

## Revision Notes on p-Block Elements:

**P-Block Elements**

1	2											13	14	15	16	17	18
1 1.008 H hydrogen																	2 4.003 He helium
3 6.941 Li lithium	4 9.012 Be beryllium											5 10.81 B boron	6 12.011 C carbon	7 14.007 N nitrogen	8 15.999 O oxygen	9 18.998 F fluorine	10 20.180 Ne neon
11 22.990 Na sodium	12 24.305 Mg magnesium											13 26.982 Al aluminum	14 28.086 Si silicon	15 30.974 P phosphorus	16 32.06 S sulfur	17 35.45 Cl chlorine	18 39.948 Ar argon
19 39.098 K potassium	20 40.078 Ca calcium	21 44.956 Sc scandium	22 47.867 Ti titanium	23 50.942 V vanadium	24 52.00 Cr chromium	25 54.938 Mn manganese	26 55.845 Fe iron	27 58.933 Co cobalt	28 58.933 Ni nickel	29 63.546 Cu copper	30 65.38 Zn zinc	31 69.723 Ga gallium	32 72.64 Ge germanium	33 74.922 As arsenic	34 78.96 Se selenium	35 79.904 Br bromine	36 83.8 Kr krypton
37 85.468 Rb rubidium	38 87.62 Sr strontium	39 88.906 Y yttrium	40 91.224 Zr zirconium	41 92.906 Nb niobium	42 95.94 Mo molybdenum	43 98 Tc technetium	44 101.07 Ru ruthenium	45 102.905 Rh rhodium	46 106.42 Pd palladium	47 107.868 Ag silver	48 112.411 Cd cadmium	49 114.818 In indium	50 118.710 Sn tin	51 121.757 Sb antimony	52 127.6 Te tellurium	53 126.905 I iodine	54 131.29 Xe xenon
55 132.905 Cs cesium	56 137.327 Ba barium	57-71 Lanthanides	72 178.49 Hf hafnium	73 180.948 Ta tantalum	74 183.84 W tungsten	75 186.207 Re rhenium	76 186.207 Os osmium	77 188.906 Ir iridium	78 195.084 Pt platinum	79 197.04 Au gold	80 200.59 Hg mercury	81 204.387 Tl thallium	82 207.2 Pb lead	83 208.98 Bi bismuth	84 209 Po polonium	85 210 At astatine	86 222 Rn radon
87 223 Fr francium	88 226 Ra radium	89-103 Actinides	104 261 Rf rutherfordium	105 262 Db dubnium	106 263 Sg seaborgium	107 269 Bh bohrium	108 269 Hs hassium	109 270 Mt meitnerium	110 270 Ds darmstadtium	111 270 Rg roentgenium	112 270 Cn copernicium	113 270 Uut ununtrium	114 270 Fl flerovium	115 270 Uup ununpentium	116 270 Lv livermorium	117 270 Uus ununseptium	118 270 Uuo ununoctium
		57 138.9 La lanthanum	58 140.1 Ce cerium	59 140.9 Pr praseodymium	60 144.2 Nd neodymium	61 145 Pm promethium	62 150.4 Sm samarium	63 152 Eu europium	64 157.3 Gd gadolinium	65 158.9 Tb terbium	66 162.5 Dy dysprosium	67 164.9 Ho holmium	68 167.3 Er erbium	69 168.9 Tm thulium	70 173.1 Yb ytterbium	71 175 Lu lutetium	
		89 227 Ac actinium	90 232 Th thorium	91 231 Pa protactinium	92 238 U uranium	93 237 Np neptunium	94 244 Pu plutonium	95 244 Am americium	96 247 Cm curium	97 247 Bk berkelium	98 251 Cf californium	99 251 Es einsteinium	100 252 Fm fermium	101 252 Md mendelevium	102 258 No nobelium	103 262 Lr lawrencium	

\*H: [1.00784, 1.00811]  
 Li: [6.938, 6.997]  
 B: [10.806, 10.821]  
 C: [12.0096, 12.0116]  
 N: [14.00643, 14.00728]  
 O: [15.99903, 15.99977]  
 Mg: [24.304, 24.307]  
 Si: [28.086, 28.086]  
 S: [32.059, 32.076]  
 Cl: [35.446, 35.457]  
 Br: [79.901, 79.907]  
 I: [126.904, 126.905]  
 Zn: [65.38, 65.38]  
 Se: [78.96, 78.96]  
 He: [4.0026, 4.0026]

### Boron Family (Group 13 Elements)

- **Members:** B, Al, Ga, In & Tl
- **Melting Point:** Decreases from B to Ga and then increases up to Tl.
- **Ionization Energies:**  $1^{\text{st}} \lll 2^{\text{nd}} < 3^{\text{rd}}$
- **Metallic Character:** Increases from B to Tl. B is non-metal

