THE D-AND F-BLOCK ELEMENTS

INTRODUCTION OF D-BLOCK ELEMENTS

❖ TRANSITION ELEMENTS (D&F BLOCK ELEMENTS)
D-BLOCK ELEMENTS
INTRODUCTION

(a) The elements positioned between the s- and p-block elements in the periodic table are collectively referred to as transition or transitional elements (T.E.S.).

(b) Their properties exhibit a transition from the highly electropositive s-block elements to the least electropositive p-block elements.

(c) In d-block elements, the last differentiating electron is accommodated in the penultimate shell.

(d) The general electronic configuration of transition element is $(n-1)d^{1-10}\ ns^{0,\ 1\ or\ 2}$

(e) These elements either in their atomic state or in any of their common oxidation state have partly filled (n-1)d orbitals of $(n-1)^{th}$ main shell.

(f) The transition elements have an incompletely filled d-level. Since Zn, Cd, Hg elements have d^{10} configuration and are not considered as transition elements but they are d-block elements.

Electronic Configuration

Ist Transition Series

Symbol	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Atomic No.	21	22	23	24	25	26	27	28	29	30
3d electrons	1	2	3	5	5	6	7	8	10	10
4s electrons	2	2	2	1	2	2	2	2	1	2

Irregular electronic configuration Cr, Cu

IInd Transition Series

Symbol	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
Atomic No.	39	40	41	42	43	44	45	46	47	48
4d electrons	1	2	4	5	5	7	8	10	10	10

5s electrons	2	2	1	1	2	1	1	0	1	2

Irregular electronic configuration Nb, Mo, Ru, Rh, Pd, Ag

IIIrd Transition Series

Symbol	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg
Atomic No.	57	72	73	74	75	76	77	78	79	80
5d electrons	1	2	3	4	5	6	7	9	10	10
6s electrons	2	2	2	2	2	2	2	1	1	2

Irregular electronic configuration W, Pt, Au

GENERAL PROPERTIES OF D-BLOCK ELEMENTS

(a) The properties of d-block elements within a specific period do not vary as significantly from one another as those of non-transition elements within the same period.

(b) This is attributed to the fact that, in a transition series, there is no alteration in the number of electrons in the outermost shell, and the only change occurs in the (n-1)d electrons from one member to another within a period.

Metallic Character

(a) As the number of electrons in the outermost shell ranges from one to two, all d-block elements are metals.

(b) They exhibit hardness, malleability, and ductility (excluding Hg). Among the IB group elements, Cu, Ag, and Au are particularly notable for their high ductility and softness.

(c) These are good conductor of heat and electricity (due to free e^-) Elements of IB group are most conductive in nature. Their order of conductivity is

$$Ag > Cu > Au > Al$$

(d) Covalent and metallic bonding both exist in the atom of transition metals.

(e) The existence of a partially filled d-subshell promotes both covalent bonding and metallic bonding. These types of bonding are further favored by the possession of one or two electrons in the outermost energy shell.

Reducing Power

(a) The reducing power of d-block elements is contingent upon their electrode potential.

(b) Copper (Cu) exhibits the minimum Standard Oxidation Potential (SOP) in the 3d series, making it the least reducing element in this series.

(c) Gold (Au) holds the distinction of being the least reducing element in the d-block, attributed to its highest positive value of Standard Reduction Potential.

(d) The limited reducing capacity of transition metals results from their high heats of vaporization, high ionization potential, and low heat of hydration of their ions, as the reduction potential is influenced by all three of these factors.

Density

(a) The atomic volume of the transition elements are low, compared with s-block, so their density is comparatively high (D = M/V)

(b) Os (22.57 gm cm^{-3}) and Ir (22.61 gm cm^{-3}) have highest density.

(c) In all the groups (except IIIB) there is normal increase in density from 3d to 4d series, and from 4d to 5d, it increases just double. Due to lanthanide contraction

Ex. $Ti < Zr << Hf$

(d) In 3d series

$$\underbrace{\text{Sc Ti V Cr Mn Fe Co Ni}}_{\text{Density increases}} \quad \underbrace{\text{Cu Zn}}_{\text{Density decreases}}$$

(e) In 3d series highest density – Cu lowest density – Sc

(f) Some important orders of density

$$Fe < Ni < Cu \qquad Fe < Cu < Au \qquad Fe < Hg < Au$$

Melting and boiling points

(a) The melting and boiling points of d-block elements surpass those of s-block elements. This is attributed to the stronger metallic bonds and the presence of covalent bonds formed by unpaired d-electrons.

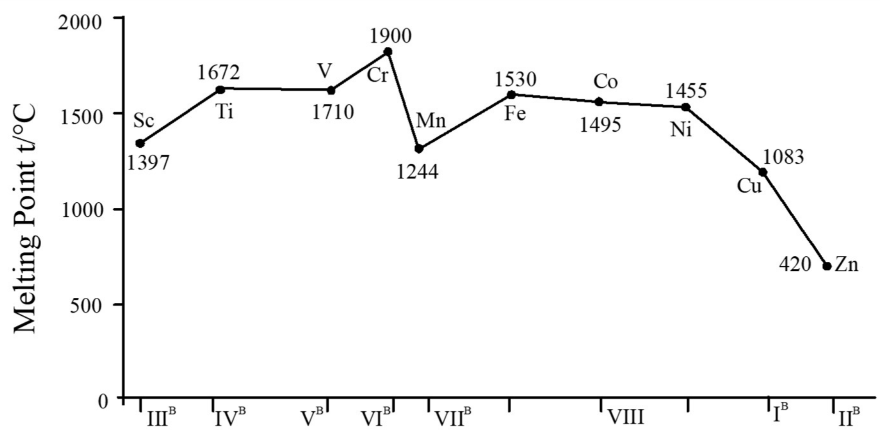
(b) In the series comprising Zn, Cd, and Hg, the absence of unpaired electrons in d-orbitals results in a significant decrease in melting and boiling points due to the lack of covalent bonds. These metals are characterized as volatile, including Zn, Cd, and Hg.

(c) Within the 3d series, from Sc to Cr, there is an increase in melting and boiling points, followed by a decrease from Mn to Zn.

(d) With an increasing number of d-electrons, the expectation is for an increase in the number of covalent bonds between atoms up to the Cr-Mo-W family, where each d-orbital contains only unpaired electrons, providing the greatest opportunity for covalent sharing.

(e) Mn and Tc exhibit comparatively low melting points due to weak metallic bonds, stemming from a stable half-filled (d5) configuration.

(f) Hg boasts the lowest melting point at -38°C, while W has the highest melting point, reaching approximately 3400°C.



Graphic representation m.p. of 3d-series elements