4. The d- AND f- BLOCK ELEMENTS

STUDY NOTES

4. 0 In this chapter, starting with electronic configuration, we study various general, physical, chemical & special properties of d-block & f- block elements and their compounds.

I) d-block Elements

4. 1 **d-block Elements:** d-block (Group 3 to 12) is located in the middle of the periodic table in between s and p block. **d series elements. 3d series:** Sc 21 to Zn 30 **, 4d series:**Y 39 to Cd 48**, 5d series:** La 57, Hf 72 to Hg 80 **6d series:** Ac 89, Rf 104 to Cn 112.

Transition Elements: Elements with partially (incomplete) filled d-subshell are specially named transition elements. Only **Zn, Cd, Hg** have completely filled d -orbitals.

Except these 3 all the d-block elements are transition elements. Thus all transition elements are d-block elements, but all d-block elements are not transition elements.

4. 2 **Electronic configuration of d-block elements:**

General Electronic configuration of **d-block elements: $(n-1)d^{1-10}\ ns^{1-2}$.**

General Electronic configuration of **transition elements: $(n-1)d^{1-9}\ ns^{1-2}$.**

In d-block elements, the last electron (differentiating) enters into the d- orbital of the penultimate (n–1)d orbital where n is the ultimate (outermost) orbit.

4. 3 **Properties of transition elements:**

4. 3.1 **Transition elements show a steady decrease in** atomic size from left to right in each period.

4. 3.2 Transition elements show **variable oxidation states. (+1 to +8),** with common O.S +2.

Ex: Oxidation states of Mn: +2 to +7

4. 3.3 Transition elements show magnetic property due to unpaired electrons.

Elements with **unpaired electrons** are **paramagnetic. Ex:** Mn^{2+} : $[Ar]4s^0 3d^5$

Elements with **paired electrons** are **diamagnetic. Ex:** Zn^{2+}: $[Ar]4s^0 3d^{10}$

Few metals Fe, Co, Ni show ferromagnetism.

PERIODIC TABLE

	s-BLOCK 1		d-BLOCK 3	4	5	6	7	8	9	10	11	12	p-BLOCK 13	14	15	16	17	18
1s	H	2																He
2s	Li	Be											2p B	C	N	O	F	Ne
3s	Na	Mg											3p Al	Si	P	S	Cl	Ar
4s	K	Ca	3d Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	4p Ga	Ge	As	Se	Br	Kr
5s	Rb	Sr	4d Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	5p In	Sn	Sb	Te	I	Xe
6s	Cs	Ba	5d La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	6p Tl	Pb	Bi	Po	At	Rn
7s	Fr	Ra	6d Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	7p Nh	Fl	Mc	Lv	Ts	Og

f-BLOCK														
4f	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
5f	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

4. 3.4 Transition metal ions show colour property due to the presence of the number of unpaired **d** electrons.

Ex: Cu^{2+} has one unpaired electron, it absorbs energy in visible region.

Hence it is coloured (blue) whereas Zn^{2+} has no unpaired electrons, hence it is colourless.

4. 3.5 Transition metals form **large number of complex compounds** due to their small size, high nuclear charge and presence of vacant d-orbitals.

4. 3.6 Transition elements show **catalytic property** and form intermediates due to their variable oxidation states.

4. 3.7 Certain Transition metals like Fe, Ti form interstitial compounds like Fe-C, Ti-H.

Here small sized atoms like H,C,B,N occupy the empty interstitial sites of crystal lattice of transition metals Fe, Ti, V to form interstitial compounds Fe-C, Ti-H.

4. 3.8 Certain transition metals forms **alloys**(homogeneous mixture) easily with improved strength due to nearly equal sizes of atoms. **Ex:** Brass (Cu- Zn), Bronze (Cu-Tin), Mischmetal etc.,

4. 3.9 Transition elements form various **oxides** and **oxo anions** of metals.

Oxides Ex: CrO, Cr_2O_3, CrO_3; MnO, MnO_2, Mn_2O_7; FeO, Fe_2O_3, Fe_3O_4, **$KMnO_4$, $K_2Cr_2O_7$**

Oxo anions Ex: : CrO_4^{2-} (yellow), $Cr_2O_7^{2-}$ (orange), MnO_4^- (purple)

4. 3.10 **Applications of d-Block Elements: Catalysts** (Fe, Ni, Pt);**Alloys** (brass, stainless steel); Electrical and magnetic materials; Coins, Jewellery.

II) f-block Elements

4.4 The f-block consists of two series i) Lanthanides ii) Actinides

i) Lanthanides [14 elements after Lanthanum, from Cerium (Ce- 58) to Lutetium (Lu-71)]

ii) Actinides [14 elements after Actinium, from Thorium (Th- 90) to Lawrencium(Lu-103)]

4.4.1 Electronic configuration of Lanthanides: **$[Xe]4f^{1-14}5d^{0-1}6s^2$**

Electronic configuration of Actinides: **$[Rn]5f^{1-14}6d^{0-1}7s^2$**

4.4.2 General Characteristics of Lanthanides:

Soft, silvery metals; Highly reactive (especially with air and water);

form **coloured ions**; mostly **Paramagnetic**; good Reducing agents

• **Lanthanide contraction** is the decrease in the size of Lanthanides even with increase in atomic number due to **poor screening effect of 4f–electrons**.

4.4.3 Comparison of Lanthanides & Actinides:

i)Actinides are more radioactive than Lanthanides.

ii) Actinides form more stronger complex compounds than Lanthanides.

iii) Actinides show more oxidation states than Lanthanides.

4.4.4 Applications of f-Block Elements:

i) Lanthanides: Used in magnets, phosphors, glass polishing

ii) Actinides: Used in **nuclear energy (U, Pu),** Radioactive isotopes in medicine