- $\text{Br}_2 + 5\text{F}_2 \text{ (excess)} \longrightarrow 2\text{BrF}_5$

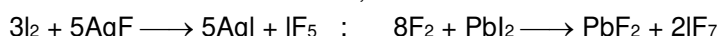
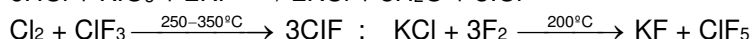
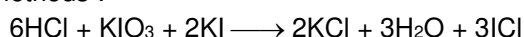
- (v)
- IF_7
- can not be prepared by direct combination of
- I_2
- &
- F_2
- .

- (vi) From lower interhalogens :



This method is generally applied for the preparation of halogen fluorides.

- (vii) Other methods :

**PROPERTIES :**

- (i) These compounds may be gases, liquids or solids.

Gases : ClF, BrF, ClF₃, IF₇; Liquids : BrF₃, BrF₅; Solids : ICl, IBr, IF₃, ICl₃.

- (ii) Interhalogens containing fluorine are colourless but inter halogens consisting of heavier halogens are coloured. The intensity of colour increases with increase in the molecular weight of the compounds.

- (iii) All interhalogens are covalent molecules and are diamagnetic in nature since all the valence electrons present as bonding or non-bonding electrons are paired.

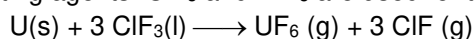




- (iv) The boiling points increases with the increase in the electronegativity difference between A and B atoms.
- (v) Thermal stability of AB type interhalogen compounds decreases with the decrease in electronegativity difference between A and B atoms. $IF > BrF > ClF > ICl > IBr > BrCl$.
More polar is the A–B bond more is the stability of interhalogen.
- (vi) Interhalogen compounds are more reactive than the parent halogens but less reactive than F_2 .
 $ICl + 2Na \longrightarrow NaI + NaCl$
 The order of reactivity of some interhalogens is as follows :
 $ClF_3 > BrF_3 > IF_7 > BrF_5 > BrF$.
- (vii) **Hydrolysis** : All these undergo hydrolysis giving halide ion derived from the smaller halogen and a hypohalite (when AB), halite (when AB_3), halate (when AB_5), and perhalate (when AB_7) anion derived from the larger halogen.
 $AB + H_2O \longrightarrow HB + HOA$
 $BrCl + H_2O \longrightarrow HCl + HOBr$; $ICl + H_2O \longrightarrow HCl + HIO$
 $ICl_3 + 2H_2O \longrightarrow 3HCl + HIO_2$; $IF_5 + 3H_2O \longrightarrow 5HF + HIO_3$
 $IF_7 + 6H_2O \longrightarrow 7HF + H_5IO_6$; $BrF_5 + 3H_2O \longrightarrow 5HF + HBrO_3$
 Oxidation state of A atom does not change during hydrolysis.
- (viii) Reaction with non-metallic and metallic oxides :
 $4BrF_3 + 3SiO_2 \longrightarrow 3SiF_4 + 2Br_2 + 3O_2$; $4BrF_3 + 2WO_3 \longrightarrow 2WF_6 + 2Br_2 + 3O_2$
- (x) Reaction with alkali metal halides :
 $IBr + NaBr \longrightarrow NaIBr_2$; $ICl_3 + KCl \longrightarrow KICl_4$

USES :

These compounds can be used as non aqueous solvents. Interhalogen compounds are very useful fluorinating agents. ClF_3 and BrF_3 are used for the production of UF_6 in the enrichment of ^{235}U .



Pseudohalogens and Pseudohalides :

- (i) A few ions are known, consisting of two or more atoms of which at least one is N, that have properties similar to those of the halide ions. They are therefore called pseudohalide ions.
- (ii) Pseudohalide ions are univalent, and these form salts resembling the halide salts. For example, the sodium salts are soluble in water, but the silver salts are insoluble.
- (iii) The hydrogen compounds are acids like the halogen acid HX . Some of the pseudohalide ions combine to form dimers comparable with the halogen molecule X_2 . These include cyanogens $(CN)_2$, thiocyanogen $(SCN)_2$ and selenocyanogen $(SeCN)_2$.

Anion		Acid		Dimer	
CN^-	Cyanide ion	HCN	Hydrogen cyanide	$(CN)_2$	Cyanogen
SCN^-	Thiocyanate ion	$HSCN$	Thiocyanic acid	$(SCN)_2$	Thiocyanogen
$SeCN^-$	Selenocyanate ion	$HO-CN$	Cyanic acid	$(SeCN)_2$	Selenocyanogen
OCN^-	Cyanate ion	H_2NCN	Cyanamide		
NCN^{2-}	Cyanamide ion	HN_3	Hydrogen azide		
N_3^-	Azide ion				

The best known pseudohalide is CN^- . This resembles Cl^- , Br^- and I^- in the following respects.

- (a) It forms an acid HCN .
- (b) It can be oxidized to form a molecule cyanogen $(CN)_2$.
- (c) It forms insoluble salts with Ag^+ , Pb^{2+} and Hg^+ .
- (d) Interpseudohalogen compounds $ClCN$, $BrCN$ and ICN can be formed.
- (e) $AgCN$ is insoluble in water but soluble in ammonia, as is $AgCl$.
- (f) It forms a large number of complexes similar to halide complexes.
 e.g. $[Cu(CN)_4]^{2-}$ and $[CuCl_4]^{2-}$ and $[Co(CN)_6]^{3-}$ and $[CoCl_6]^{3-}$

**GROUP 18 ELEMENTS : (THE NOBLE GASES / ZERO GROUP FAMILY)**

Group 18 consists of six elements: helium, neon, argon, krypton, xenon and radon. All these are gases and chemically unreactive. They form very few compounds. Because of this they are termed as noble gases.

Section (A_{II}) : Elements: Occurrence & Isolation

- (i) All the noble gases except radon occur in the atmosphere.
- (ii) Their atmospheric abundance in dry air is ~ 1% by volume of which argon is the major constituent. Helium and sometimes neon are found in minerals of radioactive origin e.g., pitchblende, monazite, cleveite.
- (iii) The main commercial source of helium is natural gas.
- (iv) Xenon and radon are the rarest elements of the group. Radon is obtained as a decay product of $^{226}_{88}\text{Ra}$.

$$^{226}_{88}\text{Ra} \longrightarrow ^{222}_{86}\text{Rn} + ^4_2\text{He}$$
- (v) Most abundant element in air is Ar. Order of abundance in the air is $\text{Ar} > \text{Ne} > \text{Kr} > \text{He} > \text{Xe}$.

Section (B_{II} + C_{II} + D_{II}) : Periodic Trends, Properties of Elements and Chemical Bonding**(1) Electronic Configuration :**

All noble gases have general electronic configuration ns^2np^6 except helium which has $1s^2$. Many of the properties of noble gases including their inactive nature are ascribed to their closed shell structures.

(2) Ionisation Enthalpy :

Due to stable electronic configuration these gases exhibit very high ionisation enthalpy. However, it decreases down the group with increases in atomic size.

(3) Atomic Radii :

Atomic radii increase down the group with increase in atomic number.

(4) Electron Gain Enthalpy :

Since noble gases have stable electronic configurations, they have no tendency to accept the electron and therefore, have larger positive values of electron gain enthalpy.

(5) Physical properties :

- (i) All the noble gases are mono-atomic.
- (ii) They are colourless, and tasteless.
- (iii) They are sparingly soluble in water.
- (iv) They have very low melting and boiling points because the only type of interatomic interaction in these elements is weak dispersion forces.
- (v) Helium has the lowest boiling point (4.2K) of any known substance. It has a unusual property of diffusing through most commonly used laboratory materials such as rubber, glass or plastics.

Table : Atomic and physical properties

Element	He	Ne	Ar	Kr	Xe
Atomic Number	2	10	18	36	54
Atomic Mass	4	20.18	39.10	83.80	131.30
Electronic configuration	$1s^2$	$[\text{He}] 2s^2 2p^6$	$[\text{Ne}] 3s^2 3p^6$	$[\text{Ar}] 3d^{10} 4s^2 4p^6$	$[\text{Kr}] 4d^{10} 5s^2 5p^6$
Atomic Radius (pm)	120	160	190	200	220
Ionization enthalpy / (kJ mol ⁻¹)	2372	2080	1520	1351	1170
Density (at STP)/g cm ⁻³	1.8×10^{-4}	9.0×10^{-4}	1.8×10^{-3}	3.7×10^{-3}	5.9×10^{-3}
Melting point / K	–	24.6	83.8	115.9	161.3
Boiling point / K	4.2	27.1	87.2	119.7	165.0

(6) Chemical Properties :

In general, noble gases are least reactive. Their inertness to chemical reactivity is attributed to the following reasons:

- (i) The noble gases except helium ($1s^2$) have completely filled $ns^2 np^6$ electronic configuration in their valence shell.
- (ii) They have high ionisation enthalpy and more positive electron gain enthalpy.
- (iii) In March 1962, Neil Bartlett, prepared a red compound which is formulated as $\text{O}_2^+ \text{PtF}_6^-$. He, then realised that the first ionisation enthalpy of molecular oxygen (1175 kJ mol⁻¹) was almost identical with that xenon (1170 kJ mol⁻¹).



- (iv) He also prepared same type of compound with $\text{Xe}^+ \text{PtF}_6^-$ by mixing Pt F_6 and Xenon. After this discovery, a number of xenon compounds mainly with most electronegative elements like fluorine and oxygen, have been synthesised.
- (v) The compounds of krypton are fewer. Only the difluoride (KrF_2) has been studied in detail.
- (vi) Compounds of radon have not been isolated but only identified (e.g., RnF_2) by radiotracer technique.
- (vii) No true compounds of Ar, Ne or He are yet known.
- (viii) If Helium is compressed and liquified it forms He(I) liquid at 4.2 K. This liquid is a normal liquid like any other liquid. But if it is further cooled then He(II) is obtained at 2.2 K, which is known as super fluid, because it is a liquid with properties of gases. It climbs through the walls of the container & comes out. It has very high thermal conductivity & very low viscosity.
- (7) Clathrate compounds :**
- (i) Inert gas molecules get trapped in the cages formed by the crystal structure of water.
- (ii) During the formation of ice Xe atoms will be trapped in the cavities (or cages) formed by the water molecules in the crystal structure of ice. Compounds thus obtained are called clathrate compounds.
- (iii) In this compounds there are no chemical bonds. They do not possess an exact chemical formula but approx it is 6 water molecules : 1 inert gas molecule.
- (iv) The cavity size is just smaller than the atom of the noble gas. Such compounds are also formed by the other organic liquids like dihydroxybenzene (for example quinol).
- (v) The smaller noble gases He and Ne do not form clathrate compounds because the gas atoms are small enough to escape from the cavities.
- (vi) Clathrate provides a convenient means of storing radioactive isotopes of Kr and Xe produced in nuclear reactors.

Section (G₁₁) : Compounds of Xenon

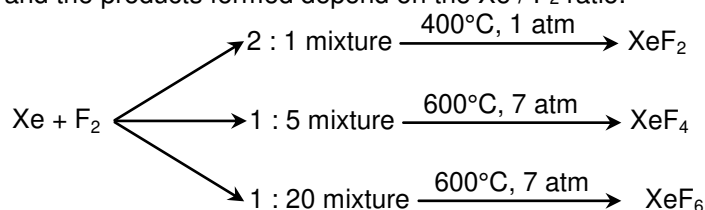
Halides & Oxyhalides :

(I) XENON FLUORIDES :

Compounds	Structures	Hybridisation	Geometry	Shape
XeF_2		sp^3d	trigonal bipyramidal	linear
XeF_4		sp^3d^2	octahedral	square planar
XeF_6		sp^3d^3	pentagonal bipyramidal	distorted octahedron

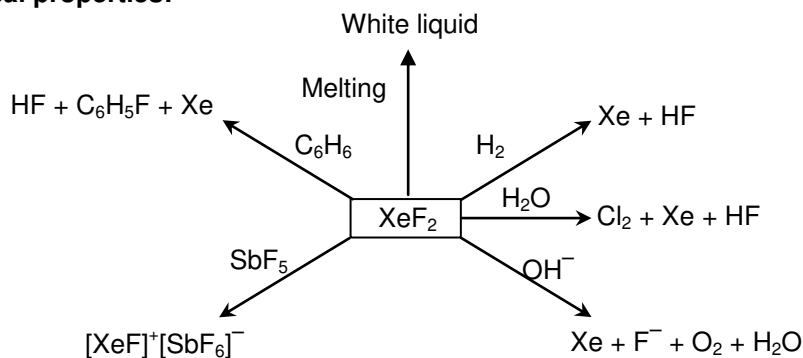
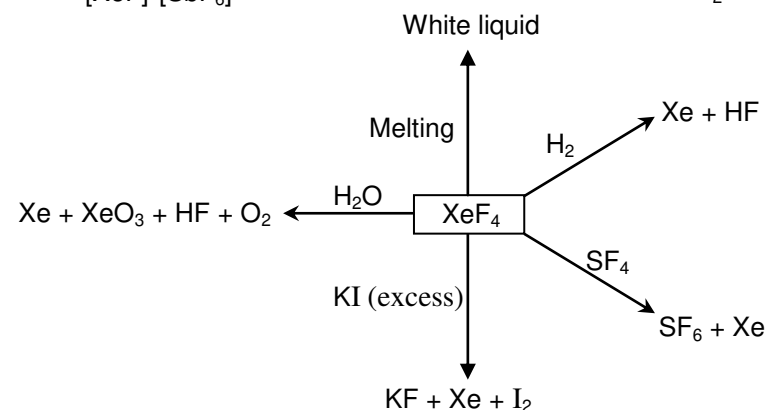
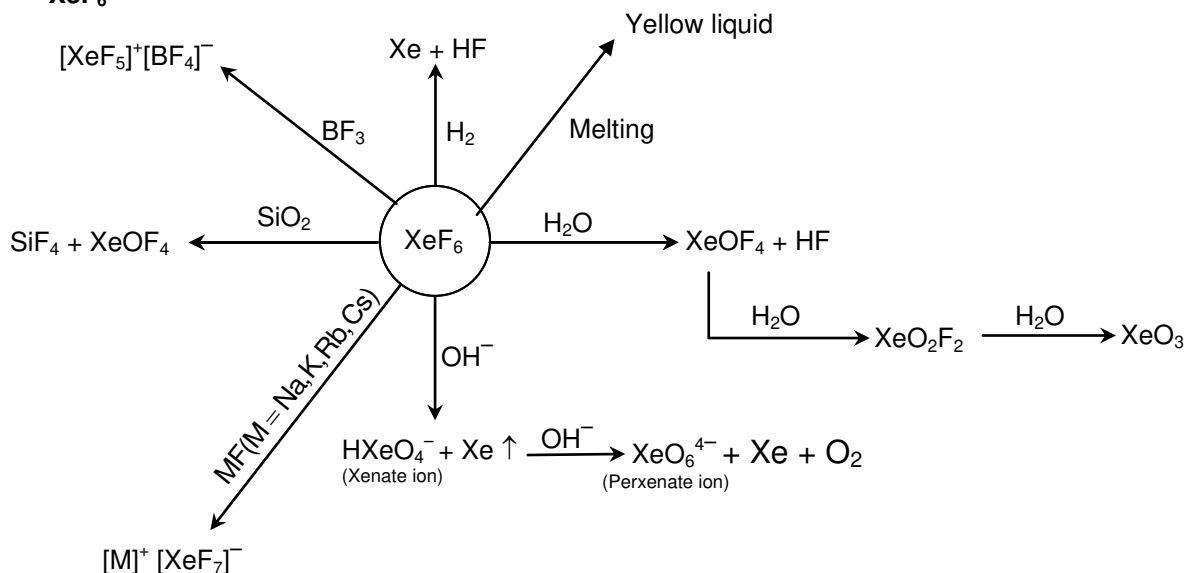
PREPARATION :

Xenon reacts directly with fluorine when the gases are heated at 300-600°C in a sealed nickel vessel and the products formed depend on the Xe / F_2 ratio.

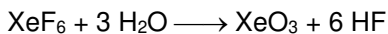


**PROPERTIES :**

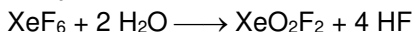
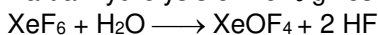
These are colourless (white) solids. They can be sublimed at room temperature and can be stored indefinitely in nickel or monel (an alloy of nickel) containers.

Chemical properties:**1. XeF_2 :****2. XeF_4 :****3. XeF_6** **(II) XENON-OXYGEN COMPOUNDS :**

Hydrolysis of XeF_4 and XeF_6 with water gives XeO_3 .



Partial hydrolysis of XeF_6 gives oxyfluorides, XeOF_4 and XeO_2F_2 .

