CLASS-XII

BRUSH UP for NEET/JEE 2021

Brush up your concepts to get high rank in NEET/JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

Unit 3

General Principles and Processes of Isolation of Elements | *p*-Block Elements (Group 15 to 18)

General Principles and Processes of Isolation of Elements

- A few elements like carbon, sulphur, gold and noble gases, occur in free state while others in combined forms in the earth's crust. The extraction and isolation of an element from its combined form involves various principles of chemistry.

METALLURGY

- The entire scientific and technological processes used for isolation of metal from its ores is called *metallurgy*.

Modes of occurrence

Elements

Native state
Least reactive elements like noble gases and noble metals occur in free state or native state.

Combined state
Highly reactive elements like fluorine, chlorine, sodium, etc. are found in combined state.

Metals

Minerals
Naturally occurring chemical substances in the earth's crust obtainable by mining.

Ores
The minerals from which we can obtain metal profitably and easily.

METALLURGICAL PROCESSES

- **Crushing and grinding of the ore :** Involves the breaking of huge lumps into small pieces using crushers or grinders which in turn reduced to fine powder using ball or stamp mill.
- **Concentration of ore :** Involves the removal of gangue from ore.

➢ The different methods used in this process are:

Based on nature of ores and impurities present

Hydraulic washing : Based on the difference in the specific gravities of the gangue and the ore particles. Therefore, heavier ore particles settle down while lighter impurities are washed away. For example, oxide ores like haematite, tinstone and native ores of Au, Ag, etc.

Electromagnetic separation : Based on the difference in magnetic properties of the gangue and ore particles. Therefore, magnetic particles fall nearer to the roller while non-magnetic particles fall farther off. For example, magnetite (Fe_3O_4), haematite (Fe_2O_3), wolframite ($FeWO_4$), chromite ($FeO{\cdot}Cr_2O_3$), etc.

Froth floatation process : Based on the difference in wetting properties of gangue and ore particles. Therefore, ore particles rise to the surface in the form of froth and impurities remain in water. For example, sulphide ores.

Leaching : Based on the difference in chemical properties of gangue and ore particles. Used for extraction of Au, Ag (*Mac Arthur Forest cyanide process*) and pure alumina from bauxite ore (*Baeyer's process*).

Extraction and isolation of metals : Involves extraction of metal in free state from concentrated ore. The following two chemical processes used are :

Oxidation or de-electronation process

- **Calcination :** Process of heating the ore strongly below its melting point either in the absence of air or in the limited supply. *e.g.*, carbonate and hydrated oxide ores.
- **Roasting :** Process of heating the ore strongly below the melting point in a sufficient supply of air to bring about its oxidation and remove volatile impurities. *e.g.*, sulphide ores.

Reduction process

Reduction of calcinated or roasted ore to metal using reducing agent. For *example*,

- Carbon or carbon monoxide is used for oxides of Fe, Cu, Zn, Mg, Co, etc.
- Electropositive metals like Na, Al, Mg or hydrogen are used for reduction of ores of Mn, Cr, Ti, Mo, W, etc.
- Water gas is used for nickel ores.
- Auto-reduction process is used for ores of Pb, Hg, Cu, etc.
- Electrolytic reduction is used for highly electropositive metals.
- Hydrometallurgy or displacement method is used for Ag, Au, etc.

Extraction of cleaner copper with energy capture!

In February 2016, a toxin-free method for extraction of copper from raw ore and other procedures using molten salts have been developed. Recent method involves the chemical processes that produce huge mountains of waste mine tailings and lake-size waste water collections, accumulating high levels of toxins such as arsenic, cadmium and sulphuric acid. But latest method works by heating ore using molten salts to temperatures exceeding 1500°F such that copper is separated from the ore without use of water and dangerous chemicals. The technology also allows for the collection of surplus heat and using it to power steam turbines and generators. These technologies could really shift the paradigm with cleaner, more efficient methods for both mining and energy storage.

Refining of metals : Involves the purification of crude metals by removing the impurities present in it.

- The different methods used in this process are :

Based on differences in properties of metals and impurities

Liquation
Used for low melting metals like Sn, Pb, Hg, Bi, etc.

