TRANSITION METALS

PHYSICAL AND CHEMICAL PROPERTIES

General electronic configuration of elements $(n - 1) d^{1-10} ns^{1-2}$

1. Similarity in Chemical Properties :- All the elements in a group and a period show similarity in properties this is due to the similarity in electronic configuration of the elements .The energy of the ns orbital and (n-1) d orbital is almost the same and all elements have got incomplete d orbital.

2. Atomic Radii (Covalent radii):- The general trend is followed i.e. they decrease in a transition series, the decrease is only slight because the d orbital screens the 's' electrons, exception to this rule is for the last elements of the series shown due to the repulsion of the added electrons. (Same is the case with the ionic radii.)

3. Ionization Potential :- It increases with increase in atomic number but the variation is very small. This is because the effect of the increased nuclear charge is canceled by the increasing screening effect.

4. Melting and Boiling Points :- The M.P and B.P increases up to elements with five unpaired electrons(Cr,Mo & W) then there is a decrease. This is due to the formation of covalent bonds between elements with unpaired electrons of neighboring atoms leading to greater bond strength. In Zn, Cd & Hg the 'd ' orbital are fully filled hence they are low melting, eg. Hg is a liquid. Since the Enthalpy of atomization of is high it is clear that the bonding in transition metals are strong.

5. Metallic Character :- All transition elements have a) Relatively low ionization energy and b) More empty orbital than the number of electrons (one or two) in their valence shell hence they have metallic character. They are found to be more brittle than 's ' block elements . Cr,Mo & W are very hard where as Zn, Cd & Hg are not.

6. Variable Oxidation State :- Transition metals show variable valency. The energy difference between (n-1)d1-9 ns1-2 orbital is very small hence (n-1) d orbital can be used in addition to ns orbital for compound formation. Since inert pair effect is not seen in transition metals the oxidation states increase by units of +1.

7. Complex Formation :- The Cations of the d block elements are almost unique in their tendency to form Co-ordination compounds with ligands like NH3, CN-, CO etc.
The following conditions should be satisfied by the element in order to form complexes:
a) Small size of the Cat ion. b) High effective nuclear charge of the Cation. c) Availability of empty inner d-orbital of approximately the same energy for bonding to Ligands.

8. Formations of Coloured Ions :- Transition metal compounds in solid and solution are coloured . e.g.Ti3+ ions are Purple, Cu2+ ions are Blue this is due to the presence of unpaired electrons. The d-orbital split up into two set of orbital under the influence of an external (Octahedral) field . The energy gap between the 2 levels in the same d - subshell being small can be obtained from the visible light [t2g to eg transitions] . Hence compounds appear coloured. Zn, Cd & Hg do not form coloured compounds due to the absence of unpaired electrons.

9. Magnetic Properties :- Transition metals and their compounds show Paramagnetic properties due to the presence of unpaired electrons. Compounds that are Diamagnetic do not have unpaired electrons. Some of the elements show Ferromagnetic property.

10. Catalytic Property:- Transitions metals are good Catalysts. e.g. V2O5 is used as catalyst in the manufacture of H2SO4, Fe and Mo in Haber process, Ni in hydrogenation of fats and oils. The availability of vacant 'd' orbital helps in accepting electrons from reactant to form intermediate compounds.

11. Formation of Alloys:- Transition metals form alloys since these elements have similar atomic size and hence can mutually substitute their positions in the crystal lattice. Alloys are relatively harder than the elements from which they are made.
E.g of Alloys:Brass Cu 60-80 % Zn 40-20 %, German Silver Cu 50 %, Zn 25 %, Ni 25 %.

12. Interstitial Compounds :- Transition Metals entrap small elements like H,N,C etc.in the interstitial sites of Crystal Lattice to give Interstitial Compounds. This will increase the tensile strength by bonding with the transition metals.This decreases the Malleability and Ductility.
E.g. Steel contains Carbon .6 - 1.5 %