

(HALOGEN & NOBLE GASES)

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Syllabus¹

Halogen & Noble Gases

Halogens: hydrohalic acids, oxides and oxyacids of chlorine, bleaching powder.

Noble gas : Isolation, Xenon fluorides, Xenon oxygen compounds.

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HALOGEN & NOBEL GAS

GROUP 17 ELEMENTS : THE HALOGEN FAMILY

Fluorine, chlorine, bromine, iodine and astatine are members of Group 17. These are collectively known as the halogens (Greek halo means salt and genes born i.e., salt producers). The halogens are highly reactive non-metallic elements.

Electronic Configuration

All these elements have seven electrons in their outermost shell (ns²np⁵) which is one electron short of the next noble gas.

Atomic and Ionic Radii

The halogens have the smallest atomic radii in their respective periods due to maximum effective nuclear charge. Atomic and ionic radii increase from fluorine to iodine due to increasing number of quantum shells.

Ionisation Enthalpy

They have little tendency to lose electron. Thus they have very high ionisation enthalpy. Due to increase in atomic size, ionisation enthalpy decreases down the group.

Electron Gain Enthalpy

Halogen have maximum negative electron gain enthalpy in the corresponding period. This is due to the fact that the atoms of these elements have only one electron less than stable noble gas configurations. Electron gain enthalpy of the elements of the group becomes less negative down the group. However, the negative electron gain enthalpy of fluorine is less than that of chlorine. It is due to small size of fluorine atom. As a result, there are strong interelectronic repulsions in the relatively small 2p orbitals of fluorine and thus, the extra electron (incoming) does not experience much attraction.

Electronegativity

They have very high electronegativity. The electronegativity decreases down the group. Fluorine is the most electronegative element in the periodic table

Bond Energy :

F - F bond dissociation energy is less than that of CI - CI and Br - Br. It is due to larger inter electronic (electron - electron) repulsion between the non bonding electrons in the 2P orbitals of fluorine atom. then these in the 3p orbitals of chlorine atoms.

F – F	CI – CI	Br – Br	I – I
38 kcal/mol	57 kcal/mol	45.5 kcal/mol	35.6 kcal/mol
$Cl_2 > Br_2 >$	$F_{2} > I_{2}$		

Physical Properties

Fluorine and chlorine are gases, bromine is a liquid whereas iodine is a solid. Their melting and boiling points steadily increase with atomic number. All halogens are coloured. This is due to absorption of radiations in visible region which results in the excitation of outer electrons to higher energy level. By absorbing different quanta of radiation, they display different colours. For example, F_2 , has yellow, Cl_2 , greenish yellow, Br_2 , red and I_2 , violet colour. Fluorine and chlorine react with water. Bromine and iodine are only sparingly soluble in water. But are soluble in organic solvents such as chloroform, carbon tetrachloride, carbon disulphide and hydrocarbons to give coloured solutions. Except the smaller enthalpy of dissociation of F_2 compared to that of Cl_2 . The X-X bond disassociation enthalpies from chlorine onwards show the expected trend : CI - CI > Br - Br > F - F > I - I. The reason for the smaller enthalpy of dissociation of F_2 is the relatively larger electrons-electrons repulsion among the lone pairs in F_2 molecule where they are much closer to each other than in case of Cl_2 .



Atomic and physical properties

Element	F	CI	Br	I
Atomic Number	9	17	35	53
Atomic Mass	19	35.45	79.90	126.90
Electronic configuration	[He] 2s ² 2p ⁵	[Ne] 3s ² 3p ⁵	[Ar] 3d ¹⁰ 4s ² 4p ⁵	[Kr] 4d ¹⁰ 5s ² 5p ⁵
Covalent Radius / pm	64	99	114	133
Ionic Radius X [−] / pm	133	184	196	220
Ionization enthalpy / (kJ mol ⁻¹)	1680	1256	1142	1008
Electron gain enthalpy /(kJ mol ⁻¹)	- 333	- 349	- 325	- 296
Distance X -X/pm	143	199	229	266
Enthalpy of dissociation (X ₂)/kJ mol ⁻¹	158.8	242.6	192.8	151.1
Electronegativity	4	3.2	3.0	2.7
Melting point / K	54.4	172	265.8	386.6
Boiling point / K	84.9	239.0	332.5	458.2

Chemical Properties

Oxidation states and trends in chemical reactivity

All the halogens exhibit -1 oxidation state. However, chlorine, bromine and iodine exhibit +1, +3, +5 and +7 oxidation states also. 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.

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.

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.

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. The decreasing oxidising ability of the halogens in aqueous solution down the group is evident from their standard electrode potentials. Fluorine oxidises water to oxygen whereas chlorine and bromine react with water to form corresponding hydrohalic and hypohalous acids. 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.

 $\begin{array}{ll} 2F_{_2}(g) + 2H_{_2}O(\ell) \to 4H^{_+}(aq) + 4F^{_-}(aq) + O_{_2}(g) \\ X_{_2}(g) + H_{_2}O(\ell) \to HX(aq) + HOX(aq) & ; \\ 4I^{_-}(aq) + 4H^{_+}(aq) + O_{_2}(g) \to 2 \ I_{_2} \ (s) + 2H_{_2}O(\ell) \end{array}$ (where X = CI or Br)

Standard Reduction Potential (SRP) and Oxidising Power :

More the value of the SRP, more powerful is the oxidising agent. Hence the order of oxidising power is $F_2 > CI_2 > Br_2 > I_2$

Hydration energy of X⁻ :

Smaller the ion, higher is the hydration energy.

F-	CI-	Br⁻	ľ	
515	381	347	305	in kJ/mol



Anomalous behaviour of fluorine

Fluorine differs considerably from other halogens due to -

- (i) Small size
- (ii) High electronegativity.
- (iii) Non availability of d orbitals in its valency shell.
- (iv) Low bond dissociation energy of F F bond.
- (a) Boiling point of HF is the highest and for other increases down the group.
- (b) Due to hydrogen bonding HF is a liquid while HCl, HBr and HI are gases.
- (c) Fluorine, being the most electronegative gives SF_6 while other member do not form hexahalides with sulphur.
- (d) It exhibits oxidation state of only -1.
- (e) It is the strongest oxidising agent.
- (f) It liberates oxygen as well as ozone with water.
- (g) HF does not ionize while HCI, HBr and HF ionize in aqueous solution.
- (h) Solubility of salts :
 - (i) AgF is soluble in water while AgCl, AgBr and AgI are insoluble.
- (i) It combines with hydrogen with explosion at a low temperature and even in the dark. No other halogens combines so readily.

 $H_2 + F_2 \longrightarrow 2HF$

(j) It liberates oxygen as well as ozone with water.

 $\begin{array}{cccc} 2H_2O + 2F_2 & \longrightarrow & 4HF + O_2 \\ 3H_2O + & 3F_2 & \longrightarrow & 6HF + O_3 \end{array}$

Comparison of $[CI_2, Br_2 \text{ and } I_2]$

S.No.	Property	Chlorine	Bromine	Iodine
1.	Physical State	Gas	Liquid	Solid
2.	Colour of Vapour	Greenish Yellow	Dark Red	Violet
3.	Action of H ₂ O	Decomposes into HCI & O ₂	Decomposes Slowly in Presence of Light	No action
4.	Oxidising Action	Strong	Good	Weak
5.	Bleaching Action	Moist Cl ₂ is a Good Bleaching Agent	Moist Br ₂ is a good Bleaching Agent	No Bleaching
6.	Action of Halides	Displaces $Br_{_2} \& I_{_2}$	Displaces I_2	No Action
7.	Combination with H_2	Explosive in Light Slow in Dark	Only on Heating	Heating + Catalyst

CHLORINE (Cl_2) :

Preparation :

(i) By heating chloride with concentrated H_2SO_4 in presence of MnO_2 .

$$4H^+ + MnO_2 + 2X^- \longrightarrow X_2 + Mn^{+2} + 2H_2O$$

Bromides and iodides also liberate Br₂ and I₂ respectively with concentrated H₂SO₄ and MnO₂.



(ii) (a)
$$Ca \underbrace{OCI}_{CI} + 2HCI \longrightarrow CaCI_2 + CI_2 + H_2O$$

- (b) $2KMnO_4 + 16 HCI \rightarrow 2 KCI + 2 MnCl_2 + 5 Cl_2 + 8 H_2O$
- (c) $PbO_2 + 4 HCI \rightarrow PbCI_2, + CI_2 + 2 H_2O$
- > These methods are exclusively used only for chlorine.

(iii) Manufacture of chlorine :

(a) **Deacon's process :** By oxidation of hydrogen chloride gas by atmospheric oxygen in the presence of CuCl₂ (catalyst) at 723 K.

4 HCl + $O_2 \xrightarrow{CuCl_2}$ 2 Cl₂ + 2 H₂O

(b) Electrolytic process : Chlorine is obtained by the electrolysis of brine (concentrated NaCl solution). Chlorine is liberated at anode. It is obtained as a by–product in many chemical industries e.g.; in manufacturing of sodium hydroxide.

NaX (aq)
$$\longrightarrow$$
 Na⁺ (aq) + X⁻ (aq)
Anode : 2X⁻ \longrightarrow X₂ + 2e⁻

Properties :

- (i) It is a greenish–yellow gas with pungent and suffocating odour. It is about 2–5 times heavier than air. It can be liquefied into greenish–yellow liquid which boils at 239 K. It is soluble in water.
- (ii) At low temperature it forms a hydrate with water having formula Cl₂. 8H₂O which is infact a clathrate compound.
- (iii) Oxidising & 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.
 - (a) It oxidises ferrous to ferric, sulphite to sulphate, sulphur dioxide to sulphuric acid and iodine to iodic acid.

 $2 \operatorname{FeSO}_{4} + \operatorname{H}_{2}\operatorname{SO}_{4} + \operatorname{Cl}_{2} \longrightarrow \operatorname{Fe}_{2}(\operatorname{SO}_{4})_{3} + 2 \operatorname{HCl}$ $\operatorname{Na}_{2}\operatorname{SO}_{3} + \operatorname{Cl}_{2} + \operatorname{H}_{2}\operatorname{O} \longrightarrow \operatorname{Na}_{2}\operatorname{SO}_{4} + 2 \operatorname{HCl}$ $\operatorname{SO}_{2} + 2 \operatorname{H}_{2}\operatorname{O} + \operatorname{Cl}_{2} \longrightarrow \operatorname{H}_{2}\operatorname{SO}_{4} + 2 \operatorname{HCl}$ $\operatorname{I}_{2} + 6 \operatorname{H}_{2}\operatorname{O} + 5 \operatorname{Cl}_{2} \longrightarrow 2 \operatorname{HIO}_{3} + 10 \operatorname{HCl}$ $\operatorname{Chloring widings heth } \operatorname{Dr}_{2} \operatorname{cod}_{1} \operatorname{to}_{2}\operatorname{Dr}_{2} \operatorname{cod}_{1} \operatorname{to}_{2}\operatorname{Dr}_{2} \operatorname{cod}_{1} \operatorname{to}_{2}\operatorname{Dr}_{2}\operatorname{cod}_{1} \operatorname{to}_{2}\operatorname{Dr}_{2}\operatorname{cod}_{1} \operatorname{to}_{2}\operatorname{Dr}_{2}\operatorname{cod}_{1} \operatorname{to}_{2}\operatorname{Dr}_{2}\operatorname{cod}_{1} \operatorname{to}_{2}\operatorname{Dr}_{2}\operatorname{cod}_{1}\operatorname{cod}_{1}\operatorname{cod}_{1}\operatorname{cod}_{1}\operatorname{cod}_{1}\operatorname{cod}_{2}\operatorname{cod}_{1}\operatorname{cod}$

(b) Chlorine oxidises both Br^- and I^- to Br_2 and I_2 respectively.

+
$$Cl_2 \longrightarrow X_2 + 2Cl_2$$

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

$$Cl_2 + H_2O \longrightarrow 2 HCl + O$$

Coloured substance + O \rightarrow Colourless substance

Х-

It bleaches vegetable or organic matter in the presence of moisture. Bleaching effect of chlorine is permanent.

