



सत्यमेव जयते

GOVERNMENT OF MAHARASHTRA

RAJARAM COLLEGE

VIDYANAGAR, KOLHAPUR – 416 004 (MS)



B. Sc. Part-II, Semester-IV

Chemistry of Elements of 3d Series Elements



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Quality Education...

For Personality...

For Nationality...



INTRODUCTION

	1A (1)																	8A (18)		
1		2A (2)													3A (13)	4A (14)	5A (15)	6A (16)	7A (17)	
2			TRANSITION ELEMENTS <i>d</i> block																	
3			3B (3)	4B (4)	5B (5)	6B (6)	7B (7)	8B (8) (9) (10)			1B (11)	2B (12)								
4			21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn								
5			39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd								
6			57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg								
7			89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110	111	112								

INNER TRANSITION ELEMENTS
f block

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

WHY STUDY DESCRIPTIVE CHEMISTRY OF TRANSITION METALS

Transition metals are found in nature

- Rocks and minerals contain transition metals.
- The color of many gemstones is due to the presence of transition metal ions.
 - Rubies are red due to Cr
 - Sapphires are blue due to presence of Fe and Ti
- Many biomolecules contain transition metals that are involved in the functions of these biomolecules
 - Vitamin B12 contains Co
 - Hemoglobin, myoglobin, and cytochrome C contain Fe

WHY STUDY DESCRIPTIVE CHEMISTRY OF TRANSITION METALS

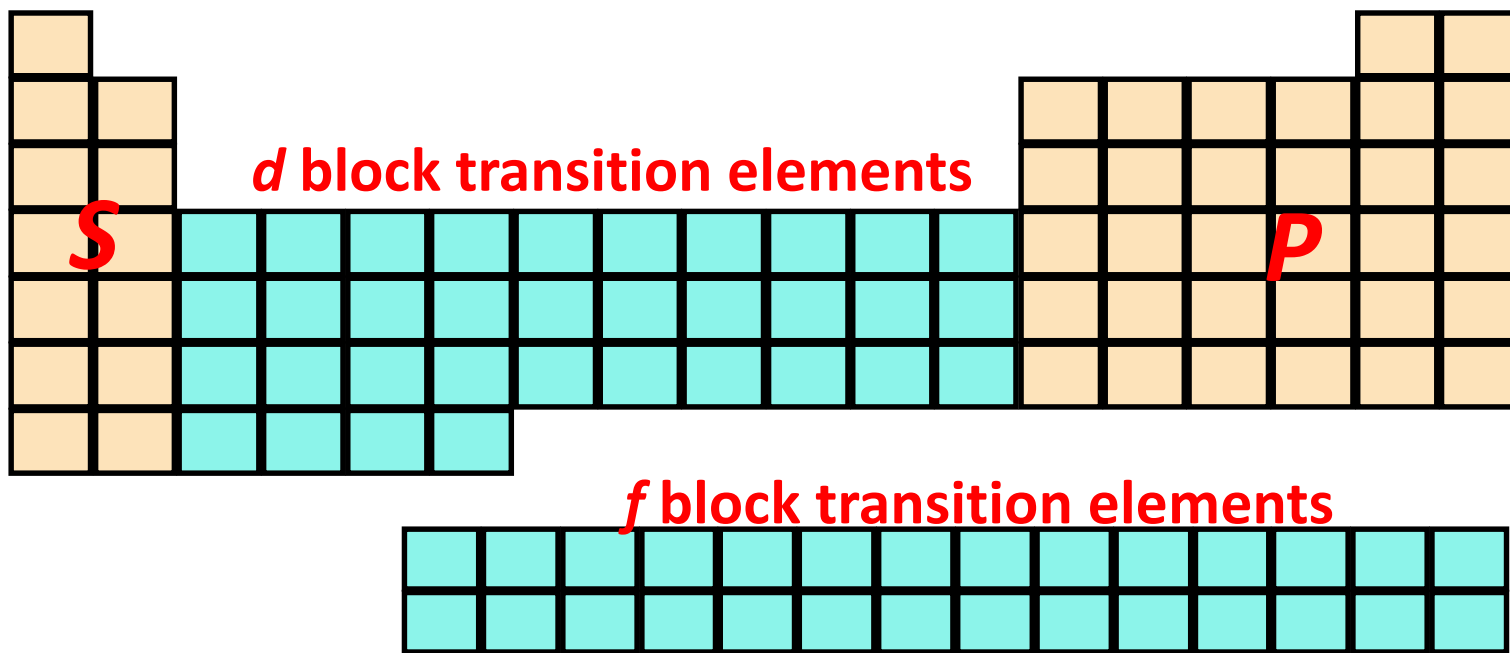
Transition metals and their compounds have many useful applications

