SUBJECT - CHEMISTRY
CLASS - BSc (Hons) PART-II
PAPER - III
GROUP - B
TOPIC - OXIDATION STATE

Dr Hari Mohan prasad Singh
Department of Chemistry
Dr. L.K.V.D College Tajpur, Samastipur

Table: oxidation states

| Electronic Structure | Sc $d^1s^2$ | Ti $d^2s^2$ | V $d^3s^2$ | Cr $d^5s^1$ | Mn $d^5s^2$ | Fe $d^6s^2$ | Co $d^7s^2$ | Ni $d^8s^2$ | Cu $d^{10}s^1$ | Zn $d^{10}s^2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| oxidation states | | | | I | | | | | I | |
| | II | II | II | II | II | II | II | II | II | II |
| | III | III | III | III | III | III | III | III | III | |
| | | IV | IV | IV | IV | IV | IV | IV | | |
| | | | IV | V | V | V | V | | | |
| | | | | VI | VI | VI | | | | |
| | | | | | VII | | | | | |

Thus Sc could have an oxidation number of (+II) if both s electrons are used for bonding and (+III) when two s and one d electrons are involved. Ti has an oxidation state (+II) when both s electrons are used for bonding, (+III) when two s and one d electrons are used and (+IV) when two s and two d electrons are used. Similarly, V shows oxidation numbers (+II), (+III), (+IV) and (+V). In the case of Cr, by using the single s electron for bonding, we get an oxidation number of (+I) hence by using varying numbers of d electrons oxidation states of (+II), (+III), (+IV), (+V) and (+VI) are possible. Mn has oxidation states (+II), (+III), (+IV), (+V), (+VI) and (+VII). Among these first five elements, The Correlation between electronic structure and minimum and

maximum oxidation states in simple compounds is complete. In the highest oxidation states of these first five elements, all of the s and d electrons are being used for bonding. Thus the properties depend only on the size and valency, and consequently show some similarities with elements of the main groups in similar oxidation states; for example, $SO_4^{2-}$ (group 16) and $CrO_4^{2-}$ (group 6) are isostructural as are $SiCl_4$ (group 14) and $TiCl_4$ (group 4).

Once the $d^5$ configuration is exceeded, i.e in the last five elements, the tendency for all the d electrons to participate in bonding decreases. Thus Fe has a maximum oxidation state of (+VI) However, the second and third elements in this group attain a maximum oxidation state of (+VIII) in $RuO_4$ and $OsO_4$. This difference between Fe and the other two elements Ru and Os is attributed to the increased size.

These facts may be conveniently memorized, because the oxidation states form a regular 'pyramid' as shown in Table. Only Sc(+II) and Co(+V) are in doubt. The oxidation number of all elements in the elemental state is zero. In addition, several of the elements have zero-valent and other low-valent states in complexes. Low oxidation states occur particularly with $\pi$ bonding ligands such as carbon monoxide and dipyridyl. Similar but not identical pyramids of oxidation states are found in the second and third rows of transition elements.