Note : The bleaching action of SO₂ is temporary because it takes place through reduction.

 $SO_2 + 2 H_2O \longrightarrow H_2SO_4 + 2 H$

 SO_3^{2-} + Coloured material $\longrightarrow SO_4^{2-}$ + Reduced colourless material.

Reduced Colourless material $\xrightarrow{O_2 \text{ of air}}$ Coloured material.

(iv) Reaction with NaOH :

- (a) 2 NaOH (cold & dilute) + $Cl_2 \longrightarrow NaCl + NaClO + H_2O$
- (b) 6 NaOH (hot & concentrated) + 3 $Cl_2 \longrightarrow 5 NaCl + NaClO_3 + 3 H_2O$

These reactions are also given by Br_2 and I_2 .



(v) **Reaction with dry slaked lime, Ca(OH)**, : To give bleaching powder.

 $2 \operatorname{Ca(OH)}_{2} + 2 \operatorname{Cl}_{2} \longrightarrow \operatorname{Ca(OCI)}_{2} + \operatorname{CaCl}_{2} + 2 \operatorname{H}_{2} O$

Uses : Cl₂ is used

1. for bleaching wood pulp (required for the manufacture of paper and rayon), bleaching cotton and textiles,

2. in the manufacture of dyes, drugs and organic compounds such as CCI_4 , $CHCI_3$, DDT, refrigerants, etc.

3. in the extraction of gold and platinum.

BROMINE (Br,):

Preparation :

(i) **Common method**: $2 \text{ NaBr} + 3H_2SO_4$ (concentrated) + $\text{MnO}_2 \xrightarrow{\Delta} \text{Br}_2 + \text{MnSO}_4 + 2\text{NaHSO}_4 + 2H_2O_4$

(ii) From Sea-water :

NaCl is main component but NaBr is also present in some quantity in sea water. Cl_2 gas is passed through sea water when vapours of bromine are evolved.

 $2 \text{ Br}(aq) + \text{Cl}_2 \longrightarrow 2 \text{Cl}(aq.) + \text{Br}_2$

The Br_2 is removed by a stream of air since Br_2 is quite volatile. The gas is passed through a solution of Na_2CO_3 when the Br_2 is absorbed forming a mixture of NaBr and NaBrO₃. The solution is then acidified and distilled to give pure bromine.

 $3Br_{2} + 3Na_{2}CO_{3} \longrightarrow 5NaBr + NaBrO_{3} + 3CO_{2}$ $5NaBr + NaBrO_{3} + 3H_{2}SO_{4} \longrightarrow 5HBr + HBrO_{3} + 3Na_{2}SO_{4}$ $5HBr + HBrO_{3} \longrightarrow 3Br_{2} + 3H_{2}O$

Properties :

(i) Reddish brown liquid, fairly soluble in water. It also forms hydrate like Cl₂

 $(Br_2 . 8H_2O) \leftarrow Clathrate compound$

(ii) Rest reactions are same as with Cl_2

IODINE (I,):

Preparation :

(i) **Common method**: $2NaI + 3H_2SO_4$ (concentrated) + $MnO_2 \xrightarrow{\Delta} I_2 + MnSO_4 + 2NaHSO_4 + 2H_2O_4$

(ii) From Caliche or Crude chile salt petre :

The main source of iodine is $NaIO_3$ (sodium iodate) which is found in nature with $NaNO_3$ (chile saltpetre). $NaIO_3$ is present in small amount. After crystallisation of $NaNO_3$, the mother liquor left contains $NaIO_3$ (soluble). To this solution $NaHSO_3$ is added where upon I_2 is precipitated.

 $\begin{array}{l} 2\mathrm{IO_3^-} + 6\mathrm{HSO_3^-} \longrightarrow 2\mathrm{I^-} + 6\,\mathrm{SO_4^{2-}} + 6\mathrm{H^+} \\ 5\mathrm{I^-} + \mathrm{IO_3^-} + 6\mathrm{H^+} \longrightarrow 3\mathrm{I_2} + 3\,\mathrm{H_2O} \end{array}$

(iii) From sea-weeds :

Certain marine plants absorb and concentrate I⁻ selectively in presence of CI⁻ and Br⁻. Sea-weeds are dried and burnt in shallow pits, ash left is called kelp. Ash on extraction with hot water dissolves out chlorides, carbonates, sulphates and iodides of sodium and potassium. The solution on concentration separates out all leaving behind iodide in the solution. Solution is mixed with MnO₂ and concentrated H₂SO₄ in iron retorts. Liberated iodine is condensed in series of earthenware known as aludels.

$$2\text{NaI} + \text{MnO}_2 + 3\text{H}_2\text{SO}_4 \longrightarrow 2\text{NaHSO}_4 + \text{MnSO}_4 + \text{I}_2 + 2\text{H}_2\text{O}$$



Properties :

(i) It is a dark violet solid, undergoes sublimation, least soluble (among halogens) in water but much more soluble in KI(aq.) due to formation of KI₃. It is soluble in organic solvents like CHCl₃, CCl₄ etc. to get violet solutions.

(ii) **Reaction with hypo :**

 $S_2O_3^{2-}$ (thiosulphate ions) + $I_2 \longrightarrow S_4O_6^{2-}$ (tetrathionate ions) + $2I^-$

This reaction is the basis of iodometric titration, which is carried out for the estimation of iodine using starch indicator.

 $\rightarrow NI_3$. $NH_3 + 3HI$

an explosive

ammoniated)

(Nitrogentriiodide

(iii) Reaction with NH, :

 $NH_{3}(g) + I_{2} \longrightarrow No Reaction$

 $NH_{3}(aq) + I_{2}(s)$ A slurry is formed (Ammonia liquor) which can be dried and on hammering it

explodes causing sound (crakers)

 $8NI_3$. $NH_3 \longrightarrow 5N_2 + 9I_2 + 6NH_4I_3$

HALOGEN ACIDS (HCI, HBr & HI):

Preparation :

(i) By direct combination of elements :

$$H_2 + CI_2 \longrightarrow 2HCI$$
 ; $H_2 + Br_2 \xrightarrow{Pt} 2HBr$; $H_2 + I_2 \xrightarrow{Pt} 450^{\circ}C \longrightarrow 2HI$

(ii) By heating a halide with concentrated acid :

(a) NaCl +
$$H_2SO_4 \xrightarrow{150^\circC} NaHSO_4 + HCl$$

 $NaHSO_4 + NaCI \xrightarrow{550^{\circ}C} Na_2SO_4 + HCI$

This method is called as salt cake method as it involves the formation of NaHSO, (salt cake). HCl cannot be dried over P_2O_5 (P_4O_{10}) or quick lime since they react with gas chemically.

$$\begin{array}{l} \mathsf{CaO}+\mathsf{2HCI} \longrightarrow \mathsf{CaCl}_{2} + \mathsf{H}_{2}\mathsf{O} \\ \mathsf{P}_{4}\mathsf{O}_{_{10}} + \mathsf{3HCI} \longrightarrow \mathsf{POCl}_{3} + \mathsf{3HPO}_{3} \end{array}$$

HCl is, hence dried by passing through concentrated H₂SO₄.

HBr (or HI) cannot be prepared by heating bromide (iodide) with concentrated H₂SO₄ because HBr (b) and HI are strong reducing agents and reduce H2SO4 to SO2 and get themselves oxidised and iodine respectively.

to bromine

$$KX + H_{2}SO_{4} \longrightarrow KHSO_{4} + HX$$

 $H_2SO_4 + 2HX \longrightarrow SO_2 + X_2 + 2H_2O (X = Br \text{ or } I)$

Hence, HBr and HI are prepared by heating bromides and iodides respectively with concentrated H₃PO₄. 3KBr(KI) + H_3 PO $_4 \longrightarrow K_3$ PO $_4 + 3$ HBr (HI)

(iii) By reaction of P₄ (Laboratory Method) :

 $P_4 + 6Br_2 (6I_2) \longrightarrow 4PBr_3 (4PI_3)$ (product in situ)

$$PBr_{3}(PI_{3}) + 3H_{2}O \longrightarrow 3HBr(HI) + H_{3}PO_{3}$$

Properties :

- These are colourless, pungent smelling gases with acidic tastes. (i)
- (ii) These are neither combustible nor supporter of combustion.
- (iii) 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.
- (iv) These are quite soluble in water. HCl ionises as below : HCl(g) + H₂O (ℓ) \longrightarrow H₃O⁺ (aq) + Cl⁻ (aq) ; K_a = 10⁷



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F-106, Road No.2 Indraprastha Industrial Area, End of Evergreen Motor, BSNL Lane, Jhalawar Road, Kota, Rajasthan (324005) Tel. : +91-744-242-5022, 92-14-233303 It aqueous solution is called hydrochloric acid. High value of dissociation constant (K_a) indicates that it is a strong acid in water.

When three parts of concentrated HCI and one part of concentrated HNO, are mixed, aqua regia is formed which is used for dissolving noble metals, e.g., gold, platinum.

Au + 4 H⁺ + NO₃⁻ + 4 Cl⁻
$$\longrightarrow$$
 [AuCl₄]⁻ + NO + 2 H₂O
3 Pt + 16 H⁺ + 4 NO₃⁻ + 18 Cl⁻ \longrightarrow 3 [PtCl₆]²⁻ + 4 NO + 8 H₂O

Reducing property and stability of hydracids : (v)

- HCI: It is quite stable and hence is oxidised by strong oxidising agents like MnO₂, KMnO₄, K₂Cr₂O₇, PbO₂, Pb₃O₄.
- $MnO_2 + 4HCI \longrightarrow MnCl_2 + 2H_2O + Cl_2$ (i)
- $2KMnO_4 + 16HCI \longrightarrow 2KCI + 2MnCl_2 + 8H_2O + 5Cl_2$ (ii)
- HBr : It is not very stable and hence more easily oxidised or acts as a strong reducing agents. In addition to above reducing properties of HCI, it also reduces H₂SO₄ to SO₂ which is not done by HCI. $H_2SO_4 + HBr \longrightarrow SO_2 + Br_2 + 2H_2O$ Aqueous HBr on exposure to atmospheric oxygen is oxidised to bromine (yellow) $4HBr + O_2 \longrightarrow 2 Br_2 + 2H_2O$
- 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 HCI, it shows following reactions also
- (a) $H_2SO_4 + 2HI \longrightarrow SO_2 + I_2 + H_2O;$ $H_{2}SO_{4} + 8HI \longrightarrow H_{2}S + 4I_{2} + 4H_{2}O;$

$$H_2SO_4 + 6HI \longrightarrow S + 3I_2 + 4H_2O;$$

 $2HNO_{2} + 2HI \longrightarrow 2NO_{2} + I_{2} + 2H_{2}O$ (c) $2HNO_2 + 2HI \longrightarrow 2NO + I_2 + 2H_2O$ (e) $K_2S_2O_8 + 2HI \longrightarrow K_2SO_4 + I_2 + H_2SO_4$ (b) (C)

(d)
$$HIO_3 + 5HI \longrightarrow 3I_2 + 2H_2O$$
 (e)

 $2\text{FeCl}_3 + 2\text{HI} \longrightarrow 2\text{FeCl}_3 + 1_2 + 2\text{HCI}$ (f)

Aqueous solution of acid, if exposed to O_2 is oxidised to iodine. \geq

$$4HI + O_2 \longrightarrow 2I_2 + 2H_2O$$

HYDROFLUORIC ACID
$$[H_2F_2, HF]$$
:

Preparation :

H₂ and F₂ 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.

Laboratory Method : (i)

Anhydrous HF is obtained by heating dry potassium hydrogen fluoride in a copper retort connected with copper condenser.

$$KHF_2 \xrightarrow{\Delta} KF + HF$$

(ii) **Industrial Method :**

HF is prepared by heating fluorspar (CaF₂) with concentrated H₂SO₄.

$$CaF_2 + H_2SO_4 \longrightarrow CaSO_4 + 2HF$$

 \geq 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:

 $Na_{2}SiO_{3} + 6HF \longrightarrow Na_{2}SiF_{6} + 3H_{2}O$; $CaSiO_{3} + 6HF \longrightarrow CaSiF_{6} + 3H_{2}O$ $SiO_2 + 4HF \longrightarrow SiF_4 + 2H_2O$; $SiF_4 + 2HF \longrightarrow H_2SiF_6$

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.
- It is a weak dibasic acid (due to strong HF bond) and forms two series of salt. (iii)

 $NaOH + H_2F_2 \longrightarrow NaHF_2 + H_2O$; $NaHF_2 + NaOH \longrightarrow 2NaF + H_2O$



OXIDES OF CHLORINE :

CHLORINE DIOXIDE (CIO₂):

Preparation :

- (i) $2 \operatorname{NaClO}_3 + \operatorname{SO}_2 + \operatorname{H}_2 \operatorname{SO}_4 \xrightarrow{\text{traces of NaCl}} 2 \operatorname{ClO}_2 + 2 \operatorname{NaHSO}_4$
- (ii) $2\text{KClO}_3 + 2\text{H}_2\text{C}_2\text{O}_4 \xrightarrow{90^\circ\text{C}} 2\text{ClO}_2(g) + 2\text{CO}_2(g) + \text{K}_2\text{C}_2\text{O}_4 + 2\text{H}_2\text{O}_2(g)$
- (iii) $2AgCIO_3 + CI_2 \xrightarrow{90^{\circ}C} 2AgCI \downarrow (white) + 2CIO_2 + O_2$

Properties :

(i) Yellow gas at room temperature dissolves in water evolving heat and giving a dark green solution.

 $CIO_2 \xrightarrow{\text{light}} CIO + [O]$

It kill bacteria better than Cl₂.

(ii) Reaction with ozone : $2CIO_2 + 2O_3 \xrightarrow{H^+} CI_2O_6$ (yellow solid) + $2O_2$ dichlorine hexa oxide

In the reaction O_{3} is behaving as an oxidising agent.

(iii) Reaction with alkaline H_2O_2 :

In this reaction H_2O_2 acts as a reducing agent. It reduces CIO_2 into CIO_2^-

 $H_2O_2 \longrightarrow 2H^+ + O_2 + 2e^ e^- + CIO_2 \longrightarrow CIO_2^-] \times 2$

 $\mathrm{H_2O_2} + 2\mathrm{CIO_2} \longrightarrow 2\mathrm{CIO_2}^- + 2\mathrm{H}^+ + \mathrm{O_2}$

or
$$H_2O_2 + 2CIO_2 + 2OH^- \longrightarrow 2CIO_2^- + 2H_2O + O_2$$

(iv) Reaction with HI :

In this reaction HI behaves as a reducing agent where it reduces CIO_2 into CI^- and itself is oxidised to I_2 .

 $2\text{CIO}_2 + 8\text{H}^+ + 10 \text{ I}^- \longrightarrow 5\text{I}_2 + 2\text{CI}^- + 4\text{H}_2\text{O}$

Dichlorine Monoxide (Cl₂O) :

Preparation :

 $2Cl_2 + 2HgO \downarrow$ (Freshly prepared precipitate, brown) $\xrightarrow{300^{\circ}C}$ HgCl₂. HgO + Cl₂O

Properties :

Cl₂O is yellow-brown gas very soluble in water.

$$3Cl_2O + 10NH_3 \longrightarrow 6NH_4Cl + 2N_2 + 3H_2O$$

$$Cl_2O + 2NaOH \longrightarrow 2NaOCI + H_2O$$

BLEACHING POWDER (CaOCI₂.H₂O)

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



Ca(OCI)CI

Preparation:

 $Ca(OH)_2 + CI_2 \xrightarrow{40^{\circ}C} Ca(OCI)CI + H_2O$

Properties

- (i) 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.
- (ii) On long standing, it undergoes auto-oxidation into calcium chlorate and calcium chloride.

 $6 \operatorname{CaOCl}_2 \rightarrow \operatorname{Ca(ClO}_3)_2 + 5 \operatorname{CaCl}_2$

(iii) $2 \operatorname{CaOCl}_2 \xrightarrow{\operatorname{CoCl}_2} 2 \operatorname{CaCl}_2 + \operatorname{O}_2$

(iv) In presence of a little amount of a dilute acid, it loses oxygen.

 $\begin{array}{l} 2 \text{ CaOCI}_2 + \text{H}_2 \text{SO}_4 \longrightarrow \text{CaCI}_2 + \text{CaSO}_4 + 2 \text{ HCIO} \\ \text{HCIO} \longrightarrow \text{HCI} + \text{O} \end{array}$

On account of the liberation of nascent oxygen, it shows oxidising and bleaching properties.

- (a) Oxidising properties $CaOCl_2 + H_2S \longrightarrow CaCl_2 + H_2O + S$ $CaOCl_2 + 2 KI + 2 HCI \longrightarrow CaCl_2 + 2 KCI + H_2O + I_2$ $3 CaOCl_2 + 2 NH_3 \longrightarrow 3 CaCl_2 + 3 H_2O + N_2$
- It oxidises NO_2^{-1} to NO_3^{-1} , As O_3^{-1} to As O_4^{-1} and Fe²⁺ to Fe³⁺ (in acidic medium)
- (b) Bleaching action

Coloured matter + $[O] \longrightarrow$ colourless product.

(v) When bleaching powder reacts with dilute acids or CO₂ it liberates chlorine which is known as available chlorine.

$$\begin{array}{l} \mathsf{CaOCl}_2 + 2 \ \mathsf{HCl} \longrightarrow \mathsf{CaCl}_2 + \mathsf{H}_2\mathsf{O} + \mathsf{Cl}_2 \\ \mathsf{CaOCl}_2 + \mathsf{H}_2\mathsf{SO}_4 \longrightarrow \mathsf{CaSO}_4 + \mathsf{H}_2\mathsf{O} + \mathsf{Cl}_2 \\ \mathsf{CaOCl}_2 + \mathsf{CO}_2 \longrightarrow \mathsf{CaCO}_3 + \mathsf{Cl}_2 \end{array}$$

 \blacktriangleright HNO₃ is a strong oxidising acid to be avoided, here.

(vi) Bleaching powder converts acetone or ethyl alcohol into CHCl₃

 $CaOCl_{2} + H_{2}O \longrightarrow Ca(OH)_{2} + Cl_{2}$ $CH_{3}COCH_{3} + 3 Cl_{2} \longrightarrow CCl_{3}COCH_{3} + 3 HCl$ $2 CCl_{3}COCH_{3} + Ca(OH)_{2} \longrightarrow (CH_{3}COO)_{2}Ca + 2 CHCl_{3}$

OXY-ACIDS OF HALOGENS:

Oxidation state Chlorine Bromine Iodine Name of acid Name of salt of halogens

+1	HCIO	HBrO	HIO	Hypohalous	Hypohalite	Stability and acidity
+3	HCIO ₂	-	-	Halous	Halite	increases but
+5	HCIO ₃	HBrO ₃	HIO_3	Halic	Halate	oxidising power
+7	HCIO ₄	HBrO ₄	HIO ₄	Perhalic	Perhalate	decreases

Acidity increases



HOX SERIES : HYPO-CHLOROUS ACID [HCIO] : Preparation :

(i) The acid is known only in solution, It is obtained by shaking precipitate of HgO with chlorine water.

 $2HgO + 2Cl_2 + H_2O \longrightarrow Hg_2OCl_2$ (Oxychloride of mercury) + 2HClO

(ii) Commercially, it is obtained by passing CO₂ 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, Cl₂O.

$$2\text{HOCI} \longrightarrow \text{H}_2\text{O} + \text{Cl}_2\text{O}$$

Properties :

(i) It is a weak acid. Its concentrated solution is yellow in colour while dilute solution is colourless. It is unstable and decomposes.

 $2\text{HCIO} \longrightarrow 2\text{HCI} + \text{O}_2$

(ii) It dissolves magnesium with evolution of hydrogen.

Mg + 3HClO \longrightarrow Mg(ClO)₂ + H₂

- (iii) With alkalies, it forms salts called hypochlorites.
- (iv) It acts as a powerful oxidising and bleaching agent. This is due to release of nascent oxygen easily. HCIO \longrightarrow HCI + O

HXO, SERIES :

CHLOROUS ACID [HCIO₂]:

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.

 $Ba(ClO_2)_2 + H_2SO_4 \longrightarrow BaSO_4 + 2HClO_2$

Properties:

(i) The freshly prepared solution is colourless but it soon decomposes to CIO_2 which makes the solution yellow.

 $5 \text{ HCIO}_2 \longrightarrow 4 \text{ CIO}_2 + \text{HCI} + 2\text{H}_2\text{O}$

(ii) Salts of HCIO₂ are called chlorite and prepared by one of the following methods.

$$2CIO_2 + 2NaOH \longrightarrow NaCIO_2 + NaCIO_3 + H_2O$$

 $2\text{CIO}_2 + \text{Na}_2\text{O}_2 \longrightarrow 2\text{NaCIO}_2 + \text{O}_2$

Chlorites are used as bleaches. They are stable in alkaline solution even when boiled, but in acid solution they disproportionate, particularly when heated.

 $5HCIO_2 \longrightarrow 4CIO_2 + HCI + 2H_2O$ and $4HCIO_2 \longrightarrow 2CIO_2 + HCIO_3 + HCI + H_2O$

HXO₃ SERIES CHLORIC ACID [HCIO₃] :

Preparation :

This acid is only known in solution. The acid is prepared by the action of the dilute H₂SO₄ on barium chlorate.

 $\mathsf{Ba}(\mathsf{ClO}_3)_2 + \mathsf{H}_2\mathsf{SO}_4 \longrightarrow \mathsf{BaSO}_4 \checkmark + 2\mathsf{HClO}_3.$

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.

 $3HCIO_3 \longrightarrow HCIO_4 + CI_2 + 2O_2 + H_2O$ HBrO₃ can be prepared by similar method using Ba(BrO₃)₂.



Properties :

Concentrated acid is colourless and pungent smelling liquid. It decomposes in light. However, it is stable in dark. It acts as a strong oxidising and bleaching agent in light. Organic substances like paper, cotton, wool, etc., catch fire in contact with the acid.

- $\blacktriangleright \qquad \mathsf{HClO}_3 \text{ oxidises SO}_2 \text{ to SO}_3: \qquad \mathsf{HClO}_3 + 3\mathsf{SO}_2 \longrightarrow \mathsf{HCl} + 3\mathsf{SO}_3$
- HBrO, is not very stable, but is known in solution, and as salts.
- \blacktriangleright HIO₃ is formed by oxidation of I₂ with concentrated HNO₃ or O₃.

$$8H^+ + 10NO_3^- + I_2 \longrightarrow 2IO_3^- + 10NO_2 + 4H_2O_3^-$$

- $\blacktriangleright \qquad \mathsf{IO}_3^- \text{ oxidises } \mathsf{I}^- \text{ to } \mathsf{I}_2^- \colon \qquad \mathsf{IO}_3^- + \mathsf{5I}^- + \mathsf{6H}^+ \longrightarrow \mathsf{3I}_2 + \mathsf{3H}_2\mathsf{O}$
- Iodic acid is reasonably stable and exists as a white solid.

PERCHLORIC ACID $[HCIO_4]$:

Preparation:

(i) It is the most stable oxy-acid of chlorine. Anhydrous $HCIO_4$ is obtained by doing distillation of $KCIO_4$ (potassium perchlorate), with 96-97.5% H_2SO_4 under low pressure at 90-160°C.

$$\text{KCIO}_4 + \text{H}_2\text{SO}_4 \longrightarrow \text{KHSO}_4 + \text{HCIO}_4$$

(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.

$$Ba(CIO_4)_2 + H_2SO_4 \longrightarrow BaSO_4 \downarrow + 2HCIO_4$$

(iii)
$$4CIO_3^- \xrightarrow{\Delta} 3CIO_4^- + CI$$

Properties:

(iii)

- (i) Anhydrous $HCIO_4$ 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 :
 - $HCIO_4 \longrightarrow H^+ + CIO_4^-$
 - It dissolves most of the metals.