- Fe is used to make steel and stainless steel
- Ti is used to make lightweight alloys
- Transition metal compounds are used as pigments
 - TiO_2 = white
 - PbCrO_4 = yellow
 - $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ (prussian blue) = blue
- Transition metal compounds are used in many industrial processes.

d - BLOCK ELEMENTS

The elements in the Periodic Table which correspond to the **d sublevels filling** are called ***d block elements***.

These elements are also known as “transition elements”



TRANSITION ELEMENTS

IIIB IVB VB VIB VIIB VIIIB IB IIB

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg

FIRST TRANSITION SERIES



Scandium, Sc; 3B(3)



Titanium, Ti; 4B(4)



Vanadium, V; 5B(5)



Chromium, Cr; 6B(6)



Manganese, Mn; 7B(7)



Iron, Fe; 8B(8)



Cobalt, Co; 8B(9)



Nickel, Ni; 8B(10)



Copper, Cu; 1B(11)

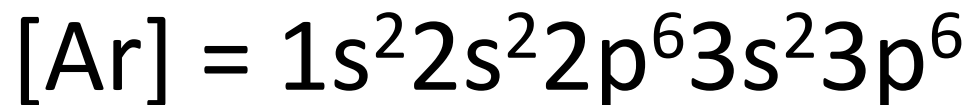


Zinc, Zn; 2B(12)

ELECTRONIC CONFIGURATION

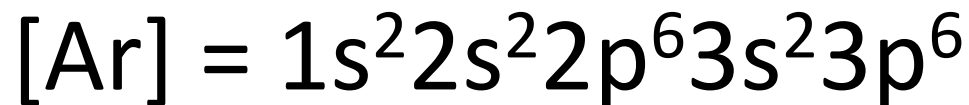


<u>Element</u>	<u>Configuration</u>
Sc	$[\text{Ar}]3d^14s^2$
Ti	$[\text{Ar}]3d^24s^2$
V	$[\text{Ar}]3d^34s^2$
Cr	$[\text{Ar}]3d^54s^1$
Mn	$[\text{Ar}]3d^54s^2$



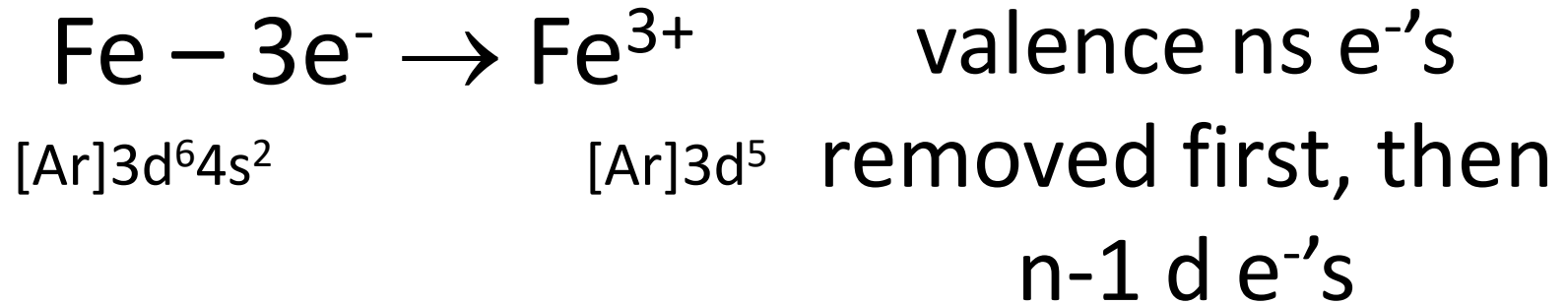
ELECTRONIC CONFIGURATION

Element	Configuration
Fe	[Ar] 3d ⁶ 4s ²
Co	[Ar] 3d ⁷ 4s ²
Ni	[Ar] 3d ⁸ 4s ²
Cu	[Ar]3d ¹⁰ 4s ¹
Zn	[Ar]3d ¹⁰ 4s ²

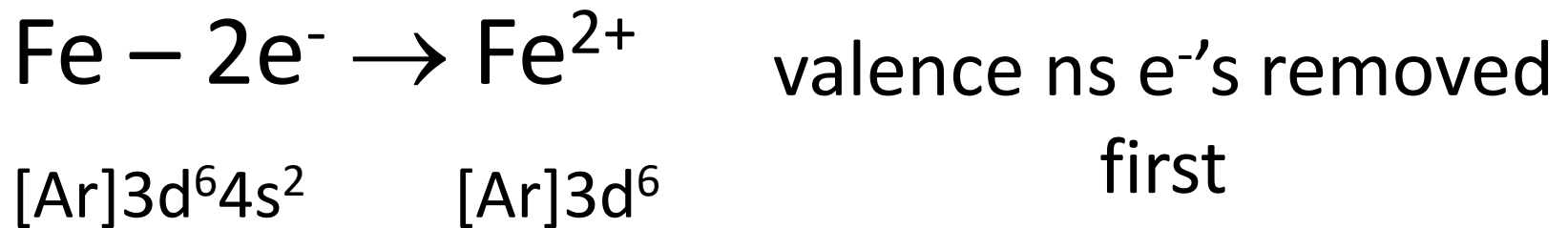


ELECTRONIC CONFIGURATION OF IONS

- Electronic configuration of Fe^{3+}



- Electronic configuration of Fe^{2+}



1. Ni^{+2}

2. Cu^{+2}

3. Zn^{+3}

4. Cr^{+2}

OXIDATION STATE

The most stable oxidation states are in **red**, rarer oxidation states **pale blue**:

3	4	5	6	7	8	9	10	11	12
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
		1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3
	4	4	4	4	4	4	4	4	4
		5	5	5	5	5	5	5	5
			6	6	6	6	6	6	6
				7	7	7	7	7	7

Maximum at Mn(VII)

Colored Ions



Scandium, Sc; 3B(3)



Titanium, Ti; 4B(4)



Vanadium, V; 5B(5)



Chromium, Cr; 6B(6)



Manganese, Mn; 7B(7)



Iron, Fe; 8B(8)



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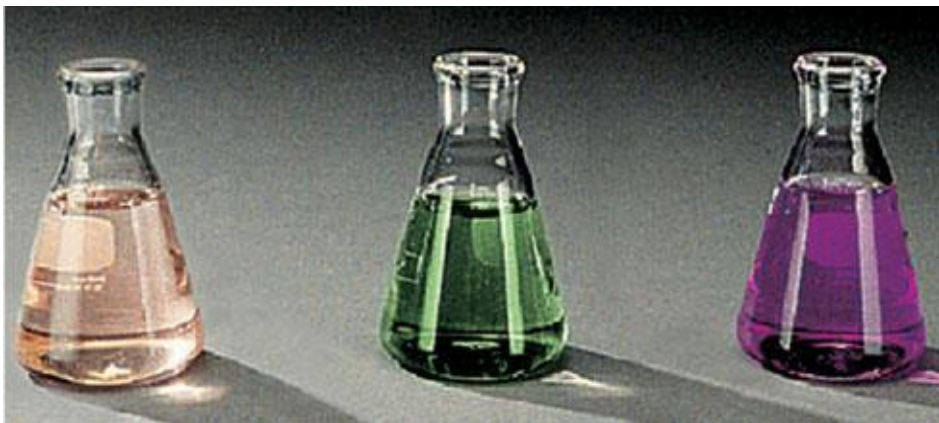
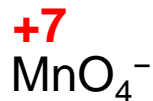
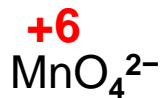
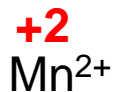