### Boron

#### Preparation of Boron:

- From Boric Acid:  $\text{B}_2\text{O}_3(\text{s}) + 3\text{Mg}(\text{s}) \rightarrow 2\text{B}(\text{s}) + 3\text{MgO}(\text{s})$
- From Boron Trichloride
  - (at 1270 K):  $2\text{BCl}_3 + 3\text{H}_2(\text{g}) \rightarrow 2\text{B}(\text{s}) + 6\text{HCl}(\text{g})$
  - (at 900 °C):  $2\text{BCl}_3(\text{g}) + 3\text{Zn}(\text{s}) \rightarrow 2\text{B}(\text{s}) + 3\text{ZnCl}_2(\text{s})$
- By electrolysis of fused mixture of boric anhydride ( $\text{B}_2\text{O}_3$ ) and magnesium oxide ( $\text{MgO}$ ) & Magnesium fluoride at 1100 °C
  - $2\text{MgO} \rightarrow 2\text{Mg} + \text{O}_2(\text{g})$
  - $\text{B}_2\text{O}_3 + 3\text{Mg} \rightarrow 2\text{B} + 3\text{MgO}$
- By thermal decomposition of Boron hydrides & halides:
  - $\text{B}_2\text{H}_6(\text{g}) + \Delta \rightarrow 2\text{B}(\text{s}) + 3\text{H}_2(\text{g})$

## Compounds of Boron:

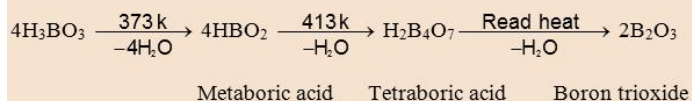
### Orthoboric acid (H<sub>3</sub>BO<sub>3</sub>)

#### Preparation of Orthoboric acid

- **From borax** :  $\text{Na}_2\text{B}_4\text{O}_7 + \text{H}_2\text{SO}_4 + 5\text{H}_2\text{O} \rightarrow \text{Na}_2\text{SO}_4 + 4\text{H}_3\text{BO}_3$
- **From colemanite** :  $\text{Ca}_2\text{B}_6\text{O}_{11} + 2\text{SO}_2 + 11\text{H}_2\text{O} \rightarrow 2\text{Ca}(\text{HSO}_3)_2 + 6\text{H}_3\text{BO}_3$

#### Properties of Orthoboric acid

- **Action of Heat:**



- **Weak monobasic acidic behavior:**



Thus on titration with NaOH, it gives sodium metaborate salt



- **Reaction with Metaloxide:**



Where M stands for a bivalent metal

- **Reaction with Ammonium boro fluoride:**



Ammonium boro fluoride

### Borax (sodium tetraborate) Na<sub>2</sub>B<sub>4</sub>O<sub>7</sub> · 10H<sub>2</sub>O

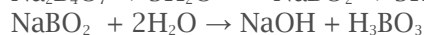
#### Preparation from Boric Acid



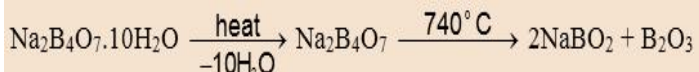
#### Properties of Borax

- **Basic Nature:-**

Aqueous solution of borax is alkaline in nature due to its hydrolysis



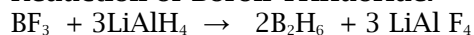
- **Action of heat:**



### Diborane (B<sub>2</sub>H<sub>6</sub>)

#### Preparation of Diborane:

##### Reduction of Boron Trifluoride:



##### From NaBH<sub>4</sub>:

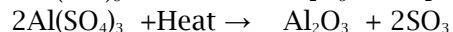
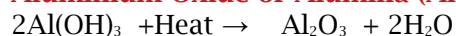


### Properties of Diborane:

- **Reaction with water:**  $\text{B}_2\text{H}_6 + \text{H}_2\text{O} \rightarrow 2\text{H}_3\text{BO}_3 + 6\text{H}_2$
- **Combustion:**  $\text{B}_2\text{H}_6 + 2\text{O}_2 \rightarrow \text{B}_2\text{O}_3 + 3\text{H}_2\text{O} \quad \Delta H = -2615 \text{ kJ/mol}$

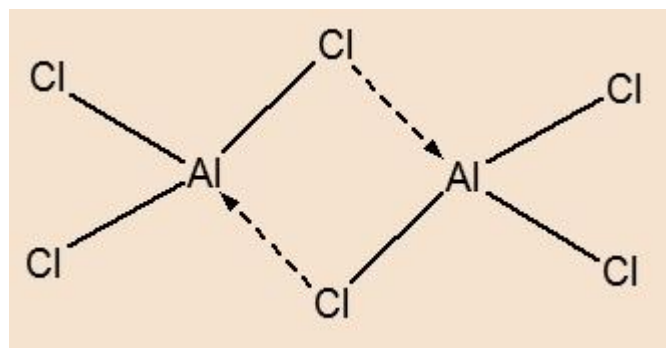
### Compounds of Aluminium:

#### Aluminium Oxide or Alumina ( $\text{Al}_2\text{O}_3$ )



#### Aluminum Chloride $\text{AlCl}_3$ :

##### Structure of Aluminium Chloride:



### Properties of Aluminium Chloride

- White, hygroscopic solid
- Sublimes at  $183^\circ\text{C}$
- Forms addition compounds with  $\text{NH}_3$ ,  $\text{PH}_3$ ,  $\text{COCl}_2$  etc.
- Hydrolysis:  $\text{AlCl}_3 + 3\text{H}_2\text{O} \rightarrow \text{Al}(\text{OH})_3 + 3\text{HCl} + 3\text{H}_2\text{O}$
- Action of Heat:  $2\text{AlCl}_3 \cdot 6\text{H}_2\text{O} \rightarrow 2\text{Al}(\text{OH})_3 + \text{Al}_2\text{O}_3 + 6\text{HCl} + 3\text{H}_2\text{O}$

### Carbon Family (Group 14 Elements):

- **Members:** C, Si, Ge, Sn, & Pb
- **Ionization Energies:** Decreases from C to Sn and then increases up to Pb.
- **Metallic Character:** C and Si are non metals, Ge is metalloid and Sn and Pb are metals
- **Catenation:** C and Si show a tendency to combine with its own atoms to form long chain polymers

### Compounds of Carbon:

#### Carbon Monoxide

##### Preparation of Carbon Monoxide

- By heating carbon in limited supply of oxygen:  $\text{C} + 1/2\text{O}_2 \rightarrow \text{CO}$ .
- By heating oxides of heavy metals e.g. iron, zinc etc with carbon.
  - $\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}$
  - $\text{ZnO} + \text{C} \rightarrow \text{Zn} + \text{CO}$
- By passing steam over hot coke:  $\text{C} + \text{H}_2\text{O} \rightarrow \text{CO} + \text{H}_2$  (water gas)
- By passing air over hot coke:  $2\text{C} + \text{O}_2 + 4\text{N}_2 \rightarrow 2\text{CO} + 4\text{N}_2$  (Producer gas)

?

### Properties of Carbon Monoxide:

- A powerful reducing agent :  $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$   
 $\text{CuO} + \text{CO} \rightarrow \text{Cu} + \text{CO}_2$
- Burns in air to give heat and carbon dioxide:  $\text{CO} + 1/2\text{O}_2 \rightarrow \text{CO}_2 + \text{heat}$ .

### Tests For Carbon Monoxide:

- Burns with blue flame
- Turns the filter paper soaked in platinum or palladium chloride to *pink or green*.

### Carbon di-oxide

#### Preparation of Carbon di-oxide

- By action of acids on carbonates:  $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$
- By combustion of carbon:  $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$

#### Properties of Carbon di-oxide

- It turns lime water milky  $\text{Ca(OH)}_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 \downarrow + \text{H}_2\text{O}$ ,
- Milkiness disappears when  $\text{CO}_2$  is passed in excess  
 $\text{CaCO}_3 + \text{H}_2\text{O} + \text{CO}_2 \rightarrow \text{Ca(HCO}_3)_2$
- Solid carbon dioxide or *dry ice* is obtained by cooling  $\text{CO}_2$  under pressure. It passes from the solid state straight to gaseous state without liquefying (hence dry ice).

### Carbides:

- **Salt like Carbides** : These are the ionic salts containing either  $\text{C}_2^{2-}$  (acetylide ion) or  $\text{C}^4-$  (methanide ion) e.g.  $\text{CaC}_2$ ,  $\text{Al}_4\text{C}_3$ ,  $\text{Be}_2\text{C}$ .
- **Covalent Carbides** : These are the carbides of non-metals such as silicon and boron. In such carbides, the atoms of two elements are bonded to each other through covalent bonds.  $\text{SiC}$  also known as *Carborundum*.
- **Interstitial Carbides** : They are formed by transition elements and consist of metallic lattices with carbon atoms in the interstices. e.g. tungsten carbide  $\text{WC}$ , vanadium carbide  $\text{VC}$ .

### Compounds of Silicon:

#### Sodium Silicate ( $\text{Na}_2\text{SiO}_3$ ):

?Prepared by fusing soda ash with pure sand at high temperature:  
 $\text{Na}_2\text{CO}_3 + \text{SiO}_2 \rightarrow \text{Na}_2\text{SiO}_3 + \text{CO}_2$

#### Silicones:

Silicon polymers containing Si - O - Si linkages formed by the hydrolysis of alkyl or aryl substituted chlorosilanes and their subsequent polymerisation.