 $Zn + 2HClO_{4} \longrightarrow Zn(ClO_{4})_{2} + H_{2}$

(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) $2\text{HCIO}_4 + \text{P}_2\text{O}_5 \longrightarrow 2\text{HPO}_3 + \text{Cl}_2\text{O}_7$
- Mg $(CIO_4)_2$ is used in dry batteries and is also an effective desiccant called anhydrone. $KCIO_4$ is used in fire works and flares.

Some important order

- (a) Acid strength (i) HI > HBr > HCl > HF (ii) HOCl > HOBr > HOI (iii) HClO₄ > HClO₃ > HClO₂ > HClO (Order of stability of conjugate base $ClO^- < ClO_2^- < ClO_3 < ClO_4^-$
-)
- (b) Oxidising powder

(i)
$$F_2 > Cl_2 > Br_2 > I_2$$

(ii) $BrO_{a}^{-} > IO_{a}^{-} > CIO_{a}^{-}$ (According to electrode potential)

- (c) Order of disproportionations $3 \text{ XO}^- \longrightarrow 2\text{ X}^- + \text{ XO}_3^-$ (hypohalite ion); IO⁻ > BrO⁻ > CIO⁻
- (d) Order of Stability HCIO > HBrO > HIO

Pseudo halogens and pseudo halides :

A few ions are known, consisting of two or more electronegative atoms of which at least one is nitrogen, that have properties similar to those of halide ions. These ions are called pseudohalide ions, Pseudohalide ions are univalent and these form salts resembling halide salts.

The pseudohalide ions are :



Cyanide ions (CN⁻) : Isocyanide ion (NC-) Cyanate ion (OCN-) Fulminate ion (ONC-) : Thiocyanate ions (SCN⁻) : Isothiocyanate ion (NCS⁻) Selenocyanate ion (SeCN⁻) :Tellurocyanate ion (TeCN⁻) Azide ion (N_2^{-}) : Azido carbon disulphide ion (SCSN,-) As the dimers of halide ions are called halogens, the covalent dimers of the pseudohalide ions are called halogens or halogenoids. The pseudohalogens known are : Cyanogen (CN)_a Oxycyanogen (OCN), ·

Thiocyanogen $(SCN)_2$: Selenocyanogen $(SeCN)_2$ Tellurocyanogen $(TeCN)_2$: Azido carbon disulphide $(SCSN_2)_2$

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.

AB	AB ₃	AB ₅	AB_7
CIF	CIF ₃		IF ₇
BrF	BrF ₃	BrF ₅	
ICI	ICl ₃	IF ₅	
IF	IF	Ũ	

Properties :

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

Gases : CIF, BrF, CIF₃, IF₇; Liquids : BrF_3 , BrF_5 ; Solids : ICI, IBr, IF₃, ICI₃.

(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

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 > CIF > ICI > IBr > BrCI.
- 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 . ICI + 2Na \longrightarrow NaI + NaCI
- (vii) Hydrolysis : All these undergo hydrolysis giving halide ion derived from the smaller halogen and a hypohalite (when AB), halite (when AB₃), halate (when AB₅), and perhalate (when AB₇) anion derived from the larger halogen.

GROUP 18 ELEMENTS : (THE 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 noble gases.



Occurrence

All the noble gases except radon occur in the atmosphere. 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. The main commercial source of helium is natural gas. Xenon and radon are the rarest elements of the group. Radon is obtained as a decay product of ²²⁶Ra.

$$^{226}_{88}$$
Ra \longrightarrow $^{222}_{86}$ Rn + $^{4}_{2}$ He

 \triangleright

Most abundant element in air is Ar. Order of abundance in the air is Ar > Ne > Kr > He > Xe.

ISOLATION

Except He, non-radioactive noble gases are commercially isolated from air by two method.

(i) Fractional Distillation of Liquid air (Claude's Method) :

Due to difference in b.p. the various constituents of air are seprated from each other.

(ii) Dewar's Coconut Chercoal Adsorption Method :

- (a) O_2 an N_2 are removed by means of compound formation.
- (b) The principle of this method is that the adsorption capacity of these gases at low temperature by coconut charcoal increases with increases in their atomic weights.
- (c) Thus He has the lowest and Xe has the maximum adsorption capacity.

Adsorption of Inert Gases :

(a) Done on coconut. Gas particles are adsorbed in surface of coconut charcoal

(b) Larger the size, more will be the adsorption so maximum adsorption of Xe at highest temp.

Physical properties

All the noble gases are mono-atomic. They are colourless, and tasteless. They are sparingly soluble in water. They have very low melting and boiling points because the only type of interatomic interaction in these elements is weak dispersion forces,. 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.

Element	He	Ne	Ar	Kr	Хе
Atomic Number	2	10	18	36	54
Atomic Mass	4	20.18	39.10	83.80	131.30
Electronic configuration	1s ²	[He] 2s ² 2p ⁶	[Ne] 3s ² 3p ⁶	[Ar] 3d ¹⁰ 4s ² 4p ⁶	[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

Atomic and physical properties

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 (1s²) have completely filled ns² np⁶ electronic configuration in their valence shell.
- (ii) They have high ionisation enthalpy and more positive electron gain enthalpy.
 - The reactivity of noble gases has been investigated occasionally ever since their discovery, but all attempt to force them to react to form the compounds were unsuccessful for quite a few years. In March 1962, Neil Bartlett, then at the University of British Columbia, observed the reaction of a noble gas. First, he prepared a red compound which is formulated as O_2^+ PtF₆⁻. 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). He made efforts to prepare same type of compound with Xe⁺ PtF₆⁻ by mixing Pt F₆ and Xenon. After this discovery, a number of xenon compounds mainly with most electronegative elements like fluorine and oxygen, have been synthesised. The compounds of krypton are fewer. Only the difluoride (KrF₂) has been studied in detail. Compounds of radon have not been isolated but only identified (e.g., RnF₂) by radiotracer technique. No true compounds of Ar, Ne or He are yet known.
- \geq 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.

Clatherate compounds :

Inert gas molecules get trapped in the cages formed by the crystal structure of water.

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 clatherate compounds.

There are no chemical bonds. They do not possess an exact chemical formula but approxit is 6 water molecules: 1 inert gas molecule. 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). The smaller noble gases He and Ne do not form clathrate compounds because the gas atoms are small enough to escape from the cavities. Clathrate provides a convenient means of storing radioactive isotopes of Kr and Xe produced in nuclear reactors.

COMPOUNDS OF XENON: XENON DIFLUORIDE (XeF_): **Preparation:**

873K,1bar $Xe + F_2 \xrightarrow{\text{OTSN, IDar}} XeF_2$ (i)

 \geq Volume ratio should be 2: 1 otherwise other higher fluorides tend to form.

- $Xe + O_2F_2 \xrightarrow{118^\circ C} XeF_2 + O_2$ (ii)
- $Xe + F_2 \xrightarrow{Hg(arc)} XeF_2$ (iii)
- Recently discovered method : (iv)

 K^+ [AgF₄]⁻ [potassium tetrafluoroargentate (III)] is first prepared and this is reacted with BF₃.

 $K^{+}[AgF_{4}]^{-} \xrightarrow{BF_{3}} AgF_{2}$ (red solid) + KBF_{4}

$$2 \text{AgF}_3 + \text{Xe} \longrightarrow 2 \text{AgF}_2$$
 (Brown solid) + XeF₂

Properties :

- Colorless crystalline solid and sublimes at 298 K.
- Dissolves in water to give a solution with a pungent odour. Much soluble in HF liquid. (ii)
- This is stored in a vessel made up of monel metal which is a alloy of nickel. (iii)
- (iv) Reaction with H, : It reacts with hydrogen gas at 400°C

$$XeF_2 + H_2 \longrightarrow Xe + 2HF$$

Hydrolysis : (v)

(i)

- (a) $2XeF_2 + 2H_2O \longrightarrow 2Xe + 4HF + O_2$ (slow) The above is neither a cationic hydrolysis nor an anionic hydrolysis as seen in ionic equilibrium. It is a covalent compound and hydrolysis is like that of PCI₅.
- (b) Hydrolysis is more rapid with alkali. $XeF_2 + 2 NaOH \longrightarrow Xe + \frac{1}{2}O_2 + 2NaF + H_2O$ (fast) The reaction (a) is slower probably due to dissolution of XeF₂ in HF.

(vi) **Oxidising properties :**

Higher the value of SRP better is the oxidising property of the species.

The standard reduction potential for XeF₂ is measured to be + 2.64 V. Therefore, it acts as a strong oxidising agent.

 $2e^- + 2H^+ + XeF_2 \longrightarrow Xe + 2HF; SRP = + 2.64 V$



This oxidises halides (except F-) to their respective halogens.

 $XeF_2 + 2 HCI \longrightarrow Xe + 2 HF + Cl_2$

It oxidises $2Br^- \longrightarrow Br_2 + 2e^-$ & $2I^- \longrightarrow I_2 + 2e^-$

- Similarly it can oxidise BrO_3^- (bromate) which are themselves good oxidising agents to BrO_4^- (perbromate ions) and Ce³⁺ to Ce⁴⁺ ion.
- (vii) **Oxidising as well as fluorinating properties :** It can act as strong oxidising agent as well as fluorinating agent.

 $\mathsf{C}_{_{\!\!6}}\mathsf{H}_{_{\!\!5}}\mathrm{I} + \mathsf{XeF}_{_2} \longrightarrow \mathsf{C}_{_{\!\!6}}\mathsf{H}_{_{\!\!5}}\mathrm{IF}_{_2} + \mathsf{Xe}\,; \qquad \mathsf{CH}_{_{\!\!3}}\mathrm{I} + \mathsf{XeF}_{_2} \longrightarrow \mathsf{CH}_{_{\!\!3}}\mathrm{IF}_{_2} + \mathsf{Xe}\,$

 $CH_{3}IF_{2}$ exists as $CH_{3}^{+}IF_{2}^{-}$, IF_{2}^{-} is analogous to I_{3}^{-}

- F_{3}^{-} can not be formed as it has no d-orbitals to attain sp³d hybridisation.
- (viii) Reactions of $XeF_2 + HF$ (anhydrous) :

 $Pt + 3XeF_{2} \xrightarrow{HF} PtF_{6} + 3Xe; \qquad S_{8} + 24 XeF_{2} \longrightarrow 8SF_{6} + 24 Xe$ $8 NH_{3} + 3 XeF_{2} \longrightarrow N_{2} + 6 NH_{4}F + 3 Xe$ $2NO_{2} + XeF_{2} \longrightarrow 2 NO_{2}F + Xe$ (nitronium fluoride)

(ix) **Formation of addition compounds :** XeF₂ reacts with fluoride ion acceptors to form cationic species and fluoride ion donors to form fluoroanions.

$$XeF_2 + PF_5 \longrightarrow [XeF]^+ [PF_6]^-$$

IF₅ (lewis acid) + $XeF_2 \longrightarrow [XeF]^+ [IF_6]^-$; 2SbF₅ (lewis acid) + $XeF_2 \longrightarrow [XeF]^+ [SbF_6]^-$ Similar behaviour is shown by PF₅ and AsF₅

XENON TETRAFLUORIDE (XeF₄):

Preparation :

 \geq

Xe +
$$2F_2 \xrightarrow[7bar,]{873K} XeF_4$$

1 · 5 Ni-tube

Properties :

- (i) It is a colorless crystalline solid and sublimes at 298 K.
- (ii) It undergoes sublimation, soluble in CF₃ COOH. It undergoes hydrolysis violently hence no moisture must be present during it's preparation.
- (iii) Reaction with H_2O : 6 XeF₄ + 12 $H_2O \longrightarrow 4$ Xe + 2XeO₃ + 24 HF + 3O₂
- \blacktriangleright XeO₃ is white solid and explosive compound (dry), soluble in water (well behaved in water)
- XeO₃ reacts with NaOH forming sodium xenate

 $XeO_3 + NaOH \longrightarrow Na^+ [HXeO_4]^-$ (sodium xenate)

It disproportionates into perxenate ion in basic medium.

$$2 [HXeO_{4}]^{-} + 2OH^{-} \longrightarrow [XeO_{6}]^{4-} + Xe + O_{2} + 2H_{2}O$$

Xenic acid $(H_2 XeO_4)$ is a very weak acid.