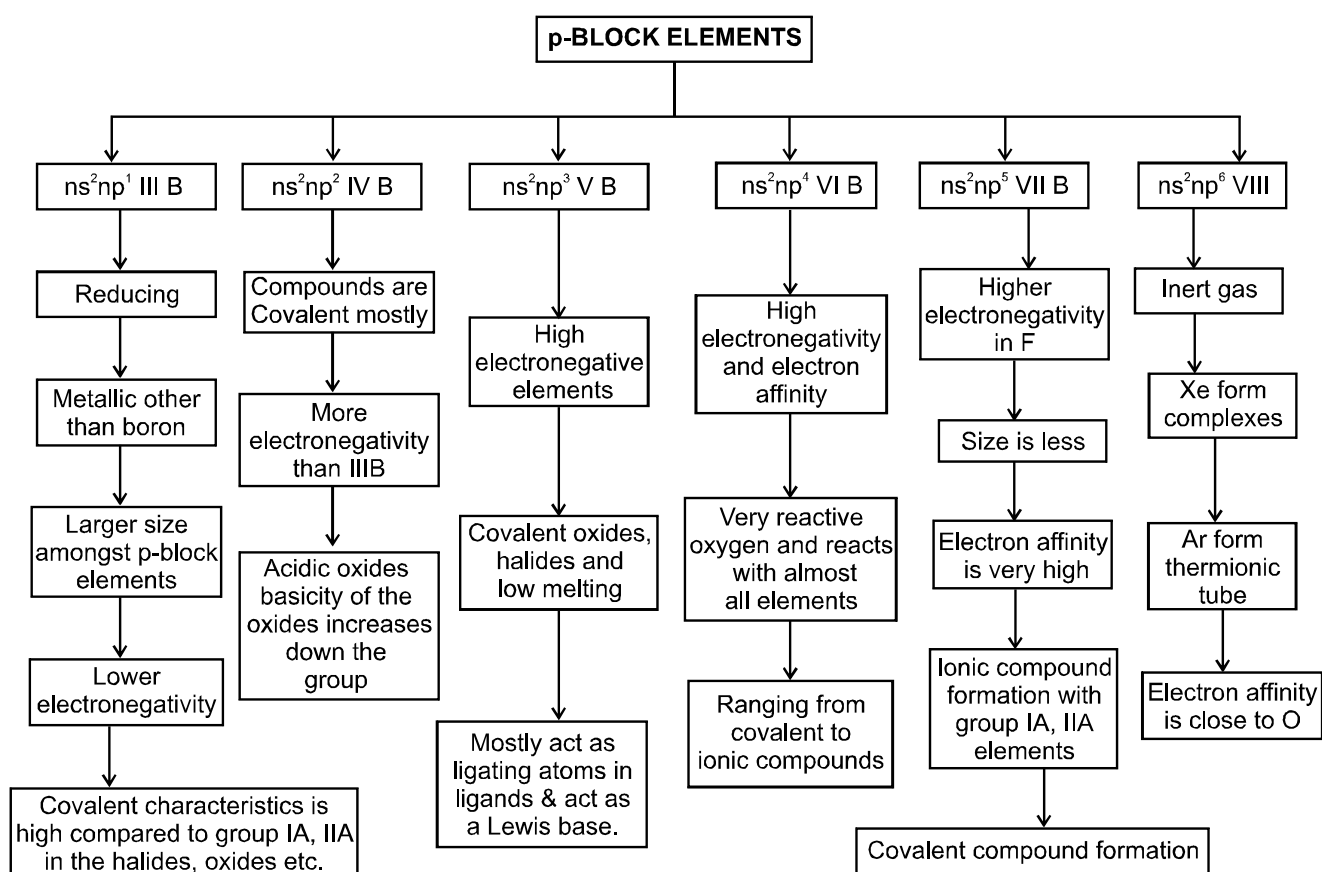




XeO_3 is a colourless explosive solid and has a pyramidal molecular structure. XeOF_4 is a colourless volatile liquid and has a square pyramidal molecular structure.

USES :

- (i) Helium is a non-inflammable and light gas. Hence, it is used in filling balloons for meteorological observations. It is also used in gas-cooled nuclear reactors.
- (ii) Liquid helium (b.p. 4.2 K) finds use as cryogenic agent for carrying out various experiments at low temperatures.
- (iii) Helium is used to produce and sustain powerful superconducting magnets which form an essential part of modern NMR spectrometers and Magnetic Resonance Imaging (MRI) systems for clinical diagnosis.
- (iv) Helium is used as a diluent for oxygen in modern diving apparatus because of its very low solubility in blood.
- (v) Neon is used in discharge tubes and fluorescent bulbs for advertisement display purposes. Neon bulbs are used in botanical gardens and in green houses.
- (vi) Argon is used mainly to provide an inert atmosphere in high temperature metallurgical processes (arc welding of metals or alloys) and for filling electric bulbs.
- (vii) Argon is also used in the laboratory for handling substances that are air-sensitive.
- (viii) Xenon and Krypton are used in light bulbs designed for special purposes.





Exercise-1

➤ Marked questions are recommended for Revision.

PART - I : SUBJECTIVE QUESTIONS

Section (A_I + A_{II}) : Elements: Occurrence & Isolation

- A_I-1.** Name the compound which is used to obtain fluorine gas on electrolysis. At which electrode does F₂ appears?
- A_I-2.** Name the valuable halogen impurities present in chile salt petre (NaNO₃).
- A_{II}-3.** What idea lead to the discovery of Xenon fluorides?

Section (B_I) : Based on Periodic Trends

- B_I-1.** Considering the parameters such as bond dissociation enthalpy, electron gain enthalpy and hydration enthalpy, compare the oxidizing power of F₂ and Cl₂.
- B_I-2.** Write all the common oxidation states of halogens.
- B_I-3.** Write and explain the order of X–X bond energy for halogen down the group.

Section (C_I + C_{II}) : Based on Chemical Bonding

- C-1.** Draw the Lewis dot structures of the following compounds :
HClO₃, XeOF₄, XeO₂F₂, ICl₂[–], ICl₄[–].
- C_I-2.** Draw the Lewis dot structures of the following multicentred compounds:
I₂O₅, Cl₂O₇.
- C_I-3.** Give the formula and describe the structure of a noble gas species which is isostructural with:
(i) ICl₄[–] (ii) IBr₂[–] (iii) BrO₃[–]
- C_{II}-4.** Arrange the XeF₂, XeF₄ in decreasing order of Xe–F bond length, give reason also.

Section (D_I + D_{II}) : Properties of elements

- D_{II}-1.** Answer the following with relevant reason.
(i) The boiling points of noble gases increase with increase in atomic number.
(ii) Why helium and neon do not form clathrate compounds with quinol ?
- D_I-2.** Why are halogens coloured ?
- D_I-3.** Write the reactions of F₂ and Cl₂ with water.
- D_I-4.** State what happens when halogens react with a cold dilute solution of NaOH ?
- D_I-5.** State what happens when halogens (X = Cl / Br / I) react with hot and conc. solution of NaOH ?
- D_I-6.** Which halogen is oxidised by conc. HNO₃? Give reaction.
- D_I-7.** Explain the following with proper reason :
(i) Fluorine cannot be prepared from fluorides by chemical oxidation.
(ii) Fluorine does not form F₃[–] (polyhalide) ion.

Section (E_I) : Oxides, Hydroxides & Oxyacids

- E_I-1.** Write chemical reactions involved in preparation of HClO₃ & HClO₄ by displacement from their salts.
- E_I-2.** When a blue litmus is dipped into a solution of hypochlorous acid, it turns red and then gets decolourised. Explain.



- E1-3.** Explain why fluorine forms only one oxyacid, HOF.
- E1-4.** Predict the products when the following reactions are carried out :
 (i) In acidic medium when SO_2 is passed through NaClO_3 .
 (ii) $\text{HCl} + \text{KIO}_3 + \text{KI} \longrightarrow$
- E1-5.** What happens when ClO_2 dissolves in NaOH ?

Section (F_I) : Hydracids

- F1-1.** Arrange the following in the order of : (i) Acidic strength (ii) Reducing behaviour
 (HI , HBr , HCl & HF)
- F1-2.** How can you prepare Cl_2 from HCl and HCl from Cl_2 ? Write reactions only.
- F1-3.** HI can not be prepared by heating NaI with concentrated H_2SO_4 . Give the method which is preferred for the preparation of HI .
- F1-4.** What is aqua regia? Write its reaction product with gold and platinum.
- F1-5.** Explain the following with proper reason :
 (i) Anhydrous HCl is a bad conductor of electricity while aqueous HCl is a good conductor.
 (ii) HF is not stored in glass bottles but kept in wax lined bottles.
 (iii) HF has a greater electronegativity difference and more ionic character than HCl , HBr and HI but it is the weakest acid.
- F1-6.** Fill in the blanks :
 (i) Among halogen acids (hydrogen halides) is the strongest reducing agent.
 (ii) $\text{H}_2\text{SO}_4 + \text{HI} \longrightarrow$ _____ + _____ + _____
- F1-7.** Predict the products when the following reactions are carried out :
 (i) Red lead is boiled with concentrated HCl .
 (ii) $\text{SiO}_2 + \text{HF} \longrightarrow$

Section (G_{II}) : Halides & Oxyhalides

- G11-1.** Write the method of preparation of XeF_2 , XeF_4 & XeF_6 .
- G11-2.** How is XeOF_4 prepared ?
- G11-3.** Does the hydrolysis of XeF_4 lead to a redox reaction ?
- G11-4.** Write the complete and the partial hydrolysis product of XeF_6 .
- G11-5.** Complete the following reactions :
 (i) $\text{XeF}_2 + \text{H}_2 \longrightarrow$ (ii) $\text{XeF}_6 + \text{SiO}_2 \longrightarrow$ (iii) $\text{XeF}_6 + \text{SbF}_5 \longrightarrow$

Section (H_I) : Other compounds (Inter halogens, Bleaching powder, Pseudo halides & Poly halides)

- H1-1.** Complete the following reactions :
 (a) $\text{Cl}_2 + \text{F}_2 \xrightarrow[(\text{Equal volume})]{473 \text{ K}}$ (b) $\text{I}_2 + 3\text{Cl}_2 \xrightarrow{(\text{Excess})}$ (c) $\text{Br}_2 + 3\text{F}_2 \longrightarrow$ (d) $\text{Br}_2 + 5\text{F}_2 \xrightarrow{(\text{Excess})}$
- H1-2.** Why ICl is more reactive than I_2 .
- H1-3.** (a) Name two interhalogens of AB_3 type.
 (b) Write the hydrolysis product of ICl ?
- H1-4.** Explain the following with proper reason :
 (i) Bleaching of flowers by chlorine is permanent while after bleaching with SO_2 , the colour returns.
 (ii) Iodine dissolves more in KI solution than in water.
- H1-5.** What happens when ? (Give balanced equations)
 (i) Sodium iodate is treated with sodium bisulphite solution.
 (ii) Chlorine is passed over slaked lime.



PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A_I + A_{II}) : Elements : Occurrence and Isolation

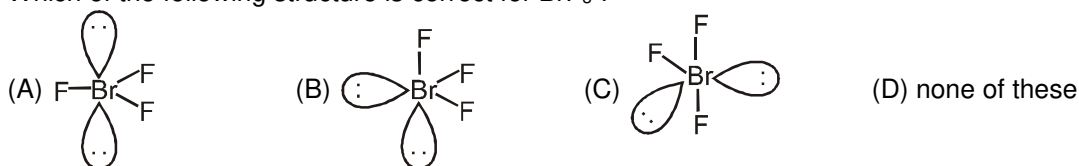
- A_{II}-1.** Which of the following gaseous molecules is monoatomic ?
 (A) chlorine (B) helium (C) oxygen (D) nitrogen
- A_{II}-2.** Which one of the following noble gases is not found in atmosphere ?
 (A) Rn (B) Kr (C) Ne (D) Ar
- A_{II}-3.** The inert gas abundantly found in atmosphere is :
 (A) Ar (B) Kr (C) He (D) Xe
- A_I-4.** Electrolysis of aqueous solution of Brine (NaCl) will give:
 (A) Cl₂ (B) H₂ (C) NaOH (D) all of these
- A_I-5.** The catalyst used in the Deacon's process for the manufacture of chlorine is :
 (A) Cu (B) An alloy of copper (C) CuCl₂ (D) CuS

Section (B_I + B_{II}) : Based on Periodic Trends

- B_{II}-1.** Which one of the following configuration represents a noble gas ?
 (A) 1s² 2s² p⁶, 3s² (B) 1s² 2s² p⁶, 3s¹ (C) 1s² 2s² p⁶ (D) 1s² 2s² p⁶, 3s² p⁶, 4s²
- B_I-2.** Astatine is the element below iodine in the group VIIA of the periodic table. Which of the following statements is not true for astatine ?
 (A) It is less electronegative than iodine.
 (B) It will exhibit only -1 oxidation state.
 (C) Intermolecular forces between the astatine molecules will be larger than that between iodine molecules.
 (D) None of these.
- B_I-3.** Which is wrong statement ?
 (A) Basic nature of X⁻ is in order F⁻ > Cl⁻ > Br⁻ > I⁻
 (B) Electron gain enthalpy in order F > Cl > Br > I.
 (C) The ionic character of M—X bond decreases in the order M—F > M—Cl > M—Br > M—I
 (D) Among F⁻, Cl⁻, Br⁻ and I⁻, F⁻ has the highest enthalpy of hydration.

Section (C_I + C_{II}) : Based on Chemical Bonding

- C_I-1.** Which of the following structure is correct for BrF₃ ?



- C_{II}-2.** Among the following molecules, (i) XeO₃ (ii) XeOF₄ (iii) XeF₆ those having same number of lone pairs on Xe are :
 (A) (i) and (ii) only (B) (i) and (iii) only (C) (ii) and (iii) only (D) (i), (ii) and (iii)
- C_{II}-3.** Select the incorrect match
 (A) XeF₂ : linear (B) XeF₄ : square planar
 (C) XeF₆ : distorted octahedral (D) XeO₃ : trigonal planar

Section (D_I) : Properties of elements

- D_I-1.** Correct order of boiling point of halogens is
 (A) F₂ < Cl₂ < Br₂ < I₂ (B) Cl₂ > F₂ > Br₂ > I₂ (C) F₂ > Cl₂ > Br₂ > I₂ (D) Cl₂ < F₂ < Br₂ < I₂
- D_{II}-2.** Which of the following statement is correct ?
 (A) Helium has abnormal behaviour on liquefaction
 (B) Iodine is readily soluble in CS₂ and the solution is purple in colour
 (C) Helium do not form any clathrate
 (D) All of these



- D1-3.** Chlorine gas is dried over :
 (A) CaO (B) NaOH (C) conc. H_2SO_4 (D) dil. H_2SO_4
- D1-4.** F_2 reacts with H_2O as follows :

$$\text{F}_2 + \text{H}_2\text{O} \longrightarrow \text{H}^+ + \text{F}^- + \text{O}_2$$

 Which of the following halogens shows same reaction but in opposite direction ?
 (A) Br_2 (B) Cl_2 (C) I_2 (D) All
- D1-5.** Chlorine acts as a bleaching agent only in presence of :
 (A) dry air (B) moisture (C) sunlight (D) pure oxygen

Section (E₁) : Oxides, Hydroxides & Oxyacids

- E1-1.** Select the incorrect statement :
 (A) Perchloric acid is a stronger acid than sulphuric acid
 (B) Only one oxyacid [HOF] is formed by fluorine
 (C) The most stable oxy-acid of chlorine is perchloric acid
 (D) None of these
- E1-2.** Cl_2O_6 reacts with water and alkali to give :
 (A) Only sodium chlorate (B) Only sodium perchlorate
 (C) Both sodium chlorate and sodium perchlorate (D) None of these
- E1-3.** On heating KClO_3 we get :
 (A) $\text{KClO}_2 + \text{O}_2$ (B) $\text{KCl} + \text{O}_2$ (C) $\text{KCl} + \text{O}_3$ (D) $\text{KCl} + \text{O}_2 + \text{O}_3$
- E1-4.** The following acids have been arranged in order of decreasing acid strength. Identify the correct order.
 ClOH (I), BrOH (II), IOH (III)
 (A) $\text{I} > \text{II} > \text{III}$ (B) $\text{II} > \text{I} > \text{III}$ (C) $\text{III} > \text{II} > \text{I}$ (D) $\text{I} > \text{III} > \text{II}$
- E1-5.** ClO_3^- ion leads with I_2 to form
 (A) ClO_4^- (B) IO_3^- and Cl_2 (C) ICl and O_2 (D) ICl and O_3
- E1-6.** The strongest acid amongst the following is :
 (A) HClO_4 (B) HClO_3 (C) HClO_2 (D) HClO

Section (F₁) : Hydracids

- F1-1.** Which of the following halogen hydrides will have the weakest conjugate base ?
 (A) HF (B) HCl (C) HBr (D) HI
- F1-2.** Concentrated H_2SO_4 cannot be used to prepare HBr from NaBr, because it :
 (A) reduces HBr (B) oxidises HBr
 (C) disproportionates HBr (D) reacts slowly with NaBr
- F1-3.** Hydrogen bromide is dried by passing the gas through :
 (A) quick lime (B) anhydrous calcium chloride
 (C) potassium hydroxide pellet (D) con. H_2SO_4
- F1-4.** Which one of the hydracid does not form any precipitate with AgNO_3 ?
 (A) HF (B) HCl (C) HBr (D) HI
- F1-5.** Which can do glass etching ?
 (A) HIO_4 (B) HF (C) HNO_3 (D) SiF_4
- F1-6.** Identify A and B in following reaction, $\text{H}_2\text{SO}_4 + \text{HBr} \longrightarrow \text{A} + \text{B} + \text{H}_2\text{O}$
 (A) Br_2 , SO_3 (B) Br_2 , S (C) BrO_3^- , SO_3 (D) Br_2 , SO_2
- F1-7.** Which of the following is obtained when gold is treated with aquaregia.
 (A) AuCl_4 (B) AuCl_3 (C) $[\text{AuCl}_4]^-$ (D) $[\text{AuCl}_4]^+$
- F1-8.** Which of the following hydrogen halide is most volatile.
 (A) HCl (B) HF (C) HI (D) HBr



- F_I-9.** Which of the following has maximum bond strength :
 (A) HI (B) HCl (C) HF (D) HBr
- F_I-10.** Which of the following is the strongest acid ?
 (A) HBr (B) HF (C) H₂S (D) PH₃

Section (G_{II}) : Halides and oxyhalides

- G_{II}-1.** The number of lone pairs on central atom in XeF₂, XeF₄ and XeF₆ are :
 (A) 1,2,3 (B) 3,2,1 (C) 2,2,1 (D) 1,3,2
- G_{II}-2.** Of the following species, one which is non-existent :
 (A) XeF₆ (B) XeF₅ (C) XeF₄ (D) XeF₂
- G_{II}-3.** XeF₂ on complete hydrolysis gives :
 (A) Xe (B) XeO₂ (C) XeO₂F₂ (D) XeO₄
- G_{II}-4.** Hydrolysis of XeF₄ and CaCN₂ gives respectively :
 (A) XeO₃ and CaCO₃ (B) XeO₂ and Ca(OH)₂
 (C) XeOF₃ and Ca(OH)₂ (D) XeOF₂ and CaCO₃
- G_{II}-5.** Xenon hexafluoride undergoes hydrolysis in strong alkaline medium:
 $2 \text{XeF}_6 + 16 \text{OH}^- \longrightarrow 8 \text{H}_2\text{O} + 12 \text{F}^- + \text{A} + \text{B} + \text{C}$ then reaction product may be:
 (A) perxenate ion (B) O₂ (C) Xenon (D) All of the above

Section (H_I) : Other compounds (Inter halogens, Bleaching powder, Pseudo halides & Poly halides)

- H_I-1.** In the inter halogen compounds of AB₃/AB₅ form which is correct :
 (A) A is large size halogen (B) B is large size halogen
 (C) B is small size halogen (D) Both (A) & (C)
- H_I-2.** Which one of the following is not a pseudohalide ?
 (A) CNO⁻ (B) RCOO⁻ (C) OCN⁻ (D) NNN⁻
- H_I-3.** Which of the following behaves like pseudohalogen compound:
 (A) NCCN (B) CN⁻ (C) N₃⁻ (D) I₃⁻
- H_I-4.** Which of the following statement is correct.
 (A) All interhalogen compounds are gas at room temperature.
 (B) Interhalogen are either gas or liquid at room temperature.
 (C) Interhalogens can be solid or liquid or gas at room temperature.
 (D) All interhalogen compounds are liquid at room temperature.

