Exercise-1

✍ **Marked questions are recommended for Revision.**

PART - I : SUBJECTIVE QUESTIONS

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

A_I-1. Name the compound which is used to obtain fluorine gas on electrolysis. At which electrode does F_2 appears?

A_I-2. Name the valuable halogen impurities present in chile salt petre ($NaNO_3$).

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 F_2 and Cl_2.

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 :
$HClO_3$, $XeOF_4$, XeO_2F_2, ICl_2^-, ICl_4^-.

C_I-2. Draw the Lewis dot structures of the following multicentred compounds:
I_2O_5, Cl_2O_7.

C_I-3. Give the formula and describe the structure of a noble gas species which is isostructural with:
(i) ICl_4^- (ii) IBr_2^- (iii) BrO_3^-

C_{II}-4. Arrange the XeF_2, XeF_4 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 F_2 and Cl_2 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. HNO_3? 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 F_3^- (polyhalide) ion.

Section (E_I) : Oxides, Hydroxides & Oxyacids

E_I-1. Write chemical reactions involved in preparation of $HClO_3$ & $HClO_4$ 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.

E_I-3. Explain why fluorine forms only one oxyacid, HOF.

E_I-4. Predict the products when the following reactions are carried out :
(i) In acidic medium when SO_2 is passed through $NaClO_3$.
(ii) $HCl + KIO_3 + KI \longrightarrow$

E_I-5. What happen when ClO_2 dissolves in NaOH?

Section (F_I) : Hydracids

F_I-1. Arrange the following in the order of : (i) Acidic strength (ii) Reducing behaviour
(HI, HBr, HCl & HF)

F_I-2. How can you prepare Cl_2 from HCl and HCl from Cl_2? Write reactions only.

F_I-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.

F_I-4. What is aqua regia? Write its reaction product with gold and platinum.

F_I-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.

F_I-6. Fill in the blanks :
(i) Among halogen acids (hydrogen halides) .... is the strongest reducing agent.
(ii) $H_2SO_4 + HI \longrightarrow$ ________ + ___________ + ________

F_I-7. Predict the products when the following reactions are carried out :
(i) Red lead is boiled with concentrated HCl.
(ii) $SiO_2 + HF \longrightarrow$

Section (G_{II}) : Halides & Oxyhalides

G_{II}-1. Write the method of preparation of XeF_2, XeF_4 & XeF_6.

G_{II}-2. How is $XeOF_4$ prepared ?

G_{II}-3. Does the hydrolysis of XeF_4 lead to a redox reaction ?

G_{II}-4. Write the complete and the partial hydrolysis product of XeF_6.

G_{II}-5. Complete the following reactions :
(i) $XeF_2 + H_2 \rightarrow$ (ii) $XeF_6 + SiO_2 \rightarrow$ (iii) $XeF_6 + SbF_5 \rightarrow$

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

H_I-1. Complete the following reactions :
(a) $\underset{\text{(Equal volume)}}{Cl_2 + F_2} \xrightarrow{473\ K}$ (b) $I_2 + \underset{\text{(Excess)}}{3Cl_2} \longrightarrow$ (c) $Br_2 + 3F_2 \longrightarrow$ (d) $Br_2 + \underset{\text{(Excess)}}{5F_2} \longrightarrow$

H_I-2. Why ICl is more reactive than I_2.

H_I-3. (a) Name two interhalogens of AB_3 type.
(b) Write the hydrolysis product of ICl ?

H_I-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.

H_I-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 : Occurence 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) Cl_2 (B) H_2 (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) $CuCl_2$ (D) CuS

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

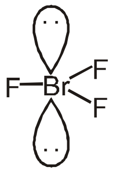
B_{II}-1. Which one of the following configuration represents a noble gas ?
(A) $1s^2\ 2s^2\ p^6,\ 3s^2$ (B) $1s^2\ 2s^2\ p^6,\ 3s^1$ (C) $1s^2\ 2s^2\ p^6$ (D) $1s^2\ 2s^2\ p^6,\ 3s^2\ p^6,\ 4s^2$

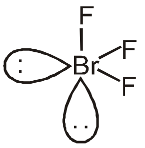
B_I-2. Astatine is the element below iodine in the group VIIA of the periodic table. Which of the following statements is not true for astatine ?
(A) It is less electronegative than iodine.
(B) It will exhibit only –1 oxidation state.
(C) Intermolecular forces between the astatine molecules will be larger than that between iodine molecules.
(D) None of these.

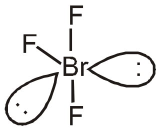
B_I-3. Which is wrong statement ?
(A) Basic nature of X^- is in order $F^- > Cl^- > Br^- > I^-$
(B) Electron gain enthalpy in order F > Cl > Br > I.
(C) The ionic character of M—X bond decreases in the order M—F > M—Cl > M—Br > M—I
(D) Among F^-, Cl^-, Br^- and I^-, F^- has the highest enthalpy of hydration.