(iv) Oxidising properties of XeF_4 :

 $XeF_4 + 2H_2 \longrightarrow Xe + 4HF; XeF_4 + 2Hg \longrightarrow Xe + 2HgF_2$

(v) Addition reactions : XeF₄ reacts with fluoride ion acceptors to form cationic species and fluoride ion donors to form fluoroanions.

 $XeF_4 + SbF_5 \longrightarrow [XeF_3]^+ [SbF_6]^-$

XENON HEXAFLUORIDE (XeF₆):

Preparation:

(i)
$$Xe + 3F_2 \xrightarrow{573K, 60-70bar} XeF_6$$
 (ii) $XeF_4 + O_2F_2 \longrightarrow XeF_6 + O_2$
1 : 20 Ni-tube



Properties:

- (i) Colourless crystalline solid and sublimes at 298 K.
- (ii) It gives yellow liquid on melting where as other form white liquids on melting (a point of difference)
- (iii) HF is a good solvent for all three fluorides.

(iv) Hydrolysis :

- (a) Complete hydrolysis : $XeF_6 + 3H_2O \longrightarrow XeO_3$ (white solid) + 2HF
- (b) Partial hydrolysis : $XeF_6 + H_2O \longrightarrow XeOF_4$ (colorless solid) + 2HF
- (v) Reaction with silica (SiO_2) :

 $2XeF_6 + SiO_2 \longrightarrow 2XeOF_4 + SiF_4$

(vi) Thermal decomposition (effect of heat) :

 $2XeF_{6} \xrightarrow{\Delta} XeF_{2} + XeF_{4} + 3F_{2}$

 \blacktriangleright XeF₂ & XeF₄ do not undergo decomposition

(vii) Formation of addition compounds :

$$XeF_6 + SbF_5 \longrightarrow [XeF_5]^+ [SbF_6]^-; XeF_6 + BF_3 \longrightarrow [XeF_5]^+ [BF_4]^-$$

- (viii) Reaction With H₂: $XeF_6 + 3H_2 \longrightarrow 6HF + Xe$
- (ix) Reaction of XeF₆ with XeO₃: XeO₃ + 2 XeF₆ \longrightarrow 3 XeOF₄
- (x) **F**⁻ donating/ **F**⁻ accepting properties : XeF₆ reacts with fluoride ion acceptors to form cationic species and fluoride ion donors to form fluoroanions.

 $XeF_6 + MF \longrightarrow M^+ [XeF_7]^- (M = Na, K, Rb or Cs)$

donation { $XeF_6 + PtF_5 \longrightarrow (XeF_5^+) (PtF_6^-)$

acceptance $\begin{cases} CsF + XeF_{6} \longrightarrow CsXeF_{7} \\ (alkali metal (caesium heptafluoroxenate) \\ fluoride) \\ 2CsXeF_{7} \longrightarrow XeF_{6} + Cs_{2}XeF_{8} \\ (caesium octafluoroxenate) \end{cases}$

XENON-OXYGEN COMPOUNDS :

Hydrolysis of XeF₄ and XeF₆ with water gives XeO₃. $6 \text{ XeF}_4 + 12 \text{ H}_2\text{O} \longrightarrow 4 \text{ Xe} + 2 \text{ XeO}_3 + 24 \text{ HF} + 3 \text{ O}_2$ XeF₆ + 3 H₂O \longrightarrow XeO₃ + 6 HF Partial hydrolysis of XeF₆ gives oxyfluorides, XeOF₄ and XeO₂F₂. XeF₆ + H₂O \longrightarrow XeOF₄ + 2 HF XeF₆ + 2 H₂O \longrightarrow XeO₂F₂ + 4 HF XeO₂ is a colourless explosive solid and has a pyramidal molecular

 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 :

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. Liquid helium (b.p.4.2 K) finds use as cryogenic agent for carrying out various experiments at low temperatures. It 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. It is used as a diluent for oxygen in modern diving apparatus because of its very low solubility in blood.

Neon is used in discharge tubes and fluorescent bulbs for advertisement display purposes. Neon bulbs are used in botanical gardens and in green houses.

Argon is used mainly to provide an inert atmosphere in high temperature metallurgical process (arc welding of metals or alloys) and for filling electric bulbs. It is also used in the laboratory for handing substances that are air–sensitive.

Xenon and Krypton are used in light bulbs designed for special purposes.





PART - I : OBJECTIVE QUESTIONS

* Mar	ked Questions are hav	ving more than one co	rrect option.		
Grou	ip 17 th				
1.	The halogens are : (A) transition elements (C) noble elements		(B) inner-transition elements (D) representative elements		
2.	Astatine is the element is not true for astatine for (A) It is less electroneg (B) It will exhibit only – (C) Intermolecular force (D) None of these.	below iodine in the group ative than iodine. 1 oxidation state. as between the astatine m	VIIA of the periodic table.	Which of the following statements an that between iodine molecules.	
3.	H_2O is oxidised to O_2 t (A) CIO_2	oy : (B) H ₂ O ₂	(C) H ₂ O	(D) F ₂	
4.	Oxidising action increation (A) $CI_2 < Br_2 < I_2 < F_2$	ses in the following order (B) $Cl_2 < I_2 < Br_2 < F_2$: (C) $I_2 < F_2 < CI_2 < Br_2$	(D) $I_2 < Br_2 < Cl_2 < F_2$	
5.	Which of the following H (A) HCI	nydrogen halide is most v (B) HF	olatile. (C) HI	(D) HBr	
6.	Which can do glass etc (A) HIO ₄	ching ? (B) HF	(C) HNO ₃	(D) SIF ₄	
7.	 Which of the following pairs is not correctly matched ? (A) A halogen which is liquid at room temperature – Bromine (B) The most electronegative element–Fluorine (C) The most reactive halogen – Fluorine (D) The strongest oxidising agent – Iodine 				
8.	Hydrogen bonding doe (A) NH ₃	s not play role in the boili (B) H ₂ O	ng point of : (C) HI	(D) HF	
9.	 Fluorine does not show positive oxidation states because - (A) It is most electronegative element (B) It forms only anions in ionic compounds (C) It cannot form multiple bonds (D) It shows non-bonded electron pair repulsion due to small size 				
10.	When iodine reacts wit (A) It gives mixture of F (C) It gives bromine	h NaF, NaBr and NaCl - \overline{f}_2 , Cl ₂ and Br ₂	(B) It gives chlorine (D) None of the above		
11.	Which one of the follow (A) CIO_3^- , sp^3 pyramida (C) ICI_4^- , sp^3d^2 square p	ing is wrongly matched ? al blanar	(B) ClO ₄ ⁻ , sp ³ tetrahedr (D) ICl ₂ ⁻ , dsp ² trigonal b	al Dipyramidal	



12.	Which of the following p (A) F_2	ossess the highest bond (B) Cl ₂	energy ? (C) Br ₂	(D) I ₂	
13.	Elements of which one o (A) oxygen group	of the following groups wi (B) nitrogen group	ll form anions most readil (C) halogens	y ? (D) alkali metals	
14.	The strongest reducing (A) F [_]	agent is : (B) Cl⁻	(C) Br-	(D) I⁻	
15.	The most powerful oxidi (A) fluorine	sing agent is : (B) chlorine	(C) bromine	(D) iodine	
16.	Which one of the hydrac (A) HF	cid does not form any pre (B) HCl	cipitate with AgNO ₃ ? (C) HBr	(D) HI	
17.	Which of the following is (A) HBr	s the strongest acid ? (B) HF	(C) H ₂ S	(D) PH ₃	
18.	Which of the following h (A) HI	as highest bond strength (B) HCI	: (C) HF	(D) HBr	
19.	On heating KCIO_3 we get (A) $\text{KCIO}_2 + \text{O}_2$	et : (B) KCI + O ₂	(C) KCl + O ₃	(D) KCl + O ₂ + O ₃	
20.	T-shape molecule are - (A) CIF ₃	(B) ICl ₃	(C) BrF ₃	(D) All of these	
21.	Of the following statements - (a) Cl_2 gas is dried by using conc. H_2SO_4 (b) Fluorine have highest oxidising power (c) Oxidising power of halogens follow the order $l_2 > Br_2 > Cl_2$ (d) HI is the strongest acid among HI, HBr, HCI (A) a, b and d are corrects (C) b, c are corrects (D) c, d are corrects				
22.	Which of the following statements about the halogen is correct ? (A) They are all diatomic and forms univalent ions (B) They are all diatomic and forms divalent ions (C) All shows variable oxidation state (D) All				
23.	Volatile nature of halogen is because - (A) Halogen molecules are bonded by strong forces (B) Halogen molecules are bonded by electrostatics force (C) The forces existing between the discrete molecule are only weak vander waal's force (D) Halogen molecules are more reactive				
24.	Hydrogen fluoride is a lio (A) F atom is small in si (C) HF molecule are hyd	quid unlike other hydroge ze Irogen bonded	n halides because - (B) HF is a weakest aci (D) Fluorine is highly rea	d active	
25.	The property of haloger (A) HF > HCl > HBr > H (C) HI > HBr > HCl > H	n acids, that indicated ind IIacidic strength Fbond length	correct is - (B) HI > HBr > HCI > H (D) HF > HCI > HBr > F	Freducing strength Hthermal stability	
26.	I ₄ O ₉ is a/an - (A) Covalent compound (C) Ionic compound		(B) Coordinate compou (D) Double salt	nd	



27.	Bleaching powder is an (A) An acidic salt	example of - (B) A complex salt	(C) A double salt	(D) A mixed salt
28.	Which of the following p (A) A halogen which is lie (B) The most electroneg (C) The most reactive ha (D) The strongest oxidis	pairs is not correctly mate quid at room temperature jative element - Fluorine alogen-Fluorine sing agent - Iodine	ched - e-Bromine	
29.	Which of the following h (A) HBr	as the greatest reducing (B) HI) power - (C) HCl	(D) HF
30.	When iodine is dissolve (A) Brown	d in CCl ₄ , the colour tha (B) Bluish green	t result is - (C) Violet	(D) Colourless
31.	CIO_2 is the anhydride of (A) HOCI	: (B) HCIO ₂	(C) HCIO ₃	(D) HClO_2 and HClO_3
32.	CIO_3 is the mixed anhyd (A) HCIO ₂ and HCIO ₃	ride of : (B) HClO ₃ and HClO ₄	(C) HClO_2 and HClO_4	(D) $\mathrm{HClO}_{_2}$ and $\mathrm{HClO}_{_3}$
33.	Concentrated H_2SO_4 car (A) reduces HBr (C) disproportionates HB	nnot be used to prepare H Sr	IBr from NaBr, because i (B) oxidises HBr (D) reacts slowly with Na	t; aBr
34.	The following acids have CIOH (I), BrOH (II), IOH (I (A) I > II > III	e been arranged in order c III) (B) II > I > III	of decreasing acid strengt (C) III > II > I	h. Identify the correct order. (D) I > III > II
35.	Which one of the followin (A) CNO [_]	ng is not a pseudohalide (B) RCOO⁻	? (C) OCN⁻	(D) NNN⁻
36.	Which of the following is (A) F_2	weakest oxidising agent (B) Cl_2	? (C) Br ₂	(D) I ₂
37.	Fluorine reacts with wate (A) oxygen and hydroge (C) hydrogen fluoride and	er to give : n fluoride d HOF	(B) HOF and O ₃ (D) No reaction	
38.	F_2 is formed by reacting (A) SbF ₅	K₂MnF ₆ with : (B) MnF₃	(C) KSbF ₆	(D) MnF ₅
39.	Which of the following is (A) F [_]	not oxidised by MnO ₂ ? (B) Cl [_]	(C) Br-	(D) I⁻
40.	Chlorine acts as a bleac (A) dry air	hing agent only in preser (B) moisture	nce of : (C) sunlight	(D) pure oxygen
41.	Which reaction is possi (A) $I_2 + 2NaBr \rightarrow Br_2 +$ (C) $Br_2 + 2NaCl \rightarrow Cl_2$	ble - 2Nal ₂ + 2NaBr	(B) $I_2 + 2NaCI \rightarrow CI_2 +$ (D) $CI_2 + 2NaBr \rightarrow Br$	2Nal ₂ + 2NaCl
42.	Which has maximum pH (A) NaClO	l in aqueous solution - (B) NaClO ₂	(C) NaClO ₃	(D) NaClO ₄
43.	Which one of the follow (A) HCIO	ing is the strongest oxidi (B) HClO ₂	sing agent - (C) HClO ₃	(D) HCIO ₄