PART - III : MATCH THE COLUMN

1. Match the reactions listed in column-I with the product(s) listed in column-II.

	Column-I		Column-II (X = Halogen)
(A)	$\text{NH}_3 + \text{F}_2 \longrightarrow$	(p)	N ₂
(B)	$\text{NH}_3 (\text{excess.}) + \text{Cl}_2 \longrightarrow$	(q)	HX
(C)	$\text{NH}_3 + \text{Br}_2 (\text{excess.}) \longrightarrow$	(r)	NH ₄ X
(D)	$\text{NH}_3 (\text{aq.}) + \text{I}_2 \longrightarrow$	(s)	Explosive

2. Match the reactions listed in column-I with the product(s) listed in column-II.

	Column - I		Column - II
(A)	$\text{Cl}_2\text{O}_6 + \text{H}_2\text{O} \rightarrow$	(p)	ClO ₂
(B)	$\text{NaClO}_4(\text{s}) + \text{HCl}(\text{conc.}) \rightarrow$	(q)	HClO ₃
(C)	$\text{KClO}_3 + (\text{COOH})_2 \rightarrow$	(r)	Cl ₂ O
(D)	$\text{HgO} + \text{Cl}_2 \xrightarrow{573\text{K}}$	(s)	HClO ₄



3. Match the compounds listed in column-I with characteristic(s) / type of reaction(s) listed in column-II.

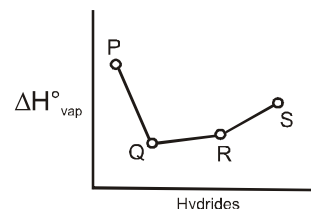
	Column-I		Column-II
(A)	XeF ₂	(p)	Undergoes hydrolysis with water.
(B)	XeF ₄	(q)	Acts as oxidising agent.
(C)	XeF ₆	(r)	Undergoes addition reaction.
(D)	XeO ₃	(s)	Has lone pair(s) of electrons.
		(t)	Gives disproportionation reaction with H ₂ O or OH ⁻ .

Exercise-2

Marked questions are recommended for Revision.

PART - I : ONLY ONE OPTION CORRECT TYPE

- The X – X bond dissociation energy is minimum in :
(A) F₂ (B) Cl₂ (C) Br₂ (D) I₂
- Iodine is liberated from KI solution when treated with :
(A) ZnSO₄ (B) CuSO₄ (C) NiSO₄ (D) FeSO₄
- Which of the following is not oxidised by MnO₂ ?
(A) F⁻ (B) Cl⁻ (C) Br⁻ (D) I⁻
- F₂ + dil NaOH → A + NaF + H₂O
F₂ + conc. NaOH → B + NaF + H₂O
A and B respectively are :
(A) OF₂ and O₂ (B) O₂ and OF₂ (C) Both O₂ (D) Both OF₂
- When thiosulphate ion is oxidised by iodine, the new product formed is :
(A) SO₃²⁻ (B) SO₄²⁻ (C) S₄O₆²⁻ (D) S₂O₆²⁻
- NH₃(excess) + Cl₂ → NH₄Cl + A(gas)
NH₃ + Cl₂(excess) → B + HCl
Incorrect statement regarding A and B.
(A) A is highly reactive gas at room temperature.
(B) Bond order of gas 'A' is same as C₂²⁻.
(C) Compound 'B' is explosive.
(D) Bond angle of compound B is greater than bond angle of NF₃.
- Which amongst the following reactions cannot be used for the respective preparation ?
(A) 2KBr + H₂SO₄ (conc.) → K₂SO₄ + 2HBr (B) NaCl + H₂SO₄ (conc.) → NaHSO₄ + HCl
(C) NaHSO₄ + NaCl → Na₂SO₄ + HCl (D) CaF₂ + H₂SO₄(conc.) → CaSO₄ + 2HF
- ΔH_{vaporisation} (KJ/mol) are given for the hydrides of halogens in the following graph. The hydride HF will correspond to
(A) P
(B) Q
(C) R
(D) S
- Alkali metal hydrogen fluorides have a formula M[HF₂]. They are found to contain a linear symmetrical anion having an overall F–H–F distance of 2.26 Å which may be compared with the H–F bond length of 0.92 Å in the moment. Which of the following is false for the anion ?
(A) Hydrogen bonding plays a significant role in the existence of the anion
(B) Average bond length (H–F) is 1.13 Å in the anion HF₂⁻
(C) The stretching of the H–F bond in the anion is 0.21 Å
(D) H-atom is bonded to two F-atoms through two T bonds in the anion.





10. A certain hypohalite on treating with hot and conc. NaOH forms anions P and Q. More stable anion among P and Q can be obtained by neutralizing its conjugate acid X. Upon heating X to very high temperature, a compound Y is formed, which is used in estimation of a toxic gas which have 300 times stronger affinity for haemoglobin than dioxygen. Then which of the following statements are true.
 (A) X is HI.
 (B) Y is Cl_2O_5
 (C) Final product Y, has total no. of bonds 5.
 (D) Y on reacting with toxic gas produces a gas which is used in fire extinguisher.
11. When F_2 is passed into a solution of mineral acid X, a greenish yellow gas Y is formed. Which on treating with slaked lime forms "Z". When Red litmus is kept in contact with Z, it changes into
 (A) Blue colour (B) No change in colour
 (C) White in colour (D) None of these
12. Which statement regarding iodine trichloride is incorrect.
 (A) It forms dimer in gaseous state.
 (B) In dimer I_2Cl_6 , the bridge bonds are longer than the terminal bonds.
 (C) In solid state, it exist as planar molecule.
 (D) On hydrolysis, it gives a mixture of iodic acid and hydrochloric acid.
13. The order of solubility of noble gases in water is
 (A) $\text{He} > \text{Ar} > \text{Kr} > \text{Ne} > \text{Xe}$ (B) $\text{He} > \text{Ne} > \text{Ar} > \text{Kr} > \text{Xe}$
 (C) $\text{Xe} > \text{Ar} > \text{Kr} > \text{He} > \text{Ne}$ (D) $\text{Xe} > \text{Kr} > \text{Ar} > \text{Ne} > \text{He}$
14. Consider following properties of the noble gases.
 I : They readily form compounds which are colourless.
 II : They generally do not form ionic compounds.
 III : Xenon has variable oxidation states in its compounds.
 IV : the smaller He and Ne do not form clathrate compounds.
 Select correct properties.
 (A) I, II, III (B) II, III, IV (C) I, III, IV (D) All
15. The formation of $\text{O}_2^+ [\text{PtF}_6]^-$ is the basis for the formation of xenon fluorides. This is because :
 (A) O_2 and Xe have comparable sizes.
 (B) both O_2 and Xe are gases.
 (C) O_2 and Xe have comparable ionisation energies.
 (D) O_2 and Xe have comparable electronegativities.
16. $[\text{HXeO}_4]^- + \text{OH}^- \longrightarrow [\text{X}] + [\text{Y}] + \text{O}_2 + \text{H}_2\text{O}$
 The products [X] and [Y] in unbalanced reaction are :
 (A) $[\text{XeO}_6]^{4-}$ & Xe (B) $[\text{XeO}_6]^{4-}$ & XeO_3 (C) XeO_3 & Xe (D) H_2XeO_4 & Xe

PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

1. The total number of electrons present in 4th shell of Astatatine ($_{85}\text{At}$) are :
2. How many of the following properties of halogen increases with increase in atomic number.
 (a) Number of valence electron (b) Metallic nature (c) Boiling points
 (d) Atomic radii (e) Density (f) Ionisation enthalpies
 (g) Electronegativities (h) Reactivity
 (i) Oxidising nature. (j) $\Delta_{\text{eg}}\text{H}$ (magnitude wise)
3. A gas P is obtained at anode during the electrolysis of brine. The gas P when treated with excess of NH_3 released a diatomic gas Q. Find the value of $(x - y)$ where x & y are the molar mass of P and Q.
4. How many orders are correct :
 (a) $\text{H-F} < \text{H-Cl} < \text{H-Br} < \text{H-I}$ (Bond length)
 (b) $\text{H-F} < \text{H-I} < \text{H-Br} < \text{H-Cl}$ (Acidic strength)
 (c) $\text{H-I} < \text{H-Br} < \text{H-Cl} < \text{H-F}$ (Bond strength)
 (d) $\text{H-F} > \text{H-Cl} > \text{H-Br} > \text{H-I}$ (Thermodynamic stability)
 (e) $\text{H-F} < \text{H-Cl} < \text{H-Br} < \text{H-I}$ (Reducing power)
 (f) $\text{H-F} > \text{H-I} > \text{H-Br} > \text{H-Cl}$ (Boiling point)





5. $\text{HCl} + \text{HNO}_3 \longrightarrow$
(Conc.) (Conc.)
In this reaction change in oxidation number of N is _____
6. How many of the following reactions would have HCl as one of the products ?
 (a) $\text{CH}_4 + \text{Cl}_2 \longrightarrow$ (b) $\text{FeSO}_4 + \text{H}_2\text{SO}_4 + \text{Cl}_2 \longrightarrow$
 (c) $\text{I}_2 + \text{Cl}_2 + \text{H}_2\text{O} \longrightarrow$ (d) $\text{Cl}_2 + \text{H}_2\text{O} \longrightarrow$
 (e) $\text{H}_2\text{O} + \text{SO}_2 + \text{Cl}_2 \longrightarrow$ (f) $\text{SO}_3 + \text{Cl}_2 \longrightarrow$
 (g) $\text{NaCl(aq)} \xrightarrow{\text{Electrolysis}}$ (h) $\text{Cl}_2\text{O}_7 + \text{H}_2\text{O} \longrightarrow$
 (i) $\text{Cl}_2 + \text{NaOH(conc.)} \longrightarrow$
7. The number of mixed anhydride among the following are
 Cl_2O ; ClO_2 ; Cl_2O_6 ; Cl_2O_7 ; N_2O_5 ; NO_2 ; N_2O
8. $\text{Br}_2 + \text{F}_2 \text{ (excess)} \longrightarrow \text{A} \xrightarrow{\text{Hydrolysis}} \text{B} + \text{C}$
 The summation of atomicities of compound A, B and C is :
9. The number of lone pairs of electrons present in central atom of ClF_3 is :
10. Which of the following interhalogens exist at room temperature and have central atom hybridization sp^3d^2
 (a) ClF_3 (b) ClF_5 (c) BrCl_3 (d) IF_3
 (e) IF_5 (f) BrF_5 (g) IF_7 (h) ICl_5
 (i) IBr_5 (j) BrF_3 (k) ClBr_5
11. How many of the following properties of noble gases would increase from Helium to Radon ?
 Boiling point, First Ionisation enthalpy, Atomic volume, Abundance in atmosphere, Density at STP, Valence electrons, Critical temperature.
12. The number of compounds/elements oxidised by XeF_2 among following is:
 HF , HBr , HCl , HI , NH_3 , CrF_2 , Pt , S_8
13. The oxidation state of xenon in perxenate ion is +n. Give the value of 'n'.
14. $\text{Xe} + \text{O}_2\text{F}_2 \longrightarrow \text{A} + \text{B}$
 \downarrow Hydrolysis
 $\text{B} + \text{C} + \text{Xe}$
 The summation of total no. of lone pairs and σ bonds in in species (A, B and C) is.
15. How many of the given compounds can produce XeO_3 .
 XeF_6 , XeF_4 , XeO_2F_2 , XeOF_4

PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. Which of the following salts will evolve halogen on treatment with conc. H_2SO_4 ?
 (A) NaCl (B) KI (C) NaBr (D) none of these
2. Which of the following reactions are correct ?
 (A) $\text{NaIO}_3 + 5\text{NaI} + 6\text{H}_2\text{SO}_4 \longrightarrow 6\text{NaHSO}_4 + 3\text{H}_2\text{O} + \text{I}_2$
 (B) $2\text{KBr} + \text{MnO}_2 + 3\text{H}_2\text{SO}_4 \longrightarrow 2\text{KHSO}_4 + \text{MnSO}_4 + 2\text{H}_2\text{O} + \text{Br}_2 \uparrow$
 (C) $\text{K}_2\text{Cr}_2\text{O}_7 + 14\text{HCl} \longrightarrow 2\text{KCl} + 2\text{CrCl}_3 + 7\text{H}_2\text{O} + 3\text{Cl}_2$
 (D) $2\text{K}_2\text{MnF}_6 + 4\text{SbF}_5 \longrightarrow 4\text{KSbF}_6 + \text{MnF}_3 + \text{F}_2$
3. Which of the following will not displace the halogen from the solution of the halide ?
 (A) Br_2 added to NaI (B) Br_2 added to NaCl (C) F_2 added to KCl (D) Cl_2 added to NaF
4. Iodine reacts with hypo to give :
 (A) NaI (B) Na_2SO_3 (C) $\text{Na}_2\text{S}_4\text{O}_6$ (D) Na_2SO_4



5. $\text{Cl}_2 + \text{NH}_3(\text{excess}) \longrightarrow \text{A} + \text{B}$
 (A) One of the product is also obtained by decomposition of $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$.
 (B) Bond order in one of the product is 3
 (C) Both products contain chlorine.
 (D) If Br_2 is used instead of Cl_2 , one of product remain same
6. In which of the following case disproportionation reaction take place.
 (A) $\text{F}_2 + \text{Hot water} \longrightarrow \text{products}$ (B) $\text{Cl}_2 + \text{Cold and dilute NaOH} \longrightarrow \text{products}$
 (C) $\text{Cl}_2 + \text{Hot and conc. NaOH} \longrightarrow \text{products}$ (D) $\text{Cl}_2 + \text{NH}_3(\text{excess}) \longrightarrow \text{products}$
7. In which following statement are correct.
 (a) Anhydrous hydrogen fluoroide is a liquid at ordinary temperature while other halogen acid are gases.
 (b) Lead acetate does not form any precipitate with HF acid but other halogen acid form precipitates.
 (c) HF is heated with a mixture of MnO_2 and H_2SO_4 , no gas is evolved but in case of HCl, HBr and HI acids evolved gases.
 (d) HF is not oxidised by strong oxidising agent but other halogen acid are oxidised.
 (A) a (B) b (C) c (D) d
8. A pungent smelling gas X after being dried by concentrated H_2SO_4 was dissolved in water to give strongly acidic solution. The gas also gives dense white fumes with NH_3 . X is also a constituent of aqua-regia. Which of the following is/are true for X ?
 (A) X is HCl
 (B) X is Cl_2
 (C) X is the most volatile among the hydrides of halogens
 (D) Solution of X in water can liberate CO_2 from the solution of sodium hydrogencarbonates.
9. Among the following which reactions are possible
 (A) $\text{F}_2 + \text{H}_2\text{O} \longrightarrow \text{HF} + \text{O}_2$ (B) $\text{Cl}_2 + \text{H}_2\text{O} \longrightarrow \text{HCl} + \text{HClO}$
 (C) $\text{Br}_2 + \text{H}_2\text{O} \longrightarrow \text{HBr} + \text{HBrO}$ (D) $\text{I}_2 + \text{H}_2\text{O} \longrightarrow \text{HI} + \text{HIO}$
10. Which of the following statements are true :
 (A) Strength of oxyacids : $\text{HClO}_4 > \text{HClO}_3 > \text{HClO}_2 > \text{HClO}$
 (B) Strength of oxyacids : $\text{HClO}_4 > \text{HBrO}_4 > \text{HIO}_4$
 (C) Number of p π -p π bonds : $\text{HClO}_4 > \text{HClO}_3 > \text{HClO}_2 > \text{HClO}$
 (D) Percentage s-character of central atom : $\text{HClO}_4 > \text{HClO}_3 > \text{HClO}_2 > \text{HClO}$.
11. Which of the following interhalogen compounds is/are possible :
 (A) ClF_3 (B) IF_5 (C) FCl_3 (D) BrF_5
12. Which of the following statement are true regarding interhalogens :
 (A) Thermal stability order $\text{IF} > \text{BrF} > \text{ClF}$
 (B) Hydrolysis of IF_7 produces H_5IO_6 and HF as products.
 (C) Interhalogen compounds are diamagnetic in nature.
 (D) IF_7 have pentagonal bipyramidal structure.
13. Which of the following inert gas(es) form(s) clathrate compound(s) with quinol ?
 (A) Helium (B) Xenon (C) Krypton (D) Neon
14. Consider the following reactions
 $\text{Xe} + \text{F}_2 \xrightarrow{\text{Ni}} \text{A}$
 2 : 1
 $\text{Xe} + \text{F}_2 \longrightarrow \text{B}$
 1 : 20
 $\text{Xe} + \text{F}_2 \longrightarrow \text{C}$
 1 : 5
 Select incorrect statements :
 (A) A, B and C all are non-polar and planar molecule (B) B has no lone pair of electrons
 (C) The order of Xe-F bond length is $\text{A} > \text{C} > \text{B}$ (D) A, B and C are act as Lewis base.
15. Which of the following statements(s) is /are true for XeF_6 ?
 (A) Its partial hydrolysis gives XeOF_4 . (B) Its reaction with silica gives XeOF_4
 (C) It is prepared by the reaction of XeF_4 and O_2F_2 (D) Its reaction with XeO_3 gives XeOF_4 .