#### Silicates:

Salts of silicic acid,  $\text{H}_4\text{SiO}_4$  comprised of  $\text{SiO}_4^{4-}$  units having tetrahedral structure formed as result of  $\text{sp}^3$  hybridization ion.

#### Nitrogen Family (Group 15 Elements)

- **Members:** N, P, As, Sb & Bi
- **Atomic Radii:** Increases down the group. Only a small increase from As to Bi.
- **Oxidation state:** +3, +4 & +5. Stability of +3 oxidation state increases down the group.
- **Ionization energy:** Increases from N to Bi.

## Nitrogen

### Preparation of Nitrogen:

- $3\text{CuO} + 2\text{NH}_3 + \text{Heat} \rightarrow \text{N}_2 + \text{Cu} + 3\text{H}_2\text{O}$
- $\text{CaOCl}_2 + 2\text{NH}_3 + \text{Heat} \rightarrow \text{CaCl}_2 + 3\text{H}_2\text{O} + \text{N}_2$
- $\text{NH}_4\text{NO}_2 + \text{Heat} \rightarrow 3\text{H}_2\text{O} + \text{N}_2 + \text{Cr}_2\text{O}_3$

### Properties of Dinitrogen:

- Formation of Nitrides (with Li, Mg, Ca & Al):  $\text{Ca} + \text{N}_2 + \text{Heat} \rightarrow \text{Ca}_3\text{N}_2$
- Oxidation:  $\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$
- Reaction with carbide (at 1273 K):  $\text{CaC}_2 + \text{N}_2 \rightarrow \text{CaCN}_2 + \text{C}$

### Oxides of Nitrogen

Formula	Resonance Structures	Bond Parameters
$\text{N}_2\text{O}$	$\ddot{\text{N}}=\text{N}=\ddot{\text{O}} \leftrightarrow \text{:N}\equiv\text{N}-\ddot{\text{O}}\text{:}$	$\text{N}-\text{N}-\text{O}$ 113 pm 119 pm Linear
$\text{NO}$	$\text{:N}=\ddot{\text{O}}\text{:} \leftrightarrow \text{:}\dot{\text{N}}=\ddot{\text{O}}\text{:}$	$\text{N}-\text{O}$ 115 pm
$\text{N}_2\text{O}_3$		 Planar
$\text{NO}_2$		 Angular
$\text{N}_2\text{O}_4$		 Planar
$\text{N}_2\text{O}_5$		 Planar

### Oxy -Acids of Nitrogen :

Oxy Acids	Name of oxy - acid
1. $\text{H}_2\text{N}_2\text{O}_2$	Hyponitrous acid
2. $\text{H}_2\text{NO}_2$	Hydronitrous acid
3. $\text{HNO}_2$	Nitrous acid
4. $\text{HNO}_3$	Nitric acid
5. $\text{HNO}_4$	Per nitric acid

## Ammonia (NH<sub>3</sub>):

### Preparation of Ammonia:

- By heating an ammonium salt with a strong alkali ;NH<sub>4</sub>Cl + NaOH --> NH<sub>3</sub> + NaCl + H<sub>2</sub>O
- By the hydrolysis of magnesium nitride: Mg<sub>3</sub>N<sub>2</sub> + 6H<sub>2</sub>O --> 3Mg(OH)<sub>2</sub> + 2NH<sub>3</sub>.
- Haber's process : N<sub>2</sub>(g) + 3H<sub>2</sub>(g) --> 2NH<sub>3</sub>(g).

### Properties of Ammonia:

- **Basic nature** : Its aq. solution is basic in nature and turns red litmus blue.  
NH<sub>3</sub> + H<sub>2</sub>O ↔ NH<sub>4</sub><sup>+</sup> + OH<sup>-</sup>
- **Reaction with halogens** :
  - 8NH<sub>3</sub> + 3Cl<sub>2</sub> --> 6NH<sub>4</sub>Cl + N<sub>2</sub>
  - NH<sub>3</sub> + 3Cl<sub>2</sub> (in excess) → NCl<sub>3</sub> + 3HCl
  - 8NH<sub>3</sub> + 3Br<sub>2</sub> → 6NH<sub>4</sub>Br + N<sub>2</sub>
  - NH<sub>3</sub> + 3Br<sub>2</sub> (in excess) → NBr<sub>3</sub> + 3HBr
  - 2NH<sub>3</sub> + 3I<sub>2</sub> → NH<sub>3</sub>.NI<sub>3</sub> + 3HI
  - 8NH<sub>3</sub>.NI<sub>3</sub> → 6NH<sub>4</sub>I + 9I<sub>2</sub> + 6N<sub>2</sub>
- **Complex formation** :
  - Ag<sup>+</sup> + NH<sub>3</sub> → [Ag(NH<sub>3</sub>)<sub>2</sub>]<sup>+</sup>
  - Cu<sup>2+</sup> + 4NH<sub>3</sub> → [Cu(NH<sub>3</sub>)<sub>4</sub>]<sup>2+</sup>
  - Cd<sup>2+</sup> + 4NH<sub>3</sub> → [Cd(NH<sub>3</sub>)<sub>4</sub>]<sup>2+</sup>