44.	The solubility of iodine (A) $Na_2S_2O_3$	in H ₂ O may be increase (B) CHCl ₃	ed by the addition of - (C) KI	(D) CS ₂	
45.	When thiosulphate ion (A) SO_3^{2-}	s oxidised by iodine, the (B) SO ₄ ²⁻	new product formed is : (C) $S_4O_6^{2-}$	(D) S ₂ O ₆ ²⁻	
46.	lodine is liberated from (A) $ZnSO_4$	KI solution when treated ((B) CuSO ₄	with : (C) NiSO ₄	(D) FeSO ₄	
47.	Concentrated HNO_3 reation (A) HI	acts with I ₂ to give : (B) HOI	(C) HIO ₃	(D) HOIO ₃	
48.	Bleaching powder is ob (A) dilute solution of Ca (C) dry calcium oxide	tained by the interaction o (OH) ₂	of chlorine and : (B) concentrated solutio (D) dry slaked lime	on of Ca(OH) ₂	
49.	Which amongst the follo (A) 2 KBr + H_2 SO ₄ (cond (C) NaHSO ₄ + NaCl —	towing reactions cannot be c.) $\longrightarrow K_2SO_4 + 2HBr \longrightarrow Na_2SO_4 + HCl$	e used for the respective p (B) NaCl + H_2SO_4 (cond (D) CaF ₂ + H_2SO_4 ——	Dreparation ? C.) \longrightarrow NaHSO ₄ + HCl \rightarrow CaSO ₄ + 2HF	
50.	In the preparation of HBr or HI, NaX (X = Br, I) is treated with H_3PO_4 and not by concentrated H_2SO_4 sinc (A) H_2SO_4 makes the reaction reversible (B) H_2SO_4 oxidises HX to X_2 (Br ₂ , I ₂) (C) Na_2SO_4 is water soluble and Na_3PO_4 is water insoluble (D) Na_3PO_4 is water insoluble and Na_2SO_4 is water soluble				
51.	HBr and HI can reduce (A) $K_2Cr_2O_7$	H ₂ SO ₄ , HCl can reduce k (B) KMnO ₄	KMnO ₄ and HF can reduce (C) H ₂ SO ₄	ce : (D) none of these	
52.	The strongest acid among (A) HCIO_4	ngst the following is : (B) HClO ₃	(C) HCIO ₂	(D) HCIO	
53.	The isoelectronic pair is (A) Cl_2O , ICl_2^-	: (B) ICl ₂ ⁻ , ClO ₂	(C) IF ₂ ⁺ , I ₃ ⁻	(D) ClO_2^- , ClF_2^+	
54.	Which one is the anhyd (A) Cl ₂ O	ride of HClO ₄ ? (B) ClO ₂	(C) Cl ₂ O ₆	(D) Cl ₂ O ₇	
55.	The reaction, 3CIO- is an example of :	$(aq.) \longrightarrow CIO_3^-(aq.) +$	2CI⁻ (aq.)		
	(A) oxidation reaction	(B) reduction reaction	(C) disproportionation	(D) decomposition reaction	
56.	The chemical name of bleaching powder is - (A) Calcium hypochlorite (C) Calcium chlorate		(B) Calcium chlorohypochlorite (D) Calcium perchlorate		
57.	Which one of the follow (A) SO(OH) ₂	ving is the strongest acid (B) SO ₂ (OH) ₂	- (C) ClO ₂ ((OH)	(D) CIO ₃ (OH)	
58.	Chorine acts as a blead (A) Dry air	ching agent only in the pi (B) Sun light	resence of - (C) Moisture	(D) Pure oxygen	
59.	Antichlor is a compoun (A) Which absorbs chlo (C) Which liberates Cl ₂	d - orine from bleaching powder	(B) Which removes Cl_2 (D) Which acts as a cata	from a material alyst in the manufacture of Cl ₂	



60.	 HCl cannot form H₂Cl₂, while HF can form hydrogen bonds - (A) Fluorine is more reactive (B) HF is more reactive (C) Fluorine atom is small and can form hydrogen bonds (D) None 							
61.	The ion that cannot under $(A) CIO_4^{-}$	ergo disproportionation i (B) CIO_3^{-}	s - (C) CIO ₂	(D) CIO				
62.	$CI_{2} \xrightarrow[Hot and conc. NaOH]{Cold and dilute NaOH} (A)$ (B)	+ NaCl + H_2O + NaCl + H_2O						
	Compounds (A) and (B) (A) NaClO ₃ , NaClO	are - (B) NaOCl ₂ , NaOCl	(C) NaClO ₄ , NaClO ₃	(D) NaOCI, NaCIO ₃				
63.*	Which is / are true state (A) Basic nature of X^- is (B) HI is strongest acid of (C) The ionic character of (D) Among F, CI, Br and	ment(s) ? in order F⁻ > CI⁻ > Br⁻ > of HF, HCI, HBr and HI of M—X bond decreases I, F has the highest enth	I⁻ in the order M—F > M—0 alpy of hydration.	CI > M—Br > M—I				
64.*	Electrolysis of aqueous s (A) Cl_2	solution of Brine (NaCl) g (B) H ₂	ives : (C) NaOH	(D) None				
65.*	Which of the following sa (A) NaCl	n treatment with conc. H ₂ (C) NaBr	SO ₄ ? (D) none of these					
66.*	lodine reacts with hypo t (A) Nal	o give : (B) Na ₂ SO ₃	$(C) Na_2S_4O_6$	(D) Na ₂ SO ₄				
67.*	Select the correct order of acidity :(B) $HCIO_4 > HBrO_4 > HIO_4$ (A) $HI > HBr > HCI > HF$ (B) $HCIO_4 > HBrO_4 > HIO_4$ (C) $HCIO < HBrO > HIO$ (D) $HCIO_4 > HCIO_3 > HCIO_2 > HCIO$							
68.*								
69.*	Which of the following pr $(A) NO_2$	roduct(s) is/are obtained (B) N_2	when Cl ₂ O reacts with NH (C) NCl ₃	H ₃ ? (D) NH ₄ Cl				
Group) 18 th							
1.	The formation of O_2^+ [Pt (A) O_2 and Xe have com (B) both O_2 and Xe are g (C) O_2 and Xe have com (D) O_2 and Xe have com	F ₆] [–] is the basis for the fo parable sizes. ases. parable ionisation energie parable electronegativities	rmation of xenon fluoride es. s.	es. This is because :				
2.	Which of the following ga (A) chlorine	aseous molecules is mor (B) helium	noatomic ? (C) oxygen	(D) nitrogen				
3.	Which one of the followin (A) Rn	ng noble gases is not fou (B) Kr	nd in atmosphere ? (C) Ne	(D) Ar				
4.	The inert gas abundantly (A) Ar	/ found in atmosphere is (B) Kr	(C) He	(D) Xe				



5.	The inert gases can be (A) Electrolysis of their (C) Adsorption on chare	isolated and separated compounds coal	by - (B) Fractional distillation of liquid air (D) Both (B) and (C)							
6.	Hybridisation involved i (A) sp ³ d ²	n the structure of XeF ₂ - (B) dsp ²	(C) sp ³ d	(D) sp ³						
7.	Which of the following n (A) He	oble gas was reacted with (B) Xe	h PtF ₆ by Bartlett to prepar (C) Ar	re the first noble gas compounds- (D) Kr						
8.	Molecular shapes of SF_4 , CF_4 and XeF_4 are - (A) The same, with 2, 0 and 1 lone pairs of electrons respectively (B) The same, with 1, 1 and 1 lone pairs of electrons respectively (C) Different, with 0, 1 and 2 lone pairs of electrons respectively (D) Different, with 1, 0 and 2 lone pairs of electrons respectively									
9.	Of the following species (A) XeF ₆	s, one which is non-existe (B) XeF ₅	ent : (C) XeF ₄	(D) XeF ₂						
10.	Maximum number of co (A) neon	ompounds are known in tl (B) xenon	he case of : (C) krypton	(D) argon						
11.	Which inert gas has abr (A) Xe	normal behaviour on lique (B) He	efaction ? (C) Ar	(D) Kr						
12.	Helium is added to oxygen used by deep sea divers because : (A) It is less soluble in blood than nitrogen under high pressure (B) It is lighter than nitrogen (C) It is readily miscible with oxygen (D) It is less poisonous than nitrogen									
13.	Helium oxygen mixture is used by deep sea divers in preference to nitrogen oxygen mix ture because-(A) Helium is much less soluble in blood than nitrogen(B) Nitrogen is much less soluble in blood than helium(C) Due to high pressure deep under sea nitrogen and oxygen react to give poisonous nitric oxide(D) Nitrogen is highly soluble in water									
14.	Which of the following (A) XeF_2 , IF_2^-	two are isostructural (B) NH ₃ , BF ₃	- (C) CO ₃ ²⁻ , SO ₃ ²⁻	(D) PCI ₅ , ICI ₅						
15.	Hybridization and strue (A) sp ³ d, trigonal bip (C) sp ³ d ² , square plan	cture of XeF ₄ is - yramidal nar	(B) sp ³ , tetrahedral (D) sp ³ d ² , hexagonal							
16.	Number of lone pairs ((A) 3, 2 and 1	of electrons on Xe atom (B) 4, 3 and 2	is in XeF ₂ , XeF ₄ and Xe (C) 2, 3 and 1	F ₆ molecules are respectively - (D) 3, 2 and 0						
17.	The ease of liqueficati (A) He > Ne > Ar > K (C) Kr > Xe > He > A	ion of noble gases decr Kr > Xe r > Xe	eases in the order - (B) Xe > Kr > Ar > No (D) Ar > Kr > Xe > Ho	e > He e > Ne						
18.	The forces acting betw (A) van der Waals for (C) London dispersion	veen noble gas atoms a ces forces	are - (B) Ion-dipole forces (D) Magnetic forces							



19.	XeF ₄ on partial hydrolysis produces -							
	(A) XeF ₂	(B) XeOF ₂	(C) XeOF ₄	(D) XeO ₃				
20.	The first compound o	f noble gases prepared	by N-Bartlett was -					
	(A) Xe ⁺ [Pt F_6] ⁻	(B) XeF ₄	(C) XeF ₆	(D) XeOF ₄				
21.	Which one fo the follo hydridization state of	wing is a correct pair wit xenon in it -	th respect to molecular f	ormula of xenon compound and				
	(A) XeF_4 , sp^3	(B) XeF ₂ , sp	(C) XeF ₂ , sp ³ d	(D) XeF_4 , sp^2				
22.	Hydrolysis of XeF_4 and	CaNCN gives respective	ly :					
	(A) XeO_3 and $CaCO_3$	(B) XeO_2 and $CaCN_2$	(C) XeOF $_3$ and CaCN $_2$	(D) $XeOF_2$ and $CaCO_3$				
23.	Consider following prop I : They readily form co II : They generally do no III : Xenon has variable IV : the smaller He and Select correct propertie	perties of the noble gases mpounds which are colou ot form ionic compounds. oxidation states in its cor Ne do not form clathrate es.	urless. npounds. compounds.					
	(A) I, II , III	(B) II , III, IV	(C) I, III, IV	(D) All				
24.	Which one of the follow (A) 1s ² 2s ² p ⁶ , 3s ²	<i>v</i> ing configuration represe (B) 1s ² 2s ² p ⁶ , 3s ¹	ents a noble gas ? (C) 1s² 2s² p ⁶	(D) 1s ² 2s ² p ⁶ , 3s ² p ⁶ , 4s ²				
25.	Among the following me those having same nur	olecules, (i) XeO_3 (ii) XeO_3 (ii) XeO_3 (ii) XeO_3	DF ₄ (iii) XeF ₆ ire :					
	(A) (i) and (ii) only	(B) (i) and (iii) only	(C) (ii) and (iii) only	(D) (i) , (ii) and (iii)				
26.	XeF ₆ on complete hydr	olysis gives :						
	(A) Xe	(B) XeO ₂	(C) XeO ₃	(D) XeO ₄				
27.	The product of the reaction $(A) XeO_2F_2$	ction between one mole of (B) XeOF ₄	f XeO ₃ and two mole of Xe (C) XeO ₃ F ₂	eF ₆ is : (D) XeO ₄				
28.	$[HXeO_4]^- + OH^- \longrightarrow [X] + [Y] + O_2 + H_2O$							
	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 ₂ XeO ₄ & Xe				
29.*	Which of the following i (A) It is chemically iner (C) It has extremely low	s/are properties of helium rt. (B) It h w boiling point.	n? nas very high thermal con (D) It has very low visco	ductivity. osity.				
30.*	Select the correct state (A) All three fluorides at (B) All three fluorides at (C) XeF_4 and XeF_6 can	ement(s) regarding the flu- re decomposed by water, re powerful oxidising ager act as fluoride ion accept	orides of xenon. XeF ₂ slowly and, XeF ₄ annts. tors as well as fluoride ion	d XeF ₆ rapidly. donors.				

