|| Shri Swami Samarth ||

General principles and processes of Isolation of elements.

(Section - I)

❒ Free state or native state.

The metals which are non-reactive with air, water, carbon dioxide and non-metals occur in free or native state.

e.g.- i) Gold and platinum are found exclusively in the free state, non metals like carbon , sulphur and noble gases occur in free state .

e.g.- ii) Copper , Silver and mercury occur partly in the free state.

- **Combined form**

Most of the metals occur in nature in the combined form with other elements i.e. in the form of compounds like oxides, sulphides, carbonates, sulphates, silicates etc.

★ **Mineral** : A naturally occurring substance obtained by mining which contains the metal in free state or combined state is called mineral.

★ **Ore** : A mineral containing a high percentage of the metal , from which the metal can be profitably extracted is called ore.

A metal may occur in several minerals. A few of these (ores) are used in the extraction of metals.

Hence, all ores are minerals. But all minerals are not ores.

Metal	Minerals		Ore
Iron (Fe)	Haematite	Fe_2O_3	Haematite Fe_2O_3
	Magnetite	Fe_3O_4	
	Limonite	$2\,Fe_2O_3, 3H_2O$	
	Iron Pyrite	FeS_2	
	Siderite	$FeCO_3$	
Zinc (Zn)	Zinc blende,	ZnS	Zinc blende, ZnS
	Zincite	ZnO	
	Calamine	$ZnCO_3$	
Magnesium (Mg)	Magnesite	$MgCO_3$	Dolomite $MgCO_3$, $CaCO_3$
	Dolomite	$MgCO_3$, $CaCO_3$	
	Epsum Salt	$MgSO_4, 7H_2O$	
Aluminium (Al)	Bauxite	$Al_2O_3, 2H_2O$	Bauxite $Al_2O_3, 2H_2O$
	Cryolite	Na_3AlF_6	
	China Clay	$Al_2O_3, 2SiO_2, 2H_2O$	

(2) Formation of carbon monoxide from carbon.

$$2C_{(s)} + O_{2(g)} \longrightarrow 2CO_{(g)}$$

OR

$$C_{(S)} + \tfrac{1}{2}\, O_{2\,(g)} \longrightarrow CO_{\,(g)}$$

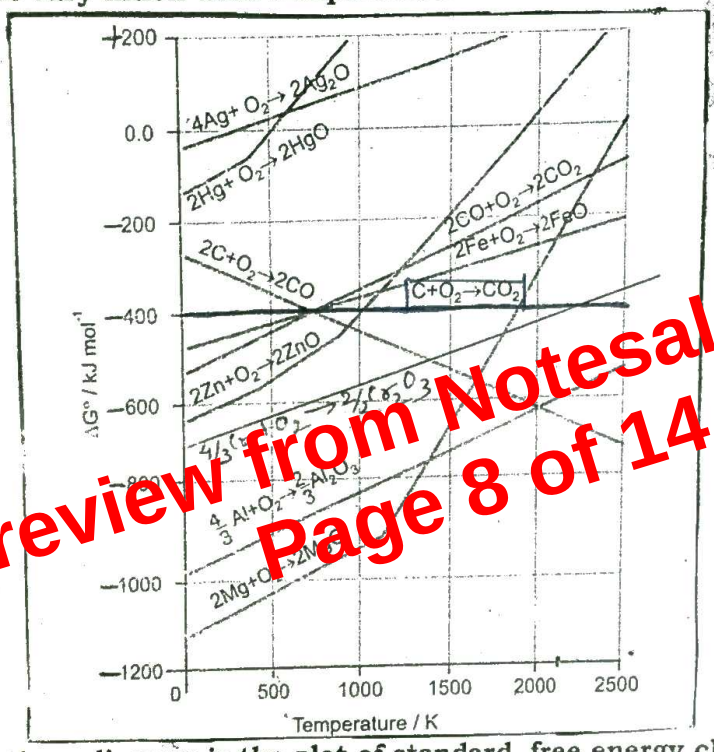
- For this reaction;
- ΔH is negative. (combustion reac.) exothermic .
- ΔS is positive. (volume of gaseous product > volume of gaseous reactants) .
- **ΔG decreases with increase in temperature and the combustion becomes more spontaneous at higher temp.**

(3) Formation of CO_2 from C.

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)} \qquad \Delta n = 1 - 1 = 0$$

- For this reaction ΔH is negative and ΔS is almost zero. Since $T\Delta S$ in equation is zero,
- **ΔG does not vary much with temperature.**

[2 mrks]



- **The Ellingham diagram is the plot of standard free energy change ΔG^o against temperature for the reaction of a metal and other elements with one mole of oxygen at 1 atmosphere.**

In terms of thermodynamics, the reduction of metal oxide with given reducing agent can occur if the free energy change (ΔG^o) for the reaction is negative.

Consider the reduction of metal oxide by carbon.

$$MO_{(s)} + C_{(s)} \longrightarrow M_{(s)} + C\,O_{(g)}$$

- This reduction can be considered as a competition between the metal and carbon to combine with oxygen.
- If the metal oxide is more stable, oxygen remains with the metal and if carbon monoxide is more stable, then oxygen is taken away by carbon from the metal oxide.
- **More negative the value of ΔG^o, the greater is the tendency of the element to combine with oxygen.**