### Precipitation of heavy metal ions from the aq. solution of their salts :

- FeCl<sub>3</sub> + 3NH<sub>4</sub>OH → Fe(OH)<sub>3</sub> + 3NH<sub>4</sub>Cl  
Brown ppt.
- AlCl<sub>3</sub> + 3NH<sub>4</sub>OH → Al(OH)<sub>3</sub> + 3NH<sub>4</sub>Cl  
White ppt.
- CrCl<sub>3</sub> + 3NH<sub>4</sub>OH → Cr(OH)<sub>3</sub> + 3NH<sub>4</sub>Cl  
Green ppt.

## Phosphorus:

### Allotropy of Phosphorus:

#### a) White phosphorus:

- Translucent white waxy solid
- Extremely reactive
- Poisonous and insoluble in water

#### b) Red Phosphorus:

- Formed by heating white phosphorus in absence of air.
- Does not burn spontaneously at room temperature.

c) **Black Phosphorus:** Formed by further heating of red phosphorus.

### Compounds of Phosphorus:

#### a) Phosphine, PH<sub>3</sub>:

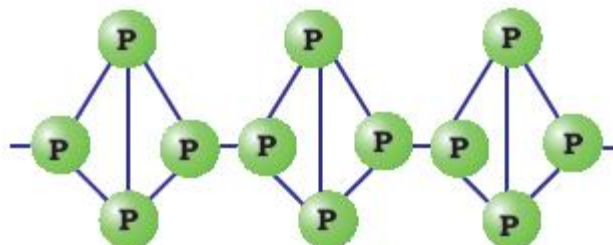
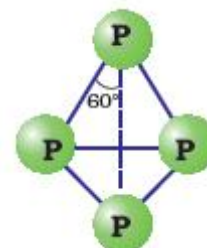
##### Preparation of Phosphine

- Ca<sub>3</sub>P<sub>2</sub> + 6H<sub>2</sub>O → 2 PH<sub>3</sub> + 3 Ca(OH)<sub>2</sub>
- 4H<sub>3</sub>PO<sub>3</sub> + Heat → PH<sub>3</sub> + 3 H<sub>3</sub>PO<sub>4</sub>
- PH<sub>4</sub>I + KOH → PH<sub>3</sub> + KI + H<sub>2</sub>O
- P<sub>4</sub> + 3KOH + 3H<sub>2</sub>O → PH<sub>3</sub> + 3KH<sub>2</sub>PO<sub>2</sub>

##### Properties of Phosphine:

- Formation of Phosphonic Iodide: PH<sub>3</sub> + HI → PH<sub>4</sub>I
- Combustion: PH<sub>3</sub> + 2O<sub>2</sub> → H<sub>3</sub>PO<sub>4</sub>

#### b) Phosphorous Halides:





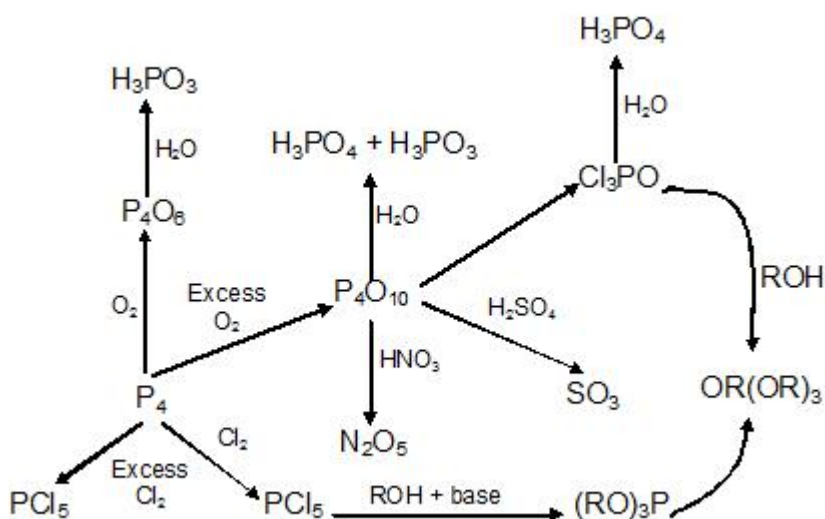
**Preparation:**

- $P_4 + 6Cl_2 \rightarrow 4PCl_3$
- $P_4 + 10Cl_2 \rightarrow 4PCl_5$
- $P_4 + 8SOCl_2 \rightarrow 4PCl_3 + 4SO_2 + 2S_2Cl_2$
- $P_4 + 10SOCl_2 \rightarrow 4PCl_5 + 10SO_2$