(D) All three fluorides are volatile, readily subliming at room temperature (298 K).



PART - I : MIXED OBJECTIVE

Single choice type Which of the following is a mixed anhydride 1. $(A) P_4 O_{10}$ (B) SO₂ $(C) Cl_2 O_{c}$ (D) SO 2. The correct order of pseudohalide, polyhalide and interhalogen are : (A) BrI_2^- , OCN⁻, IF₅ (B) IF_5 , BrI_2^- , OCN^- (C) OCN⁻, IF_{r} , BrI_{2}^{-} (D) OCN⁻, BrI_{2^{-}}, IF_{ϵ} 3. Which of the following is a false statement-(A) Halogens are strong oxidizing agent (B) Halogens show only (-1) oxidation state (C) HF molecules form intermolecular H-bonds (D) Fluorine is highly reactive 4. Consider the following perhalate ion in acidic medium CIO_{4}^{-} (I), BrO_{4}^{-} (II), IO_{4}^{-} (III) Arrange these in the decreasing order of oxidizing power. (A) | > || > |||(B) | > ||| > || (C) || > | > ||(D) || > ||| > |Which of the following reactions will give bleaching powder -5. (A) $CaCl_2 + H_2O$ (B) CaO + HCI (C) $Ca(OH)_2 + Cl_2$ (D) $CIO_2 + Ca(OH)_2$ 6. The boiling point and melting point of inert gases are -(A) Low (B) High (C) Very high (D) Very low 7. The ease of liquefaction of noble gases increases in the order -(A) He < Ne < Ar < Kr < Xe (B) Xe < Kr < Ne < Ar < He(C) Kr < Xe < He < Ne < Ar(D) Ar < Kr < Xe < Ne < He8. Noble gases can be separated by -(A) Passing them through some solution (B) Electrolysis of their compounds (C) Adsorption and desorption on coconut charcol (D) None 9. I_4O_9 is an – (A) covalent bond (B) coordinate compound (C) ionic compound (D) double salt Cold and dilute NaOH (A) + NaCl + H₂O 10. Hot and conc. NaOH $(B) + NaCl + H_0O$ Compounds (A) and (B) are -(A) NaClO₃, NaClO (B) NaOCl₂, NaOCl (C) NaClO₄, NaClO₃ (D) NaOCI, NaCIO₃ 11. When chlorine water is added to an aqueous solution of sodium iodide in the presence of chloroform, a violet colouration is obtained. On adding more of chlorine water and vigorous shaking, the violet colour disappears. This shows the conversion ofinto..... (C) HI, HIO₃ (D) I_2 , HIO (A) I_2 , HIO₃ (B) I₂, HI 12. A greenish yellow gas reacts with an alkali hydroxide to form a halate which can be used in fireworks and safety matches. The gas and the halate are -(A) Br₂, KBrO₃ (B) Cl₂, KClO₃ (C) I₂, NalO₃ (D) I_2 , KIO₃ ETOOS ACADEMY Pvt. Ltd F-106, Road No.2 Indraprastha Industrial Area, End of Evergreen Motor, HALOGEN & NOBLE GAS_ADVANCED # 24

BSNL Lane, Jhalawar Road, Kota, Rajasthan (324005) Tel. : +91-744-242-5022, 92-14-233303

More than one choice type

बहु वि	कल्पी प्रकार							
13.	Which of the following	product(s) is/are obtained	l in the following reaction					
	$KBrO_3 + F_2 + KOH \longrightarrow product(s)$							
	(A) KBrO ₄	(B) KF	(C) HOF	(D) Br ₂				
14.	Which statement is co	rrect about halogen ?						
	(A) They are all diatom	ic and form univalent ions	i					
	(B) Helogen have the s	mallest atomic radii in the	ere respective periods					
	(C) They are all diatom	ic and form diatomic ions						
	(D) They are all reducir	ng agents						
15.	Which of the following	will not displace the halog	gen from the solution of t	ne halide ?				
	(A) Br_2 added to Nal	(B) Br_2 added to NaCl	(C) Cl_2 added to KCl	(D) Cl_2 added to NaF				
16.	Cl ₂ reacts with hot agu	eous NaOH to give :						
	(A) NaCl	(B) NaClO ₃	(C) NaClO ₂	(D) NaClO ₄				
47	Thermal decomposition	n product (c) of VoF is (c)						
17.								
	(A) Xe	(B) Xer ₂	(C) Xer ₄	$(D) F_2$				
18.	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 Xe	O_3 gives XeOF ₄ .						
MAT	CH THE COLUMN							
19.	Match the following .							

0	
Column - I	Column - II
$(A)\operatorname{CIO}_2 \longrightarrow \operatorname{CI}_2\operatorname{O}_3$	(p) Boiling with NaOH solution.
$(B)[AI(OH)_{4}]^{-} \longrightarrow AI(OH)_{3} \downarrow$	(q) On passing ozone.
$(C) P_{4} \longrightarrow PH_{3} + H_{2}PO_{2}^{-}$	(r) Reaction with hydrogen.
(D) $XeF_2 \longrightarrow Xe$	(s) On passing CO_2 gas.

20. $Na_2S_2O_3$ may react with the compounds given in column (I). $Na_2S_2O_3$ exhibits the properties of the type given in the column (II)

Column - I	Column - II
(reactant)	(type of property shown)
(A) Chlorine (CI_2)	(p) Complexing reagent
(B) Silver bromide	(q) Disproportionation
(C) Hydrochloric acid	(r) Only as reductant
(D) lodine (I_2)	(s) An-antichlor



PART - II : SUBJECTIVE QUESTIONS

1. Identify (A) and (B).

 $Br_2 + OH^- (hot) \longrightarrow (A) + (B)$

 $(A) + (B) + H^{+} \longrightarrow Br_{2}$

(A) gives yellow precipitate with $AgNO_3$ which is completely soluble in concentrated NH_3 solution.

- 2. (a) When HCI reacts with finely powdered iron, it forms ferrous chloride and not ferric chloride. Why?
 - (b) Chlorine water turns blue litmus red but solution becomes colourless after sometime.
- 3. CaOCl₂ in aqueous solution changes to Cl₂. What is the type of this change ?
- 4. Identify A, B and C in the following



5. Give appropriate reasons for each of the following :

(a) Addition of Cl₂ to KI solution gives it a brown colour but excess of Cl₂ turns it colourless.

- (b) Perchloric acid is a stronger acid than sulphuric acid.
- (c) HI can not be prepared by heating NaI with concentrated H_2SO_4 .
- 6. Name the noble gas which(A) is most abundant in atmosphere.(B) has least boiling point.
- 7. What is the utility of the clatherate compounds?
- **8.** Does the hydrolysis of XeF_4 at 80°C lead to a redox reaction ?
- 9. Identify [A] [B] and [C] and gives the complete chemical reactions involved.



10. Why anhydrous HF liquid is not electrolysed alone to get F_2 ?





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

* Marked Questions are having more than one correct option.

Group 17th

1. Give an example of oxidation of one halide by another halogen. Explain the feasibility of reaction.

[JEE 2000 (M), 2/100]

- 2. The set with correct order of acidity is : [JEE 2001 (S), 3/35] (A) $HCIO < HCIO_2 < HCIO_3 < HCIO_4$ (B) $HCIO_4 < HCIO_3 < HCIO_2 < HCIO_2$ (B) $HCIO_4 < HCIO_3 < HCIO_2 < HCIO_2$ (D) $HCIO_4 < HCIO_2 < HCIO_3 < HCIO_3$
- 3.The reaction, $3ClO^{-}(aq) \rightarrow ClO_{3}^{-}(aq) + 2Cl^{-}(aq)$ is an example of :[JEE 2001 (S), 3/35](A) oxidation reaction(B) reduction reaction(C) disproportionation reaction(D) decomposition reaction

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'. [JEE 2002 (S), 3/90]

 (A) X = CO₂ , Y = Cl₂
 (B) X = Cl₂ , Y = CO₂
 (C) X = Cl₂ , Y = H₂
 (D) X = H₂ , Y = Cl₂

- Reaction of Br₂ with Na₂CO₃ in aqueous solution gives sodium bromide and sodium bromate with evolution of CO₂ gas. The number of sodium bromide molecules involved in the balanced chemical equation is [JEE 2011, 4/80]
- 6.* Which fo the following hydrogen halides react(s) with AgNO₃ (aq) to give a precipitate that dissolves in Na₂S₂O₃ (aq) ? [JEE 2012, 4/210] (A) HCI (B) HF (C) HBr (D) HI

Paragraph

Bleaching poweder and bleach solution are produced on a large scale and used in several house hold products. The effectiveness of bleach solution is often measured by iodometry.

7. Bleaching powder contains a salt of an oxoacid as one of its components. The anhydride of that oxoacid is

	(A) Cl ₂ O	(B) Cl ₂ O ₇	(C) CIO ₂	(D) Cl ₂ O ₆
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Group 18th

Paragraph for Question Nos. 1 & 2

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.

(C) pyramidal

1.	Argon is used in arc welding because of its : (A) low reactivity with metal (C) flammability	[JEE 2007 (P-I), 4/81] (B) ability to lower the melting point of metal (D) high calorific value
2.	The structure of XeO_3 is :	[JEE 2007 (P-I), 4/81]



(A) linear

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(B) planar

(D) T-shaped

[JEE 2012, 3/198]

XeF_4 and XeF_6 are	expected to be :		[JEE 2007 (P-I), 4 /81]
(A) oxidizing	(B) reducing	(C) unreactive	(D) strongly basic

All the compounds listed in Column I react with water. Match the result of the respective reactions with the 4. [JEE 2010, (P-II) 8/79] appropriate options listed in Column II.

Column I	Column II
(A) (CH ₃) ₂ SiCl ₂	(p) Hydrogen halide formation
(B) XeF ₄	(q) Redox reaction
(C) Cl ₂	(r) Reacts with glass
(D) VCI ₅	(s) Polymerization

Paragraph for Question Nos. 05 to 06

The reactions of Cl₂ gas with cold-dilute and hot-concentrated NaOH in water give sodium salts of 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.