Cupellation
Used for metals containing easily oxidisable impurities. *e.g.*, Ag containing Pb impurities.

Poling
Used for metals which contain impurities of their own oxides, *e.g.*, Cu.

Mond's process
Used for refining of Ni.

$$4CO + \underset{\text{Impure}}{Ni} \xrightarrow{\Delta} Ni(CO)_4\downarrow$$

$$\underset{\text{Pure}}{Ni} + 4CO \xleftarrow{180°C} Ni(CO)_4$$

Electrolytic refining
Used for metals like Cu, Ag, Au, Al which get deposited at cathode and impurities get deposited at anode. Solution of a soluble metal salt acts as the electrolyte.

van Arkel method
Used for ultra-pure metals like Ti, Zr which are used in space technology.

$$\underset{\text{Impure}}{Ti_{(s)}} + 2I_{2(g)} \xrightarrow{523\text{ K}} TiI_{4(g)} \xrightarrow{1673\text{ K}} \underset{\text{Pure}}{Ti_{(s)}} + 2I_{2(g)}$$

$$\underset{\text{Impure}}{Zr_{(s)}} + 2I_{2(g)} \xrightarrow{870\text{ K}} ZrI_{4(g)} \xrightarrow{1800\text{ K}} \underset{\text{Pure}}{Zr_{(s)}} + 2I_{2(g)}$$

Zone refining
Used to produce extremely pure metals (semiconductors) like Si, Ge, Ga, B and In.

THERMODYNAMIC PRINCIPLES OF METALLURGY

Thermodynamic principles :

- With the help of thermodynamics, the temperature conditions and suitable reducing agents in the metallurgical processes can be decided.
- Gibb's Helmholtz equation ($\Delta G° = \Delta H° - T\Delta S°$), is used to check the feasibility of a reaction.
- $\Delta G° < 0$ (Spontaneous reaction)

Ellingham diagram : The graphical representation of Gibbs free energy change *vs* absolute temperature for a process is known as *Ellingham diagram.*

Salient features

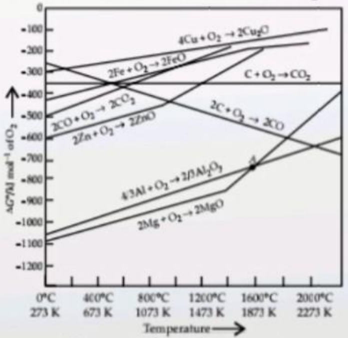
The $\Delta G°$ *vs* T graphs are straight lines unless the materials melt or vaporise (*i.e.*, change from solid → liquid or from liquid → gas).

Metal oxide with lower value of $\Delta G°$ is more stable than a metal oxide with higher $\Delta G°$.

The coupling or combination of oxidation and reduction reactions helps in interpreting whether the given reducing agent can be useful or not.

All the $\Delta G°$ *vs* T lines have slopes upwards because $\Delta G°$ becomes less and less negative with increase in temperature.

The diagram shows that reduction of the oxide of the elements in upper line is feasible by the elements represented by the lower line. Reduction is easier if the difference is large.



Gibbs energy ($\Delta G°$) *vs* T plots for formation of some oxides (Ellingham diagram)

p-Block Elements (Group 15 to 18)

GROUP 15 ELEMENTS (PNICTOGENS)

- **Electronic configuration : N(7)** - [He]$2s^2 2p^3$; **P(15)** - [Ne]$3s^2 3p^3$; **As(33)** - [Ar]$3d^{10} 4s^2 4p^3$; **Sb(51)** - [Kr]$4d^{10} 5s^2 5p^3$; **Bi(83)** - [Xe]$4f^{14} 5d^{10} 6s^2 6p^3$; **Mc(115)** - [Rn] $5f^{14}\ 6d^{10}\ 7s^2\ 7p^3$

PHYSICAL PROPERTIES

Group 15 Elements ($ns^2 np^3$)

Physical state and metallic character :
N_2 (unreactive gas), P_4 (solid non-metal),
As_4 and Sb_4 (solid metalloids), Bi (solid metal), Mc (Radioactive)

Atomicity : Nitrogen (diatomic gaseous molecule), phosphorus, arsenic, antimony (discrete tetratomic tetrahedral molecules).