PART - IV : COMPREHENSION

Read the following passage carefully and answer the questions.

Comprehension # 1

A red liquid (A) when treated with sodium carbonate gives a mixture of two salts (B) and (C) in the solution in which (C) contains oxygen. The mixture then on acidification with sulphuric acid and distillation produces the red liquid (A) again.

- Select the correct statement for the liquid (A).
 (A) It acts as an oxidising agent,
 (B) It is sparingly soluble in water
 (C) It converts the yellow-dye stuff fluorescein (I) into red colour compound
 (D) All of these
- Which of the following statement is false for salt (B) ?
 (A) Its solution in water gives pale yellow precipitate with silver nitrate solution
 (B) Its solution in water gives white precipitate with lead nitrate solution
 (C) Its acidified solution (with conc. H_2SO_4) liberates a coloured gas which produces orange red spots on starch paper
 (D) None
- Which of the following statement is correct ?
 (A) Liquid (A) undergoes disproportionation reaction in aqueous solution of sodium carbonate
 (B) The anion of compound (C) has sp^3 hybridisation and is trigonal pyramidal in shape
 (C) (A) and (B) both
 (D) None of these

Comprehension # 2

Pseudo halides are anions having resemblance with halide ions. Group I metals can form salts with pseudo halides. Pseudo halogens can act as ligands and form coordinate complexes. Their hydrides are weakly acidic and can be prepared in analogous way as halogen hydrides are prepared. Azides, cyanides, isocyanides are example of pseudo halides.

- Cyanide, CN^- is a pseudo halide. When cyanogen is heated with alkali solution, the products are :
 (A) HCN , H_2O (B) NH_3 , $(\text{NH}_4)_2\text{CO}_3$ (C) NaCN , NaOCN (D) HCOONa , NH_3
- When NaCN reacts with H_2SO_4 , the products are :
 (A) HCN and Na_2SO_4 (B) HCN and NaHSO_4
 (C) $(\text{CN})_2$ and $\text{Na}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ (D) None of these
- When sodium pseudo halides are dissolved in water, it resembles with :
 (A) NaCl (B) NaBr (C) NaF (D) NaI
- $(\text{CN})_2$ when react with Na metal, the product is :
 (A) NaCN (B) Na_2C_2 and N_2 (C) NaN_3 and C black (D) $\text{Na}(\text{CN})_2^-$

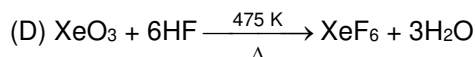
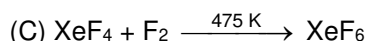
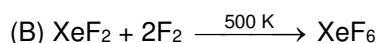
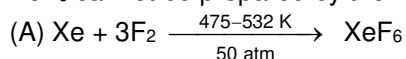
Comprehension # 3

The ionisation energy of dioxygen (O_2) is very close to that of Xenon. Also F and O have the highest electronegativity and consequently can oxidise Xe among rare gases. So Xe forms a large number of compounds with F and O. Xe and F_2 are mixed and reacted at different temperatures to give XeF_2 , XeF_4 and XeF_6 . Xe also forms an unstable gaseous XeO_4 and solid XeO_3 which is a very powerful explosive at higher temperatures. Some of the rare gases form clathrates or cage compounds by being entrapped in the cages of crystals lattice of water, phenol or quinols. Helium can form interstitial compounds with transition metals. Bigger members of rare gases do not form such compounds because of their large size.

- Xenon forms the largest number of compounds only with oxygen and fluorine because :
 (i) oxygen and fluorine have very high electronegativity.
 (ii) ionisation energy of Xe is the largest among rare gases.
 (iii) ionisation energy of Xe is low compared to those of other rare gases.
 (iv) low dissociation energy of fluorine molecule compared to those of Cl_2 and Br_2
 (A) (i), (ii), (iii) (B) (i), (iii), (iv) (C) (iii), (iv) (D) (i), (iv)



9. XeF_6 cannot be prepared by the method :



10. He and Ne do not form any clathrates because :

(A) He and Ne are very large in size.

(B) being neutral they cannot form any polar bonds with the host molecules.

(C) being too small, they cannot be entrapped in the cages of water, phenol or quinol.

(D) clathrated with He and Ne are highly explosive.

Comprehension # 4

Answer Q.11, Q.12 and Q.13 by appropriately matching the information given in the three columns of the following table.

Observe the three columns in which column-1 represents Oxy acid, column-2 represents Oxidation State of Cl while column-3 represents facts.					
Column-1 (Oxy acid)		Column-2 (Oxidation State of Cl)		Column-3	
(I)	HClO_2	(P)	+ 1	(i)	Chlorine has highest electron affinity
(II)	HClO_3	(Q)	+ 3	(ii)	Fluorine never exhibit oxidation state > 0
(III)	HClO_4	(R)	+ 5	(iii)	HI is strong hydra acid
(IV)	HClO	(S)	+ 7	(iv)	The decreasing order of thermal stability is $\text{IF} > \text{BrF} > \text{ClF}$

11. Which of the following set of combination is correct?

(A) I–(s)–(i)

(B) (II)–R–(ii)

(C) (III)–Q–(iii)

(D) (IV)–R–(iv)

12. Which of the following set of combination is incorrect?

(A) (I)–Q–(iv)

(B) (II)–R–(iii)

(C) (III)–P–(ii)

(D) (IV)–P–(i)

13. Which of the following set of combination is correct?

(A) (IV)–S–(i)

(B) (III)–S–(iii)

(C) (II)–Q–(ii)

(D) (I)–Q–(iv)

Comprehension # 5

Answer Q.14, Q.15 and Q.16 by appropriately matching the information given in the three columns of the following table.

Observe the three columns in which column-1 represents Compounds, column-2 represents Hybridisation while column-3 represents facts.					
Column-1 (Compounds)		Column-2 (Hybridisation)		Column-3	
(I)	XeF_4	(P)	sp^3d^3	(i)	Neon is used in fluorescent bulbs.
(II)	XeF_2	(Q)	sp^3d^2	(ii)	Helium do not form clatharate compounds
(III)	XeF_6	(R)	sp^3d	(iii)	XeOF_4 has square pyramidal structure
(IV)	XeO_3	(S)	sp^3	(iv)	Reacts with H_2 produces Xe & HF.

14. Which of the following set of combination is correct?

(A) (I)–(S)–(iv)

(B) (II)–(R)–(iii)

(C) (III)–(Q)–(ii)

(D) (IV)–(P)–(i)

15. Which of the following set of combination is incorrect?

(A) (IV)–(S)–(i)

(B) (III)–(P)–(ii)

(C) (II)–(R)–(iii)

(D) (I)–(S)–(iv)

16. Which of the following set of combination is correct?

(A) (II)–(Q)–(ii)

(B) (III)–(R)–(iii)

(C) (IV)–(S)–(iv)

(D) (I)–(P)–(i)



Exercise-3

* Marked Questions may have more than one correct option.

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

Section (A) : Group 17th

- Give an example of oxidation of one halide by another halogen. Explain the feasibility of reaction.
[JEE 2000 (M), 2/100]
- The set with correct order of acidity is :
(A) $\text{HClO} < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}_4$ (B) $\text{HClO}_4 < \text{HClO}_3 < \text{HClO}_2 < \text{HClO}$
(C) $\text{HClO} < \text{HClO}_4 < \text{HClO}_3 < \text{HClO}_2$ (D) $\text{HClO}_4 < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}$
[JEE 2001 (S), 3/35]
- The reaction, $3\text{ClO}^- (\text{aq}) \rightarrow \text{ClO}_3^- (\text{aq}) + 2\text{Cl}^- (\text{aq})$ is an example of :
(A) oxidation reaction (B) reduction reaction
(C) disproportionation reaction (D) decomposition reaction
[JEE 2001 (S), 3/35]
- A gas 'X' is passed through water to form a saturated solution. The aqueous solution on treatment with silver nitrate gives a white precipitate. The saturated aqueous solution also dissolves magnesium ribbon with evolution of a colourless gas 'Y'. Identify 'X' and 'Y'.
(A) $\text{X} = \text{CO}_2$, $\text{Y} = \text{Cl}_2$ (B) $\text{X} = \text{Cl}_2$, $\text{Y} = \text{CO}_2$ (C) $\text{X} = \text{Cl}_2$, $\text{Y} = \text{H}_2$ (D) $\text{X} = \text{H}_2$, $\text{Y} = \text{Cl}_2$
[JEE 2002 (S), 3/90]

Section (B) : Group 18th

Paragraph for Question Nos. 5 to 7

The noble gases have closed-shell electronic configuration and are monoatomic gases under normal conditions. The low boiling points of the lighter noble gases are due to weak dispersion forces between the atoms and the absence of other interatomic interactions.

The direct reaction of xenon with fluorine leads to a series of compounds with oxidation numbers +2, +4 and +6. XeF_4 reacts violently with water to give XeO_3 . The compounds of xenon exhibit rich stereochemistry and their geometries can be deduced considering the total number of electron pairs in the valence shell.

- Argon is used in arc welding because of its :
(A) low reactivity with metal (B) ability to lower the melting point of metal
(C) flammability (D) high calorific value
[JEE 2007 (P-I), 4 /81]
- The structure of XeO_3 is :
(A) linear (B) planar (C) pyramidal (D) T-shaped
[JEE 2007 (P-I), 4 /81]
- XeF_4 and XeF_6 are expected to be :
(A) oxidizing (B) reducing (C) unreactive (D) strongly basic
[JEE 2007 (P-I), 4 /81]
- All the compounds listed in **Column I** react with water. Match the result of the respective reactions with the appropriate options listed in **Column II**.
[JEE 2010, (P-II) 8/79]

Column I

- (A) $(\text{CH}_3)_2\text{SiCl}_2$
(B) XeF_4
(C) Cl_2
(D) VCl_5

Column II

- (p) Hydrogen halide formation
(q) Redox reaction
(r) Reacts with glass
(s) Polymerization
(t) O_2 formation

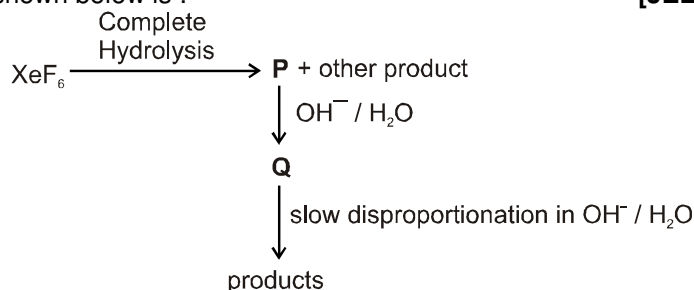
Paragraph for Questions 9 to 10

The reactions of Cl_2 gas with cold-dilute and hot-concentrated NaOH in water give sodium salts to two (different) oxoacids of chlorine, **P** and **Q**, respectively. The Cl_2 gas reacts with SO_2 gas, in presence of charcoal, to give a product **R**. **R** reacts with white phosphorus to give a compound **S**. On hydrolysis, **S** gives an oxoacid of phosphorus **T**.



9. **P** and **Q**, respectively, are the sodium salts of : [JEE(Advanced) 2013, 3/120]
 (A) hypochlorous and chloric acids
 (B) hypochlorous and chlorus acids
 (C) chloric and perchloric acids
 (D) chloric and hypochlorous acids
10. **R**, **S** and **T**, respectively, are : [JEE(Advanced) 2013, 3/120]
 (A) SO_2Cl_2 , PCl_5 and H_3PO_4
 (B) SO_2Cl_2 , PCl_3 and H_3PO_3
 (C) SOCl_2 , PCl_3 and H_3PO_2
 (D) SOCl_2 , PCl_5 and H_3PO_4
11. The unbalanced chemical reactions given in List I show missing reagent or condition (?) which are provided in List II. Match List I with List II and select the correct answer using the code given below the lists : [JEE(Advanced) 2013, 3/120]
- | List-I | | | | List-II | | | |
|--------|--|---|--|---------|---------------|--|--|
| P. | $\text{PbO}_2 + \text{H}_2\text{SO}_4 \xrightarrow{?}$ | $\text{PbSO}_4 + \text{O}_2 + \text{other product}$ | | 1. | NO | | |
| Q. | $\text{Na}_2\text{S}_2\text{O}_3 + \text{H}_2\text{O} \xrightarrow{?}$ | $\text{NaHSO}_4 + \text{other product}$ | | 2. | I_2 | | |
| R. | $\text{N}_2\text{H}_4 \xrightarrow{?}$ | $\text{N}_2 + \text{other product}$ | | 3. | Warm | | |
| S. | $\text{XeF}_2 \xrightarrow{?}$ | $\text{Xe} + \text{other product}$ | | 4. | Cl_2 | | |
- Codes :**
- | | | | | | | | | | |
|-----|---|---|---|---|-----|---|---|---|---|
| | P | Q | R | S | | P | Q | R | S |
| (A) | 4 | 2 | 3 | 1 | (B) | 3 | 2 | 1 | 4 |
| (C) | 1 | 4 | 2 | 3 | (D) | 3 | 4 | 2 | 1 |

12. Under ambient conditions, the total number of gases released as products in the final step of the reaction scheme shown below is : [JEE(Advanced) 2014, 3/120]



- (A) 0 (B) 1 (C) 2 (D) 3

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

JEE(MAIN) OFFLINE PROBLEMS

1. In case of nitrogen, NCl_3 is possible but no NCl_5 while in case of phosphorus, PCl_3 as well as PCl_5 are possible. It is due to : [AIEEE-2002, 3/225]
 (1) availability of vacant d-orbital in P but not in N.
 (2) lower electronegativity of P than N.
 (3) lower tendency of H bond formation in P than N.
 (4) occurrence of P in solid while N in gaseous state at room temperature.
2. Concentrated hydrochloric acid when kept in open air sometimes produces a cloud of white fumes. This is due to : [AIEEE-2003, 3/225]
 (1) strong affinity of HCl gas for moisture in air results in forming of droplets of liquid solution which appears like a cloudy smoke.
 (2) strong affinity for water, conc. HCl pulls moisture of air towards self. The moisture forms droplets of water and hence the cloud.
 (3) conc. HCl emits strongly smelling HCl gas all the time.
 (4) oxygen in air reacts with emitted HCl gas to form a cloud of chlorine gas.



