INTRODUCTION:

The elements in which the differentiating electron enters the d-orbital of the penultimate shell are called d - block element.

- d-block elements are present in between electropositive s-block elements and electronegative p-block elements in the periodic table.
- There are 4 series of d-block elements.
- First 3 series conation 10 elements each and fourth series is incomplete.
- 3d series – present in IV period starting from Sc(21) to Zn (30)
- 4d series – present in V period starting from Y(39) to Cd (48)
- 5d series – present in VI period starting from La(57) to Hg (80)
- 6d series – starts from Ac(89) and in complete. Present in VII period.
- d- block elements are also called transition elements, as they bring about the change from electropositive to electronegative in a gradual manner by being present in between s-block and p-blocks.
- All d-block element are not transition elements but all transition element are d-block elements.
- Zn, Cd and Hg are not transition elements as they contain completely filled (n –1)d orbitals.
- Cu, Ag and Au are called typical transition elements though they contain completely filled
  (n-1) d-orbitals because they show some similarities with other transition elements.
- A true transition element has partly filled d-sub level either in elemental state or in stable oxidation state of it's ion.
- d-block elements occupy III B – VII B, VIII, I B, II B groups of periodic table in 4th, 5th, 6th and 7th periods. VIII group has 3 elements. i.e transition triad.
- The outer electronic configuration of d-block elements is $ns^{1 \text{ or } 2}$ $(n-1)\,d^{1-10}$.
- Some d-block elements have exceptional configuration, to acquire the extra stability having half filled and completely filled d-orbtials, due to greater exchange energy.
- The following elements violate aufbau principle.

Ex : 1) Chromium - $4s^1\,3d^5$
2) Copper - $4s^1\,3d^{10}$
3) Molybdenum - $5s^1\,4d^5$
4) Palladium - $5s^0\,4d^{10}$
5) Silver - $5s^1\,4d^{10}$
6) Platinum - $6s^0 3d^{10}$or $6s^1 5d^9$
7) Gold - $6s^1\,5d^{10}$

- Transition of electrons between ns and (n –1) d levels takes place easily because the energy difference between these two levels is small.

Typical characteristic properties :

- The transition elements exhibit the following typical characteristic properties due to small size, large nuclear charge and presence of d-electrons.
  i) Variable oxidation states
  ii) Para and ferromagnetic properties
  iii) Formation of coloured hydrated ions and salts
  iv) Alloy formation
  v) Catalytic properties
  vi) Complex formation.

Variable oxidation states:

- They show variable oxidation states and variable valency due to the involvement of (n–1)d electrons along with ns electrons.
- Smaller energy difference between (n–1)d and ns electrons permit the (n–1)d electrons to participate in bonding.
- Cr and Cu can exhibit +1 oxidation state. Highest oxidation state is exhibited by Mn i.e. +7 in
  3d series.
- The number of oxidation states increases from left to middle and then decreases.
- The stability of oxidation state is related to stable electronic configuration.
  Fe^{3+} ($3d^5$) is more stable than Fe^{2+} ($3d^6$)
  Mn^{2+} ($3d^5$) is more stable than all it's other oxidation state.
  Cu^{2+}($3d^9$) is more stable than Cu^{+1} ($3d^{10}$) due to greater hydration energy.
- The maximum oxidation state of these elements is the sum of ns electrons and unpaired (n–1)d electrons.
- Co $\rightarrow$ **+ 2, + 3,** + 4
- Cr $\rightarrow$ + 1,+2,**+3**,+5,**+6** oxidation state are possible
- Sc $\rightarrow$ + 3 ; Ni $\rightarrow$ **+ 2**, + 4
- Mn$\rightarrow$ **+2**, +3, +4, + 5, +6, +7.oxidation states are possible.
- Ti $\rightarrow$ + 2, + 3, **+ 4**
- Cu$\rightarrow$ +1, **+ 2** oxidation states are possible
- V $\rightarrow$ + 2, + 3, **+ 4, + 5**
- Fe $\rightarrow$ **+ 2, + 3,** + 4, + 5, + 6

Oxidation states which are underlined are stable.