

**TDC Part II**  
**Paper I, Group B**  
**Inorganic Chemistry**



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**TOPIC:- THE BINARY COMPOUNDS  
OF FIRST TRANSITION SERIES  
ELEMENTS**

## **THE BINARY COMPOUNDS OF FIRST TRANSITION SERIES ELEMENTS**

Those compounds which are formed by the combination of two different elements / ions are called binary compounds. For example, oxides, sulphides, halides, phosphides, carbides, nitrides, etc.

### **Oxides**

The elements of the 3d-transition series react with oxygen at high temperature to give oxides. These oxides are less basic and less soluble in water. Oxides in lower oxidation states are ionic and basic, in the intermediate oxidation states their nature is amphoteric and in higher oxidation states, ionic nature decreases and covalent nature increases thereby increasing the acidic character of the oxides. It means the acidity of a salt depends on its covalent nature which in turn is based on the oxidation state of the element. Thus, oxidation state  $\propto$  covalent nature  $\propto$  acidic nature. Accordingly, the oxides may be

classified as (a) basic oxides, (b) amphoteric oxides and (c) acidic oxides.

(a) **Basic oxides** are those which are formed by the metals in the lower oxidation states. These are ionic in nature, soluble in non-oxidising acids, e.g. HCl. For example, TiO, CrO, MnO, FeO, Cu<sub>2</sub>O, CoO, NiO, etc.

(b) **Amphoteric oxides** are the oxides containing the metals in the intermediate oxidation states. These oxides are also soluble in non-oxidising acids, e.g., HCl. Examples TiO<sub>2</sub>, VO<sub>2</sub>, Cr<sub>2</sub>O<sub>3</sub>, Mn<sub>3</sub>O<sub>4</sub>, MnO<sub>2</sub>, CuO, ZnO, etc.

(c) **Acidic oxides** are of weak acidic nature and are formed by the elements in higher oxidation states. These are soluble in bases. For example, V<sub>2</sub>O<sub>5</sub>, CrO<sub>3</sub>, MnO<sub>3</sub>, Mn<sub>2</sub>O<sub>7</sub> etc.

**Reducing and oxidising nature of oxides.** The electron exchange property determines the redox nature of oxides. The oxide containing the metal in lower oxidation state acts as electron donor and

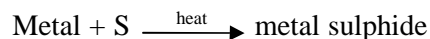
hence is a reductant (reducing agent). As atomic number increases, the reducing property in the lower oxidation state also increases, e.g.,  $\text{TiO} < \text{VO} < \text{CrO}$ . If the metal in the oxide is in higher oxidation state, the oxide is electron acceptor or oxidising agent, e.g.,  $\text{CrO}_3$ ,  $\text{Mn}_2\text{O}_7$  etc.

# Halides

The elements of 3d-transition series react with halogens at high temperature to give halides. The reactivity of halogens goes on decreasing from  $F_2$  to  $I_2$ . Fluorides are ionic, others have ionic as well as covalent nature. Halides are formed by many of these elements in different oxidation states, e.g.  $TiCl_3$ ,  $TiCl_4$ ,  $VCl_3$ ,  $VCl_5$  etc.

# Sulphides

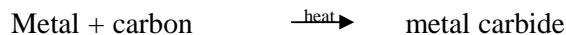
Metal sulphides may either be prepared by direct heating the mixture of metal and sulphur or by treating metal salt solution with  $H_2S$  or  $Na_2S$ :



Metals in low oxidation state form sulphides which are insoluble in water.

# Carbides

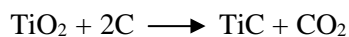
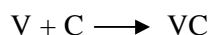
Metal carbides are generally prepared by the following two methods:



The carbides of these metals are classified as follows:

## (a) **Metallic or Interstitial carbides**

These carbides are prepared as is given below.



These are hard solids, have metallic properties like lustre, are stable at high temperature, chemically inert and are conductors. Ni does not form carbide. In solid state, these have tetrahedral or octahedral voids which are occupied by carbon atoms.

## (b) **Salt-like carbides**

These carbides are limited to Sc, Cu and Zn only and are ionic in nature:

