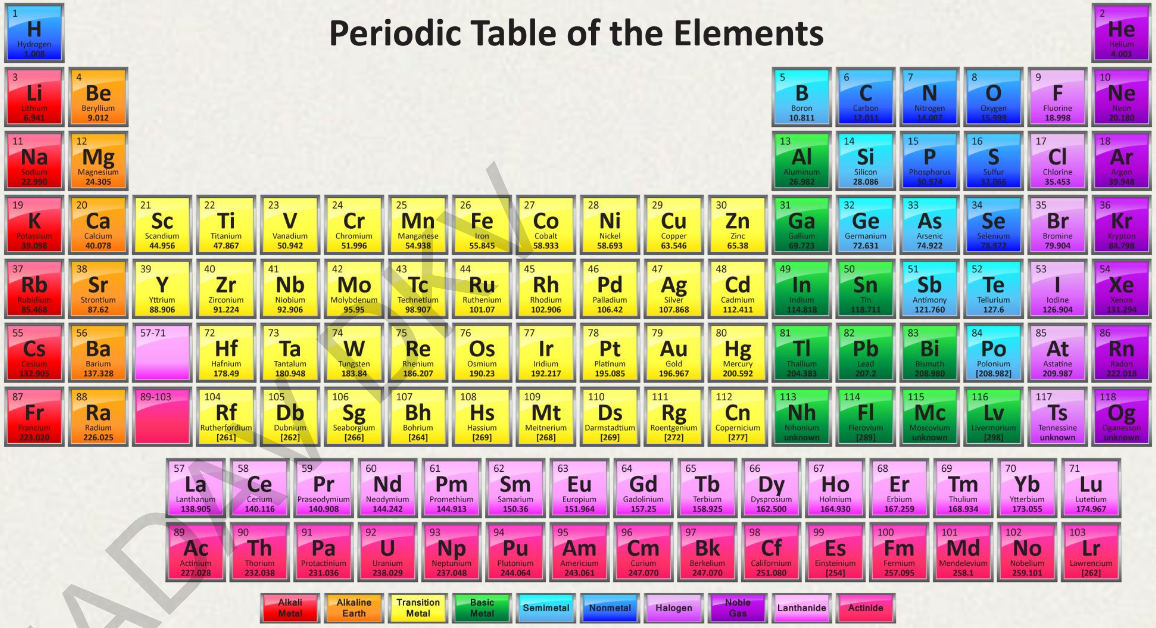

Periodic Table

Periodic Table of the Elements

1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 84.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294
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Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide

PRINCIPLE

Aufbau

1

an electron occupies orbitals in order from lowest energy to highest

Pauli

2

in a single atom, no two electrons will have an identical set or the same quantum numbers
= opposite spin

Hund

3

Every orbital in a sublevel is singly occupied before any orbital is doubly occupied.
All of the electrons in singly occupied orbitals have the same spin (to maximize total spin).

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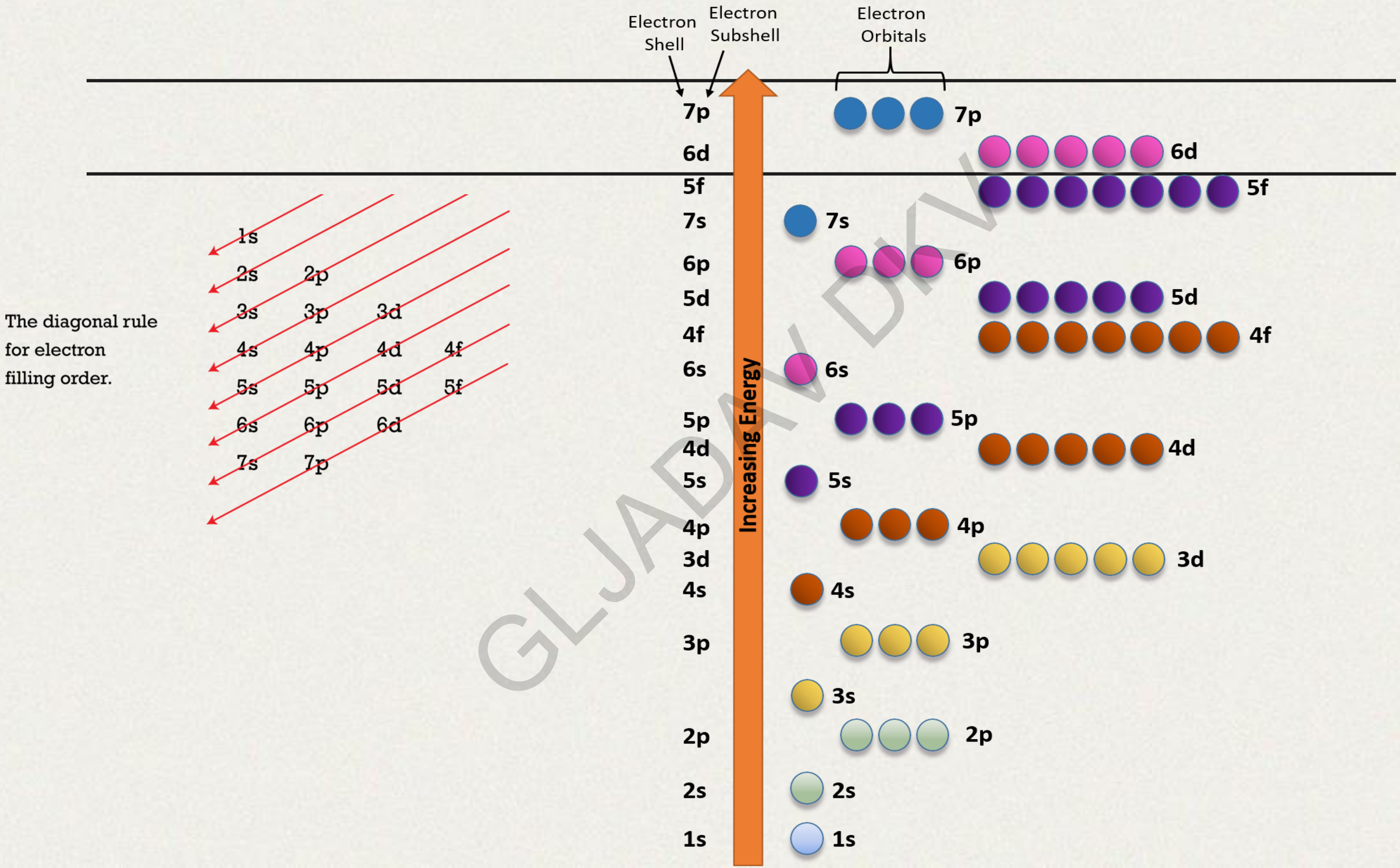
Electron Shell
Electron Subshell
Electron Orbitals
7p
6d
5f
7s
6p
5d
4f
6s
5p
4d
5s
4p
3d
4s
3p
3s
2p
2s
1s
Increasing Energy
The diagonal rule for electron filling order.
1s
2s 2p
3s 3p 3d
4s 4p 4d 4f
5s 5p 5d 5f
6s 6p 6d
7s 7p
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Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide

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99

Es

Elements of First Transition Series

d - block elements

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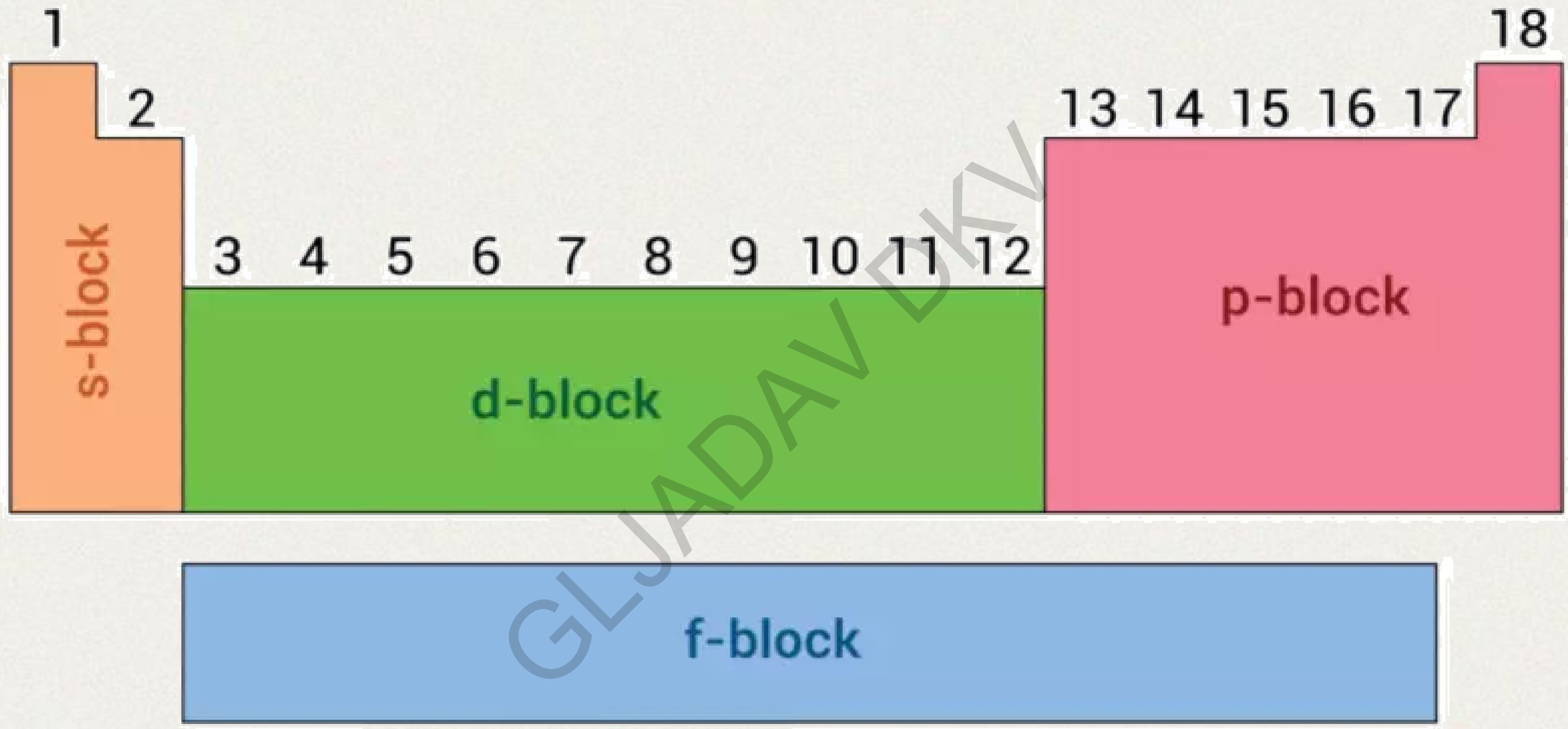

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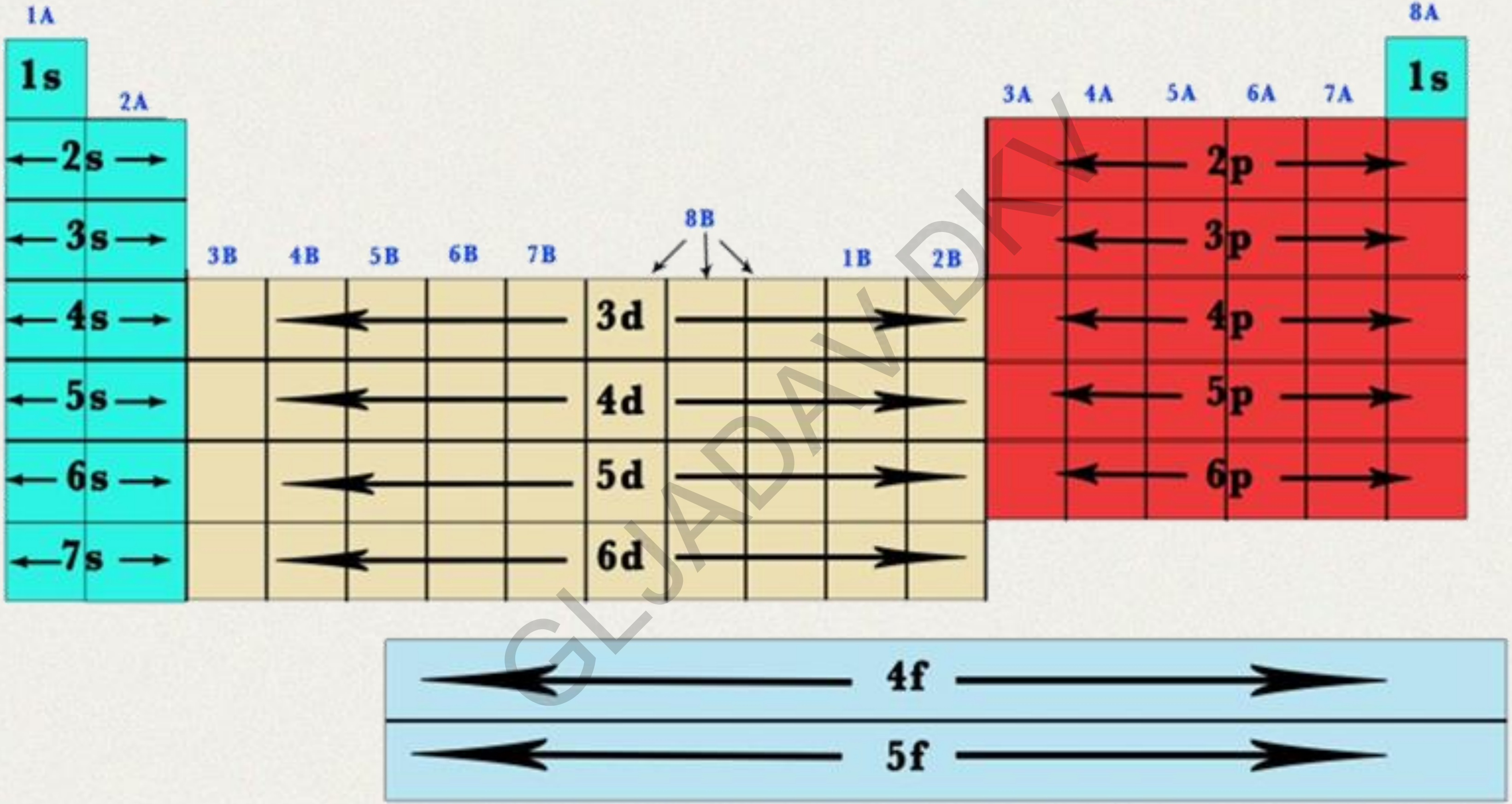
https://www.careers360.com/spdf-full-form



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https://madoverchemistry.com/2017/03/14/41-the-periodic-table-spdf-blocks/

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The elements lying between s-block and p-block elements of the periodic table and their properties represent a change from the electropositive s-block element to electronegative p-block elements. Such elements are often called "Transition Elements".

Syllabus

- Introduction, definition, electronic configuration, reversal of energies of 3d and 4s orbitals,
- Physical properties such as atomic properties (atomic radii, Ionic radii, and ionization potential), metallic conductivity, reducing properties, tendency of formation of alloys, catalytic properties and magnetic properties.
- Calculation of spin only magnetic momentum of inner orbital and outer orbital complexes $[NiCl_4]^{-2}$, $[Ni(CN)_4]^{-2}$, $[FeF_6]^{-4}$, $[Fe(CN)_6]^{-4}$

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01.

01.

Electronic configuration

$(n-1)d^{1-10}\ ns^{1-2}$ or (0,1,2)

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Element	Z	Electron configuration	Noble gas configuration	Electron in box diagram					
Scandium	21	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$	$[Ar]\ 4s^2 3d^1$	↑↓	↑				
Titanium	22	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$	$[Ar]\ 4s^2 3d^2$	↑↓	↑	↑			
Vanadium	23	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$	$[Ar]\ 4s^2 3d^3$	↑↓	↑	↑	↑		
Chromium	24	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$	$[Ar]\ 4s^1 3d^5$	↑	↑	↑	↑	↑	↑
Manganese	25	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$	$[Ar]\ 4s^2 3d^5$	↑↓	↑	↑	↑	↑	↑
Iron	26	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$	$[Ar]\ 4s^2 3d^6$	↑↓	↑↓	↑	↑	↑	↑
Cobalt	27	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$	$[Ar]\ 4s^2 3d^7$	↑↓	↑↓	↑↓	↑	↑	↑
Nickel	28	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$	$[Ar]\ 4s^2 3d^8$	↑↓	↑↓	↑↓	↑↓	↑	↑
Copper	29	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$	$[Ar]\ 4s^1 3d^{10}$	↑	↑↓	↑↓	↑↓	↑↓	↑↓
Zinc	30	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$	$[Ar]\ 4s^2 3d^{10}$	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓

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The transition elements are those elements which have incompletely (Partly) filled d-sub-shells in their ground state or in any one of their oxidation states"

$(n-1)d^{1-10}\ ns^{1-2 \text{ or } (0,1,2)}$

Element Name and Symbol	Atomic Number	Common Oxidation States	Electron Configuration	
Scandium (Sc)	21	+3	Sc: [Ar] $4s^2 3d^1$	Sc: [Ar] ↑↓ (4s) ↑ _ _ _ _ (3d)
Titanium (Ti)	22	+4	Ti: [Ar] $4s^2 3d^2$	Ti: [Ar] ↑↓ (4s) ↑ ↑ _ _ _ (3d)
Vanadium (V)	23	+2, +3, +4, +5	V: [Ar] $4s^2 3d^3$	V: [Ar] ↑↓ (4s) ↑ ↑ ↑ _ _ (3d)
Chromium (Cr)	24	+2, +3, +6	Cr: [Ar] $4s^1 3d^5$	Cr: [Ar] ↑ (4s) ↑ ↑ ↑ ↑ ↑ (3d)
Manganese (Mn)	25	+2, +3, +4, +6, +7	Mn: [Ar] $4s^2 3d^5$	Mn: [Ar] ↑↓ (4s) ↑ ↑ ↑ ↑ ↑ (3d)
Iron (Fe)	26	+2, +3	Fe: [Ar] $4s^2 3d^6$	Fe: [Ar] ↑↓ (4s) ↑↓ ↑ ↑ ↑ ↑ (3d)
Cobalt (Co)	27	+2, +3	Co: [Ar] $4s^2 3d^7$	Co: [Ar] ↑↓ (4s) ↑↓ ↑↓ ↑ ↑ ↑ (3d)
Nickel (Ni)	28	+2	Ni: [Ar] $4s^2 3d^8$	Ni: [Ar] ↑↓ (4s) ↑↓ ↑↓ ↑↓ ↑ ↑ (3d)
Copper (Cu)	29	+1, +2	Cu: [Ar] $4s^1 3d^{10}$	Cu: [Ar] ↑ (4s) ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ (3d)
Zinc (Zn)	30	+2	Zn: [Ar] $4s^2 3d^{10}$	Zn: [Ar] ↑↓ (4s) ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ (3d)

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02.

02.

REVERSAL OF ENERGIES

OF 3d AND 4s ORBITALS

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Electronic energies orbitals

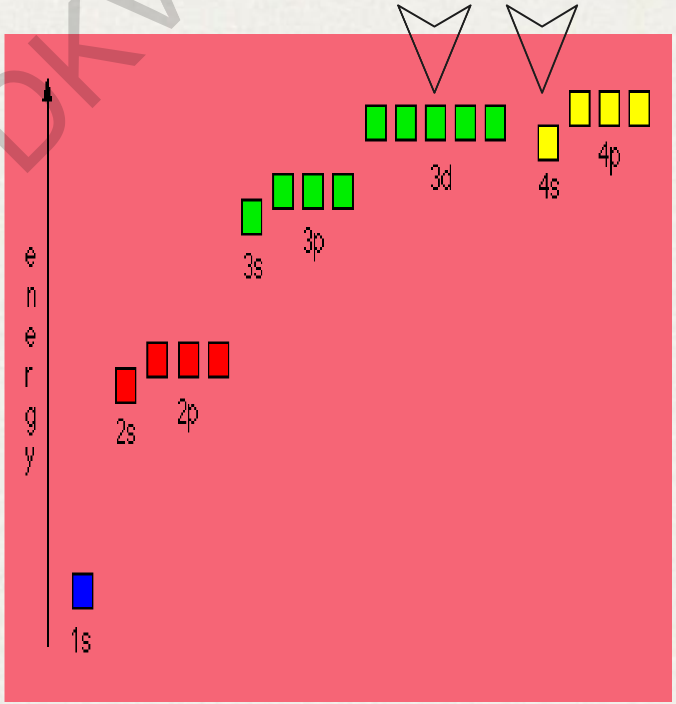
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

19
K
[Ar] $4s^1$

20
Ca
[Ar] $4s^2$

1
H

18
Ar



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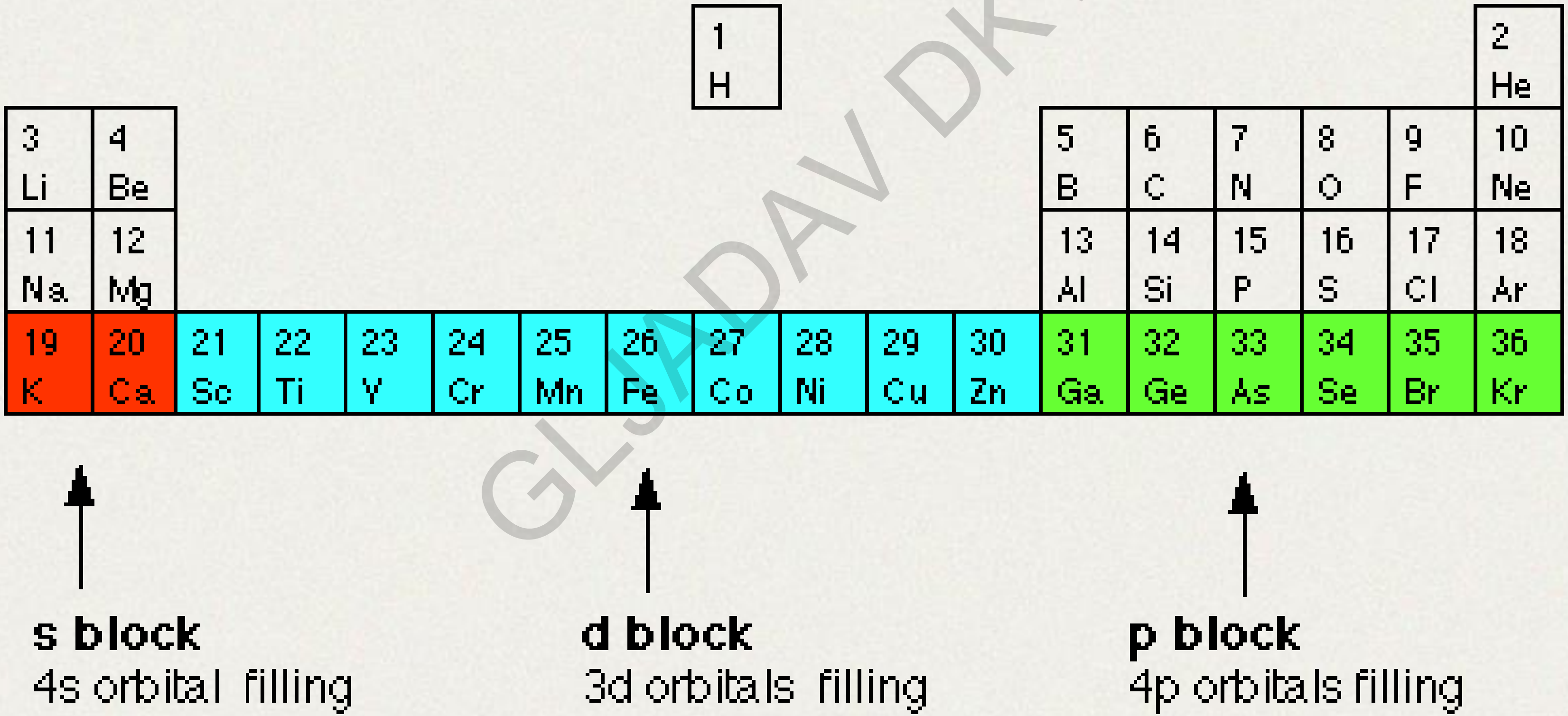
d-Block



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Elements	Symbol	At. No.	Expected Electronic Configuration	Observed Electronic Configuration
Scandium	Sc	21	[Ar] $3d^1\ 4s^2$	[Ar] $3d^1\ 4s^2$
Titanium	Ti	22	[Ar] $3d^2\ 4s^2$	[Ar] $3d^2\ 4s^2$
Vanadium	V	23	[Ar] $3d^3\ 4s^2$	[Ar] $3d^3\ 4s^2$
Chromium	Cr	24	[Ar] $3d^4\ 4s^2$	[Ar] $3d^5\ 4s^1$
Manganese	Mn	25	[Ar] $3d^5\ 4s^2$	[Ar] $3d^5\ 4s^2$
Iron	Fe	26	[Ar] $3d^6\ 4s^2$	[Ar] $3d^6\ 4s^2$
Cobalt	Co	27	[Ar] $3d^7\ 4s^2$	[Ar] $3d^7\ 4s^2$
Nickel	Ni	28	[Ar] $3d^8\ 4s^2$	[Ar] $3d^8\ 4s^2$
Copper	Cu	29	[Ar] $3d^9\ 4s^2$	[Ar] $3d^{10}\ 4s^1$
Zinc	Zn	30	[Ar] $3d^{10}\ 4s^2$	[Ar] $3d^{10}\ 4s^2$

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Electronic Structure of Fe & Fe(III)

Fe: $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $3d^6$ $4s^2$
Fe^{3+}: $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $3d^5$

The 4s electrons are lost first followed by one of the 3d electrons.

1. We say that the 4s orbitals have a **lower** energy than the 3d, and so the 4s orbitals are filled **first**.

2. We know that the 4s electrons are lost first during ionization. The electrons lost first will come from the highest energy level, furthest from the influence of the nucleus. So the 4s orbital must have a higher energy than the 3d orbitals.

Outer 4s Electrons are shielded by inner 3d electrons

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#$#

The elements up to argon: There is no problem with these. The general pattern that we drew in the diagram above works well.

Potassium and calcium: The pattern is still working here. The 4s orbital has a lower energy than the 3d, and so fills next. That entirely fits with the chemistry of potassium and calcium.

The d-block elements: For reasons which are too complicated to go into at this level, once you get to scandium, the energy of the 3d orbitals becomes slightly less than that of the 4s, and that remains true across the rest of the transition series

So, when transition metal atoms form ions,
they loss electrons from ..
4s-orbital before the 3d-orbitals.

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why is not the electronic configuration of scandium [Ar] $3d^3$ rather than [Ar] $3d^1$ $4s^2$?

Making Sc^{3+}

Imagine you are building a scandium atom from boxes of protons, neutrons and electrons. You have built the nucleus from 21 protons and 24 neutrons, and are now adding electrons around the outside. So far you have added 18 electrons to fill all the levels up as far as 3p. Essentially you have made the ion Sc^{3+}.

Making Sc^{2+}

Now you are going to add the next electron to make Sc2+. Where will the electron go? The 3d orbitals at scandium have a lower energy than the 4s, and so the next electron will go into a 3d orbital. The structure is [Ar] $3d^1$.

Making Sc^{+}

You might expect the next electron to go into a lower energy 3d orbital as well, to give [Ar] $3d^2$. But it doesn't. The energetically most stable structure for Sc+ is therefore [Ar] $3d^1 4s^1$.

Making Sc:

Putting the final electron in, to make a neutral scandium atom, needs the same sort of discussion. In this case, the lowest energy solution is the one where the last electron also goes into the 4s level, to give the familiar [Ar] $3d^1 4s^2$ structure.

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Electronic Configuration anamalous

Chromium

24
Cr

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^2$

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

Copper

29
Cu

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9\ 4s^2$

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$

A half - filled or full d - sub shell offers more stability than a full s - sub shell.

Because that is the structure in which the balance of repulsions and the size of the energy gap between the 3d and 4s orbitals happens to produce the lowest energy for the system.

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Properties of Transition elements

01.

01.

Strength

High Tensile Strength

Hard and Ductile

02.

02.

Good Conductor

Of Electricity

03.

03.

MP / BP

Strong property

04.

04.

Alloys

Forms alloy with other metal

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Physical Properties

- Atomic Properties
- Metallic Properties
- Reducing Properties
- Catalytic Properties
- Magnetic Properties

104	21	22	29	30	85	90
Rf	Sc	Ti	Cu	Zn	At	Th

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Atomic Properties

The properties related to the atomic structure are known as atomic properties.

- Atomic Radii
- Ionic Radii
- Ionization Potential or Ionization energy

4 **Be**

72 **Hl**

85 **At**

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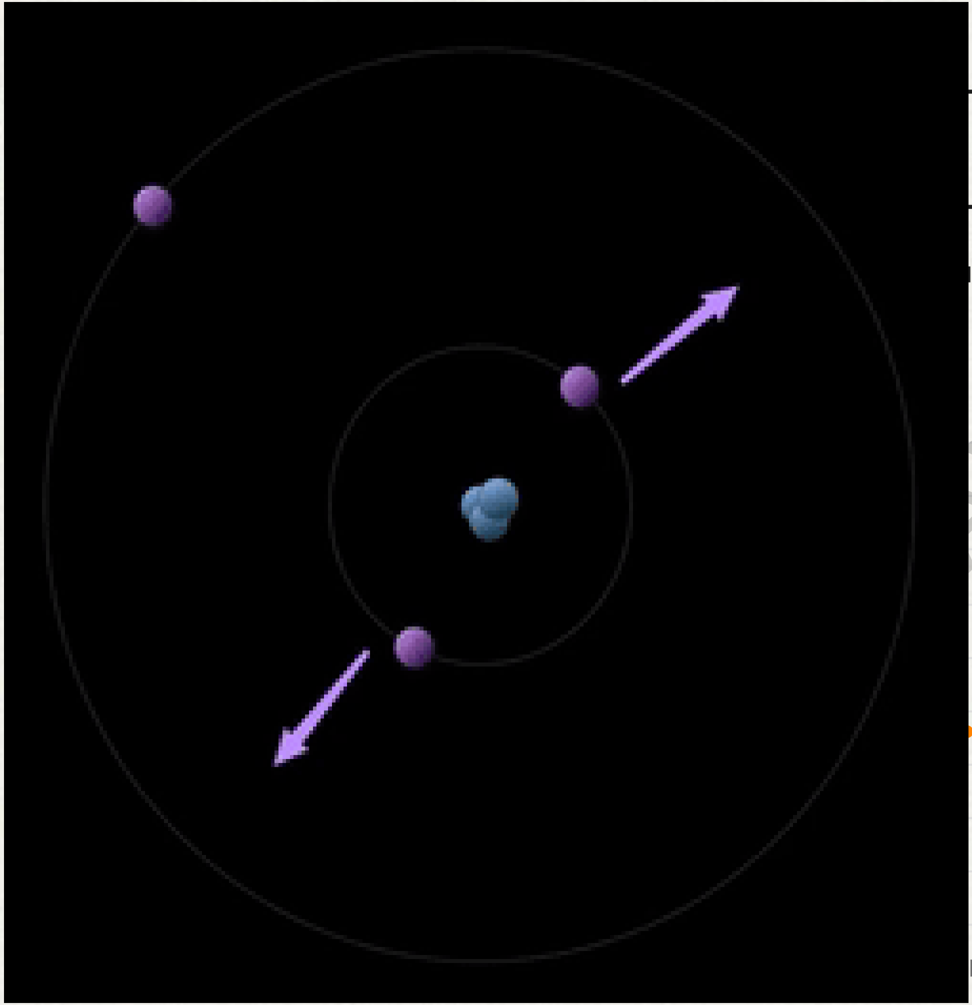


cture are

138

n

Atomic Radii

AV DKV

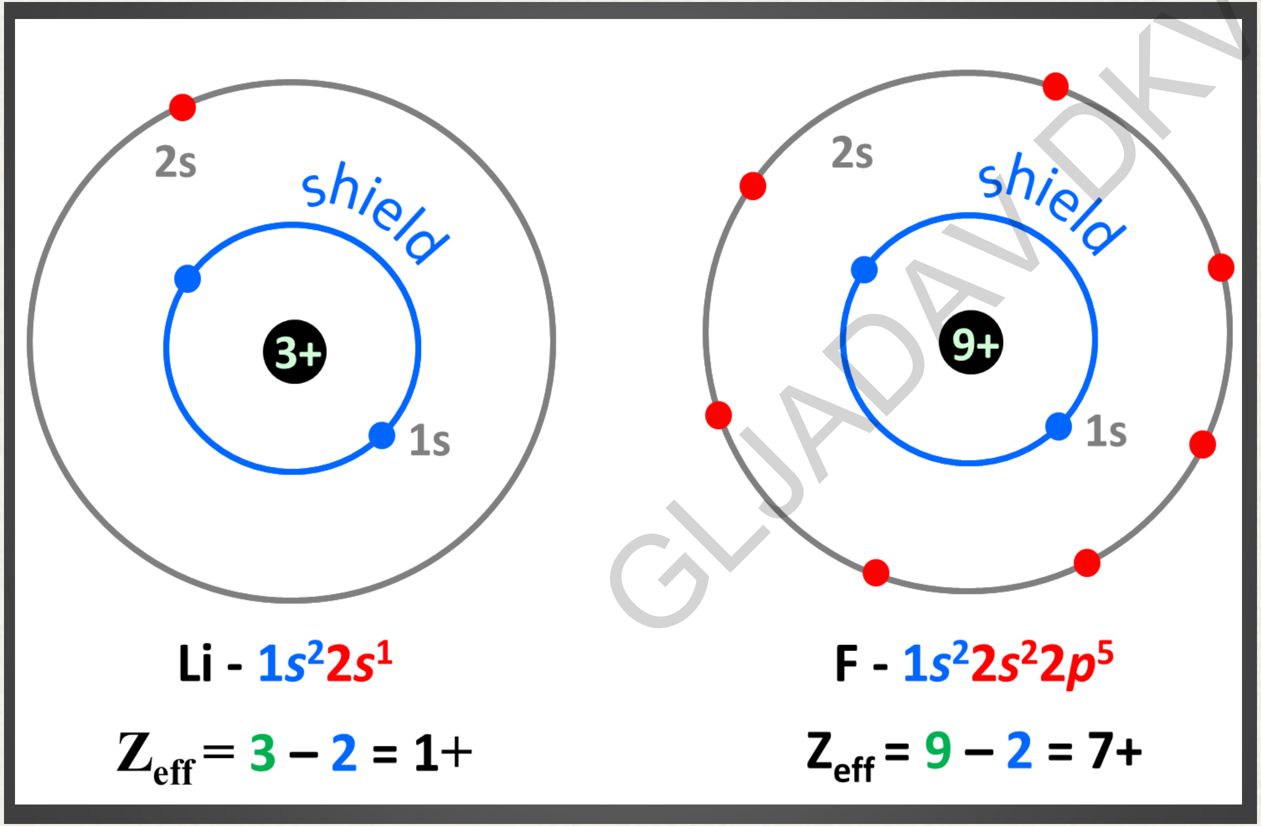
Sc to Mn

decrease is due to the gradual increase in nuclear charge with consequent contraction in size.

Screening

the electrons added to 3d-orbital screen the 4s-orbital electrons, the attraction between the nucleus and the 4s electrons decreases due to screening effect.

Atomic Properties



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Because of screening effect, the actual nuclear charge is decreased by the quantity σ, the Screening constant

Slater rule

$Z_{eff} = Z - \sigma$

Number of intervening electrons

Size of the atom

Slater rule

σ = 0.35 (e in nth shell) + 0.85(e in n-1 shell)+ 1.0 (e in next inner shell)

K (Z = 19) = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6 4s^1$

σ = 0.35 (0) + 0.85(8)+ 1.0 (10)
=16.80

$Z_{eff} = Z - \sigma$

Z_{eff} = 19 - 16.80
=2.20

Z_{eff} for 4s1 electron is 2.20

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Let us now calculate σ for $3d^1$ electron in K(19)

σ = 0.35(remaining electrons from (n-1)d orbitals) +
1.0 (electron present in (n-1)s & (n-1)p and inner shell)

σ =0.35 x 0+ 1 x18 =18.0

Z_{eff} =19-18 =1.0

Thus [Ar] $3d^0$ $4s^1$ electronic configuration would be more stable and hence the 4s orbital is filled earlier than the 3d orbital

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Removal of electron from 4s orbital

Mn (Z= 25)
[Ar]$3d^5\ 4s^2$
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$

σ for $4s^1$ = 0.35(no. of e remaining in 4s)
+ 0.85 (no. of e in n-1 shell)
+ 1.0 (no of e in inner shells)

σ for $4s^1$ = 0.35(1) + 0.85 (13)+ 1.0 (10) = 21.40

Z_{eff}= 25 – 21.40
=3.60

σ for $3d^1$ = 0.35(e remaining in n-1 d shell) + 1.0 (no of in inner shells)

= 0.35 x 4 + 1.0 x 18
=19.40

Z_{eff}= 25 – 19.40
=5.60

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Ionic Radii of cations of 3d

	Elements	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn
	Ionic Radii (pm)	+2=81 +3=88.5	+2=91 +3=76 +4=74.5	+2=88 +3=74 +4=72 +5=68	+2=84 +3=69 +4=68 +5=63 +6=58	+2=80 +3=66 +7=60	+2=76 +3=64	+2=76 +3=63	+2=72	+1=91 +2=61	+2=74

- ionic radii for various oxidation states are also different
- ionic radii of the same element in different oxidation state decreases with increase in oxidation number e.g. Cr

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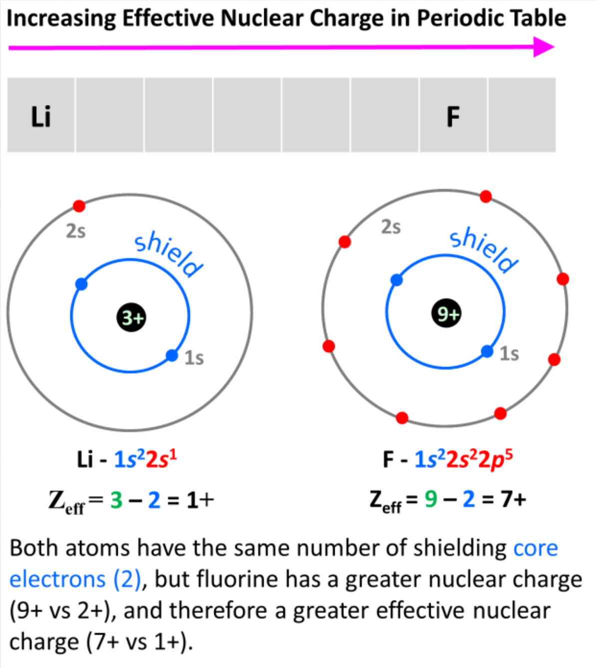
Atomic Properties

Ionization Potential or Ionization energy increase with increasing atomic number



Increased nuclear charge pull the electron cloud toward to nucleus more energy is needed to remove electron

The ionic potential of the d-block element of a first transition series is intermediate between S and P blocks elements. It means that these have been less electropositive than the S-block elements

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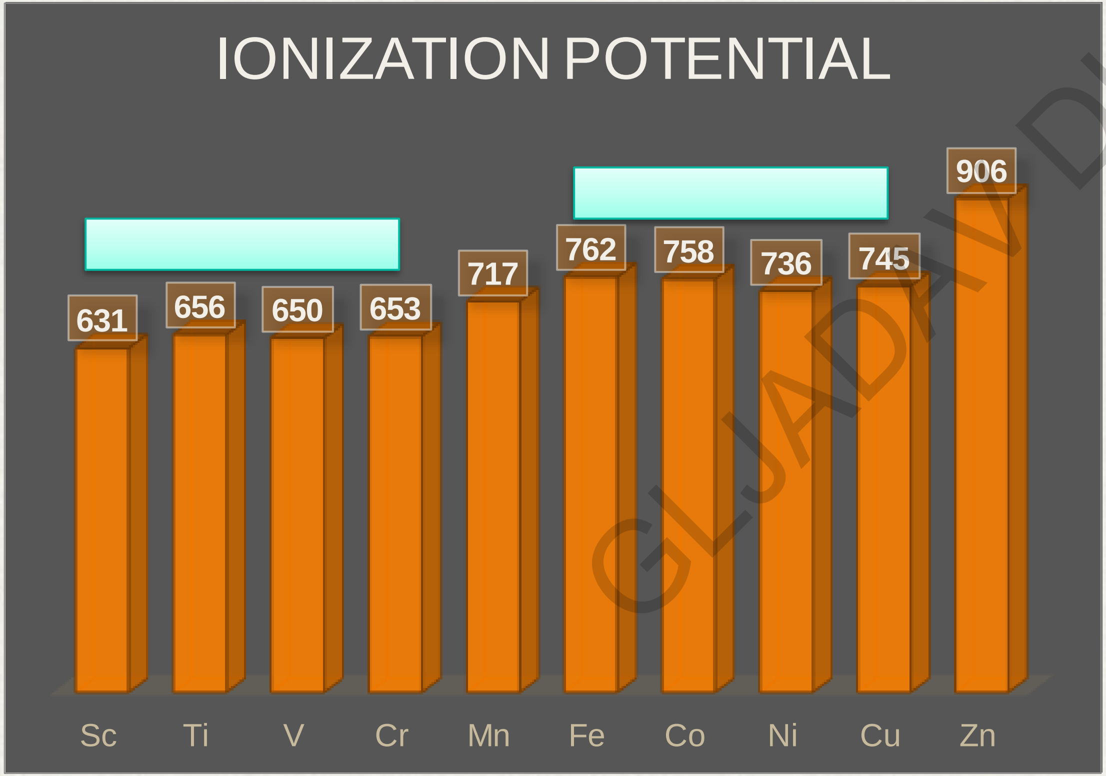
Atomic Properties



Ionization Potential or Ionization energy

Very close to each other Because of Screening effect produced by addition of e- in d orbital

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Metallic Conductivity

good conductors of electricity and heat
presence of free mobile electrons (vacant orbitals) in metallic bonding

Conductivity of oxides

- TiO, VO, CrO_2 etc.. possess conductivity like metal
- TiO_2, V_2O_3 etc.. are semi conductor
- V_2O_5, Cr_2O_3, Fe_2O_3 etc.. are insulator

84 Po

40 Zr

72 Hl

100 Fm

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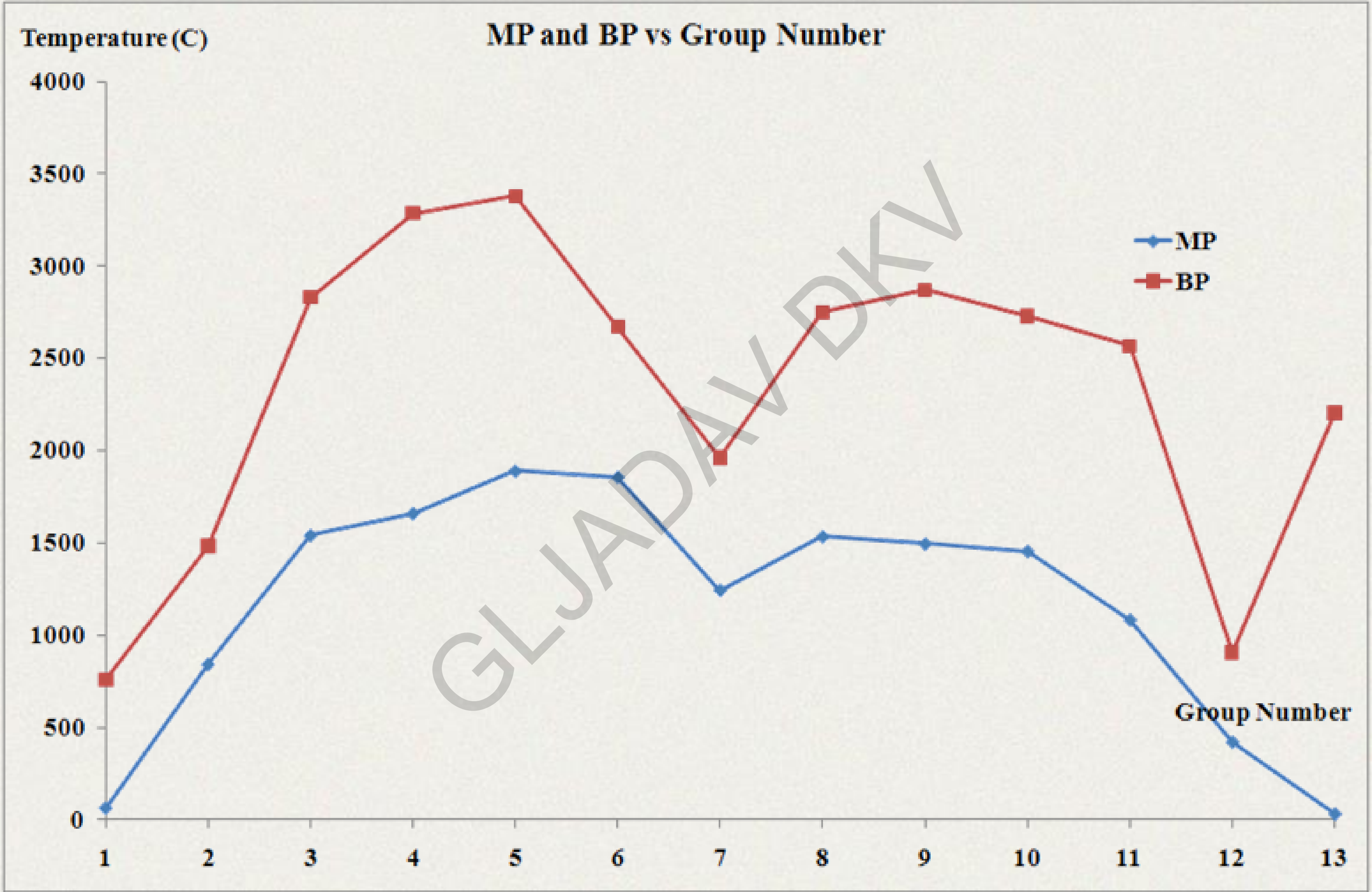

MP and BP vs Group Number
Temperature (C)
4000
3500
3000
2500
2000
1500
1000
500
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Group Number
MP
BP
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29

Cu

Reducing Properties

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Reducing Property

-ve std potential

d-block elements
Std Hydrogen
electrode (Zero)

Easy oxidation

$M \rightarrow M^{+2}_{(aq)} + 2e^-$

Reductant

Not good reducing agents as group 1,2 & 13

Reducing property

Depend on formation of aquatic ions

No reductant

High heat of vaporization
High ionization energies
Low heat of hydration

Exemption

Cu
Positive electrode potential and negative E^0 (oxidation)

$$Cu + 2H^+_{(aq)} \longrightarrow Cu^{2+}_{(aq)} + H_2$$

$$Cu \longrightarrow Cu^{2+}_{(aq)} + 2H^+_{(aq)}$$

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24

Cr

Tendency of formation of alloys

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Tendency of formation of alloys

1. Homogeneous mixture of one or more metals
2. Atomic volume of 15% or more can form alloy.
3. Transition metals are almost of same size, replacement of atoms give alloy.
4. Hard, High MP, corrosion resistant
5. Cr-Ni,Cr-Ni-Fe, Cr-V-Fe, Mn-Fe etc
6. Transition - Non Transition alloy
   a. Brass (Cu-Zn)
   b. Bronze (Cu-Ti)
   c. Pure Gold with Cu/Cd
7. Steel with Fe along with Cr, Mn, W etc

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Catalytic Properties

91
Pa

90
Th

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56	84	40	3	100
Ba	Po	Zr	Li	Fm

A number of transition elements and their compounds are used as a catalyst in various chemical reaction.
Lower Activation energy intermediate are produced

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CATALYIC ACTIVITY

Transition metals and their compounds are well **known for their catalytic activities**.

Nickel is used as catalyst *for the hydrogenation of unsaturated compounds*

Iron-Molybdenum is *used as a catalyst in the synthesis of ammonia by Haber's process.*

Platinum is used in the contact process *for the combination of SO_2 with O_2 to generate SO_3*

Vanadium petaoxide is *used for the oxidation of SO_2 with O_2 to prepare SO_3*

Manganese dioxide is *used to catalyze the decomposition of H_2O_2.*

The catalytic activity of the transition elements **is due to the availability of d-orbitals**. The d-orbitals which are exposed to the surface, **participate in the formation of activated complex which serves as a reactive intermediate in the overall reactions**. These reactive intermediates **provide low energy reaction pathways and accelerates the rate of the reaction**

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Some Examples

1. Ziegler-Natta ($TiCl_4$) catalyst for manufacturing of Polythene
2. Fenten's reagent ($FeSO_4$ + H_2O_2) for oxidation of alcohol to aldehydes.
3. MnO_2 for oxygen preparation in Laboratory.
4. $CuCl_2$ in the manufacturing of chloride.
5. Pt-Black in preparation of HCHO

6. REACTANTS + CATALYST → Unstable intermediate compound
   →Decomposition gives products + Catalyst

The transition metals and their compound provide a large surface are on which the reactants may be absorbed and there for come closer for the reaction. This can be explained by adsorption theory.

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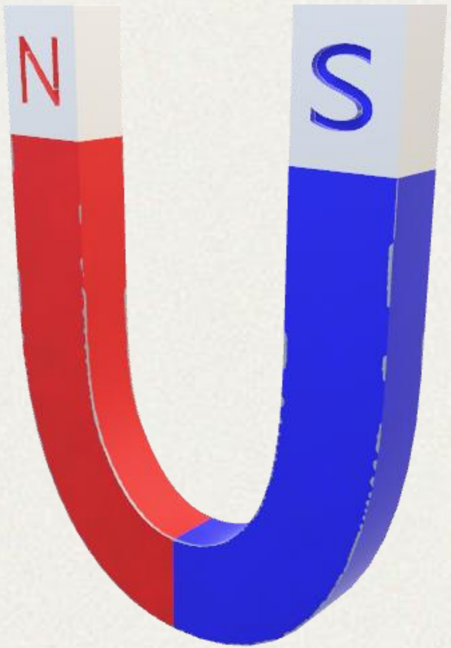
Magnetic Properties



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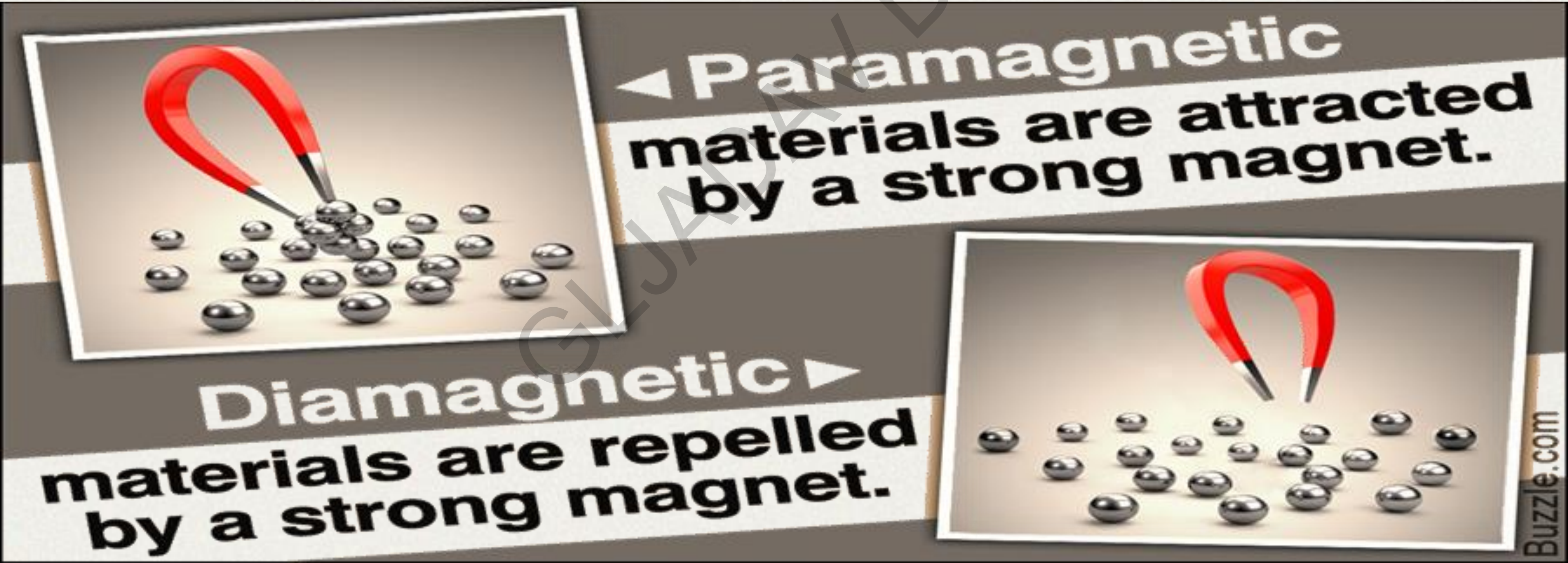
Magnetic Properties

Measurement of number of unpaired electrons

External Magnetic Field

Most of the compounds of transition metals **are paramagnetic in nature.**



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Origin of Paramagnetism

Spin motion or spinning of the electron on its axis produces spin magnetic moment

Total moment produced by an electron
Unpaired e- increases the magnetic moment

Orbital motion or the movement of the electron round the nucleus produces orbital magnetic moment

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Paramagnetic Substance

The resultant or total moment in them is sufficiently high to overcome the magnetic moment induced by an approaching magnetic field.

Hence, such substances instead of experiencing repulsion, are attracted in a magnetic field and are called paramagnetic substances

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Bohr Magneton

- Magnetic Moment increase with increase of the unpaired electrons in 3d-series
- Magnetic Moment μ and number of unpaired n electrons are related
  - $\mu = \sqrt{n(n+2)}$ B.M.

- The calculated magnetic moments corresponding to 1, 2, 3, 4 and 5 unpaired electrons will be
- $\sqrt{3} = 1.73$
- $\sqrt{8} = 2.83BM$
- $\sqrt{15} = 3.87BM$
- $\sqrt{24} = 4.90BM$
- $\sqrt{35} = 5.92BM$

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Ferromagnetic substances

Highly Magnetic properties
Iron Oxide, Iron Metal
1000 times more magnetic than metal

Ion	Configuration	Unpaired electron(s)	Magnetic moment	
			Calculated	Observed
Sc^{3+}	$3d^0$	0	0	0
Ti^{3+}	$3d^1$	1	1.73	1.75
Ti^{2+}	$3d^2$	2	2.84	2.76
V^{2+}	$3d^3$	3	3.87	3.86
Cr^{2+}	$3d^4$	4	4.90	4.80
Mn^{2+}	$3d^5$	5	5.92	5.96
Fe^{2+}	$3d^6$	4	4.90	5.3 – 5.5
Co^{2+}	$3d^7$	3	3.87	4.4 – 5.2
Ni^{2+}	$3d^8$	2	2.84	2.9 – 3, 4
Cu^{2+}	$3d^9$	1	1.73	1.8 – 2.2
Zn^{2+}	$3d^{10}$	0	0	

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56 Ba | 84 Po | 4 Be | 72 Hl

Spin Only Magnetic Moment

104 Rf | 88 Ra | 85 At | 90 Th

Spin only Magnetic Moment

Inner orbital Complexes

- Strong Field or low spin ligand
- Hybridization (dsp2, d2sp3)
- Square Planner ,Octahedral
- Ligand CN^-

Outer Orbital complexes

- Weak Field or high spin ligand
- Hybridization (sp3, sp3d2)
- Tetrahedral , octahedral
- Ligand Cl^-, F^-

6 C

26 Fe

28 Ni

8 Cl

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Spin Only Magnetic Moment of Complexes

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Inner Orbital Complexes

$[Ni(CN)_4]^{-2}$

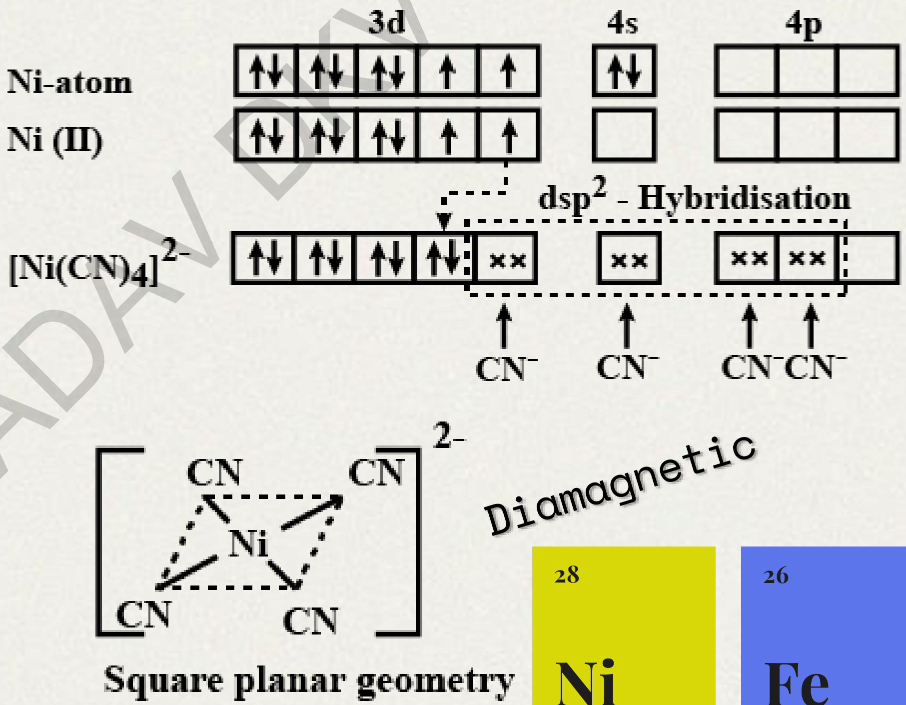
$[Fe(CN)_6]^{-4}$

Outer Orbital Complexes

$[FeF_6]^{-4}$

$[NiCl_4]^{-2}$

Inner Orbital Complexes

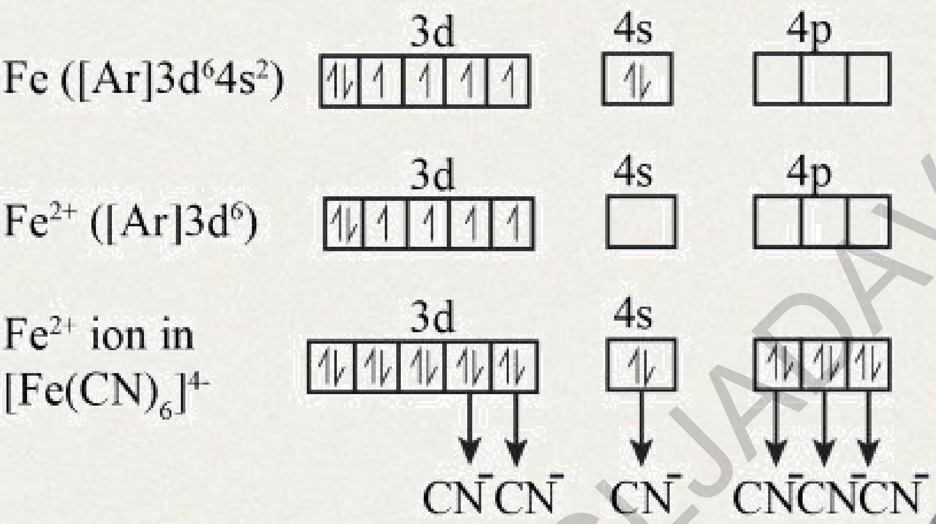


Diamagnetic

28
Ni

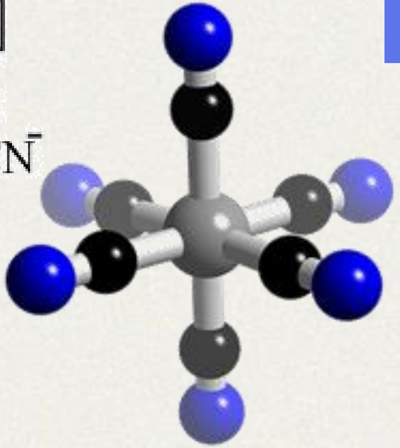
26
Fe

Inner Orbital Complexes



d^2sp^3

Octahedral
Diamagnetic



28
Ni

26
Fe

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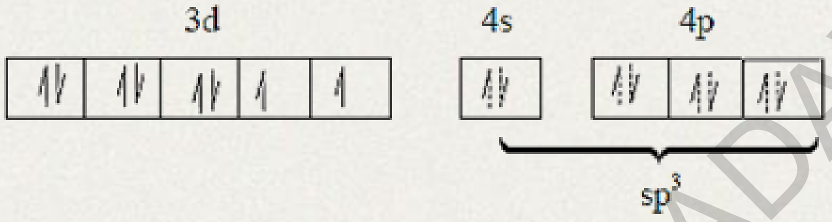
Outer Orbital Complexes

$[NiCl_4]^{-2}$, O.S. of Ni = +2
Ni(28) = $3d^8\ 4s^2$
$Ni^{+2} = 3d^8$

Cl^- being weak ligand



No. of unpaired electrons = 2
Magnetic moment $\mu = 2.82$ BM.

Para magnetic

91 Pa | 88 Ra | 22 Ti | 4 Be | 72 Hl | 85 At | 90 Th

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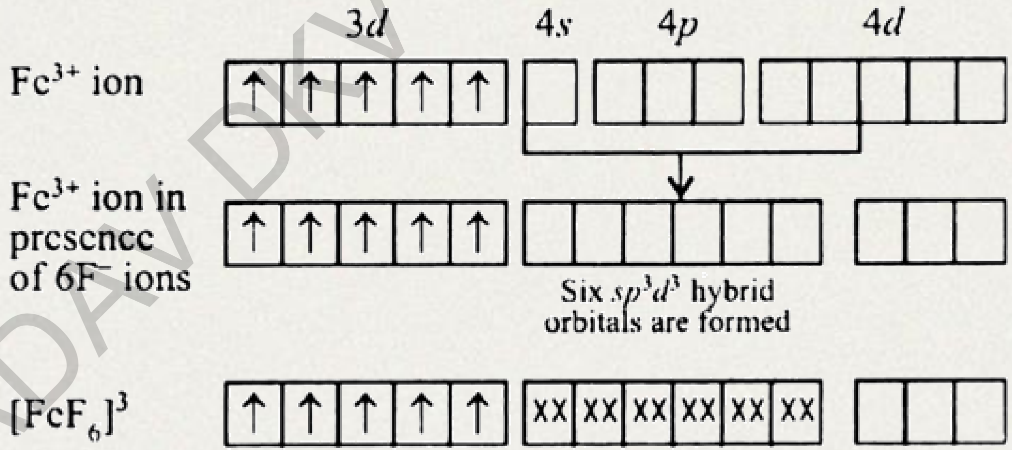
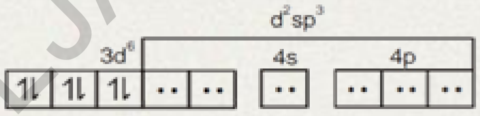
Outer Orbital Complexes

$[FeF_6]^{-3}$

Paramagnetic
Octahedral
μ=4.90 BM





Octahedral, diamagnetic complex

F⁻ is weak field ligand so it forms high spin paramagnetic complex.

$[FeF_6]^{4-}$:

Octahedral, paramagnetic complex

USES of 3d-elements

	Element
Electronic Devices, High Intensity Lamps	Scandium
Aircraft Industries, catalyst, paper paint plastic cosmetics manufacture, alloy with Al	Titanium
As catalyst, alloy with Fe in cutting tools	Vanadium
Alloy in SS, Electroplated coating, Cr_2O_3 as pigment	Chromium

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USES of 3d-elements

	Element
KMnO4 oxidizing agent, disinfectant	Manganese
Steel manufacturing, inorganic drug, catalyst	Iron
Various salts as colouring agents in porcelain glass pottery tiles etc, alloy in cutting tools	Cobalt
food processes and pharmaceutical plants	Nickel

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USES of 3d-elements

	Element
Electrical conductor, coins, pipes, mixed oxides as superconductors, $CuSO_4+Cu(OH)_2$ in agriculture against fungal attack	Copper
Coating, alloy (brass), battery, ZnO in paints rubbber cosmetic etc, ZnS in Luminous dials, X-ray TV screen fluroscent lights	Zinc

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Thank You

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Ci	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Ti	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fi	115 Mc	116 Lv	117 Ts	118 Og
		57 La	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		
		89 Ac	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		

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