Chemistry Study Materials for Class 12
(NCERT Based Notes of Chapter – 7)
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The p-Block Elements

Hydrogen Chloride (HCl)

Preparation: It is prepared in the laboratory, by heating sodium chloride with concentrated sulphuric acid.

$$NaCl + H_2SO_4\ (aq) + 420K \rightarrow NaHSO_4 + HCl$$

$$NaHSO_4 + NaCl\ (aq) + 823K \rightarrow Na_2SO_4 + HCl$$

Properties: It is a colourless and pungent smelling gas. It is extremely soluble in water and ionises as: $HCl + H_2O \rightarrow H_3O^+ + Cl^-$

Its aqueous solution is called hydrochloric acid, which is a strong acid in water. It reacts with NH_3 and gives white fumes of NH_4Cl.

$$NH_3 + HCl \rightarrow NH_4Cl$$

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

$$Au + 4\ H^+ + NO_3^- + 4Cl^- \rightarrow AuCl_4^- + NO + 2H_2O$$

$$3Pt + 16H^+ + 4NO_3^- + 18Cl^- \rightarrow 3PtCl_6^{2-} + 4NO + 8H_2O$$

Hydrochloric acid decomposes salts of weaker acids like carbonates, hydrogen carbonates, sulphites, etc.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$$

$$Na_2SO_3 + 2HCl \rightarrow 2NaCl + H_2O + SO_2$$

Uses: It is used (i) in the manufacture of chlorine, NH_4Cl and glucose (from corn starch),

(ii) for extracting glue from bones and purifying bone black,

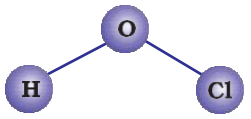
(iii) in medicine and as a laboratory reagent.

Oxoacids of Halogens

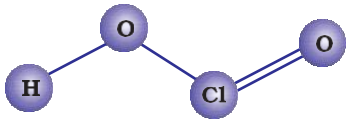
Due to high electronegativity and small size, fluorine forms only one oxoacid, HOF known as fluoric

(I) acid or hypofluorous acid. The other halogens form several oxoacids like Hypohalous acid (HOX), halous acid (HOXO) , halic acid($HOXO_2$) and perhalic acid ($HOXO_3$). They are stable only in aqueous solutions or in the form of their salts.

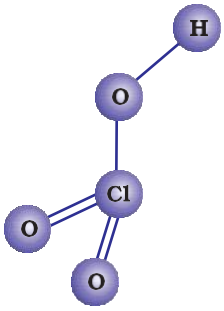
Chlorine forms 4 types of oxoacids – hypochlorous acid (HOCl), Chlorous acid (HOClO or $HClO_2$), Choric acid ($HOClO_2$ or $HClO_3$) and perchloric acid ($HOClO_3$ or $HClO_4$). The structures of them are:



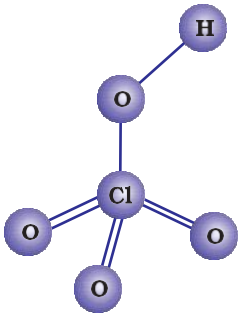
Hypochlorous acid



Chlorous acid



Chloric acid



Perchloric acid

Interhalogen Compounds

When two different halogens react with each other, interhalogen compounds are formed. They can be assigned general compositions as AX, AX_3, AX_5 and AX_7, where both A and X are halogens. A is larger and more electropositive than X. As the size of the central atom (A) increases, the stability of the compound also increases.

Preparation

The interhalogen compounds can be prepared by the direct combination or by the action of halogen on lower interhalogen compounds.

$Cl_2 + F_2 + 437K \longrightarrow 2ClF$
(equal volume)

$I_2 + 3Cl_2 \longrightarrow 2ICl_3$
(excess)

$I_2 + Cl_2 \longrightarrow 2ICl$
(equimolar)

$Br_2 + 5F_2 \longrightarrow 2BrF_5$
(excess)

Properties:

These are all covalent molecules and are diamagnetic in nature. They are volatile solids or liquids except CIF which is a gas at 298 K. Their physical properties are intermediate between those of constituent halogens. The interhalogen compounds are more reactive than halogens (except fluorine).

This is because A–X bond in interhalogens is weaker than X–X bond in halogens except F–F bond. The types of inter halogen compounds and their structures are as follows:

Type	Examples	Structure
AX	ClF, BrF, IF, BrCl, BrI	Linear
AX_3	ClF_3, BrF_3, IF_3, ICl_3, IBr_3 etc.	Bent T-shaped
AX_5	ClF_5, BrF_5, IF_5	Square pyramidal
AX_7	IF_7	Pentagonal bipyramidal

Uses: These compounds can be used as non aqueous solvents. Interhalogen compounds are very useful fluorinating agents.

Group 18 Elements

Group 18 consists of six elements- helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and radon (Rn). All these are gases and chemically unreactive. So they are called inert gases or noble gases.

All noble gases have general electronic configuration ns^2np^6 (except helium which has $1s^2$). Due to stable electronic configuration these gases have very high ionisation enthalpy and electron gain enthalpy.

Even though these elements are chemically inert, Kr and Xe form some compounds with oxygen and fluorine under special conditions.

In noble gases, there is only weak van der Waals force of attraction. So they have low melting and boiling point.