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

C_I-1. Which of the following structure is correct for BrF_3 ?

(A) 

(B) 

(C) 

(D) none of these

C_{II}-2. Among the following molecules, (i) XeO_3 (ii) $XeOF_4$ (iii) XeF_6
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) XeF_2 : linear (B) XeF_4 : square planar
(C) XeF_6 : distorted octahedral (D) XeO_3 : trigonal planar

Section (D_I) : Properties of elements

D_I-1. Correct order of boiling point of halogens is
(A) $F_2 < Cl_2 < Br_2 < I_2$ (B) $Cl_2 > F_2 > Br_2 > I_2$ (C) $F_2 > Cl_2 > Br_2 > I_2$ (D) $Cl_2 < F_2 < Br_2 < I_2$

D_{II}-2. Which of the following statement is correct ?
(A) Helium has abnormal behaviour on liquefication
(B) Iodine is readily soluble in CS_2 and the solution is purple in colour
(C) Helium do not form any clathrate
(D) All of these

D$_I$-3. Chlorine gas is dried over :
(A) CaO (B) NaOH (C) conc. H_2SO_4 (D) dil. H_2SO_4

D$_I$-4. F_2 reacts with H_2O as follows :
$$F_2 + H_2O \longrightarrow H^+ + F^- + O_2$$
Which of the following halogens shows same reaction but in opposite direction ?
(A) Br_2 (B) Cl_2 (C) I_2 (D) All

D$_I$-5. Chlorine acts as a bleaching agent only in presence of :
(A) dry air (B) moisture (C) sunlight (D) pure oxygen

Section (E$_I$) : Oxides, Hydroxides & Oxyacids

E$_I$-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

E$_I$-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

E$_I$-3. On heating $KClO_3$ we get :
(A) $KClO_2 + O_2$ (B) $KCl + O_2$ (C) $KCl + O_3$ (D) $KCl + O_2 + O_3$

E$_I$-4. The following acids have been arranged in order of decreasing acid strength. Identify the correct order.
ClOH (I), BrOH (II), IOH (III)
(A) I > II > III (B) II > I > III (C) III > II > I (D) I > III > II

E$_I$-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

E$_I$-6. The strongest acid amongst the following is :
(A) $HClO_4$ (B) $HClO_3$ (C) $HClO_2$ (D) HClO

Section (F$_I$) : Hydracids

F$_I$-1. Which of the following halogen hydrides will have the weakest conjugate base ?
(A) HF (B) HCl (C) HBr (D) HI

F$_I$-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

F$_I$-3. Hydrogen bromide is dried by passing the gas through :
(A) quick line (B) anhydrous calcium chloride
(C) potassium hydroxide pellet (D) con. H_2SO_4

F$_I$-4. Which one of the hydracid does not form any precipitate with $AgNO_3$?
(A) HF (B) HCl (C) HBr (D) HI

F$_I$-5 Which can do glass etching ?
(A) HIO_4 (B) HF (C) HNO_3 (D) SiF_4

F$_I$-6. Identify A and B in following reaction, $H_2SO_4 + HBr \longrightarrow A + B + H_2O$
(A) Br_2 , SO_3 (B) Br_2 , S (C) BrO_3^- , SO_3 (D) Br_2 , SO_2

F$_I$-7. Which of the following is obtained when gold is treated with aquaregia.
(A) $AuCl_4$ (B) $AuCl_3$ (C) $[AuCl_4]^-$ (D) $[AuCl_4]^+$

F$_I$-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) H_2S (D) PH_3

Section (G$_{II}$) : Halides and oxyhalides

G$_{II}$-1. The number of lone pairs on central atom in XeF_2 , XeF_4 and XeF_6 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) XeF_6 (B) XeF_5 (C) XeF_4 (D) XeF_2

G$_{II}$-3. XeF_2 on complete hydrolysis gives :
(A) Xe (B) XeO_2 (C) XeO_2F_2 (D) XeO_4

G$_{II}$-4. Hydrolysis of XeF_4 and $CaCN_2$ gives respectively :
(A) XeO_3 and $CaCO_3$ (B) XeO_2 and $Ca(OH)_2$
(C) $XeOF_3$ and $Ca(OH)_2$ (D) $XeOF_2$ and $CaCO_3$

G$_{II}$-5. Xenon hexafluoride undergoes hydrolysis in strong alkaline medium:
$2\,XeF_6 + 16\,OH^- \longrightarrow 8H_2O + 12F^- + A + B + C$ then reaction product may be:
(A) perxenate ion (B) O_2 (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 AB_3/AB_5 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) N_3^- (D) I_3^-

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)	$NH_3 + F_2 \longrightarrow$	(p)	N_2
(B)	NH_3 (excess.) + $Cl_2 \longrightarrow$	(q)	HX
(C)	$NH_3 + Br_2$ (excess.) $\longrightarrow$	(r)	NH_4X
(D)	NH_3 (aq.) + $I_2 \longrightarrow$	(s)	Explosive

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

	Column - I		**Column - II**
(A)	$Cl_2O_6 + H_2O \rightarrow$	(p)	ClO_2
(B)	$NaClO_4(s) + HCl(conc.) \rightarrow$	(q)	$HClO_3$
(C)	$KClO_3 + (COOH)_2 \rightarrow$	(r)	Cl_2O
(D)	$HgO + Cl_2 \xrightarrow{573K}$	(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_2O or OH^-.