Copper, Cu; 1B(11)

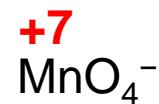
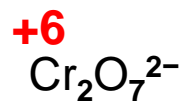
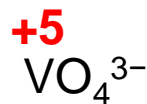


Zinc, Zn; 2B(12)

Colored Ions



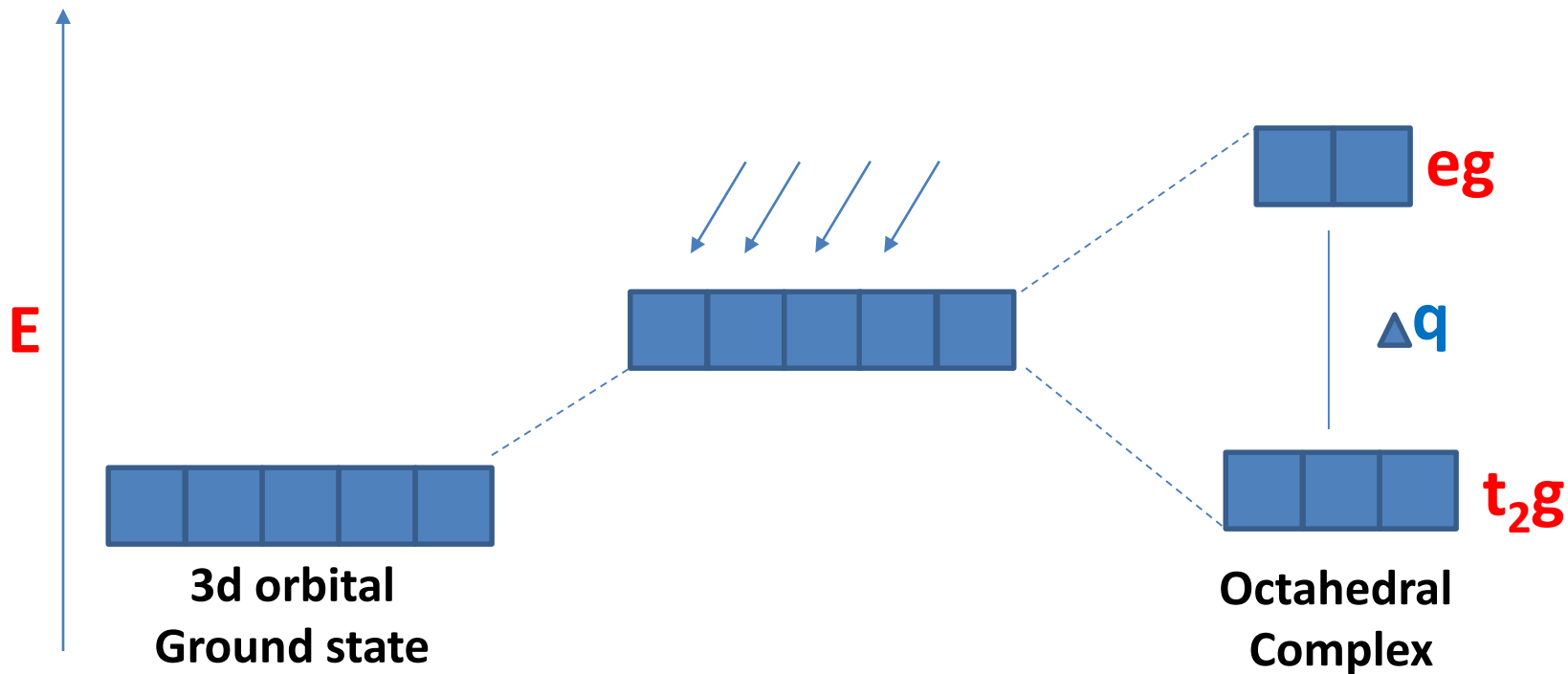
The highest oxidation state for Mn equals its group number.