Thermal and electrical conductivity : Increase down the group, as delocalisation of electrons increases.

Allotropy : Nitrogen (α and β-Nitrogen), phosphorus (white, red, scarlet, violet, α-black, β-black), arsenic (grey, yellow, black) antimony (metallic, yellow, explosive).

Atomic radioactive : Increase down the group, smaller than that of group 14 elements due to increased nuclear charge.

Melting and boiling points : M.pt. increases from N to As and then decreases whereas b. pt. increases from N to Sb and decreases very slightly.

Ionisation enthalpy : Decreases regularly down the group due to increase in size.

Electronegativity :
Decreases down the group.

CHEMICAL PROPERTIES

Chemical properties

Oxides

Group 15 elements form oxides of type X_2O_3, X_2O_4, X_2O_5
Acidic nature decreases (left to right), increases (down the group)

Hydrides

Thermal stability : $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
Solubility : $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
Basic character : $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
Bond angle : $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
Reducing character : $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$
Covalent character : $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

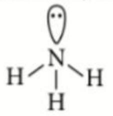
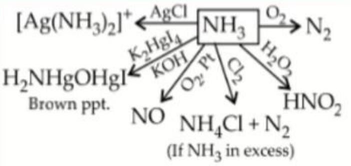
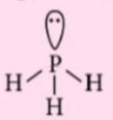
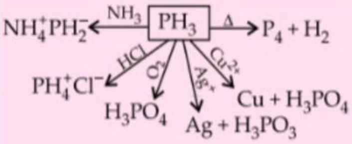
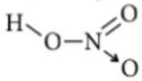
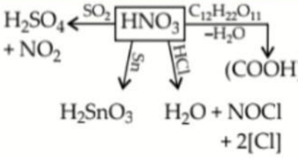
Oxidation state

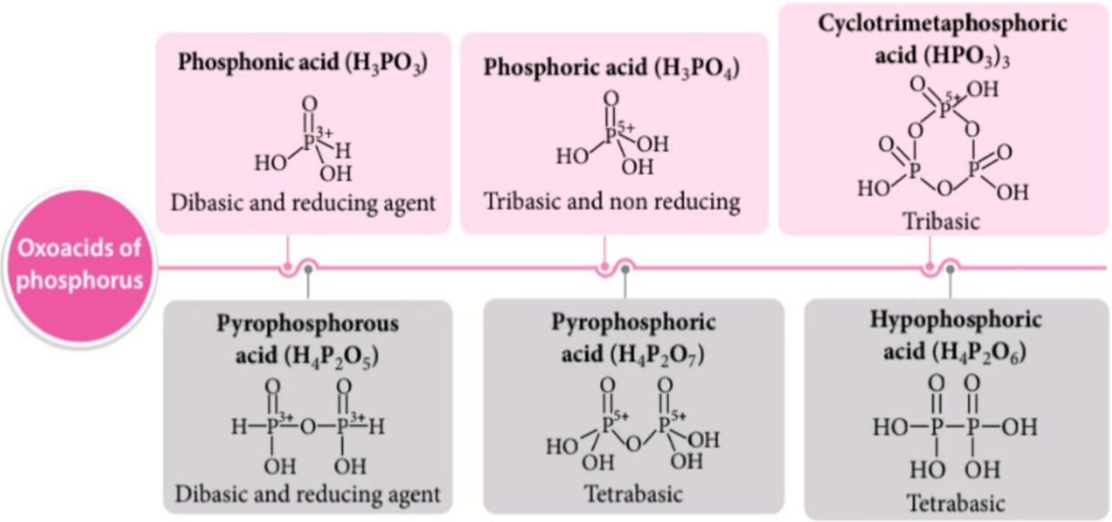
Stability of +3 increases and +5 decreases down the group.