**Properties:**

- $PCl_3 + 3H_2O \rightarrow H_3PO_3 + 3HCl$
- $PCl_5 + 4H_2O \rightarrow POCl_3 + H_3PO_4 + 5HCl$
- $PCl_3 + 3CH_3COOH \rightarrow 3CH_3COCl + H_3PO_3$
- $PCl_5 + CH_3COOH \rightarrow CH_3COCl + POCl_3 + HCl$
- $2Ag + PCl_5 \rightarrow 2AgCl + PCl_3$
- $2Sn + PCl_5 \rightarrow SnCl_4 + 2PCl_3$
- $PCl_5 + Heat \rightarrow PCl_3 + Cl_2$

**?C) Oxides of Phosphorus:**



**d) Oxy - Acids of Phosphorus:**

Oxo acid	Name
H <sub>3</sub> PO <sub>2</sub>	Hypophosphorus acid
H <sub>3</sub> PO <sub>3</sub>	Phosphorus acid
H <sub>4</sub> P <sub>2</sub> O <sub>6</sub>	Hypophosphoric acid
H <sub>3</sub> PO <sub>4</sub>	Orthophosphoric acid
H <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	Pyrophosphoric acid
HPO <sub>3</sub>	Metaphosphoric acid

**Oxygen Family (Group 16 Elements) :**

Sr. No.	Property	Oxygen	Sulfur	Selenium	Tellurium	Polonium
1.	Configuration	[He]2s <sup>2</sup> 2p <sub>4</sub>	[Ne]3s <sup>2</sup> 3p <sub>4</sub>	[Ar]4s <sup>2</sup> 4p <sub>4</sub>	[Kr]5s <sup>2</sup> 5p <sub>4</sub>	[Xe]6s <sup>2</sup> 6p <sub>4</sub>
2.	Common oxidation state	-2	-2, +4, +6	+4, +6	+4, +6	

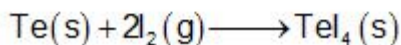
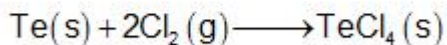
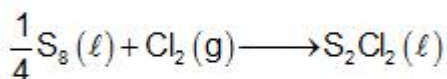
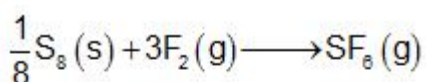
3.	Atomic radius (pm)	66	104	116	143	167
4.	First ionization energy (KJ/mol)	1314	1000	941	869	812
5.	Electronegativity	3.5	2.5	2.4	2.1	2.0

### Chemical Properties of Group 16:

#### Formation of volatile Hydrides:



#### Formation of Halides:



#### Formation of Oxide:

a) All elements (except Se) forms monoxide.

b) All elements form dioxide with formula  $\text{MO}_2$ ,  $\text{SO}_2$  is a gas,  $\text{SeO}_2$  is volatile solid. While  $\text{TeO}_2$  and  $\text{PoO}_2$  are non - volatile crystalline solids.

c) **Ozone:** It is unstable and easily decomposes into oxygen. It acts as a strong oxidising agent due to the ease with which it can liberate nascent oxygen.

#### Oxyacids:

Sulphur	Selenium	Tellurium
Sulphurous acid $\text{H}_2\text{SO}_3$ .	Selenious acid $\text{H}_2\text{SeO}_3$	Tellurous acid $\text{H}_2\text{TeO}_3$ .
Sulphuric acid $\text{H}_2\text{SO}_4$	Selenic acid $\text{H}_2\text{SeO}_4$	Telluric acid $\text{H}_2\text{TeO}_4$ .
Peroxomonosulphuric acid $\text{H}_2\text{SO}_5$ (Caro's acid)		
Peroxodisulphuric acid $\text{H}_2\text{S}_2\text{O}_8$ (Marshall's acid)		
Thio sulphuric acid $\text{H}_2\text{S}_2\text{O}_3$		
Dithionic acid $\text{H}_2\text{S}_2\text{O}_6$		
Pyrosulphuric acid $\text{H}_2\text{S}_2\text{O}_7$		

#### Allotropes of Sulphur :

##### Rhombic sulphur:

- It has bright yellow colour.
- It is insoluble in water and carbon disulphide. Its density is  $2.07 \text{ gm cm}^{-3}$  and exists as  $\text{S}_8$  molecules. The 8 sulphur atoms in  $\text{S}_8$  molecule forms a puckered ring.