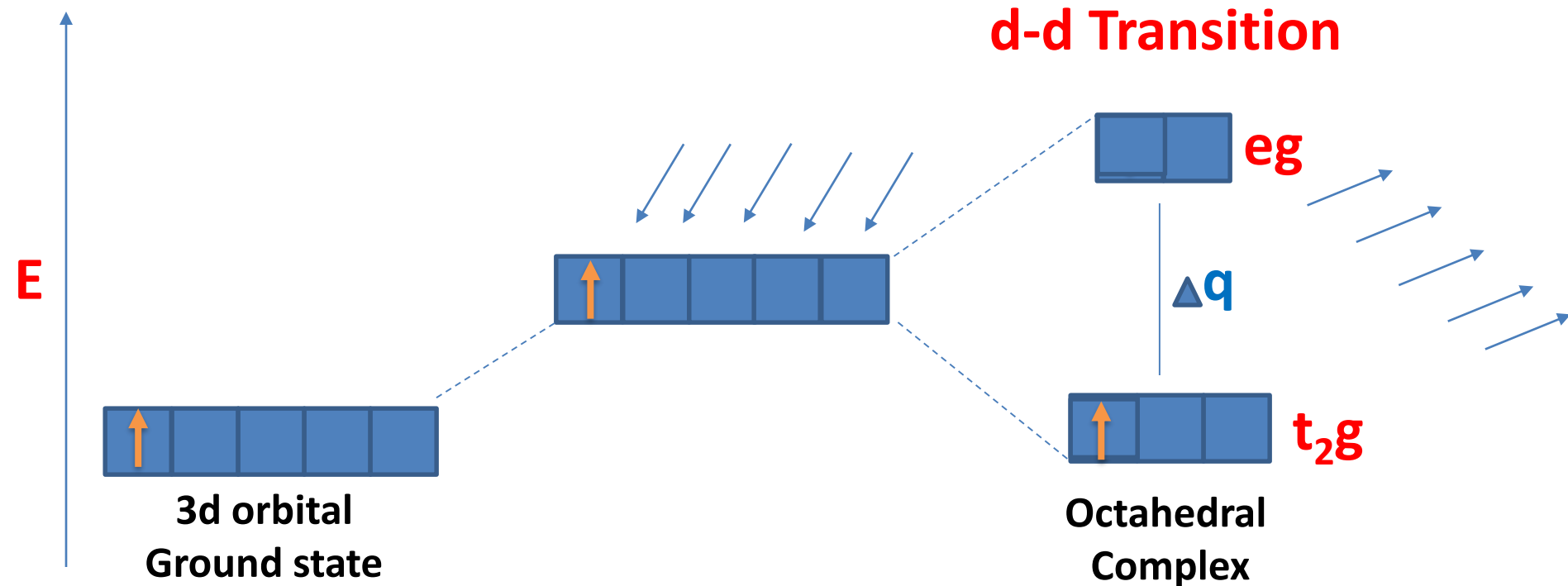
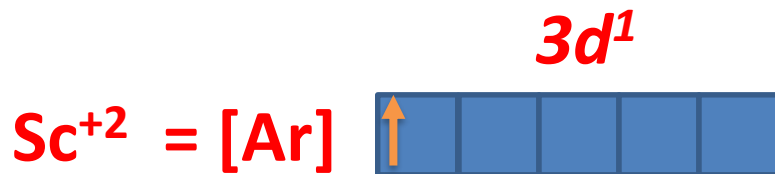
Transition metal ions are often highly colored.