Exercise-2

✍ **Marked questions are recommended for Revision.**

PART - I : ONLY ONE OPTION CORRECT TYPE

1. The X – X bond dissociation energy is minimum in :
(A) F_2 (B) Cl_2 (C) Br_2 (D) I_2

2. Iodine is liberated from KI solution when treated with :
(A) $ZnSO_4$ (B) $CuSO_4$ (C) $NiSO_4$ (D) $FeSO_4$

3. Which of the following is not oxidised by MnO_2 ?
(A) F^- (B) Cl^- (C) Br^- (D) I^-

4. $F_2 + \text{dil NaOH} \longrightarrow A + NaF + H_2O$

$F_2 + \text{conc. NaOH} \longrightarrow B + NaF + H_2O$

A and B respectively are :
(A) OF_2 and O_2 (B) O_2 and OF_2 (C) Both O_2 (D) Both OF_2

5. When thiosulphate ion is oxidised by iodine, the new product formed is :
(A) SO_3^{2-} (B) SO_4^{2-} (C) $S_4O_6^{2-}$ (D) $S_2O_6^{2-}$

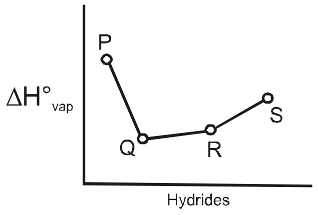
6. $NH_3(\text{excess}) + Cl_2 \longrightarrow NH_4Cl + A(\text{gas})$

$NH_3 + Cl_2(\text{excess}) \longrightarrow B + HCl$

Incorrect statement regarding A and B.
(A) A is highly reactive gas at room temperature.
(B) Bond order of gas 'A' is same as C_2^{2-}.
(C) Compound 'B' is explosive.
(D) Bond angle of compound B is greater than bond angle of NF_3.

7. Which amongst the following reactions cannot be used for the respective preparation ?
(A) $2KBr + H_2SO_4\ (\text{conc.}) \longrightarrow K_2SO_4 + 2HBr$ (B) $NaCl + H_2SO_4\ (\text{conc.}) \longrightarrow NaHSO_4 + HCl$
(C) $NaHSO_4 + NaCl \longrightarrow Na_2SO_4 + HCl$ (D) $CaF_2 + H_2SO_4(\text{conc.}) \longrightarrow CaSO_4 + 2HF$

8. $\Delta H_{\text{vaporisation}}$ (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



9. Alkali metal hydrogen fluorides have a formula $M[HF_2]$. 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 HF_2^-
(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 σ-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 iodous acid and hydrochloric acid.

13. The order of solubility of noble gases in water is
(A) He > Ar > Kr > Ne > Xe (B) He > Ne > Ar > Kr > Xe
(C) Xe > Ar > Kr > He > Ne (D) Xe > Kr > Ar > Ne > 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 $O_2^+ [PtF_6]^-$ 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. $[HXeO_4]^- + OH^- \longrightarrow [X] + [Y] + O_2 + H_2O$
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

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PART - II : NUMERICAL VALUE VALUE TYPE

1. The total number of electrons present in 4th shell of Astatatine ($_{85}At$) 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) Inoisation enthalpies
(g) Electronegativities (h) Reactivity
(i) Oxidising nature. (j) $\Delta_{eg}H$ (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) H–F < H–Cl < H–Br < H–I (Bond length)
(b) H–F < H–Cl < H–Br < H–I (Acidic strength)
(c) H–I < H–Br < H–Cl < H–F (Bond strength)
(d) H–F > H–Cl > H–Br > H–I (Thermodynamic stability)
(e) H–F < H–Cl < H–Br < H–I (Reducing power)
(f) H–F > H–I > H–Br > H–Cl (Boiling point)

5. $\underset{\text{(Conc.)}}{HCl} + \underset{\text{(Conc.)}}{HNO_3} \longrightarrow$

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) $CH_4 + Cl_2 \longrightarrow$ (b) $FeSO_4 + H_2SO_4 + Cl_2 \longrightarrow$
(c) $I_2 + Cl_2 + H_2O \longrightarrow$ (d) $Cl_2 + H_2O \longrightarrow$
(e) $H_2O + SO_2 + Cl_2 \longrightarrow$ (f) $SO_3 + Cl_2 \longrightarrow$
(g) NaCl(aq) $\xrightarrow{\text{Electrolysis}}$ (h) $Cl_2O_7 + H_2O \longrightarrow$
(i) Cl_2 + 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. $Br_2 + F_2$ (excess) $\longrightarrow A \xrightarrow{\text{Hydrolysis}} B + C$