Halides (MX_3 and MX_5)

Group 15 elements form MX_3, whereas all form MX_5 except nitrogen.
Stability : $NF_3 > NCl_3 > NBr_3$
Lewis acid strength : $PCl_3 > AsCl_3 > SbCl_3$ and $PF_3 > PBr_3 > PI_3$
Lewis base strength : $NI_3 > NBr_3 > NCl_3 > NF_3$
Bond angle : $PF_3 < PCl_3 < PBr_3 < PI_3$ (increasing $b.p.$ – $b.p.$ repulsions)

IMPORTANT COMPOUNDS OF NITROGEN AND PHOSPHORUS

Compounds	Preparations	Properties
Ammonia (NH_3)  sp^3 hybridisation (pyramidal)	**Haber's process :** $N_{2(g)} + 3H_{2(g)} \xrightleftharpoons{773K} 2NH_{3(g)}$ $NH_4Cl + NaOH \longrightarrow NH_3 + H_2O + NaCl$ $2NH_4Cl + \underset{\text{Slaked lime}}{Ca(OH)_2} \xrightarrow{\Delta} CaCl_2 + 2NH_3 + 2H_2O$ $Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$	
Phosphine (PH_3)  sp^3 hybridisation (pyramidal)	$4H_3PO_3 \xrightarrow{478\text{-}483\ K} 3H_3PO_4 + PH_3$ $P_4 + 3NaOH + 3H_2O \longrightarrow 3NaH_2PO_2 + PH_3$ $PH_4I + KOH \longrightarrow PH_3 + KI + H_2O$ $Ca_3P_2 + 6H_2O \longrightarrow 3Ca(OH)_2 + 2PH_3$	
Nitric acid **(HNO_3)** 	$2KNO_3 + H_2SO_4 \longrightarrow 2HNO_3 + K_2SO_4$ $4NH_{3(g)} + 5O_{2(g)} \xrightarrow[\text{500 K, 9 bar}]{\text{Pt/Rh gauge}} 4NO_{(g)} + 6H_2O_{(g)}$ $2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$ $3NO_{2(g)} + H_2O_{(l)} \longrightarrow 2HNO_{3(aq)} + NO_{(g)}$	



Oxoacids of phosphorus

Phosphonic acid (H_3PO_3)

Dibasic and reducing agent

Phosphoric acid (H_3PO_4)

Tribasic and non reducing

Cyclotrimetaphosphoric acid $(HPO_3)_3$

Tribasic

Pyrophosphorous acid ($H_4P_2O_5$)

Dibasic and reducing agent

Pyrophosphoric acid ($H_4P_2O_7$)

Tetrabasic

Hypophosphoric acid ($H_4P_2O_6$)

Tetrabasic

GROUP 16 ELEMENTS (CHALCOGENS)

- **Electronic configurations :** **O(8)** - [He]$2s^22p^4$; **S(16)**-[Ne]$3s^23p^4$; **Se(34)**-[Ar]$3d^{10}4s^24p^4$; **Te(52)**-[Kr]$4d^{10}5s^25p^4$; **Po(84)**-[Xe]$4f^{14}5d^{10}6s^26p^4$; **Lv(116)** - [Rn] $5f^{14}\ 6d^{10}\ 7s^2\ 7p^4$

PHYSICAL PROPERTIES

Group 16 Elements (ns^2np^4)

Allotropy : All elements show allotropy

Electronegativity : Decreases down the group.

Electron gain enthalpy : Increases from oxygen to sulphur and then decreases.

Melting and boiling points : Increase down the group upto Te and then decreases.

Physical state and metallic character : O_2 (gas), S_8 (solid non-metal), Se and Te (solid metalloids), Po (radioactive metal), Lv (radioactive)

Atomic radii : Increase down the group.

Ionisation enthalpy : Decreases down the group.

Atomicity : Oxygen (diatomic molecule), S, Se, Te (form polyatomic complex molecules).

CHEMICAL PROPERTIES

Chemical properties

Oxidation state

Stability of –2, +6 oxidation states decreases down the group and +4 oxidation state increases down the group.

Hydrides

Boiling point : $H_2O > H_2Te > H_2Se > H_2S$
Volatility : $H_2S > H_2Se > H_2Te > H_2O$
Bond angle : $H_2O > H_2S > H_2Se > H_2Te$
Acidic character : $H_2O < H_2S < H_2Se < H_2Te$
Reducing power : $H_2Te > H_2Se > H_2S > H_2O$

Halides (EX_6, EX_4 and EX_2)

Hexahalides stability: $SF_6 > SeF_6 > TeF_6$

Tetrahalides : SF_4(gas), SeF_4 (liquid), TeF_4 (solid). SF_4 readily hydrolysed than SF_6.