(a) <u>Xenon-fluorine compounds</u>

Xenon forms three binary fluorides, XeF_2, XeF_4 and XeF_6 by the direct reaction of elements under suitable conditions.

$Xe\ (g) + F_2\ (g) \xrightarrow{673K/1\ bar} XeF_2(s)$

(xenon in excess)

$Xe\ (g) + 2F_2\ (g) \xrightarrow{873K,\ 7\ bar} XeF_4(s)$

(1:5 ratio)

$Xe\ (g) + 3F_2\ (g) \xrightarrow{573K,\ 60\text{-}70bar} XeF_6(s)$

(1:20 ratio)

XeF_6 can also be prepared by the interaction of XeF_4 and O_2F_2 at 143K.

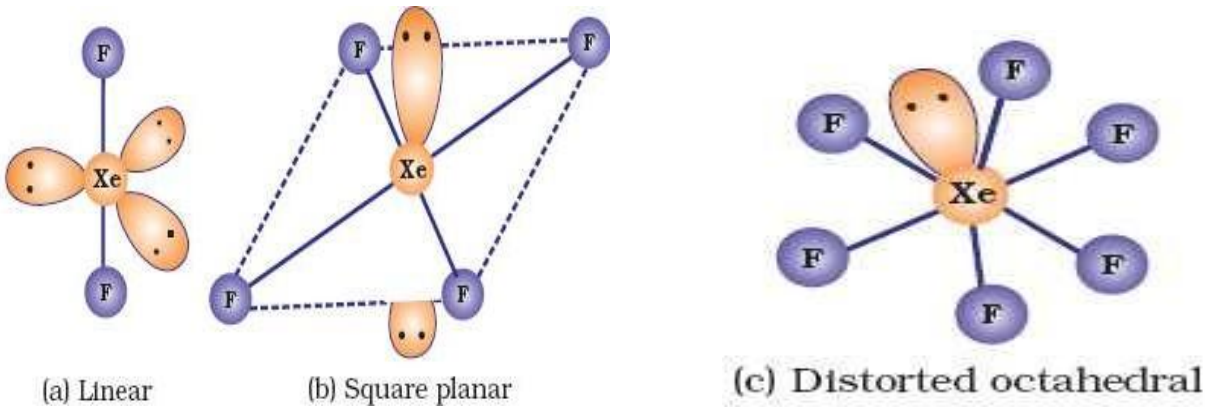
$$XeF_4 + O_2F_2 \rightarrow XeF_6 + O_2$$

XeF_2, XeF_4 and XeF_6 are colourless crystalline solids. They are powerful fluorinating agents. They are readily hydrolyzed even by traces of water. For example, XeF_2 is hydrolysed to give Xe, HF and O_2.

$$2XeF_2\ (s) + 2H_2O(l) \rightarrow 2Xe\ (g) + 4\ HF(aq) + O_2(g)$$

Structures

XeF_2 and XeF_4 have linear and square planar structures respectively. XeF6 has seven electron pairs (6 bonding pairs and one lone pair) and thus, have a distorted octahedral structure



(b) <u>Xenon-oxygen compounds</u>

1. **<u>XeO_3</u>**: It is obtained by the hydrolysis of XeF_4 and XeF_6 with water.

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

$$XeF_6 + 3\ H_2O \rightarrow XeO_3 + 6\ HF$$

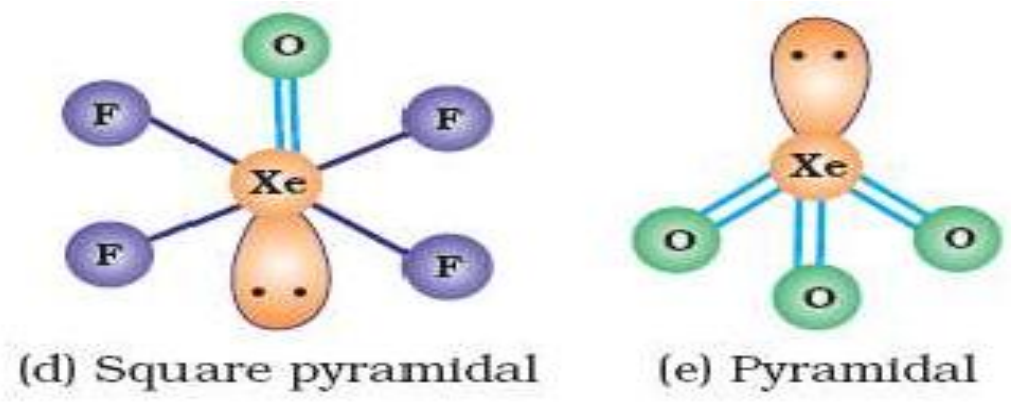
2. **<u>$XeOF_4$ & XeO_2F_2</u>**: Partial hydrolysis of XeF_6 gives oxyfluorides, $XeOF_4$ and XeO_2F_2.

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

$$XeF_6 + 2\ H_2O \rightarrow XeO_2F_2 + 4HF$$

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.



(d) Square pyramidal (e) Pyramidal

Uses of noble gases:

Helium is used in filling balloons for meteorological observations. It is also used in gas-cooled nuclear reactors. Liquid helium is used as cryogenic agent for carrying out various experiments at low temperatures. 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 to provide an inert atmosphere in high temperature metallurgical processes and for filling electric bulbs. It is also used in the laboratory for handling substances that are air-sensitive.

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

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