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.
$$\begin{tikzcd}
Xe + O_2F_2 \arrow[r] & A + B \arrow[d, "\text{Hydrolysis}"] \\
& B + C + Xe
\end{tikzcd}$$

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) $NaIO_3 + 5NaI + 6H_2SO_4 \longrightarrow 6NaHSO_4\ 3H_2O + I_2$
(B) $2KBr + MnO_2 + 3H_2SO_4 \longrightarrow 2KHSO_4 + MnSO_4 + 2H_2O + Br_2 \uparrow$
(C) $K_2Cr_2O_7 + 14HCl \longrightarrow 2\ KCl + 2CrCl_3 + 7H_2O + 3Cl_2$
(D) $2K_2MnF_6 + 4SbF_5 \longrightarrow 4KSbF_6 + MnF_3 + F_2$

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) $Na_2S_4O_6$ (D) Na_2SO_4

5. $Cl_2 + NH_3(\text{excess}) \longrightarrow A + B$
(A) One of the product is also obtained by decomposition of $(NH_4)_2Cr_2O_7$.
(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) F_2 + Hot water $\longrightarrow$ products (B) Cl_2 + Cold and dilute NaOH $\longrightarrow$ products
(C) Cl_2 + Hot and conc. NaOH $\longrightarrow$ products (D) $Cl_2 + NH_3(\text{excess}) \longrightarrow$ products

7. In which following statement are correct.
(a) Anhydrous hydrogen fluroide is a liquid at ordianry temperature while other halogen acid are gases.
(b) Lead acetate does not form any precipitate with HF acid but other halogen acid from precipitates.
(c) HF is heated with a mixture of MnO_2 and H_2SO_4, no gas is evloved 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) $F_2 + H_2O \longrightarrow HF + O_2$ (B) $Cl_2 + H_2O \longrightarrow HCl + HClO$
(C) $Br_2 + H_2O \longrightarrow HBr + HBrO$ (D) $I_2 + H_2O \longrightarrow HI + HIO$

10. Which of the following statements are true :
(A) Strength of oxyacids : $HClO_4 > HClO_3 > HClO_2 > HClO$
(B) Strength of oxyacids : $HClO_4 > HBrO_4 > HIO_4$
(C) Number of $p\pi$-$d\pi$ bonds : $HClO_4 > HClO_3 > HClO_2 > HClO$
(D) Percentage s-character of central atom : $HClO_4 > HClO_3 > HClO_2 > HClO$.

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 regareding interhalogens :
(A) Thermal stability order IF > BrF > 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 compoud(s) with quinol ?
(A) Helium (B) Xenon (C) Krypton (D) Neon

14. Consider the following reactions
$Xe + F_2 \xrightarrow{Ni} A$
2 : 1
$Xe + F_2 \longrightarrow B$
1 : 20
$Xe + F_2 \longrightarrow C$
1 : 5
Select incorrect statements :
(A) A, B and C all are non-polar and planner molecule (B) B has no lone pair of electrons
(C) The order of Xe-F bond length is A > C > 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.

1. 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

2. 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

3. 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 acts 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, selonocyanides are example of pseudo halides.

4. Cyanide, CN^- is a pseudo halide. When cyanogen is heated with alkali solution, the products are :
(A) HCN, H_2O (B) NH_3, $(NH_4)_2CO_3$ (C) NaCN, NaOCN (D) HCOONa, NH_3

5. When NaCN reacts with H_2SO_4, the products are :
(A) HCN and Na_2SO_4 (B) HCN and $NaHSO_4$
(C) $(CN)_2$ and $Na_2SO_4.H_2O$ (D) None of these

6. When sodium pseudo halides are dissolved in water, it resembles with :
(A) NaCl (B) NaBr (C) NaF (D) NaI

7. $(CN)_2$ when react with Na metal, the product is :
(A) NaCN (B) Na_2C_2 and N_2 (C) NaN_3 and C black (D) $Na(CN)_2^-$

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 cystals laiitice of water, phenol of quinols. Helium can form intersitital compoudns with transition metals. Bigger members of rare gases do not form such compounds because of their large size.

8. Xenon forms the larges 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 :

(A) $Xe + 3F_2 \xrightarrow[50\text{ atm}]{475\text{–}532\text{ K}} XeF_6$　　(B) $XeF_2 + 2F_2 \xrightarrow{500\text{ K}} XeF_6$

(C) $XeF_4 + F_2 \xrightarrow{475\text{ K}} XeF_6$　　(D) $XeO_3 + 6HF \xrightarrow[\Delta]{475\text{ K}} XeF_6 + 3H_2O$

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.

<table>
<tr><td colspan="6">Observe the three columns in which column-1 represents Oxy acid, column-2 represents Oxidation State of Cl while column-3 represents facts.</td></tr>
<tr><th colspan="2">Column-1
(Oxy acid)</th><th colspan="2">Column-2
(Oxidation State of Cl)</th><th colspan="2">Column-3</th></tr>
<tr><td>(I)</td><td>$HClO_2$</td><td>(P)</td><td>+ 1</td><td>(i)</td><td>Chlorine has highest electron affinity</td></tr>
<tr><td>(II)</td><td>$HClO_3$</td><td>(Q</td><td>+ 3</td><td>(ii)</td><td>Fluorine never exhibit oxidation state > 0</td></tr>
<tr><td>(III)</td><td>$HClO_4$</td><td>(R)</td><td>+ 5</td><td>(iii)</td><td>HI is strong hydra acid</td></tr>
<tr><td>(IV)</td><td>HClO</td><td>(S)</td><td>+ 7</td><td>(iv)</td><td>The decreasing order of thermal stability is IF < BrF > ClF</td></tr>
</table>

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.

<table>
<tr><td colspan="6">Observe the three columns in which column-1 represents Compounds, column-2 represents Hybridisation while column-3 represents facts.</td></tr>
<tr><th colspan="2">Column-1
(Compounds)</th><th colspan="2">Column-2
(Hybridisation)</th><th colspan="2">Column-3</th></tr>
<tr><td>(I)</td><td>XeF_4</td><td>(P)</td><td>sp^3d^3</td><td>(i)</td><td>Neon is used in fluorescent bulbs.</td></tr>
<tr><td>(II)</td><td>XeF_2</td><td>(Q)</td><td>sp^3d^2</td><td>(ii)</td><td>Helium do not form clatharate compounds</td></tr>
<tr><td>(III)</td><td>XeF_6</td><td>(R)</td><td>sp^3d</td><td>(iii)</td><td>$XeOF_4$ has square pyramidal structure</td></tr>
<tr><td>(IV)</td><td>XeO_3</td><td>(S)</td><td>sp^3</td><td>(iv)</td><td>Reacts with H_2 produces Xe & HF.</td></tr>
</table>

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)–(ii)　　(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

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) $HClO < HClO_2 < HClO_3 < HClO_4$
(B) $HClO_4 < HClO_3 < HClO_2 < HClO$
(C) $HClO < HClO_4 < HClO_3 < HClO_2$
(D) $HClO_4 < HClO_2 < HClO_3 < HClO$

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

4. 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 = CO_2, Y = Cl_2
(B) X = Cl_2, Y = CO_2
(C) X = Cl_2, Y = H_2
(D) X = H_2, Y = Cl_2

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.

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

6. The structure of XeO_3 is : **[JEE 2007 (P-I), 4 /81]**
(A) linear
(B) planar
(C) pyramidal
(D) T-shaped

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

8. 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	**Column II**
(A) $(CH_3)_2SiCl_2$	(p) Hydrogen halide formation
(B) XeF_4	(q) Redox reaction
(C) Cl_2	(r) Reacts with glass
(D) VCl_5	(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 phosphours to give a compound **S**. On hydrolysis, **S** gives an oxoacid of phosphours **T**.

9. **P** and **Q**, respectively, are the sodium salts of : **[JEE(Advanced) 2013, 3/120]**
(A) hypochlorus and chloric acids
(B) hypochlorus and chlorus acids
(C) chloric and perchloric acids
(D) chloric and hypochlorus 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

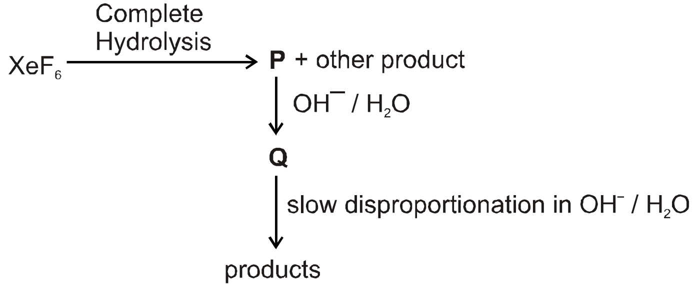
11. The unbalanced chemical reactions given in List I show missing reagent or condition (?) which are provided in List II. Match List I with List II and select the correct answer using the code given below the lists : **[JEE(Advanced) 2013, 3/120]**

List-I	**List-II**
P. $PbO_2 + H_2SO_4 \xrightarrow{?} PbSO_4 + O_2$ + other product	1. NO
Q. $Na_2S_2O_3 + H_2O \xrightarrow{?} NaHSO_4$ + other product	2. I_2
R. $N_2H_4 \xrightarrow{?} N_2$ + other product	3. Warm
S. $XeF_2 \xrightarrow{?}$ Xe + 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) ONLINE PROBLEMS (PREVIOUS YEARS)