3. The substance used in holmes singnals of the ship is a mixture of : [AIEEE-2003, 3/225]
 (1) $\text{CaC}_2 + \text{Ca}_3\text{P}_2$ (2) $\text{Ca}_3(\text{PO}_4)_2 + \text{Pb}_3\text{O}_4$ (3) $\text{H}_3\text{PO}_4 + \text{CaCl}_2$ (4) $\text{NH}_3 + \text{HOCl}$
4. What would happen when a solution of potassium chromate is treated with an excess of dilute nitric acid ? [AIEEE-2003, 3/225]
 (1) Cr^{3+} and $\text{Cr}_2\text{O}_7^{2-}$ are formed (2) $\text{Cr}_2\text{O}_7^{2-}$ and H_2O are formed
 (3) CrO_4^{2-} is reduced to + 3 state of Cr (4) CrO_4^{2-} is oxidized to + 7 state of Cr
5. Which one of the following statements regarding helium is incorrect ? [AIEEE-2004, 3/225]
 (1) It is used to produce and sustain powerful superconducting magnets
 (2) It is used as a cryogenic agent for carrying out experiments at low temperatures
 (3) It is used to fill gas balloons instead of hydrogen because it is lighter and non-inflammable
 (4) It is used in gas-cooled nuclear reactors
6. Which among the following factors is the most important in making fluorine the strongest oxidizing halogen? [AIEEE-2004, 3/225]
 (1) Hydration enthalpy (2) Ionization enthalpy
 (3) Electron affinity (4) Bond dissociation energy
7. The correct order of the thermal stability of hydrogen halides (H-X) is : [AIEEE-2005, 3/225]
 (1) $\text{HI} > \text{HBr} > \text{HCl} > \text{HF}$ (2) $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$
 (3) $\text{HCl} < \text{HF} < \text{HBr} < \text{HI}$ (4) $\text{HI} > \text{HCl} < \text{HF} < \text{HBr}$
8. Which of the following statements is true? [AIEEE 2006, 3/165]
 (1) H_3PO_3 is a stronger acid than H_2SO_3 (2) In aqueous medium HF is a stronger acid than HCl
 (3) HClO_4 is a weaker acid than HClO_3 (4) HNO_3 is a stronger acid than HNO_2
9. What products are expected from the disproportionation reaction of hypochlorous acid? [AIEEE 2006, 3/165]
 (1) HClO_3 and Cl_2O (2) HClO_2 and HClO_4 (3) HCl and Cl_2O (4) HCl and HClO_3
10. Identify the incorrect statement among the following. [AIEEE 2007, 3/120]
 (1) Cl_2 reacts with excess of NH_3 to give N_2 and HCl .
 (2) Br_2 reacts with hot and strong NaOH solution to give NaBr , NaBrO_4 and H_2O .
 (3) Ozone reacts with SO_2 to given SO_3 .
 (4) Silicon reacts with $\text{NaOH}_{(\text{aq})}$ in the presence of air to give Na_2SiO_3 and H_2O .
11. Which one of the following reactions of Xenon compounds is not feasible ? [AIEEE 2009, 4/144]
 (1) $3\text{XeF}_4 + 6\text{H}_2\text{O} \rightarrow 2\text{Xe} + \text{XeO}_3 + 12\text{HF} + 1.5\text{O}_2$
 (2) $2\text{XeF}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{Xe} + 4\text{HF} + \text{O}_2$
 (3) $\text{XeF}_6 + \text{RbF} \rightarrow \text{Rb}[\text{XeF}_7]$
 (4) $\text{XeO}_3 + 6\text{HF} \rightarrow \text{XeF}_6 + 3\text{H}_2\text{O}$
12. Which among the following is the most reactive ? [JEE(Main) 2015, 4/120]
 (1) Cl_2 (2) Br_2 (3) I_2 (4) ICl
13. The products obtained when chlorine gas reacts with cold and dilute aqueous NaOH are : [JEE(Main) 2017, 4/120]
 (1) ClO_2^- and ClO_3^- (2) Cl^- and ClO^- (3) Cl^- and ClO_2^- (4) ClO^- and ClO_3^-

JEE(MAIN) ONLINE PROBLEMS

1. Shapes of certain interhalogen compounds are stated below. Which one of them is not correctly stated? [JEE(Main) 2014 Online (11-04-14), 4/120]
 (1) IF_7 : pentagonal bipyramid (2) BrF_5 : trigonal bipyramid
 (3) BrF_3 : planar T-shaped (4) ICl_3 : planar dimeric
2. Which of the following xenon-OXO compounds may not be obtained by hydrolysis of xenon fluorides ? [JEE(Main) 2014 Online (12-04-14), 4/120]
 (1) XeO_2F_2 (2) XeOF_4 (3) XeO_3 (4) XeO_4



3. The least number of oxyacids are formed by: **[JEE(Main) 2015 Online (10-04-15), 4/120]**
 (1) Nitrogen (2) Fluorine (3) Chlorine (4) Sulphur
4. Chlorine water on standing loses its colour and forms: **[JEE(Main) 2015 Online (11-04-15), 4/120]**
 (1) HCl only (2) HCl and HClO₂ (3) HCl and HOCl (4) HOCl and HOCl₂
5. The non-metal that does not exhibit positive oxidation state is : **[JEE(Main) 2016 Online (09-04-16), 4/120]**
 (1) Fluorine (2) Oxygen (3) Chlorine (4) Iodine
6. The following statements concern elements in the periodic table. Which of the following is true? **[JEE(Main) 2017 Online (10-04-16), 4/120]**
 (1) The Group 13 elements are all metals.
 (2) All the elements in Group 17 are gases.
 (3) Elements of Group 16 have lower ionization enthalpy values compared to those of Group 15 in the corresponding periods.
 (4) For Group 15 elements, the stability of +5 oxidation state increases down the group.
7. XeF₆ on partial hydrolysis with water produces a compound 'X'. The same compound 'X' is formed when XeF₆ reacts with silica. The compound 'X' is : **[JEE(Main) 2017 Online (09-04-17), 4/120]**
 (1) XeO₃ (2) XeF₄ (3) XeF₂ (4) XeOF₄
8. Xenon hexafluoride on partial hydrolysis produces compounds 'X' and 'Y'. Compounds 'X' and 'Y' and the oxidation state of Xe are respectively : **[JEE(Main) 2018 Online (15-04-18), 4/120]**
 (1) XeOF₄ (+6) and XeO₃ (+6) (2) XeO₂ (+4) and XeO₃ (+6)
 (3) XeOF₄ (+6) and XeO₂F₂ (+6) (4) XeO₂F₂ (+6) and XeO₂ (+4)
9. Among the following reactions of hydrogen with halogens, the one that requires a catalyst is: **[JEE(Main) 2019 Online (10-01-19), 4/120]**
 (1) H₂ + F₂ → 2HF (2) H₂ + Cl₂ → 2HCl (3) H₂ + I₂ → 2HI (4) H₂ + Br₂ → 2HBr
10. Chlorine on reaction with hot and concentrated sodium hydroxide gives: **[JEE(Main) 2019 Online (12-01-19), 4/120]**
 (1) ClO₃⁻ and ClO₂⁻ (2) Cl⁻ and ClO⁻ (3) Cl⁻ and ClO₃⁻ (4) Cl⁻ and ClO₂⁻

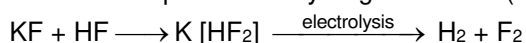


Answers

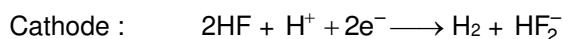
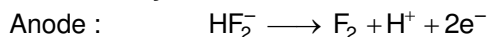
EXERCISE - 1

PART - I

A_I-1. A solution of potassium hydrogen fluoride (KHF₂) in anhydrous HF.



On Electrolysis :

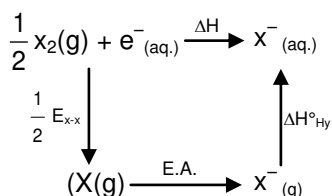


A_I-2. It contains trace amounts of NaIO₃ and NaIO₄. An important property of chile salt petre is that it is soluble in water while its impurities are not.

A_{II}-3. Neil Bartlett obtained an orange yellow solid from the reaction of xenon with PtF₆ to have Xe⁺[PtF₆]⁻. He noticed earlier that O₂ with PtF₆ reacts to give O₂⁺[PtF₆]⁻ and since ionisation enthalpies of O₂ and Xe were close to each other (Xe = 1170, O₂ = 1175 kJ mol⁻¹), he could succeed to prepare Xe⁺[PtF₆]⁻ from Xe and PtF₆.

B_I-1. The electrode potential of F₂ (+2.87 V) is much higher than that of Cl₂ (+1.36 V).

$$\Delta H = \frac{1}{2} E_{\text{x-x}} - |\text{E.A.}| - |\Delta H^\circ_{\text{Hy}}|$$



	F ₂	Cl ₂	Order
Bond dissociation enthalpy/kJmol ⁻¹	158.8	242.6	F ₂ < Cl ₂
Magnitude of E.A./kJmol ⁻¹	333	349	F ₂ < Cl ₂
Magnitude of ΔH°Hyd./kJmol ⁻¹	515	381	F ₂ > Cl ₂
Oxidizing power			F ₂ > Cl ₂

Therefore F₂ is much stronger oxidising agent than Cl₂.

B_I-2. F : -1, 0

Cl : -1, 0, +3, +5, +7

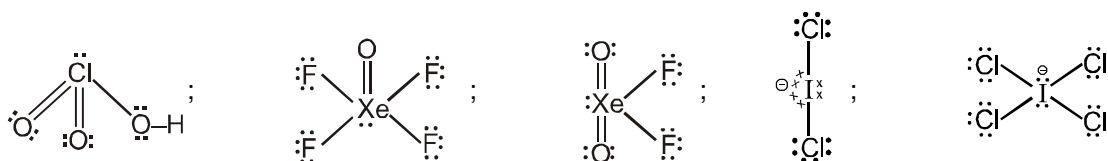
Br : -1, 0, +3, +5, +7

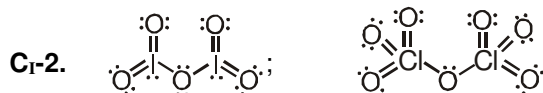
I : -1, 0, +3, +5, +7

B_I-3. Enthalpy of dissociation (x-x)/kJ mol⁻¹

Cl-Cl > Br-Br > F-F > I-I, Smaller enthalpy of dissociation of F₂ is due to relatively large electrons-electrons repulsion among the lone pairs in F₂ molecule.

C-1.





C1-3.

(i) **Structure of ICl_4^-**

No. of electrons in the valence shell of the central I atom = 7.

No. of electrons provided by four Cl atoms = $4 \times 1 = 4$

Charge on the central atom = 1

\therefore Total no. of electrons around the central atom = $7 + 4 + 1 = 12$

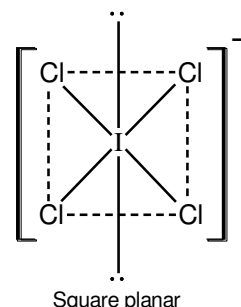
Total no. of electron pairs around the central atom = $12 / 2 = 6$

But the no. of bond pairs = 4 (\because there are four I-Cl bonds)

\therefore No. of lone pairs = $6 - 4 = 2$

Thus, I in ICl_4^- has 4 bond pairs and 2 lone pairs. Therefore, according to VSEPR theory, it should be square planar.

Now a noble gas compound having 12 electrons in the valence shell of the central atom is XeF_4 ($8 + 1 \times 4 = 12$). Like ICl_4^- , it also has 4 bond pairs and 2 lone pairs. Therefore, like, XeF_4 is also square planar.



(ii) **Structure of IBr_2^-**

No. of electrons in the valence shell of the central I atom = 7

No. of electrons provided by two Br atoms = $2 \times 1 = 2$

Charge on the central I atom is = 1

\therefore Total no. of electrons around the central I atom = $7 + 2 + 1 = 10$

But the no. of bond pairs = 2 (\because there are two I-Br bonds)

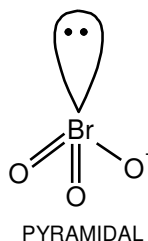
\therefore No. of lone pairs = $5 - 2 = 3$

Thus, I in IBr_2^- has two bond pairs and three lone pairs. Therefore, according to VSEPR theory, it should be linear.

Now a noble gas compound having 10 electrons in the valence shell of the central atom is XeF_2 ($8 + 1 \times 2 = 10$). Like IBr_2^- , it also has 2 bond pairs and 3 lone pairs.

(iii) **Structure of BrO_3^-**

In BrO_3^- , since O is more electronegative than Br, therefore, -ve charge stays on the O atom.



Therefore, in BrO_3^- , there are two $\text{Br} = \text{O}$ bonds and one bond $\text{Br} - \text{O}^-$ bond.

Now according to VSEPR theory, double bonds do not contribute any electron while single bonds contribute one electron towards the total number of the central atom. However, both double and single bonds contribute one bond pair. Thus, total number of electrons in the valence shell of the central Br atom = $7 + 2 \times 0 + 1 \times 1 = 8$

\therefore No. of electron pairs around Br atom = $8 / 2 = 4$

But total number of bond pairs = 2×1 ($\text{Br} = \text{O}$) + 1×1 ($\text{Br} - \text{O}^-$) = 3 and lone pairs = $4 - 3 = 1$.

Thus, BrO_3^- has 3 bond pairs and one lone pair. Therefore, according to VSEPR theory, it should be pyramidal.

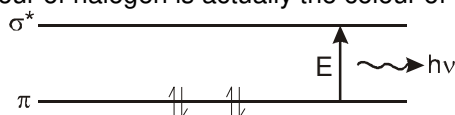
Now a noble gas compound having 8 electrons in the valence shell of the central atom is XeO_3 ($8 \times 1 + 3 \times 0 = 8$). Like BrO_3^- , it also has 3 bond pairs and one lone pair. Therefore, like BrO_3^- , XeO_3 is also pyramidal.



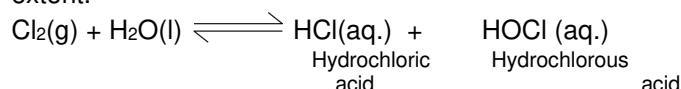
- CII-4.** $\text{XeF}_2 > \text{XeF}_4$
 $2.00 \text{ \AA} > 1.94 \text{ \AA}$ (Order of Xe–F bond length)
 XeF_2 : sp^3d , axial bonds are long & weak
 XeF_4 : sp^3d^2 square planar : all bonds identical.

- DI-1.** (i) Van der Waal's forces of attraction among molecules increase with the increase of atomic masses. Thus, higher energy is required to separate these molecules as to get gaseous state. Hence, the boiling points increase with increase of atomic masses.
 (ii) The size of cavities formed during crystallisation of quinol is more than the size of helium and neon atoms.

- DI-2.** All the halogens are coloured. The colour is due to the allowed $\pi \rightarrow \sigma^*$ molecular orbital transitions. The colour of halogen is actually the colour of transmitted light.



- DI-3.** F_2 being a strong oxidizing agent H_2O to O_2 or O_3 .
 $2\text{F}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \longrightarrow 4\text{H}^+(\text{aq.}) + 4\text{F}^-(\text{aq.}) + \text{O}_2(\text{g})$
 $3\text{F}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l}) \longrightarrow 6\text{H}^+(\text{aq.}) + 6\text{F}^-(\text{aq.}) + \text{O}_3(\text{g})$
 Cl_2 , on the other hand, reacts with H_2O to form hydrochloric acid and hypochlorous acid to a small extent.



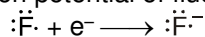
- DI-4.** $2\text{F}_2 + 2\text{NaOH} \longrightarrow \text{OF}_2 + 2\text{NaF} + \text{H}_2\text{O}$



- DI-5.** $\text{X}_2 + 2\text{NaOH} \xrightarrow{\text{Hot}} \text{NaX} + \text{NaXO}_3 + \text{H}_2\text{O}$

- DI-6.** $\text{I}_2, \text{I}_2 + \text{HNO}_3(\text{conc.}) \longrightarrow \text{HIO}_3 + \text{NO}_2 + \text{H}_2\text{O}$

- DI-7.** (i) The standard reduction potential of fluorine is maximum.



Thus, it cannot be oxidised by any other reagent. F^- ion is very stable due to small size and high electronegativity of fluorine atom.

(ii) F-does not have empty d-orbital like other halogen. The formation of X_3^- ions involves sp^3d -hybridization.

- EI-1.** $\text{Ba}(\text{ClO}_3)_2 + \text{H}_2\text{SO}_4 \longrightarrow \text{BaSO}_4\downarrow + 2\text{HClO}_3$
 $\text{KClO}_4 + \text{H}_2\text{SO}_4 \longrightarrow \text{KHSO}_4 + \text{HClO}_4$

- EI-2.** HOCl acts as an acid, $\text{HOCl} \longrightarrow \text{H}^+ + \text{OCl}^-$, and thus turns blue litmus to red. It also works as a bleaching agent, $\text{HOCl} \longrightarrow \text{HCl} + [\text{O}]$, and the red litmus is decolorized by nascent oxygen.

- EI-3.** Chlorine, bromine and iodine form four series of oxyacids of the general formula HOX , HOXO , HOXO_2 and HOXO_3 in which the oxidation states of halogen ($\text{X} = \text{Cl}, \text{Br}$ or I) is +1, +3, +5 and +7 respectively. However, due to high electronegativity, small size and absence of d-orbitals, F cannot act as a central atom in higher oxyacids such as HOFO , HOFO_2 and HOFO_3 in which the oxidation state of F would be +3, +5 and +7. It just forms one oxyacid, i.e., HOF in which the oxidation state of F is –1 and oxygen is in +1.

- EI-4.** (i) $2\text{NaClO}_3 + \text{SO}_2 + \text{H}_2\text{SO}_4 \longrightarrow 2\text{NaHSO}_4 + 2\text{ClO}_2$
 (ii) $5\text{I}^- + \text{IO}_3^- + 6\text{H}^+ \longrightarrow 3\text{I}_2 + 3\text{H}_2\text{O}$

- EI-5.** $\text{ClO}_2(\text{s})$ is a mixed anhydride of HClO_2 and HClO_3 because on dissolving in water it gives a mixture of these two acids.