Colored Ions



Colored Ions

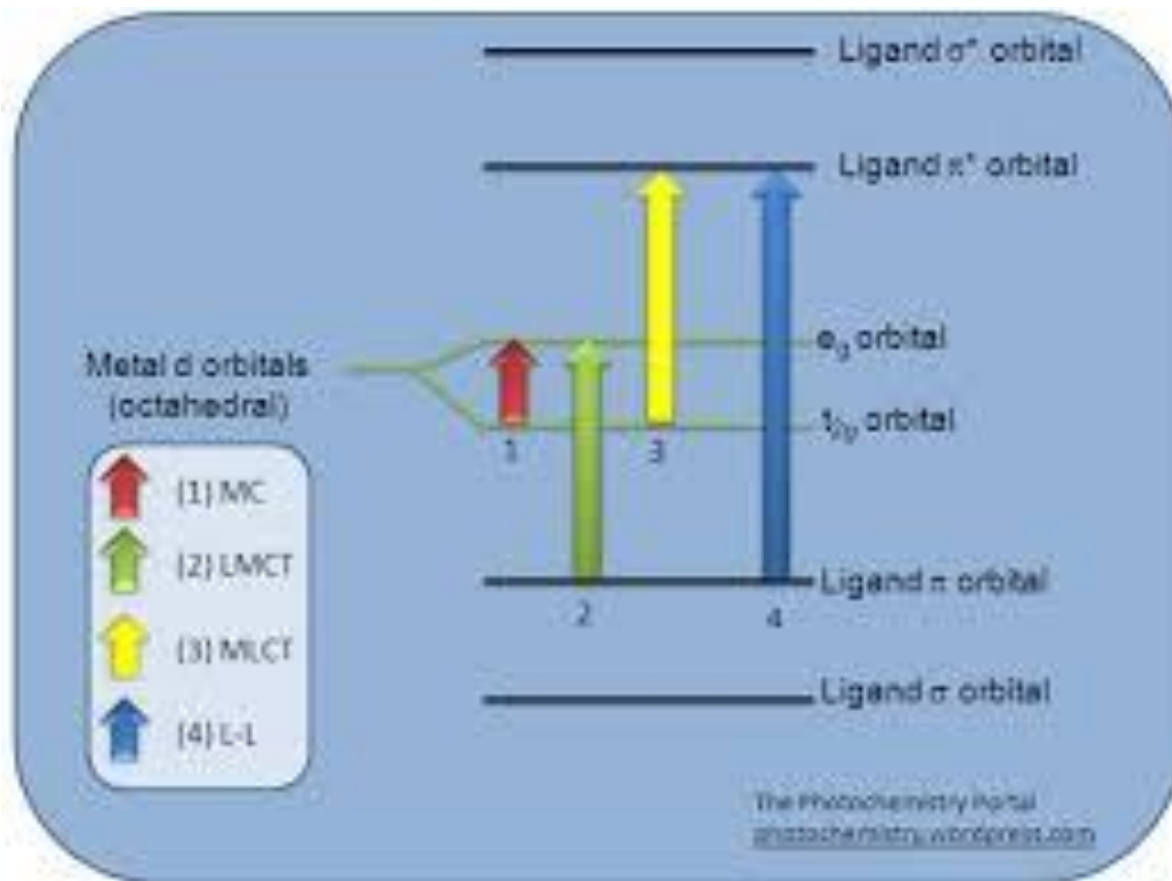


Colored Ions

Ion	Outer E. C.	Nos of unpaired e	Colour
Sc [III]	$3d^0$	0	Colourless
Ti [III]	$3d^1$	1	Purple
V [III]	$3d^2$	2	Green
Cr [III]	$3d^3$	3	Violet
Mn [III]	$3d^4$	4	Violet
Fe [II]	$3d^5$	5	Yellow
Cu [I]	$3d^{10}$	0	Colourless
Zn [II]	$3d^{10}$	0	Colourless

Colored Ions

Charge Transfer Transition



1. ELECTRONIC CONFIGURATION OF Cr IS

A. [Ar] $3d^4 4s^2$

B. [Ar] $3d^5 4s^1$

C. [Ar] $3d^6 4s^0$

D. [Ar] $3d^5 4s^2$

2. Colour of ion is due to

A. d-d Transition

B. Charge transfer transition

C. Both A & B

D. Ligand Transfer Spectra



3. Compounds of _____ ions are colourless

A. Cu [I]

B. Ni [II]

C. Cu [II]

D. Fe [II]

4. Compounds of ions are colour

A. Zn [II]

B. Sc [III]

C. Cu [I]

D. Cr [III]



Magnetic Character

- PARAMAGNETIC SUBSTANCES:
- DIAMAGNETIC SUBSTANCES:
- FERROMAGNETIC SUBSTANCES: [Fe, Co, Ni]



Thank You...