(t) O₂ formation

- 5. R, S and T, respectively, are : [JEE_Advanced_2013, P-II] (A) SO₂Cl₂, PCl₅ and H₃PO₄ (B) SO₂Cl₂, PCl₃ and H₃PO₃ (C) SOCI₂, PCI₃ and H₃PO₂ (D) $SOCI_2$, PCI_5 and H_3PO_4
- 6. P and Q, respectively, are the sodium salts of :
 - (A) hypochlorus and chloric acids
 - (C) chloric and perchloric acids

[JEE_Advanced_2013, P-II]

(B) hypochlorus and chlorus acids

(D) chloric and hypochlorus acids



3.

PART - II : AIEEE PROBLEMS (PREVIOUS YEARS)

Marked Questions are having more than one correct option. 1. Concentrated hydrochloric acid when kept in open air sometimes produces a cloud of white fumes. This is due to : [AIEEE 2003] (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. HCI 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. 2. Which one of the following statements regarding helium is incorrect? [AIEEE 2004] (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 3. Which among the following factors is the most important in making fluorine the strongest oxidizing halogen? [AIEEE-2004] (1) Hydration enthalpy (2) Ionization enthalpy (3) Electron affinity (4) Bond dissociation energy The correct order of the thermal stability of hydrogen halides (H - X) is : 4. [AIEEE 2005] (1) HI > HBr > HCl > HF (2) HF > HCl > HBr > HI (3) HCl < HF < HBr < HI (4) HI > HCI < HF < HBr5. Which of the following chemical reactions depicts the oxidizing behaviour of H₂SO₄? [AIEEE 2006] (1) $2HI + H_2SO_4 \rightarrow I_2 + SO_2 + 2H_2O_1$ (2) $Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O_4$ (3) NaCl + $H_3SO_4 \rightarrow NaHSO_4 + HCl$ (4) $2PCI_{c} + H_{a}SO_{d} \rightarrow 2POCI_{a} + 2HCI + SO_{a}CI_{a}$ 6. What products are expected from the disproportionation reaction of hypochlorous acid? [AIEEE 2006] (3) HCl and Cl₂O (4) HCI and HCIO₂ (1) HCIO, and CIO (2) $HCIO_{2}$ and $HCIO_{4}$ 7. The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence : [AIEEE 2007, 3/120] (1) $GeX_2 < SiX_2 < SnX_2 < PbX_2$ (2) $SiX_2 < GeX_2 < PbX_2 < SnX_2$ (3) SiX₂ < GeX₂ < SnX₂ < PbX₂ (4) $PbX_{2} < SnX_{2} < GeX_{2} < SiX_{2}$ [AIEEE 2007, 3/120] 8. Identify the incorrect statement among the following. (1) Cl₂ reacts with excess of NH₃ to give N₂ and HCl. (2) Br, reacts with hot and strong NaOH solution to give NaBr, NaBrO, and H₂O. (3) Ozone reacts with SO_2 to given SO_3 . (4) Silicon reacts with NaOH_(a0) in the presence of air to give Na₂SiO₃ and H₂O. 9 [AIEEE 2009, 4/144] Which one of the following reactions of Xenon compounds is not feasible? (1) $3XeF_4 + 6H_2O \rightarrow 2Xe + XeO_3 + 12HF + 1.5O_2$ (2) $2XeF_2 + 2H_2O \rightarrow 2Xe + 4HF + O_2$ (3) $XeF_{6} + RbF \rightarrow Rb[XeF_{7}]$ (4) XeO₃ + 6HF \rightarrow XeF₆ + 3H₂O 10. Which of the following exists as covalent crystals in the solid state ? [JEE Mains_2013] (1) lodine (2) Silicon (3) sulphur (4) Phosphorus





NCERT QUESTIONS

- 1. Why are halogens strong oxidising agents?
- 2. Explain why fluorine forms only one oxoacid, HOF.
- **3.** Explain why inspite of nearly the same electronegativity, nitrogen forms hydrogen bonding while chlorine does not.
- 4. Write two uses of CIO_2 .
- 5. Why are halogens coloured?
- **6.** Write the reactions of F_2 and CI_2 with water.
- 7. How can you prepare Cl₂ from HCl and HCl from Cl₂? Write reactions only.
- 8. What inspired N. Bartlett for carrying out reaction between Xe and PtF₆?
- 9. What are the oxidation states of phosphorus in the following : (i) H_3PO_3 (ii) PCI_3 (iii) Ca_3P_2 (iv) Na_3PO_4 (v) POF_3 ?
- Write balanced equations for the following :
 (i) NaCl is heated with sulphuric acid in the presence of MnO₂.
 (ii) Chlorine gas is passed into a solution of Nal in water.
- **11.** How are xenon fluorides XeF_2 , XeF_4 and XeF_6 obtained?
- **12.** With what neutral molecule is CIO⁻ isoelectronic? Is that molecule a Lewis base?
- **13.** How are XeO_3 and $XeOF_4$ prepared?
- Arrange the following in the order of property indicated for each set :
 (i) F₂, Cl₂, Br₂, l₂ increasing bond dissociation enthalpy.
 (ii) HF, HCl, HBr, HI increasing acid strength.
 (iii) NH₄, PH₃, AsH₃, SbH₄, BiH₄ increasing base strength.
- **16.** Give the formula and describe the structure of a noble gas species which is isostructural with : (i) ICI_4^- (ii) IBr_2^- (iii) BrO_3^-
- 17. Why do noble gases have comparatively large atomic sizes?
- **18.** List the uses of neon and argon gases.



	ANSWERS												
EXERCISE # 1													
PART - I													
Grou	p 17 th												
1.	(D)	2.	(B)	3.	(D)	4.	(D)	5.	(A)	6.	(B)	7.	(D)
8.	(C)	9.	(A)	10.	(D)	11.	(D)	12.	(B)	13.	(C)	14.	(D)
15.	(A)	16.	(A)	17.	(A)	18.	(C)	19.	(B)	20.	(D)	21.	(A)
22.	(A)	23.	(C)	24.	(C)	25.	(A)	26.	(C)	27.	(D)	28.	(D)
29.	(B)	30.	(C)	31.	(D)	32.	(B)	33.	(B)	34.	(A)	35.	(B)
36.	(D)	37.	(A)	38.	(A)	39.	(A)	40.	(B)	41.	(D)	42.	(A)
43.	(A)	44.	(C)	45.	(C)	46.	(B)	47.	(C)	48.	(D)	49.	(A)
50.	(B)	51.	(D)	52.	(A)	53.	(D)	54.	(D)	55.	(C)	56.	(B)
57.	(D)	58.	(C)	59.	(B)	60.	(C)	61.	(A)	62.	(D)	63.*	(BC)
64.*	(ABC)	65.*	(BC)	66.*	(AC)	67.*	(ABD)	68.*	(CD)	69.*	(BD)		
Grou	p 18 th												
1.	(C)	2.	(B)	3.	(A)	4.	(A)	5.	(D)	6.	(C)	7.	(B)
8.	(D)	9.	(B)	10.	(B)	11.	(B)	12.	(A)	13.	(A)	14.	(A)
15.	(C)	16.	(A)	17.	(B)	18.	(A)	19.	(B)	20.	(A)	21.	(C)
22.	(A)	23.	(B)	24.	(C)	25.	(D)	26.	(C)	27.	(B)	28.	(A)
29.*	(ABCD) 30. *	(ABCD)		. ,								()
					ΕX	(ERC	SE #	¥2					
						PAR	T - I						
1.	(C)	2.	(D)	3.	(B)	4.	(D)	5.	(C)	6.	(D)	7.	(A)
8.	(C)	9.	(C)	10.	(D)	11.	(A)	12.	(B)	13.	(AB)	14.	(AB)
15.	(BCD)	16.	(AB)	17.	(BCD)	18.	(ABCD))			、		· · /
19.	(A - q); $(B - s)$; $(C - p)$; $(D - p.r)$						(A - r, s) : (B - p) : (C - q) : (D - r)						
	PART - II												
1.	$Br_2 + O$	H⁻ (hot)	$\longrightarrow E$	Br⁻ + BrC) ₃ -								
	Br⁻ + B	rO ₃ - + H	+ distilla	$\xrightarrow{\text{ation}} B$	r ₂								
2.	(a)	lt forms	s H ₂ gas.		2								
		Fe + 2	нсі —	\rightarrow FeC	I ₂ + H ₂ .	Liberati	on of hyd	drogen p	revents	the forma	ation of f	erric chlo	ride.

(b) Blue litmus change into red due to acidic nature $(CI_2 + H_2O \rightarrow HOCI + HCI)$ but it is bleaching agent also (oxidising agent), therefore, it decolourises the red litmus.

3.
$$CaOCl_2 + H_2O \longrightarrow Ca(OH)_2 + Cl_2$$
 Redox reaction.

4.
$$HCIO_4 + P_2O_5 \longrightarrow Cl_2O_7 + HPO_3$$



5. (a) Cl_2 being a stronger oxidising agent than l_2 , first oxidises KI to l_2 which imparts brown colour to the solution. But when Cl_2 is passed in excess, the l_2 so formed gets further oxidised to HIO₃ (colourless)

 $2\text{KI} (\text{aq}) + \text{CI}_2(\text{g}) \longrightarrow 2\text{KCI} (\text{aq}) + \text{I}_2(\text{s}) \text{ ; } 5\text{CI}_2 + \text{I}_2 + 6\text{H}_2\text{O} \longrightarrow 10\text{HCI} + 2\text{HIO}_3$

(b) Oxidation state of CI in $HCIO_4$ is + 7 and that of S in H_2SO_4 is + 6. (CI is more electronegative than S). As a result, CIO_3 part of $HCIO_4$ can break the O–H bond more easily to liberate a proton than SO_2 part in H_2SO_4 . Thus $HCIO_4$ is a stronger acid then H_2SO_4 .

(c) HI is a stronger reducing agent. It, therefore, reduces H_2SO_4 to SO_2 and itself gets oxidised to I_2 .



 $Nal + H_2SO_4 \longrightarrow NaHSO_4 + HI] \times 2$ $H_2SO_4 + 2HI \longrightarrow SO_2 + I_2 + 2H_2O$

 $2\text{Nal} + 3\text{H}_2\text{SO}_4 \longrightarrow 2\text{NaHSO}_4 + \text{I}_2 + 2\text{H}_2\text{O} + \text{SO}_2$

6. (A) Argon.

(B) Helium ; Exists as mono-atomic molecules and are held together by weak van der Waal's forces. These van der Waal's forces increase with the increase in atomic size of the atom, and therefore, the boiling points increases from He to Rn. Hence He has least boiling point.

- 7. It can be used to separate mixture of inert gases containing say He and Xe. Process is much cheaper than say distillation as a means of separation.
- 8. $XeF_4 + H_2O \xrightarrow{-80^{\circ}C} XeOF_2 + 2HF.$

The oxidation states of all the elements in the products remain the same as it was in the reacting state. hence, it is a not redox reaction.

- **9.** $[A] = Br^{-}; [B] = BrO_{3}^{-}; [C] = \text{concentrated } H_2SO_4$
- **10.** Anhydrous HF is only slightly ionized and is, therefore a poor conductor of electricity Thus a mixture of KF and HF is electrolysed to increase the conductivity.



Group 17th

1. $2KI(aq.) + Cl_2 \longrightarrow 2KCl(aq.) + I_2$ In the reaction Cl₂ oxidises iodide ion (-1 oxidation state) to I₂ (0 oxidation state). Cl₂ has higher oxidation potential than I₂ and thus oxidises iodide to iodine getting itself reduced to chloride ion. Similarly, $2l^{-}(aq.) \longrightarrow l_{2}(s) + 2e^{-}$. $Cl_2(g) + 2e^- \longrightarrow 2Cl^-(aq).$ $2I^{-}(aq) + CI_{2}(g) \longrightarrow I_{2}(s) + 2CI^{-}(aq).$ 2. (A) 5. 6.* (ACD) 7. 3. (C) 4. (C) 5 (A) Group 18th 1. (A) 2. (C) 3. (A) 4. (A - p, s); (B - p, q, r, t); (C - p, q); (D - p)5. (A) 6. (A) PART - II (2)(1) 1. (4) (3) 3. (4) 4. 5. 6. (4) 7. (3)2. 8. (2) 9 (4) 10. (2)