Dihalides : All elements except selenium form dihalides.

Monohalides : Dimeric in nature and undergoes disproportionation.

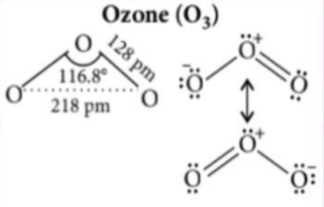
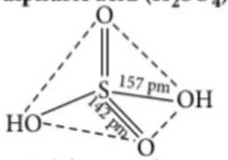
Oxides

Monoxides : Except selenium, all elements form monoxides, *MO*.

Dioxides : All elements form dioxides MO_2, when burnt in air. SO_2 (monomeric), SeO_2 (polymeric), TeO_2 and PoO_2 (ionic solids).

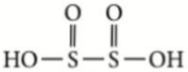
Trioxides : Sulphur, selenium, tellurium form trioxides, MO_3.

IMPORTANT COMPOUNDS OF OXYGEN AND SULPHUR

Compounds	Preparation	Properties
Ozone (O_3) 	Silent electric discharge $3O_2 \rightleftharpoons 2O_3$	$O_3 \xrightarrow{NO} O_2 + NO_2$ $O_3 \xrightarrow{H_2S} H_2O + S + O_2$ $O_3 \xrightarrow{KOH} KO_3$ $O_3 \xrightarrow{PbS} PbSO_4$ $O_3 \xrightarrow{HCl + SnCl_2} SnCl_4$ $O_3 \xrightarrow[H_2O/Zn]{CH_2=CH_2} HCHO$
Sulphuric acid (H_2SO_4)  Sulphuric acid	**Contact process :** $2SO_{2(g)} + O_{2(g)} \xrightarrow{V_2O_5} 2SO_{3(g)}$ $2SO_{3(g)} \xrightarrow{H_2SO_4} H_2S_2O_7$ $2H_2SO_4 \xleftarrow{H_2O} H_2S_2O_7$	$H_2SO_4 \xrightarrow{NaOH} NaHSO_4 + H_2O$ $H_2SO_4 \xrightarrow{2NaOH} Na_2SO_4 + 2H_2O$ $H_2SO_4 \xrightarrow{Zn} ZnSO_4 + H_2$ $H_2SO_4 \xrightarrow{C_{12}H_{22}O_{11}} 12C + 11H_2O$ $H_2SO_4 \xrightarrow{S_8} SO_2 + H_2O$ $H_2SO_4 \xrightarrow{Na_2S} Na_2SO_4 + H_2S$ $H_2SO_4 \xrightarrow{BaCl_2} BaSO_4 + HCl$ $H_2SO_4 \xrightarrow{K_4[Fe(CN)_6]} K_2SO_4 + FeSO_4 + (NH_4)_2SO_4 + CO\uparrow$

Oxoacids of sulphur

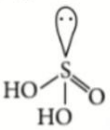
Hyposulphurous acid ($H_2S_2O_4$)



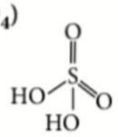
$HO-\overset{\overset{O}{\|}}{S}-\overset{\overset{O}{\|}}{S}-OH$

Unstable in pure form but stable as salts.
O.S. of S = +3

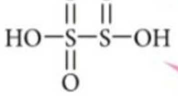
Sulphurous acid (H_2SO_3)
Dibasic acid, strong reducing agent.
O.S. of S = +4



Sulphuric acid (H_2SO_4)
Dibasic acid, strong oxidising and dehydrating agent.
O.S. of S = +6

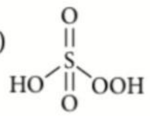


Pyrosulphurous acid or Disulphurous acid ($H_2S_2O_5$)
O.S. of S = +3 and +5

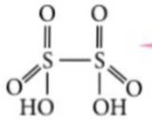


$HO-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-\overset{\overset{O}{\|}}{S}-OH$

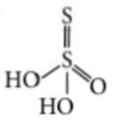
Peroxomonosulphuric acid (Caro's acid) (H_2SO_5)
Monobasic acid, strong oxidising agent.
O.S. of S = +6