- F_I-1.** (i) $\text{HI} > \text{HBr} > \text{HCl} > \text{HF}$; Due to decrease in bond energy
(ii) HI is the strongest reducing agent.
- F_I-2.** Conc. HCl can be oxidized to Cl_2 by heating with a number of oxidizing agents such as MnO_2 , KMnO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$, etc.

$$\text{MnO}_2 + 4 \text{HCl} \longrightarrow \text{MnCl}_2 + \text{Cl}_2 + 2 \text{H}_2\text{O}$$

$$\text{Cl}_2 \text{ can be reduced to HCl by its reaction with H}_2 \text{ in presence of diffused sunlight.}$$

$$\text{H}_2 + \text{Cl}_2 \xrightarrow{\text{Diffused sunlight}} 2 \text{HCl}$$
- F_I-3.** HI is a strong reducing agent and, therefore, reduces H_2SO_4 to SO_2 and itself get oxidised to I_2 .

$$3\text{NaI} + \text{conc. H}_3\text{PO}_4 \xrightarrow{\Delta} \text{K}_3\text{PO}_4 + \text{HI}$$
- F_I-4.** Aqua regia is three parts of concentrated HCl and one part of concentrated HNO_3 .

$$2\text{Au} + 11\text{HCl} + 3\text{HNO}_3 \longrightarrow 2\text{H}[\text{AuCl}_4] + 3\text{NOCl} + 6\text{H}_2\text{O}$$

$$8\text{HCl} + 2\text{HNO}_3 + \text{Pt} \longrightarrow \text{H}_2[\text{PtCl}_6] + 2\text{NOCl} + 4\text{H}_2\text{O}$$
- F_I-5.** (i) In anhydrous state, HCl is a covalent molecule. In aqueous solution, HCl combines with water molecule to form H_3O^+ and Cl^- ions.

$$\text{HCl (g)} + \text{H}_2\text{O (l)} \longrightarrow \text{H}_3\text{O}^+ \text{ (aq)} + \text{Cl}^- \text{ (aq)}$$
(ii) HF attacks glass bottles. The sodium and potassium silicates are converted into fluosilicates

$$\text{Na}_2\text{SiO}_3 + 6\text{HF} \longrightarrow \text{Na}_2\text{SiF}_6 + 3\text{H}_2\text{O}$$
(iii) The weakest acidic nature of HF is due to :
 - High bond dissociation enthalpy of HF bond.
 - HF has conjugate base F^- . Small size and concentrated charge make F^- a Lewis base. Hence, it can accept back H^+ .
- F_I-6.** (i) HI (hydrogen iodide) (ii) $\text{I}_2 + \text{SO}_2 + \text{H}_2\text{O}$
- F_I-7.** (i) $\text{Pb}_3\text{O}_4 + 8\text{HCl} \longrightarrow 3\text{PbCl}_2 + 4\text{H}_2\text{O} + \text{Cl}_2$
(ii)
$$3 [\text{SiO}_2 + 4\text{HF} \longrightarrow \text{SiF}_4 + 2\text{H}_2\text{O}]$$

$$3\text{SiF}_4 + 3\text{H}_2\text{O} \longrightarrow 2\text{H}_2\text{SiF}_6 + \text{H}_2\text{SiO}_3$$
- Overall :
$$3\text{SiO}_2 + 12\text{HF} \longrightarrow \underbrace{2\text{H}_2\text{SiF}_6 + \text{H}_2\text{SiO}_3}_{\text{White waxy deposit}} + 3\text{H}_2\text{O}$$
- G_{II}-1.**
$$\text{Xe(g)} + \text{F}_2\text{(g)} \xrightarrow{673 \text{ K, 1 bar}} \text{XeF}_2\text{(s)}$$
(Xenon in excess)

$$\text{Xe(g)} + 2\text{F}_2\text{(g)} \xrightarrow{873 \text{ K, 7 bar}} \text{XeF}_4\text{(s)}$$
(1 : 5 ratio)

$$\text{Xe(g)} + 3\text{F}_2\text{(g)} \xrightarrow{573 \text{ K, 60-70 bar}} \text{XeF}_6\text{(s)}$$
(1 : 20 ratio)
- G_{II}-2.** Partial hydrolysis of XeF_6 gives XeOF_4 .

$$\text{XeF}_6 + \text{H}_2\text{O} \longrightarrow \text{XeOF}_4 + 2 \text{HF}$$
- G_{II}-3.** Yes, hydrolysis of XeF_4 leads to a redox reaction(disproportionation)

$$6\text{XeF}_4 + 12 \text{H}_2\text{O} \longrightarrow 4 \text{Xe} + 2\text{XeO}_3 + 24 \text{HF} + 3\text{O}_2$$
- G_{II}-4.**
$$\text{XeF}_6 + 3 \text{H}_2\text{O} \longrightarrow \text{XeO}_3 + 6 \text{HF}$$

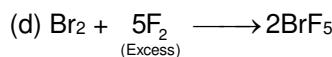
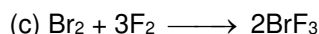
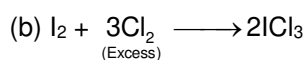
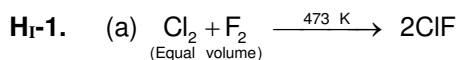
$$\text{XeF}_6 + \text{H}_2\text{O} \longrightarrow \text{XeOF}_4 + 2 \text{HF}$$

$$\text{XeF}_6 + 2\text{H}_2\text{O} \longrightarrow \text{XeO}_2\text{F}_2 + 4 \text{HF}$$
- G_{II}-5.** (i) $\text{XeF}_2 + \text{H}_2 \rightarrow \text{Xe} + 2\text{HF}$
(ii)
$$2\text{XeF}_6 + \text{SiO}_2 \rightarrow 2\text{XeOF}_4 + \text{SiF}_4$$

$$2\text{XeOF}_4 + \text{SiO}_2 \rightarrow 2\text{XeO}_2\text{F}_2 + \text{SiF}_4$$

$$2\text{XeO}_2\text{F}_2 + \text{SiO}_2 \rightarrow 2\text{XeO}_3 \text{ (Explosive)} + \text{SiF}_4$$

(iii) $\text{XeF}_6 + \text{SbF}_5 \rightarrow [\text{XeF}_5]^+ [\text{SbF}_6]^-$ [Addition ionic product is formed]

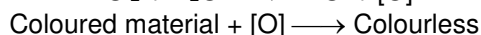
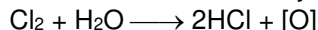


H_I-2. ICl is more reactive than I₂ because I-Cl bond is weaker than I-I bond. Consequently, ICl breaks easily to form halogen atoms which readily bring about the reactions.

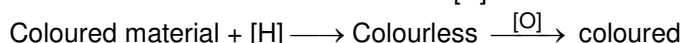
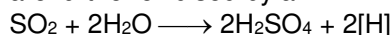
H_I-3. (a) Chlorine trifluoride (ClF₃); iodine trichloride (ICl₃ or I₂Cl₆)
(b) $\text{ICl} + \text{H}_2\text{O} \longrightarrow \text{HCl} + \text{HOI}$

H_I-4. (i) Chlorine bleaching action is due to oxidation while that of sulphur dioxide is due to reduction. Hence, the substance bleached by SO₂ is reoxidised by the oxygen of the air to its original state.

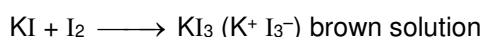
Cl₂ bleaches coloured material by oxidation and thus bleaching is permanent.



On the other hand bleaching by SO₂ is by reduction and thus temporary because colourless articles are further oxidised by air.



(ii) I₂ is a covalent molecule. Thus, its solubility is less in polar solvent, i.e., water. Potassium iodide combines with iodine and forms a polyhalide which is an ionic compound. Being ionic, KI₃ is more soluble.



H_I-5. (i) $2\text{NaIO}_3 + 5\text{NaHSO}_3 \longrightarrow 3\text{NaHSO}_4 + 2\text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{I}_2$
(ii) $\text{Ca}(\text{OH})_2 + \text{Cl}_2 \longrightarrow \text{Ca}(\text{OCl})\text{Cl} + \text{H}_2\text{O}$

PART - II

A_{II}-1. (B)	A_{II}-2. (A)	A_{II}-3. (A)	A_I-4. (D)	A_I-5. (C)
B_{II}-1. (C)	B_I-2. (B)	B_I-3. (B)	C_I-1. (C)	C_{II}-2. (D)
C_{II}-3. (D)	D_I-1. (A)	D_{II}-2. (D)	D_I-3. (C)	D_I-4. (C)
D_I-5. (B)	E_I-1. (D)	E_I-2. (C)	E_I-3. (B)	E_I-4. (A)
E_I-5. (B)	E_I-6. (A)	F_I-1. (D)	F_I-2. (B)	F_I-3. (B)
F_I-4. (A)	F_I-5. (B)	F_I-6. (D)	F_I-7. (C)	F_I-8. (A)
F_I-9. (C)	F_I-10. (A)	G_{II}-1. (B)	G_{II}-2. (B)	G_{II}-3. (A)
G_{II}-4. (A)	G_{II}-5. (D)	H_I-1. (D)	H_I-2. (B)	H_I-3. (A)
H_I-4. (C)				

PART - III

1. (A - p,q) ; (B - p,r) ; (C - q,s) ; (D - p,q,r,s) 2. (A - q,s) ; (B - s) ; (C - p) ; (D - r)
3. (A - p,q,r,s) ; (B - p,q,r,s,t) ; (C - p,q,r,s) ; (D - q,s,t)

EXERCISE - 2

PART - I

- | | | | | |
|---------|---------|---------|---------|---------|
| 1. (D) | 2. (B) | 3. (A) | 4. (A) | 5. (C) |
| 6. (A) | 7. (A) | 8. (A) | 9. (D) | 10. (D) |
| 11. (C) | 12. (A) | 13. (D) | 14. (B) | 15. (C) |
| 16. (A) | | | | |

**PART - II**

- | | | | | |
|-------|-------|-------|--------|-------|
| 1. 32 | 2. 4 | 3. 43 | 4. 6 | 5. 2 |
| 6. 5 | 7. 3 | 8. 13 | 9. 2 | 10. 3 |
| 11. 4 | 12. 7 | 13. 8 | 14. 20 | 15. 4 |

PART - III

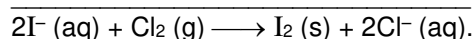
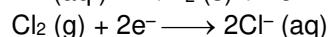
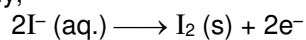
- | | | | | |
|-----------|------------|----------|----------|------------|
| 1. (BC) | 2. (ABCD) | 3. (BD) | 4. (AC) | 5. (ABD) |
| 6. (BC) | 7. (ACD) | 8. (ACD) | 9. (ABC) | 10. (ABC) |
| 11. (ABD) | 12. (ABCD) | 13. (BC) | 14. (AB) | 15. (ABCD) |

PART - IV

- | | | | | |
|---------|---------|---------|---------|---------|
| 1. (D) | 2. (D) | 3. (C) | 4. (C) | 5. (A) |
| 6. (C) | 7. (A) | 8. (B) | 9. (D) | 10. (C) |
| 11. (B) | 12. (C) | 13. (B) | 14. (B) | 15. (D) |
| 16. (C) | | | | |

EXERCISE – 3**PART - I**

1. $2\text{KI(aq.)} + \text{Cl}_2 \longrightarrow 2\text{KCl(aq.)} + \text{I}_2$
 In the reaction Cl_2 oxidises iodide ion (–1 oxidation state) to I_2 (0 oxidation state). Cl_2 has higher oxidation potential than I_2 and thus oxidises iodide to iodine getting itself reduced to chloride ion. Similarly,



- | | | | | |
|---------|---|---------|--------|--------|
| 2. (A) | 3. (C) | 4. (C) | 5. (A) | 6. (C) |
| 7. (A) | 8. (A - p, s) ; (B - p, q, r, t) ; (C - p, q) ; (D - p) | | | 9. (A) |
| 10. (A) | 11. (D) | 12. (C) | | |

PART – II**JEE(MAIN) OFFLINE PROBLEMS**

- | | | | | |
|---------|---------|---------|--------|---------|
| 1. (1) | 2. (4) | 3. (1) | 4. (2) | 5. (3) |
| 6. (1) | 7. (2) | 8. (4) | 9. (4) | 10. (2) |
| 11. (4) | 12. (4) | 13. (2) | | |

JEE(MAIN) ONLINE PROBLEMS

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (2) | 2. (4) | 3. (2) | 4. (3) | 5. (1) |
| 6. (3) | 7. (4) | 8. (3) | 9. (3) | 10. (3) |



Additional Problems for Self Practice (APSP)

This Section is not meant for classroom discussion. It is being given to promote self-study and self testing amongst the Resonance students.

PART - I : PRACTICE TEST-1 (IIT-JEE (MAIN Pattern))

Max. Time : 1 Hr.

Max. Marks : 120

Important Instructions

- The test is of **1 hour** duration.
- The Test Booklet consists of **30** questions. The maximum marks are **120**.
- Each question is allotted **4 (four)** marks for correct response.
- Candidates will be awarded marks as stated above in Instructions No. 3 for correct response of each question. **¼ (one fourth)** marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
- There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 4 above.

- The manufacture of fluorine is done by :
 (1) heating anhydrous HF and MnO_2 .
 (2) electrolysis of aqueous HF.
 (3) electrolysis of anhydrous HF mixed with KHF_2 .
 (4) heating a mixture of KF, MnO_2 and conc. H_2SO_4 .
- The catalyst used in Decons process is :
 (1) CuCl_2 (2) Cu (3) CuSO_4 (4) CuS
- Which electrolyte is used in Dennis method for the preparation of fluorine ?
 (1) KHF_2 solution in anhydrous HF (2) molten cryolite
 (3) pure dry molten KHF_2 (4) none of these
- Chlorine is liberated when we heat :
 (1) $\text{KMnO}_4 + \text{NaCl}$ (2) $\text{K}_2\text{Cr}_2\text{O}_7 + \text{MnO}_2$ (3) $\text{Pb}(\text{NO}_3)_2 + \text{MnO}_2$ (4) $\text{K}_2\text{Cr}_2\text{O}_7 + \text{HCl}$
- An easy way of obtaining Cl_2 gas in the laboratory is :
 (1) by heating NaCl and concentrated H_2SO_4 . (2) by heating NaCl and concentrated MnO_2 .
 (3) by mixing HCl and KMnO_4 . (4) by passing F_2 through NaCl solution.
- When chlorine reacts with turpentine oil, the product formed is :
 (1) carbon (2) carbon and HCl (3) turpentine chloride (4) none of these
- Which of the following does not decolourise iodine ?
 (1) Na_2SO_3 (2) $\text{Na}_2\text{S}_2\text{O}_3$ (3) NaCl (4) NaOH
- In the reaction, $3\text{Br}_2 + 6\text{CO} + 3\text{H}_2\text{O}_3^{2-} \longrightarrow 5\text{Br}^- + \text{BrO} + 6\text{HCO}$:
 (1) bromine is oxidised and carbonate is reduced (2) bromine is both oxidised and reduced
 (3) bromine is reduced and water is oxidised (4) bromine is neither oxidised nor reduced
- A greenish yellow gas reacts with an alkali metal hydroxide to form a halate which can be used in fire works and safety matches. The gas and halate respectively are :
 (1) Br_2 , KBrO_3 (2) Cl_2 , KClO_3 (3) I_2 , NaIO_3 (4) none
- Two gases X & Y bring about bleaching of flowers, X bleaches by reducing the colouring matter. While Y bleaches due to oxidation of dye. X and Y are respectively.
 (1) SO_2 , Cl_2 (2) Cl_2 , SO_2 (3) SO_2 , O_2 (4) None of these
- Which of the following gases can be dried by concentrated H_2SO_4 ?
 (1) HCl (2) HBr (3) HI (4) H_2S





12. H_2SO_4 cannot be used for obtaining HBr from KBr because :
 (1) HBr oxidises H_2SO_4 . (2) HBr reduces H_2SO_4 .
 (3) HBr undergoes disproportionation. (4) KBr reacts very slowly.
13. Which of the following is weakest acid ?
 (1) HF (2) HCl (3) HBr (4) HI
14. Among the following which reaction is not correct :
 (1) $\text{NaAlO}_2 + \text{HCl} + \text{H}_2\text{O} \longrightarrow \text{NaCl} + \text{Al}(\text{OH})_3$
 (2) $\text{Ca}_3\text{N}_2 + \text{HCl} \longrightarrow \text{CaCl}_2 + \text{NH}_3$
 (3) $\text{Au} + \text{H}^+ + \text{NO}_3^- + \text{Cl}^- \longrightarrow \text{AuCl}_3^- + \text{NO} + \text{H}_2\text{O}$
 (4) $\text{Pt} + \text{H}^+ + \text{NO}_3^- + \text{Cl}^- \longrightarrow \text{PtCl}_6^{2-} + \text{NO} + \text{H}_2\text{O}$
15. Order of boiling point is :
 (1) $\text{HF} > \text{HI} > \text{HBr} > \text{HCl}$ (2) $\text{HF} > \text{HBr} > \text{HI} > \text{HCl}$
 (3) $\text{HCl} > \text{HBr} > \text{HI} > \text{HF}$ (4) $\text{HCl} > \text{HI} > \text{HBr} > \text{HF}$
16. Euchlorine is :
 (1) obtained by heating perchlorate with conc. HCl. (2) a chloride of europium
 (3) a mixture of Cl_2 and Cl_2O_7 (4) a mixture of Cl_2 and Cl_2O_2
17. Consider the oxy acids HClO_n series here value of n is 1 to 4, then incorrect statement regarding these oxyacids is :
 (1) Acidic chloride of oxy acids increases with increasis n.
 (2) Oxidising power of oxy acids increases with decreasis n.
 (3) Thermal stability oxy acids decreases with increasis n.
 (4) Cl–O bond order decreases with decreasis n.
18. How many of the following are correctly match :
 (1) Cl_2O - (a) yellow-brown gas (b.p. 10°C).
 (2) ClO_2 - (b) React with O_3 gives Cl_2O_6 (dark red) it is a mixed anhydride of HClO_3 and HClO_4 .
 (3) Cl_2O_7 - (c) It is anhydride of HClO_4 (only).
 (4) Cl_2O_7 - (d) Oily explosive colourless liquid.
 (5) Cl_2O_7 - (e) has 2 type of O–Cl bond length.
 (6) I_2O_5 - (f) Obtained by reaction between I_2 and CO.
 (1) (1) - (a); (2) - (b); (3) - (c); (4) - (d) (2) (3) - (b); (4) - (e); (5) - (d); (6) - (f)
 (3) (1) - (b); (2) - (a); (3) - (c); (4) - (d) (4) (2) - (c); (3) - (b); (4) - (d); (5) - (e)
19. The strongest acid amongst the following is :
 (1) HClO_4 (2) HClO_3 (3) HClO_2 (4) HClO
20. Which of the following is not the characteristic of interhalogen compounds ?
 (1) They are more reactive than halogens.
 (2) They are quite unstable but none of them is explosive.
 (3) They are covalent in nature.
 (4) They have low boiling points and are highly volatile.
21. Which of the following statement is correct.
 (1) All interhalogen compounds are gaseous at room temperature.
 (2) Interhalogen are either gaseous or liquid at room temperature.
 (3) Interhalogens can solid or liquid or gaseous at room temperature.
 (4) Interhalogen compounds are liquid at room temperature.
22. In which following statement is incorrect :
 (1) Pseudohalogen ions are not spherical
 (2) Pseudohalides are generally less electronegative than the lighter halide (F^- , Cl^-)
 (3) OCN^- , NNN^- pseudohalide are bidentate ligands
 (4) Pseudohalogens form dimers and form molecular compound with non metal and Ionic compounds with alkali metal.