### Monoclinic Sulphur :

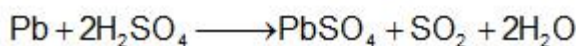
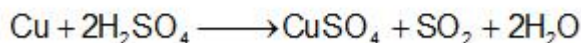
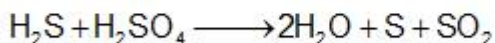
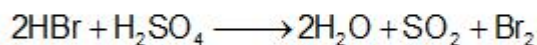
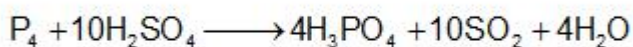
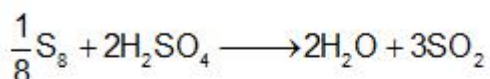
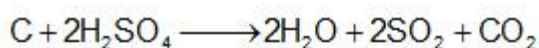
- Stable only above 369 K. It is dull yellow coloured solid, also called *b - sulphur*. It is soluble in CS<sub>2</sub> but insoluble in H<sub>2</sub>O.
- It slowly changes into rhombic sulphur. It also exist as S<sub>8</sub> molecules which have puckered ring structure. It however, differs from the rhombic sulphur in the symmetry of the crystals

### Plastic Sulphur:

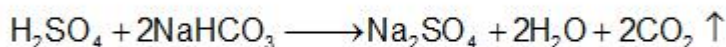
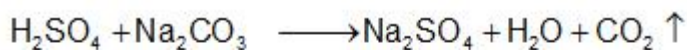
- It is obtained by pouring molten sulphur to cold water.
- It is amorphous form of sulphur.
- It is insoluble in water as well as CS<sub>2</sub>.

### Sulphuric Acid:

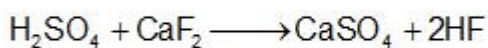
- Due to strong affinity for water, H<sub>2</sub>SO<sub>4</sub> acts as a powerful dehydrating agent.
- Concentrated H<sub>2</sub>SO<sub>4</sub> reacts with sugar, wood, paper etc to form black mass of carbon. This phenomenon is called charring.
- It is moderately strong oxidizing agent.



- Decomposes carbonates, bicarbonates, sulphides, sulphites, thiosulphates and nitrites at room temperatures.



- Salts like chlorides, fluorides, nitrates, acetates, oxalates are decomposed by hot conc.  $\text{H}_2\text{SO}_4$  liberating their corresponding acids.



### Halogen Family ( Group 17 Elements)

#### Inter halogen compounds:

Type $\text{XX}'_1$ (n = 1) (with linear shape)	Type $\text{XX}'_3$ (n = 3) (with T-shape)	$\text{XX}'_5$ (n = 5) (with square pyramidal shape)	$\text{XX}'_7$ (n = 7) with pentagonal bipyramidal shape)
ClF	ClF <sub>3</sub>	ClF <sub>5</sub>	
BrF BrCl	BrF <sub>3</sub>	BrF <sub>5</sub>	
ICl, IBr, IF	ICl <sub>3</sub> , IF <sub>3</sub>	IF <sub>5</sub>	IF <sub>7</sub>

#### Hydrogen Halides:

##### Properties of Hydrogen Halides:

- All the three acids are reducing agents HCl is not attacked by  $\text{H}_2\text{SO}_4$ .
  - $2\text{HBr} + \text{H}_2\text{SO}_4 \rightarrow 2\text{H}_2\text{O} + \text{SO}_2 + \text{Br}_2$
  - $2\text{HI} + \text{H}_2\text{SO}_4 \rightarrow 2\text{H}_2\text{O} + \text{SO}_2 + \text{I}_2$
- All the three react with  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$ 
  - $2\text{KMnO}_4 + 16\text{HCl} \rightarrow 2\text{KCl} + 2\text{MnCl}_2 + 8\text{H}_2\text{O} + 5\text{Cl}_2$
  - $\text{K}_2\text{Cr}_2\text{O}_7 + 14\text{HBr} \rightarrow 2\text{KBr} + 2\text{CrBr}_3 + 7\text{H}_2\text{O} + 3\text{Br}_2$
- Other reactions are similar.
  - Dipole moment :  $\text{HI} < \text{HBr} < \text{HCl} < \text{HF}$
  - Bond length:  $\text{HF} < \text{HCl} < \text{HBr} < \text{HI}$
  - Bond strength:  $\text{HI} < \text{HBr} < \text{HCl} < \text{HF}$
  - Thermal stability:  $\text{HI} < \text{HBr} < \text{HCl} < \text{HF}$
  - Acid strength:  $\text{HF} < \text{HCl} < \text{HBr} < \text{HI}$
  - Reducing power:  $\text{HF} < \text{HCl} < \text{HBr} < \text{HI}$

#### Pseudohalide ions and pseudohalogens:

Ions which consist of two or more atoms of which at least one is nitrogen and have properties similar to those of halide ions are called pseudohalide ions. Some of these pseudohalide ions can be oxidised to form covalent dimers comparable to halogens ( $\text{X}_2$ ). Such covalent dimers of pseudohalide ions are called pseudohalogens.