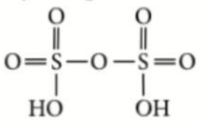
Dithionic acid ($H_2S_2O_6$) :
Dibasic acid
O.S. of S = +5



Thiosulphuric acid ($H_2S_2O_3$)
Dibasic acid, reducing agent.
O.S. of S = −2, +6

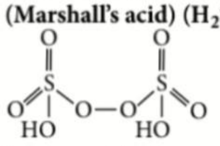


Disulphuric acid or Pyrosulphuric acid ($H_2S_2O_7$)
A sulphuric acid analogue of acetic anhydride.
O.S. of S = +6



$O=\underset{\underset{HO}{|}}{\overset{\overset{O}{\|}}{S}}-O-\underset{\underset{OH}{|}}{\overset{\overset{O}{\|}}{S}}=O$

Peroxodisulphuric acid (Marshall's acid) ($H_2S_2O_8$)



Dibasic acid, strong oxidising agent.
O.S. of S = +6

GROUP 17 ELEMENTS (HALOGENS)

- **Electronic configuration : F(7)** - [He]$2s^2 2p^5$; **Cl(17)** - [Ne]$3s^2 3p^5$; **Br(35)** - [Ar]$3d^{10} 4s^2 4p^5$; **I(53)** - [Kr]$4d^{10} 5s^2 5p^5$; **At(85)** - [Xe]$4f^{14} 5d^{10} 6s^2 6p^5$; **Ts(117)** - [Rn] $5f^{14} 6d^{10} 7s^2 7p^5$

PHYSICAL PROPERTIES

Group 17 Elements (ns^2np^5)

Heat of hydration :
$F^- > Cl^- > Br^- > I^-$

Oxidising power and reactivity
$F_2 > Cl_2 > Br_2 > I_2$

Colour and physical state : F_2 (pale yellow gas), Cl_2 (greenish yellow gas), Br_2 (reddish brown liquid), I_2 (purple solid), Ts (radioactive).

Bond energy :
$Cl_2 > Br_2 > F_2 > I_2$

Atomic radii : Increase down the group.

Melting and boiling points :
Increase down the group.

Ionisation enthalpy : Very high and decreases down the group.

Electron gain enthalpy : Cl > F > Br > I

Electronegativity :
Decreases down the group.

CHEMICAL PROPERTIES

Chemical properties

Oxidation state

F shows only – 1 oxidation state (except +1 in HOF while other elements show –1, +1, +3, +5 and +7 oxidation states also.

Hydrogen halides

Boiling points : HF > HI > HBr > HCl
Melting points : HI > HF > HBr > HCl
Bond lengths : HI > HBr > HCl > HF
Bond dissociation enthalpy : HF > HCl > HBr > HI
Acidic strength : HI > HBr > HCl > HF
Thermal stability : HF > HCl > HBr > HI
Reducing power : HI > HBr > HCl > HF

Oxides

OF_2, O_2F_2
Cl_2O, ClO_2, Cl_2O_6 and Cl_2O_7
Br_2O, BrO_2, BrO_3
I_2O_4, I_4O_9
All are covalent and powerful oxidising agents.
Oxidising power : $Cl_2O > ClO_2 > Cl_2O_6 > Cl_2O_7$
Stability : $Cl_2O < ClO_2 < Cl_2O_6 < Cl_2O_7$

Oxoacids

Acid strength : $HClO_4 > HClO_3 > HClO_2 > HClO$; $HOCl > HOBr > HOI$
Oxidising power : $HOCl \simeq HOBr > HOI$;
$BrO_4^- > IO_4^- > ClO_4^-$
$HClO_4 < HClO_3 < HClO_2 < HClO$