23. Ionisation energy values are given for Xenon (Xe) and Radon (Rn)
- | Element | IE(KJ/mol) |
|---------|------------|
| Xe | 1169 |
| Rn | 1036 |
- Predict a suitable reason for the fact that the chemistry of Rn has not been studied significantly while that of Xe has been extensively studied.
- (1) Rn appears to be more reactive (2) Xe is less reactive than Rn
(3) Rn isotopes have shorter lifetimes (4) Rn is heavier than Xe.
24. In the clathrates of xenon with water, the nature of bonding between xenon and water molecule is :
(1) covalent (2) hydrogen bonding
(3) co-ordinate (4) dipole-induced dipole interaction
25. Among noble gases (from He to Xe) only xenon reacts with fluorine to form stable fluorides because xenon :
(1) has the largest size. (2) has the lowest ionization enthalpy.
(3) has the highest heat of vaporization. (4) is the most readily available noble gas.
26. What are the products formed in the reaction of xenon hexafluoride with silicon dioxide ?
(1) $\text{XeSiO}_4 + \text{HF}$ (2) $\text{XeF}_2 + \text{SiF}_4$ (3) $\text{XeOF}_4 + \text{SiF}_4$ (4) $\text{XeO}_3 + \text{SiF}_2$
27. Which of the following are partial hydrolysis gives XeOF_2 .
(1) XeF_2 (2) XeF_4 (3) XeF_6 (4) XeOF_4
28. The ratio of total number of lonepairs in XeF_2 and XeF_4 are :
(1) 3 : 2 (2) 9 : 14 (3) 14 : 19 (4) 9 : 19
29. Xenon reacts with $\text{P} + \text{F}_6$ to form
(1) XeF_2 (2) $\text{Xe}^+ [\text{P} + \text{F}_6]^-$ (3) $\text{Xe}^- [\text{Pt F}_6]^+$ (4) XeF_4
30. Which among the following statement is incorrect.
(1) XeF_4 and SbF_5 combine to form salt.
(2) XeF_6 on complete hydrolysis gives XeO_3 .
(3) XeF_6 react with H_2 produce XeF_2 and HF .
(4) Xenon hexafluoride react with silica to form a Xenon compound and this Xenon compound have oxidation of Xenon is +6.

Practice Test-1 (IIT-JEE (Main Pattern))

OBJECTIVE RESPONSE SHEET (ORS)

Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18	19	20
Ans.										
Que.	21	22	23	24	25	26	27	28	29	30
Ans.										

PART-II : NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) STAGE-I

1. Acid used for making permanent markings on the glass surface is: [NSEC 2001]
(A) HNO_3 (B) HF (C) HIO_3 (D) H_2SO_4
2. One gas bleaches the colour of flowers by reduction while the other by oxidation. The gases are [NSEC 2002]
(A) SO_2, Cl_2 (B) CO, Cl_2 (C) $\text{H}_2\text{S}, \text{Br}_2$ (D) NH_3, SO_3



3. Fluorine has -1 oxidation state while iodine exhibits oxidation states of -1 , $+1$, $+3$, $+5$ and $+7$. This is due to [NSEC 2002]
 (A) fluorine being a gas (B) availability of d-orbitals in iodine
 (C) non-availability of d-orbitals in iodine (D) none of the above
4. Which pseudo-halogen does not have dimeric nature [NSEC 2002]
 (A) cyanogen (B) azide (C) thiogene (D) selenothigen.
5. The correct sequence of reducing power of halide ions are [NSEC 2002]
 (A) $\text{Cl}^- > \text{Br}^- > \text{I}^-$ (B) $\text{Br}^- > \text{I}^- > \text{Cl}^-$ (C) $\text{I}^- > \text{Br}^- > \text{Cl}^-$ (D) $\text{Cl}^- > \text{I}^- > \text{Br}^-$
6. The order of decreasing basicity in the four halide ions is : [NSEC 2002]
 (A) $\text{I}^- > \text{Br}^- > \text{Cl}^- > \text{F}^-$ (B) $\text{Cl}^- > \text{Br}^- > \text{I}^- > \text{F}^-$ (C) $\text{F}^- > \text{Cl}^- > \text{Br}^- > \text{I}^-$ (D) $\text{Cl}^- > \text{F}^- > \text{Br}^- > \text{I}^-$
7. Which group of periodic table have large negative energy of activation ? [NSEC 2002]
 (A) Alkali metal (B) Zero group (C) Halogen family (D) Alkaline earth metal.
8. The compound that cannot be formed by xenon is [NSEC 2003]
 (A) XeO_3 (B) XeF_4 (C) XeCl_4 (D) XeOF_4
9. $\text{K}_2\text{S}_2\text{O}_8$, acidic $\text{K}_2\text{S}_2\text{O}_8$ and acidic MnO_2 oxidise I^- , Br^- , Cl^- to I_2 , Br_2 and Cl_2 , respectively. From the given data, the sequence that represents the correct order of increasing oxidising ability is [NSEC 2003]
 (A) $\text{I}_2 > \text{K}_2\text{S}_2\text{O}_8 > \text{Br}_2$ (B) acidic $\text{MnO}_2 > \text{K}_2\text{S}_2\text{O}_8 > \text{Cl}_2$
 (C) $\text{K}_2\text{S}_2\text{O}_8 > \text{I}_2 > \text{Br}_2$ (D) $\text{Cl}_2 > \text{K}_2\text{S}_2\text{O}_8 > \text{Br}_2$.
10. Hydrogen fluoride is a liquid at room temperature due to [NSEC 2005]
 (A) dimerisation (B) dissociation followed by aggregation.
 (C) association (D) polymerisation
11. Which of the following is a "super acid" [NSEC 2008]
 (A) $(\text{HF} + \text{SbF}_5)$ in SO_2 (B) $(\text{H}_2\text{SO}_4 + \text{SO}_3)$ in SO_2
 (C) $(\text{HNO}_3 + \text{BF}_3)$ in SO_2 (D) $(\text{H}_3\text{PO}_4 + \text{PF}_5)$ in SO_2
12. The noble gas was first time discovered by [NSEC 2008]
 (A) Cavendish (B) William Ramsay (C) Rayleigh (D) Frankland
13. Of the interhalogen compounds, ClF_3 is more reactive than BrF_3 , but BrF_3 has higher conductance in the liquid state. The reason is that [NSEC 2011]
 (A) BrF_3 has higher molecular weight (B) ClF_3 is volatile
 (C) BrF_3 dissociates into BrF_2^+ and BrF_4^- more easily (D) ClF_3 is most reactive
14. Radioactive inert gas is : [NSEC 2011]
 (A) technetium (B) radon (C) xenon (D) curium
15. The gas which liberates bromine from a solution of KBr is [NSEC 2013]
 (A) Cl_2 (B) I_2 (C) SO_2 (D) HI
16. Bleaching powder contains a salt of an oxoacid as one of its components. The anhydride of that acid is [NSEC 2014]
 (A) Cl_2O (B) Cl_2O_7 (C) ClO_2 (D) Cl_2O_6
17. Which of the following hydrogen halides react with AgNO_3 to give a precipitate that dissolves in hypo solution? [NSEC 2014]
 (I) HCl (II) HF (III) HI (IV) HBr
 (A) (III), (I), (II) (B) (I), (III), (IV) (C) (IV), (II), (I) (D) (II), (IV), (III)
18. With respect to halogens, four statements are given below [NSEC 2015]
 (I) The bond dissociation energies for halogens are in the order : $\text{I}_2 < \text{F}_2 > \text{Br}_2 < \text{Cl}_2$
 (II) The only oxidation state is -1
 (III) The amount of energy required for the excitation of electrons to first excited state decreases progressively as we move from F to I
 (IV) They form HX_2^- species in their aqueous solutions (X = halogen)
 The correct statements are
 (A) I, II, IV (B) I, III, IV (C) II, III, IV (D) I, III



19. Consider a compound CsXY_2 where X and Y are halogens. Which of the following statement/s is/are correct? [NSEC 2016]
 (i) X and Y have different oxidation states.
 (ii) For Y with lower atomic number than X, X can assume oxidation states higher than normal.
 (iii) Such compounds exist because Cs^+ has a high charge to size ratio.
 (A) Only (i) (B) (i) and (ii) (C) Only (ii) (D) (i) and (iii)
20. Iodine is a solid and sublimes at ordinary temperature. This is because of : [NSEC 2017]
 (A) weak I–I bonds (B) strong I–I bonds
 (C) lone pair-bond pair repulsions (D) weak van der Waals forces between I_2 molecules
21. A 500 mL glass flask is filled at 298 K and 1 atm, pressure with three diatomic gases X, Y and Z. The initial volume ratio of the gases before mixing was 5 : 3 : 1. The density of the heaviest gas in the mixture is not more than 25 times that of the lightest gas. When the mixture was heated, vigorous reactions take place between X and Y and X and Z in which all the three gases were completely used up. The gases X, Y, Z respectively are [NSEC 2017]
 (A) H_2 , O_2 , N_2 (B) H_2 , O_2 , Cl_2 (C) H_2 , F_2 , O_2 (D) O_2 , H_2 , F_2

PART - III : PRACTICE TEST-2 (IIT-JEE (ADVANCED Pattern))

Max. Time : 1 Hr.

Max. Marks : 66

Important Instructions

A. General :

- The test is of 1 hour duration.
- The Test Booklet consists of 22 questions. The maximum marks are 66.

B. Question Paper Format

- Each part consists of five sections.
- Section-1 contains 7 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE is correct.
- Section-2 contains 5 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE OR MORE THAN ONE are correct.
- Section 3 contains 6 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9 (both inclusive).
- Section 4 contains 1 paragraphs each describing theory, experiment and data etc. 3 questions relate to paragraph. Each question pertaining to a particular passage should have only one correct answer among the four given choices (A), (B), (C) and (D).
- Section 5 contains 1 multiple choice questions. Question has two lists (list-1 : P, Q, R and S; List-2 : 1, 2, 3 and 4). The options for the correct match are provided as (A), (B), (C) and (D) out of which ONLY ONE is correct.

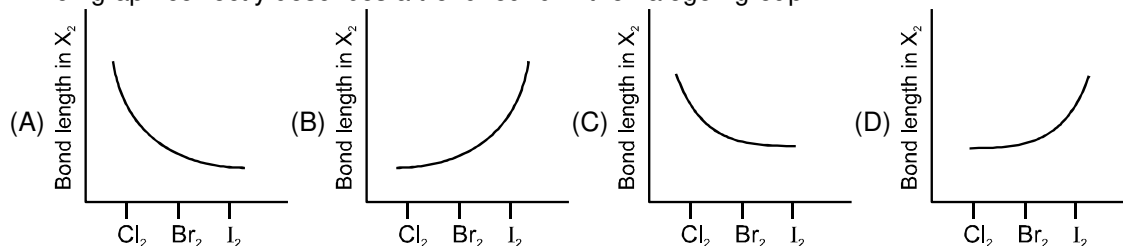
C. Marking Scheme :

- For each question in Section 1, 4 and 5 you will be awarded 3 marks if you darken the bubble corresponding to the correct answer and zero mark if no bubble is darkened. In all other cases, minus one (– 1) mark will be awarded.
- For each question in Section 2, you will be awarded 3 marks. If you darken all the bubble(s) corresponding to the correct answer(s) and zero mark. If no bubbles are darkened. No negative marks will be answered for incorrect answer in this section.
- For each question in Section 3, you will be awarded 3 marks if you darken only the bubble corresponding to the correct answer and zero mark if no bubble is darkened. No negative marks will be awarded for incorrect answer in this section.

**SECTION-1 : (Only One option correct Type)**

This section contains 7 multiple choice questions. Each questions has four choices (A), (B), (C) and (D) out of which Only ONE option is correct.

1. Which graph correctly describes a trend found in the halogen group?



2. (i) $(r) + (p) \longrightarrow NaClO_2 + O_2$
 (ii) $IO_3^- + I^- \xrightarrow{H^+} (q)$
 (iii) Acidic solution of $ClO_2^- \longrightarrow (s) + (r)$.
 (disproportionation reaction)
 (p) used as air purifier and CO_2 absorber.
 (q) estimated by hypo and it forms violet colour vapour (it self).
 (r) is yellow colour gas
 (s) gives chromylchloride test.
 Which option is correct.
 (A) (p) = Na_2O_2 , (q) = I_2 (B) (q) = I_2O_5 , (r) = Cl^-
 (C) (p) = Na_2O , (r) = Cl_2O (D) (r) = Cl_2 , (s) = Cl_2O_3
3. $[HXeO_4]^- + OH^- \longrightarrow [X] + [Y] + O_2 + H_2O$
 The products [X] and [Y] in unbalanced reaction are :
 (A) $[XeO_6]^{4-}$ & Xe (B) $[XeO_6]^{4-}$ & XeO_3 (C) XeO_3 & Xe (D) H_2XeO_4 & Xe
4. Consider following properties of the noble gases.
 I : They readily form compounds which are colourless.
 II : They generally do not form ionic compounds.
 III : Xenon has variable oxidation states in its compounds.
 IV : the smaller He and Ne do not form clathrate compounds.
 Select correct properties.
 (A) I, II, III (B) II, III, IV (C) I, III, IV (D) All
5. Which behave like pseudohalide in following
 (A) $(CN)_2$ (B) $(SCN)_2$ (C) N_3^- (D) I_3^-
6. $Cl_2(g) + Ba(OH)_2 \longrightarrow X(aq) + BaCl_2 + H_2O$
 $X + H_2SO_4 \longrightarrow Y + BaSO_4$
 $Y \xrightarrow[\text{365 K}]{\Delta} Z + H_2O + O_2$
 Y and Z, are respectively :
 (A) $HClO_4$, ClO_2 (B) $HClO_3$, ClO_2 (C) $HClO_3$, ClO_6 (D) $HClO_4$, Cl_2O_7
7. Which of the following on treatment with XeF_6 gives Xe?
 (A) H_2 (B) HCl (C) OH^- (conc) (D) All of these

Section-2 : (One or More than one options correct Type)

This section contains 5 multipole choice questions. Each questions has four choices (A), (B), (C) and (D) out of which ONE or MORE THAN ONE are correct.

8. Which of the following have melting points less than 298 K.
 (A) Fluorine (B) Bromine (C) Iodine (D) Chlorine



9. Aq. solution of salt $\xrightarrow[\text{acid (X)}]{\text{Halogen}}$ A $\xrightarrow[\text{Halogen acid (X)}]{\text{excess}}$ soluble
- \downarrow K_2CrO_4 (aq.)
- Yellow precipitate
The halogen acid (X) is
- (A) HF (B) HCl (C) HI (D) Cl_2 (aq.)
10. Select the correct statement(s).
(A) Cl_2O and ClO_2 are used as bleaching agents and as germicides.
(B) I_2O_5 is used in the quantitative estimation of CO.
(C) ClO_2 is the anhydride of HClO_2 and HClO_3 .
(D) Cl_2O is a colourless oily liquid.
11. Which of the following are Pseudo halid.
(A) CN^- (B) N_3^- (C) OCN^- (D) NO_3^-
12. Which of the following can be obtained by hydrolysis of XeF_6
(A) XeO_3 (B) HF (C) XeO_2F_2 (D) Xe

Section-3 : (One Integer Value Correct Type.)