The best known pseudohalide ion is  $\text{CN}^-$

Pseudohalide ions	Name
$\text{CN}^-$	Cyanide ion
$\text{OCN}^-$	Cyanate ion
$\text{SCN}^-$	Thiocyanate ion
$\text{SeCN}^-$	Selenocyanate ion
$\text{NCN}^{2-}$	Cyanamide ion
$\text{N}_3^-$	Azide ion
$\text{OMC}^-$	Fulminate ion

## Pseudohalogen

- $(\text{CN})_2$  cyanogen
- $(\text{SCN})_2$  thiocyanogen

## Some important stable compound of Xenon

- $\text{XeO}_3$  Pyramidal
- $\text{XeO}_4$  Tetrahedral
- $\text{XeOF}_4$  Square pyramidal
- $\text{XeO}_2\text{F}_2$  Distorted octahedral

First rare gas compound discovered was  $\text{Xe}^+ (\text{PtF}_6)^-$  by Bartlett.

## Oxyacids of Chlorine

Formula	Name	Corresponding Salt
$\text{HOCl}$	Hypochlorous acid	Hypochlorites
$\text{HClO}_2$	Chlorous acid	Chlorites
$\text{HClO}_3$	Chloric acid	Chlorates
$\text{HClO}_4$	Perchloric acid	Perchlorates

**Acidic Character:** Acidic character of the same halogen increases with the increase in oxidation number of the halogen:  $\text{HClO}_4 > \text{HClO}_3 > \text{HClO}_2 > \text{HOCl}$

## Preparation

### $\text{HOCl}$ :

- $\text{Ca}(\text{OCl})_2 + 2\text{HNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + 2\text{HOCl}$

### $\text{HClO}_2$ :

- $\text{BaO}_2 + 2\text{ClO}_2 \rightarrow \text{Ba}(\text{ClO}_2)_2 (\text{liquid}) + \text{O}_2$
- $\text{Ba}(\text{ClO}_2)_2 + \text{H}_2\text{SO}_4(\text{dil.}) \rightarrow \text{BaSO}_4 + 2\text{HClO}_2$

### $\text{HClO}_3$ :

- $6\text{Ba}(\text{OH})_2 + 6\text{Cl}_2 \rightarrow 5\text{BaCl}_2 + \text{Ba}(\text{ClO}_3)_2 + 6\text{H}_2\text{O}$
- $\text{Ba}(\text{ClO}_3)_2 + \text{H}_2\text{SO}_4(\text{dil.}) \rightarrow \text{BaSO}_4 + 2\text{HClO}_3$

### $\text{HClO}_4$ :

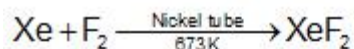
- $\text{KClO}_4 + \text{H}_2\text{SO}_4 \rightarrow \text{KHSO}_4 + \text{HClO}_4$
- $3\text{HClO}_3 \rightarrow \text{HClO}_4 + 2\text{ClO}_2 + \text{H}_2\text{O}$

## The Noble Gases (Group 18 Elements):

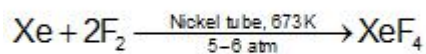
The noble gases are inert in nature. They do not participate in the reactions easily because they have

- stable electronic configuration i.e. complete octet.
- high ionization energies.
- low electron affinity.

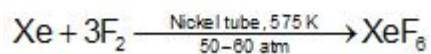
## Compounds of Xenon



(1: 2)



(1: 5)



(1: 20)

Molecule	Total electron pairs (BP + LP)	Hybridisation	Shape
XeF <sub>2</sub>	5	Sp <sup>3</sup> d	Linear
XeF <sub>4</sub>	6	Sp <sup>3</sup> d <sup>2</sup>	Square planar
XeF <sub>6</sub>	7	sp <sup>3</sup> d <sup>3</sup>	Distorted octahedral

### Uses of Nobles gas

The noble gases are used in following ways:

#### (A) Helium

- It is used to fill airships and observation balloons.
- In the oxygen mixture of deep sea divers.
- In treatment of asthma.
- Used in inflating aeroplane tyres.
- Used to provide inert atmosphere in melting and welding of easily oxidizable metals.

#### (B) Neon

- It is used for filling discharge tubes, which have different characteristic colours and are used in advertising purposes.
- Also used in beacon lights for safety of air navigators as the light possesses fog and stram penetrating power.

#### (C) Argon

Along with nitrogen it is used in gas - filled electric lamps because argon is more inert than nitrogen.