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 $HClO_2$ (3) HCl and HOCl (4) HOCl and $HOCl_2$

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. XeF_6 on partial hydrolysis with water produces a compound 'X'. The same compound 'X' is formed when XeF_6 reacts with silica. The compound 'X' is : **[JEE(Main) 2017 Online (09-04-17), 4/120]**

(1) XeO_3 (2) XeF_4 (3) XeF_2 (4) $XeOF_4$

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) $XeOF_4$ (+6) and XeO_3 (+6) (2) XeO_2 (+4) and XeO_3 (+6)
(3) $XeOF_4$ (+6) and XeO_2F_2 (+6) (4) XeO_2F_2 (+6) and XeO_2 (+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) $H_2 + F_2 \rightarrow 2HF$ (2) $H_2 + Cl_2 \rightarrow 2HCl$ (3) $H_2 + I_2 \rightarrow 2HI$ (4) $H_2 + Br_2 \rightarrow 2HBr$

10. Chlorine on reaction with hot and concentrated sodium hydroxide gives:
[JEE(Main) 2019 Online (12-01-19), 4/120]

(1) ClO_3^- and ClO_2^- (2) Cl^- and ClO^- (3) Cl^- and ClO_3^- (4) Cl^- and ClO_2^-

Answers

EXERCISE - 1

PART - I

A_{I}-1. A solution of potassium hydrogen fluoride (KHF_2) in anhydrous HF.

$KF + HF \longrightarrow K[HF_2] \xrightarrow{\text{electrolysis}} H_2 + F_2$

On Electrolysis :

Anode : $HF_2^- \longrightarrow F_2 + H^+ + 2e^-$

Cathode : $2HF + H^+ + 2e^- \longrightarrow H_2 + HF_2^-$

A_{I}-2. It contains trace amounts of $NaIO_3$ and $NaIO_4$. 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 $PtF_6$to have $Xe^+[PtF_6]^-$. He noticed earlier that O_2 with PtF_6 reacts to give $O_2^+[PtF_6]^-$ and since ionisation enthalpies of O_2 and Xe were close to each other (Xe = 1170, O_2 = 1175 kJ mol^{-1}), he could succeed to prepare $Xe^+[PtF_6]^-$ from Xe and PtF_6.

B_{I}-1. The electrode potential of F_2 (+2.87 V) is much higher than that of Cl_2 (+1.36 V).

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

$$\begin{tikzcd}
\frac{1}{2}x_2(g) + e^-_{(aq.)} \arrow[r, "\Delta H"] \arrow[d, "\frac{1}{2}E_{x\text{-}x}"'] & X^-_{(aq.)} \\
(X(g)) \arrow[r, "E.A."] & X^-_{(g)} \arrow[u, "\Delta H^\circ_{Hy}"']
\end{tikzcd}$$

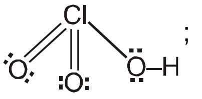
	F_2	Cl_2	Order
Bond dissociation enthalpy/kJmol^{-1}	158.8	242.6	$F_2 < Cl_2$
Magnitude of E.A/kJmol^{-1}	333	349	$F_2 < Cl_2$
Magnitude of ΔH°Hyd./kJmol^{-1}	515	381	$F_2 > Cl_2$
Oxidizing power	▨	▨	$F_2 > Cl_2$

Therefore F_2 is much stronger oxidising agent than Cl_2.

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 F_2 is due to relatively large electrons-electrons repulsion among the lone pairs in F_2 molecule.

C-1.



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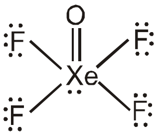

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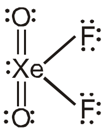

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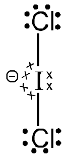

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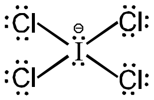
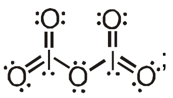
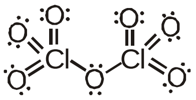
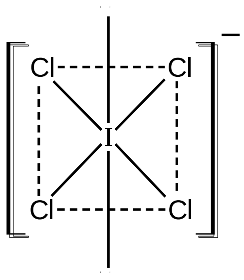


CI-2.





CI-3. (i) **Structure of ICl_4^-**

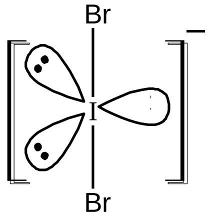

Square planar

No. of electrons in the valence shell of the central I atom = 7.
No. of electrons provided by four Cl atoms = 4×1 = 4
Charge on the central atom = 1
∴ 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 (∵ there are four I-Cl bonds)
∴ 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 × 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^-.**


LINEAR

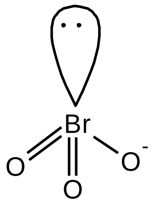
No. of electrons in the valence shell of the central I atom = 7
No. of electrons provided by two Br atoms = 2 × 1 = 2
Charge on the central I atom is = 1
∴ Total no. of electrons around the central I atom = 7 + 2 + 1 = 1
But the no. of bond pairs = 2 (∵ there are two I – Br bonds)
∴ No. of lone pairs = 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 × 2 =10). Like IBr^-, 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.