This section contains 6 questions. Each question, when worked out will result in one integer from 0 to 9 (both inclusive)

13. What is the sum of group number and period number (according to IUPAC system) of the non-metal which exist in liquid state at room temperature.
14. How many of the following compounds form HCl on hydrolysis as one of the products (major or minor)
(i) BCl_3 (ii) BiCl_3 (iii) SO_2Cl_2 (iv) NCl_3 (v) PCl_5
(vi) CrO_2Cl_2 (vii) CH_3Cl (viii) NaCl (ix) ZnCl_2
15. $\text{NH}_4\text{ClO}_4 + \text{NHO}_3 \longrightarrow (\text{A}) + (\text{B}) \xrightarrow{\Delta} (\text{C})$ (neutral oxide)
The summation of number of lone pairs and atomicities of compound B and C is.
16. The oxidation state of iodine in compound which is obtained by heating HIO_3 at 170°C is +n.
Give value of n.
17. Hydrolysis of compound A, two acids P and Q forms, P is used in etching of glass, Q on strongly heating gives a oxide R. R is used in estimation of carbon monoxide. Calculate total number of lone pairs on compound A.
18. The simplest ratio x : y of xenon and fluorine when passes through Ni-tube (400°C) at high pressure gives XeF_6 . Here x + y is :

SECTION-4 : Comprehension Type (Only One options correct)

This section contains 1 paragraphs, each describing theory, experiments, data etc. 3 questions relate to the paragraph. Each question has only one correct answer among the four given options (A), (B), (C) and (D)

Paragraph for Questions 19 to 21

White crystalline solid (A) reacts with H_2 to form a highly associated liquid (B) and a monoatomic, colorless gas (C). The liquid (B) is used for etching glass. Compound (A) undergoes hydrolysis slowly to form (C), (B) and a diatomic gas (D) whose IE is almost similar to that of (C). (B) forms an addition compound with KF to form (E) which is electrolysed in the molten state to form a most reactive gas (F) which combines with (C) in 2:1 ratio to produce (A).

19. According to Molecular Orbital Theory, which of the following is correct about the molecule D ?
(A) its bond order is 2.0 (B) it has two unpaired electrons in π -bonding M.O.
(C) both the above are correct (D) none of these is correct



20. Which of the following is correct for the white crystalline solid (A) ?
 (A) It oxidises F^- to F_2
 (B) It on hydrolysis with alkali under goes disproportionation.
 (C) It is obtained by the reaction of (C) with O_2F_2 at $118^\circ C$.
 (D) None of these.
21. The compound 'A' reacts with sulphur to form a compound in which hybridisation state of sulphur atom is :
 (A) sp^3d (B) sp^3d^2 (C) sp^3 (D) sp^3d^3

SECTION-5 : Matching List Type (Only One options correct)

This section contains 1 questions, each having two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (A), (B), (C) and (D) out of which one is correct

22. Match the reaction products listed in column-I with the particulars listed in column-II

	Column-I		Column-II
(A)	$XeF_2 + H_2O \longrightarrow$	(p)	Redox reaction
(B)	$XeF_4 + H_2O \longrightarrow$	(q)	Disproportionation
(C)	$XeF_6 + H_2O \longrightarrow$	(r)	O_2 formation
(D)	$XeO_3 + NaOH \longrightarrow$	(s)	Xe formation
		(t)	Etching glass

Practice Test-2 (IIT-JEE (ADVANCED Pattern))

OBJECTIVE RESPONSE SHEET (ORS)

Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18	19	20
Ans.										
Que.	21	22								
Ans.		(A)		(B)		(C)		(D)		





APSP Answers

PART - I

1. (3)	2. (1)	3. (1)	4. (4)	5. (3)
6. (2)	7. (3)	8. (2)	9. (2)	10. (1)
11. (1)	12. (2)	13. (1)	14. (3)	15. (1)
16. (4)	17. (3)	18. (1)	19. (1)	20. (4)
21. (3)	22. (3)	23. (3)	24. (4)	25. (2)
26. (3)	27. (2)	28. (2)	29. (2)	30. (3)

PART - II

1. (B)	2. (A)	3. (B)	4. (B)	5. (C)
6. (C)	7. (C)	8. (C)	9. (D)	10. (C)
11. (A)	12. (B)	13. (C)	14. (B)	15. (A)
16. (A)	17. (B)	18. (D)	19. (B)	20. (D)
21. (C)				

PART - III

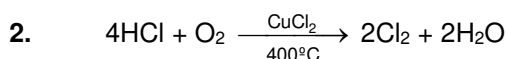
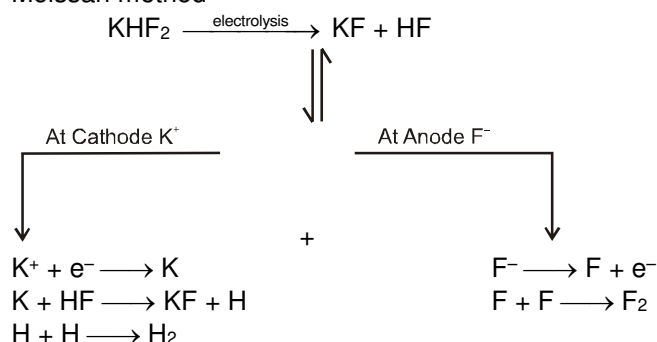
1. (B)	2. (A)	3. (A)	4. (B)	5. (C)
6. (B)	7. (D)	8. (ABD)	9. (BC)	10. (ABC)
11. (ABC)	12. (ABC)	13. 21	14. 5	15. 24
16. 5	17. 16	18. 21	19. (A)	20. (C)
21. (B)	22. (A) – (p,q,r,s,t) ; (B) – (p,q,r,s,t) ; (C) – (t) ; (D) – (p,q,r,s)			



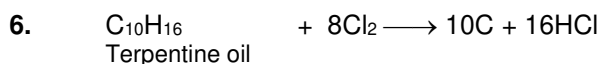
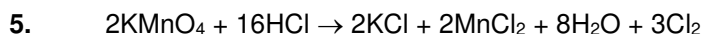
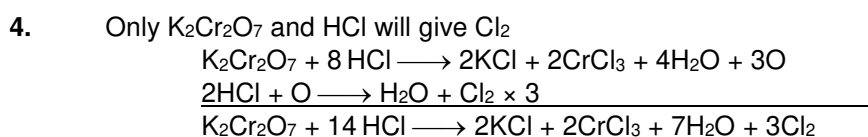
APSP Solutions

PART - I

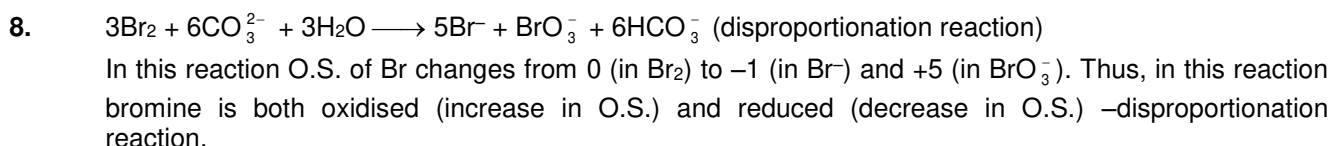
1. Moissan method



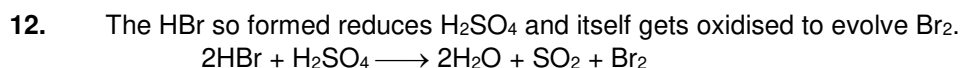
3. KHF_2 solution in anhydrous HF.



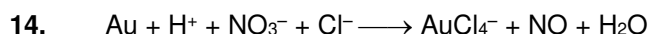
7. NaCl has no reaction with iodine.



11. HCl is dried over conc. H_2SO_4 . Because HBr , HI and H_2S are oxidised by H_2SO_4 .

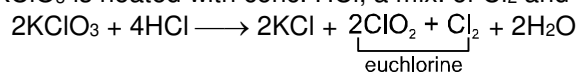


13. Acid strength order : $\text{HI} > \text{HBr} > \text{HCl} > \text{HF}$
Amongst these HI , HBr , HCl are strong acids whereas HF is a weak acid.



15. $\text{BP} \uparrow$ with increase in atomic mass of the halogens. HF has highest BP due to association of HF molecule through H-bonding.

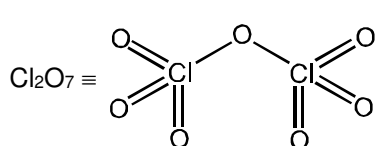
16. When KClO_3 is heated with conc. HCl , a mix. of Cl_2 and ClO_2 is formed known as euchlorine.



17. (1) Acidic chloride : $\text{HOCl} < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}_4$
(2) Oxidising power : $\text{HOCl} > \text{HClO}_2 > \text{HClO}_3 > \text{HClO}_4$
(3) Thermal stability : $\text{HOCl} < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}_4$
(4) Cl-O bond order : $\text{HOCl} < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}_4$



18. $\text{ClO}_2 + \text{O}_3 \xrightarrow{0^\circ\text{C}} \text{Cl}_2\text{O}_6$ (dark red)
 $\text{Cl}_2\text{O}_6 + \text{H}_2\text{O} \longrightarrow \text{HClO}_3 + \text{HClO}_4$
 $2\text{HClO}_4 \xrightarrow{-\text{H}_2\text{O}} \text{Cl}_2\text{O}_7$

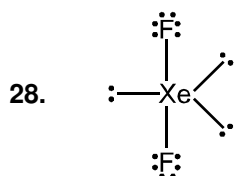


2 : $\overset{(1.71\text{\AA})}{\text{O}-\text{Cl}}$ bond

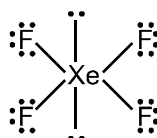
6 : $\overset{(1.41\text{\AA})}{\text{O}=\text{Cl}}$ bond



19. ClO_4^- , conjugate base is most stable as charge is dispersed over four oxygen atom and so HClO_4 is the strongest acid.
20. Interhalogen compounds are mostly liquid or solid at room temperature and are not highly volatile.
21. It is a fact
22. OCN^- , NNN^- are ambidentate and monodentate ligands both donate only one lone pair. So both are monodentate ligand.
23. Due to short life-times, Rn has not been studied.
24. In clathrates the bonding between noble gas atom and water is dipole-induced dipole interaction.
25. Out of He, Ne, Ar, Kr and Xe, Xe has the lowest ionisation energy as ionisation energies decrease down a group.
26. $2\text{XeF}_6 + \text{SiO}_2 \longrightarrow \text{SiF}_4 + 2\text{XeOF}_4$
27. (1) $\text{XeF}_2 + \text{H}_2\text{O} \longrightarrow \text{Xe} + 2\text{HF} + \frac{1}{2}\text{O}_2$ (2) $\text{XeF}_4 + \text{H}_2\text{O} \longrightarrow \text{XeOF}_2 + 2\text{HF}$
 (3) $\text{XeF}_6 + \text{H}_2\text{O} \longrightarrow \text{XeOF}_4 + 2\text{HF}$ (4) $\text{XeOF}_4 + \text{H}_2\text{O} \longrightarrow \text{XeO}_2\text{F}_2 + 2\text{HF}$



Total number of lone pair = 9
 Ratio = 9 : 14



Total number of lone pair = 14

30. (1) $\text{XeF}_4 + \text{SbF}_5 \longrightarrow [\text{XeF}_3]^+ [\text{SbF}_5]^-$
 (2) $\text{XeF}_6 + \text{H}_2\text{O} \longrightarrow \text{XeO}_3 + \text{HF}$
 (3) $\text{XeF}_6 + \text{H}_2 \longrightarrow \text{Xe} + \text{HF}$
 (4) $\text{SiO}_2 + \text{XeF}_6 \longrightarrow \overset{+6}{\text{XeOF}_4} + [\text{SbF}_5]^-$

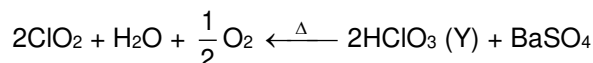
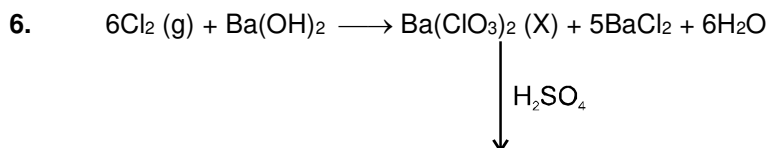
PART - III

1. With increasing number of electrons in the molecule and hence increasing molecular size and increase in van der Waal's forces.
2. $\text{ClO}_2 + \text{Na}_2\text{O}_2 \longrightarrow \text{NaClO}_2 + \text{O}_2$
 $\text{IO}_3^- + \text{I}^- \longrightarrow \text{I}_2 + \text{H}_2\text{O}$
 $5\text{ClO}_2^- \xrightarrow{\text{H}^+} 4\text{ClO}_2 + \text{Cl}^- + \text{H}_2\text{O}$
 (+3) (+4) (-1)
 $\text{A} = \text{Na}_2\text{O}_2$; $\text{B} = \text{I}_2$; $\text{C} = \text{ClO}_2$; Cl^-
3. $2[\text{HXeO}_4]^- + 2\text{OH}^- \longrightarrow [\text{XeO}_6]^{4-} + \text{Xe} + \text{O}_2 + 2\text{H}_2\text{O}$



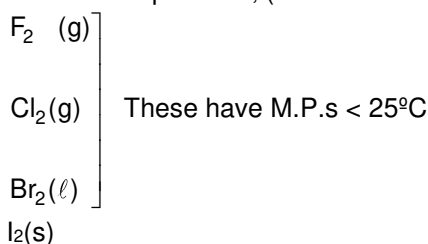
4. (I) They do not form compounds readily as they are chemically inert on account of stable electron configuration.
(II), (III) & (IV) are correct statement.

5. N_3^- is pseudohalide.
 $(\text{CN})_2$ and $(\text{SCN})_2$ behave like pseudohalogen.
 I_3^- is polyhalide.



7. $\text{XeF}_6 + 3\text{H}_2 \longrightarrow \text{Xe} + 6\text{HF}$
 $\text{XeF}_6 + 6\text{HCl} \longrightarrow \text{Xe} + 6\text{HF} + 3\text{Cl}_2$

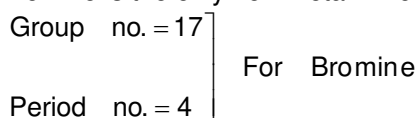
8. At room temperature; (298 K = 25°C)



10. $2\text{ClO}_2 + \text{H}_2\text{O} \longrightarrow \text{HClO}_2 + \text{HClO}_3$
 $\text{I}_2\text{O}_5 + 5\text{CO} \longrightarrow \text{I}_2 + 5\text{CO}_2$
 Cl_2O is brownish yellow gas which condenses to an orange coloured liquid in a freezing mixture (b.pt. = 2°C).

12. $\text{XeF}_6 + 3\text{H}_2\text{O} \longrightarrow \text{XeO}_3 + 6\text{HF}$ Complete hydrolysis
 $\text{XeF}_6 + 2\text{H}_2\text{O} \longrightarrow \text{XeO}_2\text{F}_2 + 4\text{HF}$ (Partial hydrolysis)

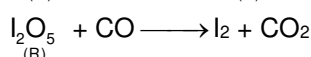
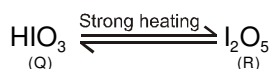
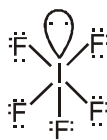
13. Bromine is the only non-metal which exist as liquid at room temperature.



14. (i), (ii), (iii), (v), (vi), (ix)

16. $\text{HIO}_3 \xrightarrow{\Delta} \text{I}_2\text{O}_5$

17. $\text{IF}_5 + \text{H}_2\text{O} \longrightarrow \text{HF} \longrightarrow + \text{HIO}_3$
(A) (P) (Q)
HF is used in etching of glass

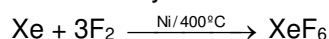


Total number of lone pair in A = 16.



18. 1 : 20 mixture of Xe and F₂ will give XeF₆.

$$\therefore x + y = 1 + 20 = 21$$

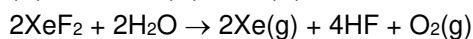


19. Compound (D) is O₂ and therefore, its bond order = $\frac{10-6}{2} = 2$.

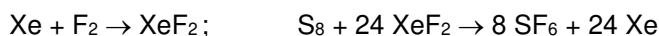
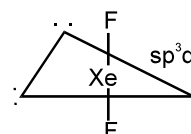
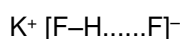
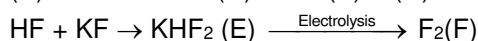
20. Compound (A) is XeF₂; so, $\text{Xe} + \text{O}_2\text{F}_2 \xrightarrow{118^\circ\text{C}} \text{XeF}_2 + \text{O}_2$

21. $\text{XeF}_2 + \text{H}_2 \rightarrow \text{Xe}(\text{g}) + 2\text{HF}(\ell)$

(A) (C) (B)



(A) (C) (B) (D)



1 : 2

(C) (F) (A)

22. (A) $2\text{XeF}_2 + 2\text{H}_2\text{O} \longrightarrow 2\text{Xe} + 4\text{HF} + \text{O}_2$
 (B) $6\text{XeF}_4 + 12\text{H}_2\text{O} \longrightarrow 4\text{Xe} + 2\text{XCO}_3 + 24\text{HF} + 3\text{O}_2$
 (C) $\text{XeF}_6 + 3\text{H}_2\text{O} \longrightarrow \text{XeO}_3 + 6\text{HF}$
 (D) $\text{XeO}_3 + \text{NaOH} \longrightarrow \text{Na}^+ [\text{HXeO}_4]^-$
 $2[\text{HXeO}_4]^- + 2\text{OH}^- \longrightarrow [\text{XeO}_6]^{4-} + \text{Xe} + \text{O}_2 + \text{H}_2\text{O}$