IMPORTANT COMPOUNDS OF HALOGEN FAMILY

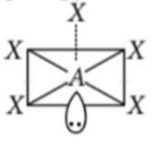
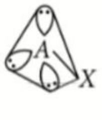
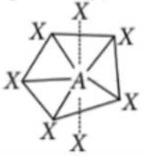
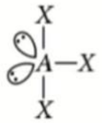
Compounds	Preparation	Properties
Chlorine (Cl_2)	**Laboratory method :** $2NaCl + 3H_2SO_4 + MnO_2 \longrightarrow 2NaHSO_4 + MnSO_4 + 2H_2O + Cl_2$	$Cl_2 + 2FeSO_4 + H_2SO_4 \longrightarrow Fe_2(SO_4)_3 + HCl$ $Cl_2 + H_2S \longrightarrow 2HCl + S$ $Cl_2 + 2NaOH_{(dil.)} \longrightarrow NaCl + NaOCl + H_2O$ $3Cl_2 + 6NaOH_{(conc.)} \longrightarrow 5NaCl + NaClO_3 + 3H_2O$ $Cl_2 \xrightarrow{H_2O} 2HCl + [O] \xrightarrow[\text{substance}]{\text{Coloured}} \text{Colourless}$
Hydrogen Chloride (HCl)	$NaCl + H_2SO_4 \xrightarrow{420\text{ K}} NaHSO_4 + HCl$ $NaHSO_4 + NaCl \xrightarrow{823\text{ K}} Na_2SO_4 + HCl$	Colourless and pungent smelling gas, easily liquifiable, extremely soluble in water. $Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$ $Na_2SO_3 + 2HCl \longrightarrow 2NaCl + H_2O + SO_2$

Oxoacids of halogens :

Oxidation state of halogen	Chlorine	Bromine	Iodine	Name of acid
+1	HClO	HBrO	HIO	Hypohalous
+3	$HClO_2$	–	–	Halous
+5	$HClO_3$	$HBrO_3$	HIO_3	Halic
+7	$HClO_4$	$HBrO_4$	HIO_4 H_5IO_6	Perhalic

INTERHALOGEN COMPOUNDS

Properties					
Covalent in nature	Strong oxidising agents	Diamagnetic in nature	Reactive than halogens	Partially ionised in solution or in liquid state	Coloured in nature

Types of interhalogen compounds			
AX_5 sp^3d^2 Square pyramidal 	AX sp^3 Linear 	AX_7 sp^3d^3 Pentagonal bipyramidal 	AX_3 sp^3d T-shaped 

GROUP 18 ELEMENTS (NOBLE OR INERT GASES)

- **Electronic configuration : He(2)** - $1s^2$; **Ne(10)** - $[He]2s^22p^6$; **Ar(18)** - $[Ne]3s^23p^6$; **Kr(36)** - $[Ar]3d^{10}4s^24p^6$; **Xe(54)** - $[Kr]4d^{10}5s^25p^6$; **Rn(86)** - $[Xe]4f^{14}5d^{10}6s^26p^6$; **Og(118)** - $[Rn]\ 5f^{14}6d^{10}7s^27p^6$

PHYSICAL PROPERTIES

Physical state : All are monoatomic gases and Og is radioactive

Ease of liquefication : Increases down the group.

Atomic radii : Increase down the group.

Group 18 Elements ($ns^2\ np^6$)

Ionisation enthalpy : Decreases down the group.

Electron gain enthalpy : Positive

Melting and boiling points : Very low due to weak dispersion forces.

COMPOUNDS OF XENON

Compound	Preparation	Properties
Xenon difluoride (XeF_2)	$Xe + F_2 \xrightarrow{673\text{ K, 1 bar}} XeF_2$ (Xe in excess)	Linear, sp^3d
Xenon tetrafluoride (XeF_4)	$Xe + 2F_2 \xrightarrow[6\text{-}7\text{ bar}]{873\text{ K}} XeF_4$ (1 : 5)	Square planar, dsp^2
Xenon hexafluoride (XeF_6)	$Xe + 3F_2 \xrightarrow[60\text{-}70\text{ bar}]{573\text{ K}} XeF_6$ (1 : 20)	Distorted octahedral, sp^3d^3
Xenon trioxide (XeO_3)	$XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$	Pyramidal, sp^3
Xenon oxydifluoride ($XeOF_2$)	$XeF_4 + H_2O \longrightarrow XeOF_2 + 2HF$	T-shaped, sp^3d
Xenon oxytetrafluoride ($XeOF_4$)	$XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF$	Square pyramidal, sp^3d^2
Xenon dioxydifluoride (XeO_2F_2)	$XeOF_4 + H_2O \longrightarrow XeO_2F_2 + 2HF$	Distorted trigonal bipyramidal, sp^3d