PYRAMIDAL

Therefore, in BrO_3^-, there are two Br = O bonds and one bond Br – 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 is the valence shell of the central Br atom = 7 + 2 × 0 + 1 × 1 = 8

∴ No. of electron pairs around Br atom = 8/2 = 4

But total number of bond pairs = 2 × 1 (Br = 0) + 1 × 1 (Br – O^-) = 3 and lone pairs = 4 – 3 = 1.

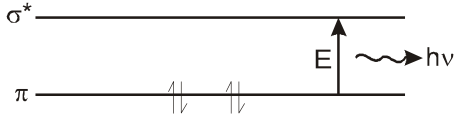
Thus, BrO_3^- has 3 bond pairs and one lone pair. Therefore, according to VSEPR theory, it should be pyramidal.

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

C$_{II}$-4. XeF_2 > XeF_4
2.00 Å 1.94 Å (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.

D$_{II}$-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.

D$_I$-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.



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

$$Cl_2(g) + H_2O(l) \rightleftharpoons \underset{\text{Hydrochloric acid}}{HCl(aq.)} + \underset{\text{Hydrochlorous acid}}{HOCl(aq.)}$$

D$_I$-4. $2F_2 + 2NaOH \longrightarrow OF_2 + 2NaF + H_2O$
Other halogens (X = Cl / Br / I) disproportionate : $X_2 + 2NaOH \xrightarrow{Cold} NaX + NaOX + H_2O$

D$_I$-5. $X_2 + 2NaOH \xrightarrow{Hot} NaX + NaXO_3 + H_2O$

D$_I$-6. I_2 , $I_2 + HNO_3$ (conc.) $\longrightarrow HIO_3 + NO_2 + H_2O$

D$_I$-7. **(i)** The standard reduction potential of fluorine is maximum.

$$:\underset{\cdot\cdot}{\ddot{F}}\cdot + e^- \longrightarrow :\underset{\cdot\cdot}{\ddot{F}}:^-$$

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 liked other halogen. The formation of X_3^- ions involves sp^3d-hybridizaion.

E$_I$-1. $Ba(ClO_3)_2 + H_2SO_4 \longrightarrow BaSO_4\downarrow + 2HClO_3$
$KClO_4 + H_2SO_4 \longrightarrow KHSO_4 + HClO_4$

E$_I$-2. HOCl acts as an acid, $HOCl \longrightarrow H^+ + OCl^-$, and thus turns blue litmus to red. It also work as bleaching agent, $HOCl \longrightarrow HCl + [O]$, and the red litmus is decolorized by nascent oxygen.

E$_I$-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 (X = Cl, Br or I) is + 1, + 3 , and + 5 and + 7 respectively. However, due to high electronegativity, small size and absence of d-orbitals, F cannot act as central atom in higher oxacids 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 oxoacid. i.e., HOF in which the oxidation state of F is –1 and oxygen is in +1.

E$_I$-4. (i) $2NaClO_3 + SO_2 + H_2SO_4 \longrightarrow 2NaHSO_4 + 2ClO_2$
(ii) $5I^- + IO_3^- + 6H^+ \longrightarrow 3I_2 + 3H_2O$

E$_I$-5. ClO_2 (s) is a mixed anhydride of $HClO_2$ and $HClO_3$ because on dissolving in water it gives a mixture of these two acids.

$$2ClO_2 + 2NaOH \longrightarrow NaClO_2 + NaClO_3 + H_2O$$

FI-1. (i) HI > HBr > HCl > HF ; Due to decrease in bond energy
(ii) HI is the strongest reducing agent.

FI-2. Conc. HCl can be oxidized to Cl_2 by heating with a number of oxidizing agents such as MnO_2, $KMnO_4$, $K_2Cr_2O_7$, etc.

$$MnO_2 + 4\,HCl \longrightarrow MnCl_2 + Cl_2 + 2\,H_2O$$

Cl_2 can reduced to HCl by its reaction with H_2 in presence of diffused sunlight.

$$H_2 + Cl_2 \xrightarrow{\text{Diffused sunlight}} 2\,HCl$$

FI-3. HI is a strong reducing agent and, therefore, reduces H_2SO_4 to SO_2 and itself get oxidised to I_2.

$$3NaI + \text{conc. } H_3PO_4 \xrightarrow{\Delta} K_3PO_4 + HI$$

FI-4. Aqua regia is three parts of concentrated HCl and one part of concentrated HNO_3.

$$2Au + 11HCl + 3HNO_3 \longrightarrow 2H[AuCl_4] + 3NOCl + 6H_2O$$
$$8HCl + 2HNO_3 + Pt \longrightarrow H_2[PtCl_6] + 2NOCl + 4H_2O$$

FI-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.

$$HCl\,(g) + H_2O(\ell) \longrightarrow H_3O^+\,(aq) + Cl^-\,(aq)$$

(ii) HF attacks glass bottles. The sodium and potassium silicates are converted into flurosilicates

$$Na_2SiO_3 + 6HF \longrightarrow Na_2SiF_6 + 3H_2O$$

(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^+.

