GROUP-16 ELEMENTS (CHALCOGENS)

Grouo 16 Elements: O,S,Se,Te,Po

General electronic configuration: ns^2np^4

ATOMIC & PHYSICAL PROPERTIES

- Ionisation enthalpy decreases from oxygen to polonium.
- Oxygen atom has less negative electron gain enthalpy than S because of the compact nature of the oxygen atom.However from the S onwards the value again becomes less negative upto polonium.
- Electronegativity gradually decreases from oxygen to polonium,metallic character increases from oxygen to polonium.
- Oxygen & S are non-metals,selenium and telurium are metalloids.Po is a radioactive metal.
- Oxygen is a diatomic gas while S,Se&Te are octa atomic solid S_8,Se_8&Te_8 molecules which has puckered ' ring' structure**.**

CHEMICAL PROPERTIES

- Common oxidation state:- -2,+2,+4 &+6.
- Due to inert pair effect,the stability of +6 decreases down the group and stability of +4 increases.

Oxygen exhibits +1 state in O_2F_2,+2 in OF_2**.**

Anamolous behavior of oxygen-due to its small size,high electronegativity and absence of d-orbitals.

TREND IN PROPERTIES

Acidic character-$H_2O<H_2S<H_2Se<H_2Te$

Thermal stability-$H_2O>H_2S>H_2Se>H_2Te$

Reducing character-$H_2S<H_2Se<H_2Te$

Boiling point-$H_2S<H_2Se<H_2Te<H_2O$

Reducing property of dioxides-$SO_2>SeO_2>TeO_2$

Stability of halides-F>Cl>Br>I

HALIDES OF SULPHUR

DI HALIDES:sp^3hybridisation but angular structure,SCl_2

TETRA HALIDES:SP^3hybridisation-see-saw geometry,SF_4

HEXA HALIDES:sp^3d^2,octahedral SF_6

DIOXYGEN

$2Fe^{3+}+SO_2+2H_2O \rightarrow 2Fe^{2+} + SO_4^{2-} + 4H^+$

$5SO_2+2MnO_4^- +2H_2O \rightarrow 5SO_4^{2-} +4H^+ +2Mn^{2+}$

SO_2 molecule is angular.

OXIDES

A binary compound of oxygen with another element is called oxide. Oxides can be classified on the basis of nature

- **Acidic Oxides:-**Non metallic oxides. Aqueous solutions are acids. Neutralize bases to form salts.Ex:So_2,Co_2,N_2O_5 etc**.**
- **Basic Oxides:**metallicoxides.Aqueous solutions are alkalis. Neutralize acids to form salts.Ex:Na_2O,K_2o,etc.
- **Amphoteric oxides:-**some metallic oxides exhibit a dual behavior. Neutralize bothacids& bases to form salts.
  Ex:-Al_2O_3,SbO_2,SnO,etc**……..**

  Neutral non metal oxide → CO, N_2O, NO

OZONE

PREPARATION

Prepared by subjecting cold, dry oxygen to silent electric discharge.

$3O_2 \rightarrow 2O_3$

PROPERTIES

Due to the ease with which it liberates atoms of nascent oxygen, it acts as a powerful oxidizing agent. For eg:- it oxidisesleadsulphide to lead sulphate and iodide ions to iodine.

$PbS+4O_3 \rightarrow PbSO_4+4O_2$

SULPHUR DIOXIDE

PREPARATION

Burning of S in air

$S+O_2 \rightarrow SO_2$

Roasting of sulphide minerals

$4FeS_2 + 110_2 \rightarrow 2Fe_2O_3+8SO_2$

(Iron pyrites)

$2ZnS+ 3O_2 \rightarrow 2ZnO + 2SO_2$

(Zinc blende)

PROPERTIES

- Highly soluble in water to form solution of sulphurous acid
  $SO_2+H_2O \rightarrow H_2SO_3$
- SO_2 reacts with Cl_2 to form sulphuryl chloride
  $SO_2+Cl_2 \rightarrow SO_2Cl_2$
- It reacts with oxygen to form SO_3 in presence of V_2O_5 catalyst
  $2SO_2+O_2 \rightarrow 2SO_3$

- Moist SO_2 behaves as a reducing agent. It converts Fe(III) ions to Fe(II) ions&decolourises acidified potassium permanganate (VII) solution(It is the test for the gas).

SULPHURIC ACID

PREPARATION

It is manufactured by contact process which involves following reactions.

$S+O_2 \rightarrow SO_2$

$$2SO_2+O_2 \xrightarrow{V_2O_5} 2SO_3$$

$SO_3+H_2SO_4 \rightarrow H_2S_2O_7$(Oleum)

$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

PROPERTIES

1. **H_2SO_4 is a di-basic acid which ionizes as -**

$$H_2SO_4 + H_2O \rightarrow H_3O^+ + HSO_4^-$$

$$HSO_4^- + H_2O \rightarrow H_3O^+ + SO_4^{2-}$$

2. **It is a strong dehydrating agent .eg:-charring action of sugar**

$$C_{12}H_{22}O_{11} \xrightarrow{H_2SO_4} 12C + 11H_2O$$

It is a moderately strong oxidizing agent.

$Cu+2H_2SO_4$(conc.) $\rightarrow CuSO_4+SO_2+2H_2O$

$C+2H_2SO_4$(conc.)$\rightarrow CO_2+2SO_2+2H_2O$