FI-6. (i) HI (hydrogen iodide) (ii) $I_2 + SO_2 + H_2O$

FI-7. (i) $Pb_3O_4 + 8HCl \longrightarrow 3PbCl_2 + 4H_2O + Cl_2$

(ii)
$$3\,[SiO_2 + 4HF \longrightarrow SiF_4 + 2H_2O]$$
$$3SiF_4 + 3H_2O \longrightarrow 2H_2SiF_6 + H_2SiO_3$$

Overall :
$$3SiO_2 + 12HF \longrightarrow \underbrace{2H_2SiF_6 + H_2SiO_3}_{\text{White waxy deposit}} + 3H_2O$$

GII-1.
$$\underset{\text{(Xenon in excess)}}{Xe(g) + F_2(g)} \xrightarrow{673\text{ K, } 1\text{ bar}} XeF_2(s)$$
$$\underset{(1\,:\,5\text{ ratio})}{Xe(g) + 2F_2(g)} \xrightarrow{873\text{ K, } 7\text{ bar}} XeF_4(s)$$
$$\underset{(1\,:\,20\text{ ratio})}{Xe(g) + 3F_2(g)} \xrightarrow{573\text{ K, } 60\text{–}70\text{ bar}} XeF_6(s)$$

GII-2. Partial hydrolysis of XeF_6 gives $XeOF_4$.

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

GII-3. Yes, hydrolysis of XeF_4 leads to a redox reaction(disproportination)

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

GII-4.
$$XeF_6 + 3\,H_2O \longrightarrow XeO_3 + 6\,HF$$
$$XeF_6 + H_2O \longrightarrow XeOF_4 + 2\,HF$$
$$XeF_6 + 2H_2O \longrightarrow XeO_2F_2 + 4\,HF$$

GII-5.
(i) $XeF_2 + H_2 \rightarrow Xe + 2HF$
(ii) $2XeF_6 + SiO_2 \rightarrow 2XeOF_4 + SiF_4$;
$2XeOF_4 + SiO_2 \rightarrow 2XeO_2F_2 + SiF_4$
$2XeO_2F_2 + SiO_2 \rightarrow 2XeO_3$ (Explosive) $+ SiF_4$
(iii) $XeF_6 + SbF_5 \rightarrow [XeF_5]^+\,[SbF_6]^-$ [Addition ionic product is formed]

H$_I$-1. (a) $\underset{\text{(Equal volume)}}{Cl_2 + F_2} \xrightarrow{473\ K} 2ClF$ (b) $I_2 + \underset{\text{(Excess)}}{3Cl_2} \longrightarrow 2ICl_3$

(c) $Br_2 + 3F_2 \longrightarrow 2BrF_3$ (d) $Br_2 + \underset{\text{(Excess)}}{5F_2} \longrightarrow 2BrF_5$

H$_I$-2. ICl is more reactive than I_2 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 (ClF_3); iodine trichloride (ICl_3 or I_2Cl_6)
(b) $ICl + H_2O \longrightarrow HCl + HOI$

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 SO_2 is reoxidised by the oxygen of the air to its original state.

Cl_2 bleaches coloured material by oxidation and thus bleaching is permanent.

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

Coloured material + [O] ⟶ Colourless

On the other hand beaching by SO_2 is by reduction and thus temporary because colourless articles are further oxidised by air.

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

Coloured material + [H] ⟶ Colourless $\xrightarrow{[O]}$ coloured

(ii) I_2 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, KI_3 is more soluble.

$$KI + I_2 \longrightarrow KI_3\ (K^+\ I_3^-) \text{ brown solution}$$

H$_I$-5. **(i)** $2NaIO_3 + 5NaHSO_3 \longrightarrow 3\ NaHSO_4 + 2Na_2SO_4 + H_2O + I_2$
(ii) $Ca(OH)_2 + Cl_2 \longrightarrow Ca(OCl)Cl + H_2O$

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. $2KI(aq.) + Cl_2 \longrightarrow 2KCl(aq.) + I_2$

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,

$$2I^- (aq.) \longrightarrow I_2 (s) + 2e^-$$
$$Cl_2 (g) + 2e^- \longrightarrow 2Cl^- (aq)$$
$$\overline{2I^- (aq) + Cl_2 (g) \longrightarrow I_2 (s) + 2Cl^- (aq).}$$

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

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